July 1979 $2.50

73 Magazine for Radio Amateurs

Antennas!

the praise is pouring in

*Shown with accessory touch tone pad

Top view

We have never enjoyed such an overwhelming response to a new product. Letters of praise for Tempo's S-1 are coming in daily. Words such as great, fabulous, and fantastic are common. In a few short months the S-1 has taken the Amateur world by storm. In addition to its unique features and its versatility, it has now proven itself to be an extremely rugged and dependable unit...qualities unmatched at any price, but unheard of at the S-1's low price.

This amazing pocket sized radio represents a major breakthrough in 2-meter communications. Other units that are larger, heavier and are similarly priced can offer only 6 channels. The S-1's price includes the battery pack, charger, and a telescoping antenna. But, far more important is its *proven* performance record as a fully synthesized 800 channel hand held transceiver.

The optional touch tone pad adds greatly to its convenience and the addition of a Tempo solid solid state amplifier adds tremendously to its power.

The Tempo line also features a fine line of extremely compact UHF and VHF pocket receivers. They're low priced, dependable, and available with CTCSS and 2-tone decoders. The Tempo FMT-2 & FMT-42 (UHF) provides excellent mobile communications and features a remote control head for hide-away mounting.

The Tempo FMH-42 (UHF) and the *NEW* FMH-12 and FMH-15 (VHF) micro hand held transceivers provide 6 channel capability, dependability plus many worthwhile features at a low price. FCC type accepted models also available.

Please call or write for complete information. Also available from Tempo dealers throughout the U.S. and abroad.

The proven TEMPO S-1 does it all... portable...mobile ...base station and gives you 800 channels in one of the smallest hand helds

SPECIFICATIONS

Frequency Coverage:	144 to 148 MHz
Channel Spacing:	Receive every 5 kHz, transmit Simplex or ±600 kHz
Power Requirements:	9.6 VDC
Current Drain:	17 ma-standby 500 ma-transmit
Batteries:	8 cell ni-cad pack included
Antenna Impedance:	50 ohms
Dimensions:	40 mm x 62 mm x 165 mm (1.6" x 2.5" x 6.5")
RF Output:	Better than 1.5 watts
Sensitivity:	Better than .5 microvolts

SUPPLIED ACCESSORIES

Telescoping whip antenna, ni-cad battery pack, charger

OPTIONAL ACCESSORIES

Touch tone pad: $55 • Tone burst generator: $29.95 • CTCSS sub-audible tone control: $29.95 • Rubber flex antenna: $8 • Leather holster: $16 • Cigarette lighter plug mobile charging unit: $6 • Matching 30 watt output 13.8 VDC power amplifier (S30): $89 • Matching 80 watt output power amplifier (S80): $169

Price... $349.00 With touch tone pad... $399.00

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Drive Power	Output	Model No.	Price
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30W	130W	130A30	$199
2W	80W	80A02	$169
10W	80W	80A10	$149
30W	80W	80A30	$159
2W	50W	50A02	$129
2W	30W	30A02	$ 89

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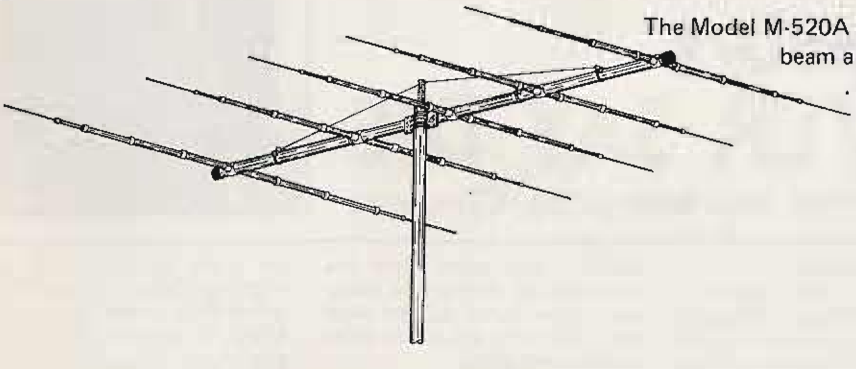
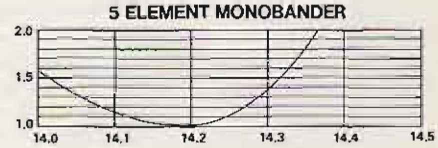
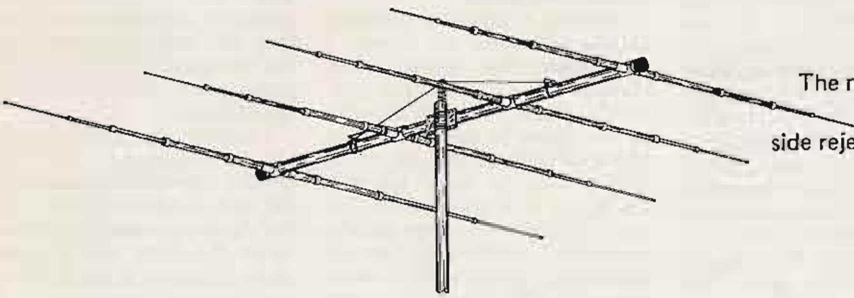
NEW, IMPROVED
Wilson's MONO-BANDERS



The Model M-520A offers the discriminating DXer an unexcelled beam antenna that really punches through the QRM . . . ask anyone who owns one! Features 5 full sized elements on a 2" O.D. x 34 ft. boom. Low SWR across the entire 20 meter band. The M-520A is shipped UPS in two cartons.

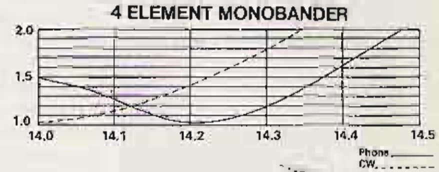
M-520A
5 ELEMENT MONOBANDER



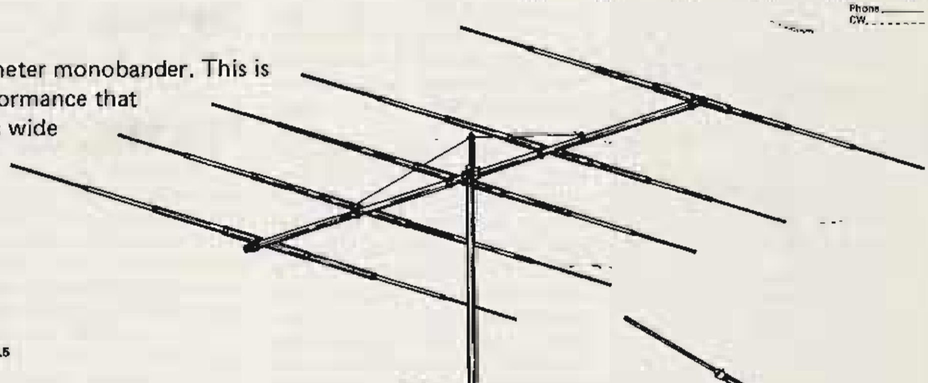


The magic 20 meter beam: M-420A . . . 4 elements on a 26 ft. boom. Super front-to-back and side rejection. The M-420A ships UPS in two cartons.

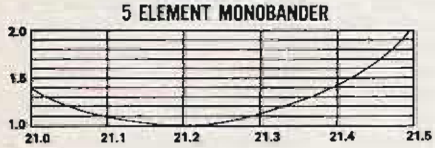
M-420A
4 ELEMENT MONOBANDER



The M-155A is the top of the line 15 meter monobander. This is the one for the serious DXer. Top performance that will make you heard on 15! 5 elements wide spaced on a 25' 7" boom.

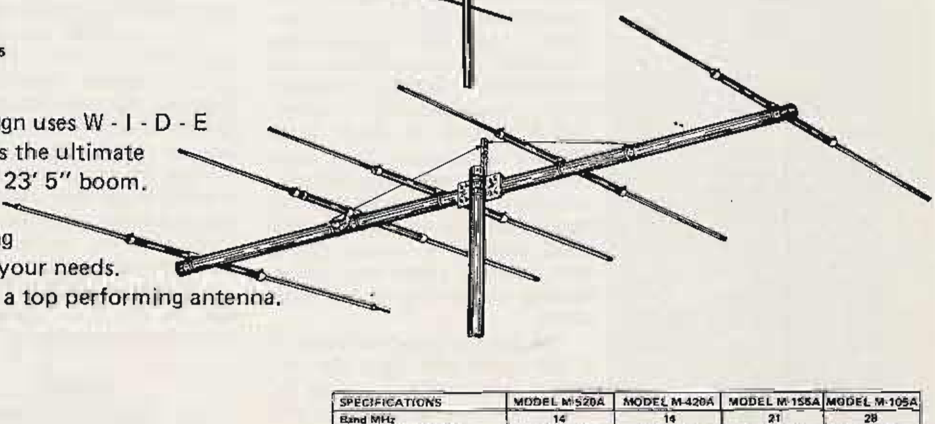


M-155A
5 ELEMENT MONOBANDER

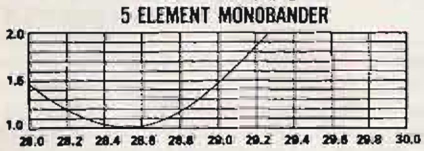


The M-105A — our latest 10 meter design uses W - I - D - E spacing. Well researched design provides the ultimate in a 10 meter antenna. 5 elements on a 23' 5" boom.

With the 10 meter band making a strong comeback, choose our model to fulfill your needs. Five wide spaced elements will provide a top performing antenna.



M-105A
5 ELEMENT MONOBANDER



SPECIFICATIONS	MODEL M-520A	MODEL M-420A	MODEL M-155A	MODEL M-105A
Band MHz	14	14	21	28
Maximum Power Input	Legal Limit	Legal Limit	Legal Limit	Legal Limit
Gain (dB)	11.5	10	12.0	12.0
VSWR (at Resonance)	1.1:1	1.1:1	1.1:1	1.1:1
Impedance	52 ohms	50 ohms	50 ohms	52 ohms
Front-to-Back Ratio (dB)	25	25	26	25
Boom (O.D. x Length)	2" x 34'6"	2" x 26'	2" x 25'7"	2" x 23'5"
No. Elements	5	4	5	5
Longest Element	36'6"	36'6"	25'3"	18'2"
Turning Radius	25'	22'6"	17'6"	22'6"
Mast Diameter	2" O.D.	2" O.D.	2" O.D.	2" O.D.
Boom Diameter	2" O.D.	2" O.D.	2" O.D.	2" O.D.
Surface Area (Sq. Ft.)	8.9	7.6	4.26	2.8
Wind Load	227 lbs.	186 lbs.	108 lbs.	75 lbs.
Assembled Weight (Approx.)	70 lbs.	50 lbs.	40 lbs.	35 lbs.
Shipping Weight (Approx.)	79 lbs.	55 lbs.	46 lbs.	40 lbs.
Matching Method	Beta	Beta	Beta	Beta

Prices and specifications subject to change without notice.

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W2NSD/1 NEVER SAY DIE

editorial by Wayne Green

DAYTON

Despite the rapid growth of the Atlanta Hamfestival, Dayton pulls 'em in in greater numbers every time. It's gotten so big that it is difficult to see everyone there. No, it's impossible. Whether they have 15,000 or 20,000 in attendance is irrelevant—it's too much to handle.

I had not really intended to get to Dayton this time, feeling that I would do better to spend the four days involved working on Instant Software and a new publishing project. But I began to waver just a bit when they called up and wanted to know where they could reach Jean Shepherd K2ORS in order to get him to entertain at the banquet. Then they asked if I would be available to speak on the microcomputer forum . . . and I gave in.

Shep was outstanding, as usual. I think they had well over 1,500 at the banquet, and he had them in stitches. The banquet was nice . . . grilled hockey pucks, I think. I wasn't sure. The potato was good, which is more than I can say for a lot of restaurants . . . and the company was fine. Most of the entertainment was a bore . . . some local group singing and dancing . . . unfortunately none of them were singers or dancers. That went on incredibly long. The MC was excellent . . . he introduced the two hundred or so people at the head table in a minute and a half, making some very entertaining comments as he went along.

The Dayton crew has been at it for years and they are certainly professional about it. There are few glitches in the Hamvention.

The crowds seemed to be down a bit this year—no one knows why. I heard rumors that they clocked in 14,000, compared to 19,000 last year. The aisles were easier to traverse. Other later reports put attendance at 17,000. Big deal . . . that's numbers. I talked with exhibitors, and sales were the best ever, no matter how many were there. Some dealers went home with over $50,000 in sales for the three days.

Despite long-term delivery delays promised by Drake, I understand that dealers were really loaded up with Drake gear for the show . . . which brought prices down to perhaps $5 or $10 over cost on the big gear. While this is hard on the dealers, it is a bonanza for the rest of us. All HTs were selling well, too. I don't think a single dealer went home with an HT in his truck. The showing of the first prototype of the new Yaesu programmable HT helped convince dealers that long-term stocks of the more traditional HTs would not be prudent. It's getting time to liquidate HT crystal stocks.

Swan showed their new line of transceivers and wowed everyone. Their microprocessor-controlled units will be in short supply for a long time. The Japanese are going to have to work a little harder to keep their large share of the US market.

But long after the new ham gear and the acres upon acres of flea market fade into fuzzy memory, the Jean Shepherd entertainment at the banquet will live on in memory. Long after the old rig we bought off a flea market truck that chilly Saturday has been auctioned off at a local hamfest, we'll remember Shep and his problems with the Texas kilowatt on 7182 kHz back in the '30s. "Doesn't that sonofagun ever sleep?"

ARMA

The most recent meeting of the Amateur Radio Manufacturer's Association came the night before the Dayton Hamvention and was sparsely attended, considering that almost 250 firms run ads in any one month in the ham magazines.

A representative from the Electronic Industries Association was there to try to convince the ham industry that they might do better to join the EIA rather than fritter around with ARMA. It was noted that only one ham manufacturer is presently a member of EIA, and that one admitted discovering the membership with some surprise, a sort of bonus for their CB affiliation.

I don't think I helped that project as much as I might have when I reminded everyone that we had heard this same story ten years ago when Bob Waters lured the ham industry away from a ham manufacturer's association and into the EIA. The ham industry was in the same division as the CB industry, and thus when it came to any conflicts between the two (and there were beauts, like 220 MHz), money talked and the ham industry seemed to get a deaf ear.

The costs of joining the EIA are not insignificant. It would cost *73* about $2,000 per year to belong, with few (if any) benefits which I could pin down. And then, if any special projects for lobbying came up, the cost of them would be on top of the two thou. Someday, I'd like to have a general idea of how much Hy-Gain and Johnson put into the pot to get more CB channels on eleven meters and the 220 MHz band for CB. Both of those projects were bummers, incidentally. The eleven meter expansion project resulted in the serious wounding of CB and cost the industry billions. It sank Hy-Gain.

It was noted that ARMA had not been able to decide on anything and follow it through with success. The effort to stave off FCC actions on linear amplifiers was an abject failure. I feel that this total defeat was primarily due to the lack of support of ARMA by some of the larger firms in the ham industry, the back-stabbing (to put it politely) by the ARRL, and the lack of strong leadership in ARMA to put together a program with which to fight the

TS-120S...A big little rig.

It's a compact, up to 200 watts PEP input, all solid-state HF transceiver with such standard features as built-in digital readout, IF shift, new PLL technology ...and requires no tuning!

Exciting and perfect for car or ham shack use! But, there's more to say about the TS-120S! This unique all solid-state HF, SSB/CW transceiver produces a hefty signal and also offers a lot of other great features in a very attractive, compact package.

FEATURES:

- All solid-state with wideband RF amplifier stages. No final dipping or loading, no transmit drive peaking, and no receive preselector tuning! *Just dial your frequency and operate!*
- Five bands, plus WWV. Transmits and receives on 80/75, 40, 20, 15, and all of 10 meters...and receives WWV on 15 MHz.
- 200 watts PEP (160 watts DC) input on 80-15 meters, 160 watts PEP (140 watts DC) input on 10 meters. LSB, USB, and CW.
- Digital frequency display (standard). 100-Hz resolution. Six digits. Special green fluorescent tubes eliminate viewing fatigue. Analog subdial, too, for backup display.
- IF shift (passband tuning), to remove adjacent-frequency interference and sideband splatter.
- Advanced PLL circuit, which eliminates need for heterodyne crystal element for each band. PLL lock frequency, CAL marker signal, and counter clock circuit use single reference frequency crystal. Simplifies circuitry, improves overall stability. Also improves transmit and receive spurious characteristics.
- Attractive, compact design. Measures only 3½" high X 9¼" wide X 13½" long, and weighs only 4.9 kg (11.7 lbs.). A perfect size for convenient mobile operation and rugged enough for either mobile or portable use. Also has all the desired features for optimum ham-shack operation at home.
- Noise blanker. You'll wonder where the ignition noise went.

See the big little TS-120S rig and matching accessories (VFO-120 remote VFO, SP-120 external speaker, PS-30 AC power supply, MB-100 mobile mounting bracket, AT-120 antenna tuner and YK-88C CW Filter) at your nearest Authorized Kenwood Dealer!

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FCC and win.

One of the more serious problems facing any industry association is the seeming preference for the death of amateur radio over accommodation between the US manufacturers and importers of Japanese (called "foreign") equipment. I can understand the emotions involved, particularly when you consider that somewhere around 70% of the ham gear being sold is being imported from Japan. I've heard repeated claims that the Japanese are selling this ham gear at a loss here in order to destroy the US manufacturers. I'd sure like to see some proof of this contention.

On the surface of it, the high sales of Japanese equipment seems to be the result of a lot of advertising, excellent design, good marketing, and factors such as this. The Japanese have some unfair advantages, I'll admit, in that they have about 400,000 hams in Japan as a market that is virtually closed to our manufacturers. With about double the market for ham gear, they can afford to spend more on design and run larger production runs . . . which means lower costs.

Then there is the matter of Japanese productivity vs. that of the US. A recent article in *Fortune* pointed out that the US has been down toward the bottom of the list in worker productivity improvements. The Japanese have been building new and more automated plants, while our unions and government have been making it almost impossible for us to do the same, thus forcing dealers to sell imported equipment which has more features and costs less.

There have been some strong moves to turn this around. Swan has stopped importing their equipment and is now making everything here in the US. Their new line of transceivers is going to have a strong effect on the market, for they are taking advantage of microcomputer technology. But other US manufacturers have been complacent, telling dealers that they are so busy with other things that ham gear will be six months or more back-ordered. And one major firm which has been making a big deal out of hams buying American has some very clearly indentifiable Japanese parts in its new rig.

Some of the US problems undoubtedly could be cured if we could get the government out of the act. I talked with one manufacturer recently who had had his plant closed down by OSHA because they found a fire escape support column which was painted. It seems that they could not inspect the column for any possible cracks . . . so everyone had to be sent home until the paint could be removed from the fire escape column.

OSHA seems to be the cause of the recent semiconductor plant shutdown which caused incredible consternation in the entire electronics industry. The early estimates are that much over $10 billion was lost as a result of this unnecessary action. Some 20¢ chips were being bid up to $5.00 and more by contractors frantic to finish contracts on time or by manufacturers being pressured by customers for delivery.

I doubt if they are having nearly as much government harassment in Japan . . . and this means that they can be more competitive with us. If you read much about Japan, you know that workers take their jobs very seriously and are dedicated to their employers. The excesses of many industrialists of a hundred years ago spawned a strong union movement in the US, and some of the ramifications of that have not been helpful in making us competitive with other countries. The strong union positions in England have been a powerful factor in keeping that country from being seriously competitive with much of the world.

In the microcomputer field, no other country has been able to provide any serious competition for the US. You can bet that the Japanese microcomputer makers have been over here, sizing up the market, but they haven't been able to do much about it. Between our technological advances and the dollar/yen situation, US firms are getting into better positions to give the Japanese a run for their money. Where we are not being held back by union restrictions on modernization and excessive government regulation, we can raise hell with imports.

Well, getting back to ARMA, the suggestion was made that instead of trying to represent the industry, getting involved with battles with the FCC, or trying to help our WARC position, it be made more of a social club . . . perhaps with an industry friendship dinner during the more important hamfests and conventions. If the group is afraid to tackle anything more meaningful than that, then let's have dinner meetings and eat. That's better than protracted meetings hassling over bylaws, dues, and elections, which are just an enormous waste of time and of little interest.

There is one point of history that I would like to clarify since it seems to already be in the process of being rewritten. It was mentioned at the ARMA meeting that the opinion about trying to do something to help the amateur radio position at WARC was about evenly split. I might remind ARMA that the motion to tackle this project was made by Tom Gentry of Icom—it was carried with one and only one negative vote.

I recognize that the eventual scuttling of the project, which I attribute to *Ham Radio* magazine, calls for a distribution of

Continued on page 164

CB TO 10

Many readers have written or called to ask about obtaining back issues which contain articles in our "CB to 10" series. For everyone's information, the issues which have thus far featured "CB to 10" articles are listed below.

1977—May—Part I—"Bandplan and Crystal Information"
1977—Jul—Part II—"Conversion Data"
Part III—"Converting the TRC-47"
Part IV—"Johnson 123A Mod"
Part V—"Converting the Hy-Gain 670B"
1977—Dec—Part VI—"Antenna Suggestions"
Part VII—"Convert a TRC-11"
1978—Feb—Part VIII—"The Publicom I"
1978—Jul—"How About SSB CB Conversions?"
1978—Aug—Part IX—"A Pair of Radio Shack Rigs"
1978—Sep—Part X—"Realistic's Mini 23"
Part XI—"Hy-Gain's PLL Rigs"
1978—Oct—Part XII—"Convert a Kraco PLL Rig"
1978—Nov—Part XIII—"The Lafayette Telsat SSB-75"
Part XIV—"A Realistic PLL Rig"
Part XV—"A Realistic HT"
1979—Jan—Part XVI—"A CW Conversion"
Part XVII—"SBE and Pace Rigs"
1979—May—Part XVIII—"Several PLL Rigs"
1979—Jun—Part XIX—"Lafayette SSB Rigs"

These issues may be purchased at $8.50 for 5 of your choice (order #STO500), $14 for 10 of your choice (# ST1000), or $25 for 25 of your choice (#ST2501). Include $1 for postage and handling, and send your order to 73 Radio Bookshop, Peterborough NH 03458.

INFO.

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LETTERS

MEMORIES

I was reading my March issue of *73* and noticed your story of the trip we took to Europe in October, 1963. I always felt that the idea of the Institute of Amateur Radio was a very good one and that hams getting to know hams through group tours to other countries was an excellent way of promoting amateur radio.

I am a holder of a lifetime subscription to *73* (yes, I was one of the lucky ones who subscribed in Miami back in '61 or '62), and I have followed you through your editorials. Many times I started to write and tell you how much Anna and I enjoyed the trip, but somehow I never got around to it.

Do you remember your miniature greyhound jumping off the bed and breaking its leg? Or Annora Todd yelling that she wanted to get off at "Arts and Meters" underground station in Paris? Wasn't the cannelloni good at the restaurant in Rome where we went with you one evening and ate in the open-air section? Do you remember when one of the single guys had to double up in the room with the gal in the red coat and her husband? I can't remember her name, but in a crowd we would all say, "Follow the gal in the red coat."

Well, I've finally gotten around to telling you (after all these years) how good I think your idea was and how great the trip was. I have gone many places since then, but never had one-tenth the fun we all did on that momentous trip to Europe by *73* hams. If that trip could ever be duplicated and it leaked out how much fun it was and how interesting it was to meet hams from other countries, you would have to form a full-time travel agency.

I have recently retired from practicing dentistry, and Anna and I moved here to the mountains of western North Carolina from Miami, Florida. Good luck, Wayne, and keep up the good work.

Lamon L. Whiddon K4MHY
Boone NC

It was January, 1961, and you were Life Subscriber #1. I remember it well! The Italian greyhound was named Petite Chienne because that's what everyone called her when we got to Paris. The Rome restaurant was the Tres Scalini and it is still there and superb. I often look at the slides and relive that fantastic trip.—Wayne.

Somehow I was propelled to open the March copy of *73* and I read Never Say Die.

My husband has been dead a year and I had not opened any of his ham magazines until today. As one of the XYLs on that 1963 trip to Europe, I want to thank you for renewing all those wonderful memories.

It would be wonderful to be in contact with the travel group again.

Annora Todd
222 W. Hawthorne St.
Aurora MO 65605

SCHOLARSHIPS

High-school graduates who plan to enter college this fall and who are licensed amateurs may be eligible for one of the $250 scholarships offered by the Atlanta Radio Club. If you qualify, write to the ARC Scholarship Fund, PO Box 77171, Atlanta GA 30357.

Philip J. Latta W4GTS
Marietta GA

ABSURDITY

I feel that the idea of each ITU country having one vote each at WARC is absurd.

Although some people have expressed discontent at the very idea of one country having more say than another, citing it undemocratic, I see it as just the opposite. I see it undemocratic when a handful of radio users have the same vote as millions. This is totally unreasonable for the millions of radio users, since the more operators there are, the more air space is required.

The only truly fair way on which to base votes is on radio population. Because it is not going to change, I feel the US should drop out of the ITU. Many countries play the ITU game during conferences and then disregard the decisions made afterwards, anyway.

William D. Matteo WB2IVI
Toms River NJ

WPIX

From time to time, you mention your television career. With this in mind, I thought you might be interested in the accompanying picture which shows a young (1948) Wayne Green, hair and all, behind a WPIX RCA-TK 10 camera.

I believe the man at the piano is Sigmund Spaeth, who had a program called "The Tune Detective."

I am sure your loss to TV was a gain for amateurs.

Otis Freeman
WPIX, Inc.
New York City NY

Thanks, Otis! Sure, I remember Dr. Spaeth and his program . . . and little things like the night I did the Woody Woodpecker call for him on camera. I remember the Gloria Swanson show, too, with Zasu Pitts and a lot of other old-time stars. Those were fantastic times. The hair? Heck, my father has more hair than I do . . . so did his father, right up until he died . . . but then they didn't have the aggravation of my first wife.—Wayne.

SURPLUS

I just read an article in one of the back issues of *73*. The issue, Feb., '78, had an article by James C. Chapel W9HDA, entitled "Surplus Adventures—pound foolish!" He didn't feel he could trust a company to ship a signal generator to him from a government surplus outlet. Well, this definitely points out a need of hams.

I want to become a ham but suffer from a pecuniary deficiency. Since I work at the Ogden depot, which is a major electronics surplus outlet in Utah, I think I can benefit all those out there who wish to purchase this equipment and who do not wish to suffer expensewise in the process! In short, I offer, for a reasonable fee, to ship what they wish from Ogden to wherever they may desire.

My background consists of thirteen years in electronics, the last 6 months of which have been as a quality control inspector in the same field. I could, most likely, even inspect the item they wish to bid on, given enough lead time. Not only will all the hams out there benefit, but maybe I'll finally be able to join the fraternity.

If I should thrive at this, I shall definitely make it a business and we'll all benefit because then I'll be able to afford to advertise in your superb magazine. Until then, I shall have to rely on your largess to print this in your next Letters column. If anyone out there is interested, please have them include an SASE.

Thomas W. Newbery
610 North Liberty St.
Ogden UT 84404

HOT CHIHUAHUA

I am returning to the frontiers of Texas again, this time backpacking in the arid wilderness mountains of the Chihuahuan Desert. Please publish the particulars of the expedition so that more experimental NBVM stations may participate. One of the following mountain ranges will be selected for a base camp above the desert floor where temperatures will be more tolerable while operating: Chisos, Davis, Glass, Guadalupe, Christmas, Solitario, or Caballo Muerta.

We will carry in all water, radios, a solar array, food, and shelter. We will be operating Sunday, July 1, through Saturday, July 7, with a two-Watt output transceiver in NBVM, SSB, and CW modes on all HF bands. In addition, we will carry a Tempo S1 2-meter FM hand-held (1.5 Watts). There are a few VHF

Continued on page 176

Looking West

Bill Pasternak WA6ITF
24854-C Newhall Ave.
Newhall CA 91321

Mike Davis WD6FFV of Torrance, California, is a real live 13-year-old hero. On the evening of April 24th, Mike's parents gave him permission to stay up late in order to indulge in a bit of his favorite pastime: operating his station and hunting DX. Everyone else in the house was asleep as Mike searched the band looking for the western Caroline Islands. At about 1:00 am on the morning of April 25th, Mike happened across a QSO between someone on a fishing boat off the coast of Jamaica and someone in New Zealand. Conditions between the craft (later identified as the fishing vessel *Carmen*) and ZL-land were poor at best, and the information exchanged showed that an emergency existed. When those aboard the *Carmen,* identified as the boat's owner Leonard Hutchinson and crew members David Dalquist and Sergio Perez, again sent out a "Mayday" call, Mike responded, obtained their latitude and longitude, and phoned this information to the Long Beach Coast Guard station, which in turn relayed same to Miami. The situation was this: The *Carmen* was some 60 miles off the coast of Jamaica. It had been severely battered by high winds and rough seas and was taking on water. Those aboard knew that the craft would sink; they needed immediate rescue. Mike spent the next 45 minutes relaying information between the Coast Guard and the stricken *Carmen* until the signal from the vessel disappeared due to changes in propagation. It was at that time that a W5 in New Mexico acquired the *Carmen*'s signal and continued the relay between the Miami Coast Guard and the *Carmen.*

As a result of Mike's quick thinking, the Coast Guard dispatched a rescue plane which dropped a pump, rescue raft, and marine Coast Guard radio. Later, the cutter *Sherman* took the stricken 75' *Carmen* in tow and brought it back to Montego Bay, Jamaica. A spokesman for the Coast Guard credited the success of the rescue to Mike's quick thinking and positive action. Because he maintained his cool, three men who might have drowned are alive today. They have a 13-year-old amateur radio operator in Torrance, California, to thank for this.

THE "HAIL-TO-THE-QUEEN" DEPARTMENT

Nate Brightman K6OSC is another amateur we can all take pride in. He is a ham who had a dream and persevered for twelve years to see it come true. Thanks to Nate, amateur radio is now operational in full view of the general public on a day-to-day basis aboard one of southern California's most renowned tourist attractions: the *Queen Mary* ocean liner now permanently docked in Long Beach harbor.

Nate is a member of the Associated Radio Amateurs of Long Beach, California. Twelve years ago, when the *Queen Mary* made her last sea voyage from England to her final home in Long Beach, Nate and his club thought that it would be fitting to have an operational amateur station on the trip. Nate spearheaded the drive and succeeded. It was at that time that the idea of a permanent station came to him. Having an idea and making it come true are not always one and the same. In this case it took years. During its transition from an ocean liner to a tourist attraction and hotel, the original wireless room had been dismantled. Nate's idea was to restore this room to as close to its original state as possible and then add a permanent amateur station.

On April 22, 1979, Nate's dream came true. On that evening, Sharon and I attended a special invitational press preview of what had been accomplished by Nate and the Associated Radio Amateurs of Long Beach. On the top deck of the illustrious *Queen*, the wireless room had indeed been restored. Amid the relics of times gone by was nestled neatly, in a special panel arrangement, some of today's most sophisticated amateur equipment on indefinite loan from such well-known firms as Yaesu, Trio-Kenwood, Swan, DenTron, and others. What about antennas? Neatly built into one of the *Queen's* stacks and rising above it stands a triband beam and a two-meter Ringo from Cushcraft. The array is rotated by an Alliance rotor. Shortly, two dipoles (one for 75/80 and another for 40 meters) will give the ship's station 80- through 2-meter capability (six meters excluded).

Something very apropos happened the evening that the station opened. After the initial ceremony was concluded, it was time to place the station on the air. One of those present was famed DXer Don Wallace W6AM. When his turn came, Don contacted a station in New Zealand. As the QSO progressed, it was learned that the ZL had been one of the wireless operators who served on the *Queen Mary* during World War II. I remember the ZL saying, "Don, if you are where I think you are, then I preceded you some 30 years ago and had my feet in the same spot that yours are now." All of us gathered around the TS-820's speaker beamed with delight. If the QSO had been planned—and it was not—nothing could have been

Continued on page 170

A very happy Nate Brightman K6OSC (center) chats with Roy Neal K6DUE (left) and WA6ITF during a break in the filming of "The World of Amateur Radio" aboard the Queen Mary. *(Photo by KH6IAF)*

OMNI HAS IT *ALL*. All the advantages and capabilities, all the new conveniences and new levels of performance you need, whatever your HF operating specialty. All built-in, ready to use.

***ALL* SOLID-STATE.** All the advantages of total solid-state from the pioneer of HF solid-state technology. Reliable, cool, stable — from receiver front-end to transmitter final.

***ALL* HF BANDS.** From 160 through 10 meters (and all the crystals) plus convertible 10 MHz and "AUX" band positions for possible future needs.

***ALL* BROADBAND.** Band changing without tuneup — without danger to the final amp.

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***ALL* FILTERS INCLUDED:** 4-position CW/SSB filter (150 Hz bandwidth with 3 selectable skirt contours) plus 8-pole Crystal filter (2.4 kHz bandwidth, 1.8 shape factor.)

***ALL* MODE SWITCH** puts all filters to work in any mode.

***ALL* BREAK-IN:** Instant or delayed receiver muting to fit any band condition or mobile operation.

***ALL*-VERSATILE OFFSET TUNING;** dual ranges, ±5 kHz range for off-frequency DX or ±0.5 kHz range for fine tuning.

***ALL*-SENSITIVE RECEIVER;** from 2 μV on 160 m to 0.3 μV on 10 m (10 dB S+N/N) for ideal balance between dynamic range and sensitivity.

***ALL* OVERLOADS HANDLED;** dynamic range typically exceeds 90 dB and PIN diode switched 18 dB attenuator also included for extra overload protection.

***ALL* LINEAR/ANTENNA BANDSWITCHING FROM FRONT PANEL;** auxiliary bandswitch terminals on back panel for external relays or circuits are controlled simultaneously by the OMNI bandswitch.

***ALL* INTERFACE JACKS FOR PHONE PATCH;** access to speaker and microphone signals.

***ALL*-LEVEL ADJUSTABLE ALC;** set output from low power to full, retain low distortion at desired drive to power amp.

***ALL* SIDETONE ADJUSTMENTS;** pitch and volume.

***ALL*-POWERFUL, *ALL*-WARRANTED FINAL AMPLIFIER.** 200 watts input to final. Proven design with full warranty for first year and pro-rata warranty for additional 5 years.

***ALL* 100% DUTY CYCLE.** For RTTY, SSTV or sustained hard usage.

***ALL*-MODE POWER:** basic 12 VDC for easy mobile use, external supplies for 117/220 VAC operation.

***ALL* FRONT PANEL MICROPHONE AND PHONE JACKS.** Convenient.

PLUS *ALL* THE OTHER HANDY BUILT-INS: "Timed" 25 kHz crystal calibrator in OMNI-A with automatic 5-10 sec. "on" time for easy 2-hand dial skirt adjustment . . . Zero-Beat switch for placing your signal exactly on CW listening frequencies . . . SWR bridge switches "S" meter to read SWR each time you transmit for continuous antenna monitoring . . . Separate receive antenna capability . . . Dual speakers for greater sound at lower distortion . . . Plug-in circuit boards for fast, easy field service.

***ALL*-FUNCTIONAL STYLING.** "Clamshell" aluminum case clad in textured black vinyl with complementary nonreflective warm dark metal front panel and extruded aluminum bezel and bail. Convenient controls. Complete shielding. And easier-to-use size: 5¾"h x 14¼"w x 14"d.

AND *ALL* THE OPTIONS: Model 645 Keyer, Model 243 Remote VFO, Model 248 Noise Blanker, Model 252MO AC Power Supply.

Model 545 OMNI-A $899 Model 546 OMNI-D $1069

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OSCAR Orbits

Courtesy of AMSAT

The listed data tells you the time and place that OSCAR 7 and OSCAR 8 cross the equator in an ascending orbit for the first time each day. To calculate successive OSCAR 7 orbits, make a list of the first orbit number and the next twelve orbits for that day. List the time of the first orbit. Each successive orbit is 115 minutes later (two hours less five minutes). The chart gives the longitude of the day's first ascending (northbound) equatorial crossing. Add 29° for each succeeding orbit. When OSCAR is ascending on the other side of the world from you, it will descend over you. To find the equatorial descending longitude, subtract 166° from the ascending longitude. To find the time OSCAR 7 passes the North Pole, add 29 minutes to the time it passes the equator. You should be able to hear OSCAR 7 when it is within 45 degrees of you. The easiest way to determine if OSCAR is above the horizon (and thus within range) at your location is to take a globe and draw a circle with a radius of 2450 miles (4000 kilometers) from your QTH. If OSCAR passes above that circle, you should be able to hear it. If it passes right overhead, you should hear it for about 24 minutes total. OSCAR 7 will pass an imaginary line drawn from San Francisco to Norfolk about 12 minutes after passing the equator. Add about a minute for each 200 miles that you live north of this line. If OSCAR passes 15° east or west of you, add another minute; at 30°, three minutes; at 45°, ten minutes. Mode A: 145.85-.95 MHz uplink, 29.4-29.5 MHz downlink, beacon at 29.502 MHz. Mode B: 432.125-.175 MHz uplink, 145.975-.925 MHz downlink, beacon at 145.972 MHz.

OSCAR 8 calculations are similar to those for OSCAR 7, with some important exceptions. Instead of making 13 orbits each day, OSCAR 8 makes 14 orbits during each 24-hour period. The orbital period of OSCAR 8 is therefore somewhat shorter: 103 minutes.

To calculate successive OSCAR 8 orbits, make a list of the first orbit number (from the OSCAR 8 chart) and the next thirteen orbits for that day. List the time of the first orbit. Each successive orbit is then 103 minutes later. The chart gives the longitude of the day's first ascending equatorial crossing. Add 26° for each succeeding orbit. To find the time OSCAR 8 passes the North Pole, add 26 minutes to the time it crosses the equator. OSCAR 8 will cross the imaginary San Francisco-to-Norfolk line about 11 minutes after crossing the equator. Mode A: 145.85-.95 MHz uplink, 29.4-29.50 MHz downlink, beacon at 29.40 MHz. Mode J: 145.90-146.00 MHz uplink, 435.20-435.10 MHz downlink, beacon on 435.090 MHz.

OSCAR 7 Orbital Information				OSCAR 8 Orbital Information			
Orbit	Date (July)	Time (GMT)	Longitude of Eq. Crossing °W	Orbit	Date (July)	Time (GMT)	Longitude of Eq. Crossing °W
21151	1	0021:39	69.3	6728Jbn	1	0045:35	56.3
21164qrp	2	0115:56	82.9	6742Abn	2	0050:46	57.6
21176	3	0015:16	67.8	6756Abn	3	0055:56	58.9
21189X	4	0109:33	81.3	6770X	4	0101:06	60.2
21201	5	0008:53	66.2	6784Abn	5	0106:17	61.5
21214	6	0103:10	79.8	6798Abn	6	0111:27	62.9
21226	7	0002:31	64.6	6812Jbn	7	0116:37	64.2
21239	8	0056:48	78.2	6826Jbn	8	0121:48	65.5
21252qrp	9	0151:04	91.8	6840Abn	9	0126:58	66.8
21264	10	0050:25	76.7	6854Abn	10	0132:08	68.1
21277X	11	0144:42	90.3	6868X	11	0137:18	69.4
21289	12	0044:02	75.1	6882Abn	12	0142:29	70.7
21302	13	0138:19	88.7	6895Abn	13	0004:25	46.2
21314	14	0037:39	73.6	6909Jbn	14	0009:35	47.5
21327	15	0131:56	87.1	6923Jbn	15	0014:46	48.8
21339qrp	16	0031:16	72.0	6937Abn	16	0019:56	50.1
21352	17	0125:33	85.6	6951Abn	17	0025:06	51.4
21364X	18	0024:54	70.4	6965X	18	0030:16	52.7
21377	19	0119:11	84.0	6979Abn	19	0035:26	54.1
21389	20	0018:31	68.9	6993Abn	20	0040:36	55.4
21402	21	0112:48	82.5	7007Jbn	21	0045:46	56.7
21414	22	0012:08	67.3	7021Jbn	22	0050:56	58.0
21427qrp	23	0106:25	80.9	7035Abn	23	0056:07	59.3
21439	24	0005:45	65.8	7049Abn	24	0101:17	60.6
21452X	25	0100:02	79.4	7063X	25	0106:27	61.9
21465	26	0154:19	92.9	7077Abn	26	0111:37	63.2
21477	27	0053:40	77.8	7091Abn	27	0116:47	64.5
21490	28	0147:56	91.4	7105Jbn	28	0121:57	65.8
21502	29	0047:17	76.2	7119Jbn	29	0127:07	67.1
21515qrp	30	0141:34	89.8	7133Abn	30	0132:17	68.4
21527	31	0040:54	74.7	7147Abn	31	0137:27	69.8

RTTY Loop

Marc I. Leavey, M.D. WA3AJR
4006 Winlee Road
Randallstown MD 21133

Oh, heavy sigh and deja vu, didn't we have a computer program in last July's RTTY Loop? Of course we did, but, as promised last month, this is the other half: the transmitting program for the 6800. Let's plunge right into the program, shown in Program 1. If you have the flowcharts from last month handy, use them along side.

The first 96 memory locations ($20 to $7F) are reserved for the table used to convert ASCII to Baudot. The ASCII value is used as an index to retrieve the data, representing the Baudot representation of that ASCII code. The encoding used represents the Baudot case as the Most Significant Bit (MSB), "1" for Letters and "0" for Figures, and the next five bits the character itself. Thus, ASCII "R", which has a value of $52, is found at memory location $72 [$20 (start of table) + $52 (R value) = $72]. The data at that location is $A8, which, in binary, is 10101000. This interprets to 1 - 01010 - 00, or LTRS - Baudot code 01010 (R). The last two bits are not used in this scheme. Note that, for example, a "4", which is ASCII $34 and found at location $54 in the table, would be represented by $28. This is binary 0 - 01010 - 00. That is, FIGS - Baudot code 01010 (R), since "4" is the uppercase Baudot "R".

Continued on page 166

Program 1.

```
                        NAM    RTTYXMIT
                        OPT    O,NOG
                 *
                 * RTTY TRANSMIT PROGRAM
                 * VER 0.6 - 06 MAY 79
                 * MARC I. LEAVEY, M.D.
                 *
                 * EXTERNAL REFERENCES
                 *
            801C PIADA  EQU    $801C
            801D PIACA  EQU    $801D
            E07E PDATA  EQU    $E07E
            E1AC INEEE  EQU    $E1AC
            A048 PGCTR  EQU    $A048
                 *
      0020              ORG    $20
      0020 FE    TABLE  FCB    $FE          LETTERS
      0021 00           FCB    0,0,0
      0024 00           FCB    0,0,0
      0027 50           FCB    $50          BELL
      0028 00           FCB    0,0
      002A A0           FCB    $A0          LINE FEED
      002B 00           FCB    0,0
      002D FF           FCB    $FF          CARRIAGE
      002E 00           FCB    0,0,0         RETURN
      0031 00           FCB    0,0,0
      0034 00           FCB    0,0,0
      0037 00           FCB    0,0,0
      003A 00           FCB    0,0,0
      003D 00           FCB    0,0,0
      0040 90           FCB    $90          SPACE
      0041 58           FCB    $58          !
      0042 44           FCB    $44          "
      0043 FF           FCB    $FF          #
      0044 48           FCB    $48          $
      0045 FF           FCB    $FF          %
      0046 2C           FCB    $2C          &
      0047 68           FCB    $68          '
      0048 78           FCB    $78          (
      0049 24           FCB    $24          )
      004A FF           FCB    $FF          *
      004B FF           FCB    $FF          +
      004C 18           FCB    $18          ,
      004D 60           FCB    $60          -
      004E 1C           FCB    $1C          .
      004F 5C           FCB    $5C          /
      0050 34           FCB    $34          0
      0051 74           FCB    $74          1
      0052 64           FCB    $64          2
      0053 40           FCB    $40          3
      0054 28           FCB    $28          4
      0055 04           FCB    $04          5
      0056 54           FCB    $54          6
      0057 70           FCB    $70          7
      0058 30           FCB    $30          8
      0059 0C           FCB    $0C          9
      005A 38           FCB    $38          :
      005B 3C           FCB    $3C          ;
      005C FF           FCB    $FF          <
      005D FF           FCB    $FF          =
      005E FF           FCB    $FF          >
      005F 4C           FCB    $4C          ?
      0060 FF           FCB    $FF          @
      0061 E0           FCB    $E0          A
      0062 CC           FCB    $CC          B
      0063 B8           FCB    $B8          C
      0064 C8           FCB    $C8          D
      0065 C0           FCB    $C0          E
      0066 D8           FCB    $D8          F
      0067 AC           FCB    $AC          G
      0068 94           FCB    $94          H
      0069 B0           FCB    $B0          I
      006A E8           FCB    $E8          J
      006B F8           FCB    $F8          K
      006C A4           FCB    $A4          L
      006D 9C           FCB    $9C          M
      006E 98           FCB    $98          N
      006F 8C           FCB    $8C          O
      0070 B4           FCB    $B4          P
      0071 F4           FCB    $F4          Q
      0072 A8           FCB    $A8          R
      0073 D0           FCB    $D0          S
      0074 84           FCB    $84          T
      0075 F0           FCB    $F0          U
      0076 BC           FCB    $BC          V
      0077 E4           FCB    $E4          W
      0078 DC           FCB    $DC          X
      0079 D4           FCB    $D4          Y
      007A C4           FCB    $C4          Z
      007B FF           FCB    $FF          [
      007C FF           FCB    $FF          \
      007D FF           FCB    $FF          ]
      007E FF           FCB    $FF          ↑
      007F FF           FCB    $FF          ←
      0080 23    SPTABL FCB    $23,$98,$A8  #=NR
      0083 25           FCB    $25,$B4,$B8  %=PC
      0086 2A           FCB    $2A,$E0,$D0  *=AS
      0089 2B           FCB    $2B,$B4,$A4  +=PL
      008C 3C           FCB    $3C,$A4,$84  <=LT
      008F 3D           FCB    $3D,$C0,$F4  ==EQ
      0092 3E           FCB    $3E,$AC,$84  >=GT
      0095 40           FCB    $40,$E0,$84  @=AT
      0098 5B           FCB    $5B,$78,$78  [=((
```

Continued on page 166

TS-1

TS-1JR

PE-2

SD-1

THE DAWNING

The age of tone control has come to Amateur Radio. *What better way to utilize* our ever diminishing resource of frequency spectrum? Sub-audible tone control allows several repeaters to share the same channel with minimal geographic separation. It allows protection from intermod and interference for repeaters, remote base stations, and autopatches. It even allows silent monitoring of our crowded simplex channels.

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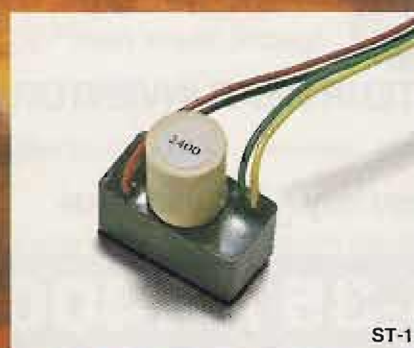
ME-3


TE-8


TE-12


ST-1

OF A NEW AGE.

TS-1 Sub-Audible Encoder-Decoder • Microminiature in size, 1.25" x 2.0" x .65" • Encodes and decodes simultaneously • **$59.95** complete with K-1 element.

TS-1JR Sub-Audible Encoder-Decoder • Microminiature version of the TS-1 measuring just 1.0" x 1.25" x .65", for hand-held units • **$79.95** complete with K-1 element.

ME-3 Sub-Audible Encoder • Microminiature in size, measures .45" x 1.1" x .6" • Instant start-up • **$29.95** complete with K-1 element.

TE-8 Eight-Tone Sub-Audible Encoder • Measures 2.6" x 2.0" x .7" • Frequency selection made by either a pull to ground or to supply • **$69.95** with 8 K-1 elements.

PE-2 Two-Tone Sequential Encoder for paging • Two call unit • Measures 1.25" x 2.0" x .65" • **$49.95** with 2 K-2 elements.

SD-1 Two-Tone Sequential Decoder • Frequency range is 268.5 - 2109.4 Hz • Measures 1.2" x 1.67" x .65" • Momentary output for horn relay, latched output for call light and receiver muting built-in • **$59.95** with 2 K-2 elements.

TE-12 Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25" x 2.5" x 1.5" • **$79.95** with 12 K-1 elements.

ST-1 Burst-Tone Encoder • Measures .95" x .5" x .5" plus K-1 measurements • Frequency range is 1650 - 4200 Hz • **$29.95** with K-1 element.

COMMUNICATIONS SPECIALISTS
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Reader Service—see page 211

Contests

Robert Baker WB2GFE
15 Windsor Dr.
Atco NJ 08004

COLOMBIAN INDEPENDENCE DAY CONTEST
Starts: 0001 GMT Saturday, July 14
Ends: 2359 GMT Sunday, July 15

The purpose of this contest is to commemorate the Colombian 169th independence anniversary and to promote and increase DX activity of HK radio amateurs. Entry classifications include: single operator/single band, single operator/multiband, multi-operator/multiband/one rig. Use all amateur bands 80 through 10 meters on phone, SSB, or CW. Only one contact per band with the same station will be permitted. No crossband or crossmode contacts. Club stations can only take part as multi-operator/multiband/single transmitter. A minimum of 50 QSOs must be shown in logs when applying for any award.

EXCHANGE:
RS(T) and QSO number from 001.

SCORING:
Each QSO with an HK station scores 5 points, each station in another continent counts 3 points, a station in a DX country counts 2 points, and stations in the same country count 1 point. The multiplier is the total number of different countries worked on each band. The total score will be the sum of QSO points on each band multiplied by the sum of different countries worked on each band.

ENTRIES AND AWARDS:
Logs must show all times in GMT; keep separate logs for each band and enter the country only the first time it is contacted. Each entry must be accompanied by a summary sheet listing all scoring info. The logs not summarized according to the abovementioned instructions will be used only as check logs. Awards include a silver plate for the world winner, certificates for continental winners, and winners in each classification. Violation of the regulations of amateur radio in the country of the contestant or the rules of the contest, taking credit for incorrect QSOs or multipliers, or duplicate contacts in excess of 2% of the total made will be deemed sufficient cause for disqualification. The LCRA Contest Awards Committee decisions shall be final. All logs must be mailed to: LCRA—Concurso Independencia, c/o Contest Committee Manager, Apartado Postal 584, Bogota, Colombia, SA. All entries must be postmarked no later than September 30.

CW COUNTY HUNTERS CONTEST
Starts: 0000 GMT July 28
Ends: 0200 GMT July 30

The CW County Hunters Net invites all amateurs to participate in the 1979 contest. All mobile and portable operation in less active counties is welcome and encouraged. General call is "CQ CH." Stations may be worked once on each band and again if the station has changed counties. Portable or mobile stations changing counties during the contest may repeat contacts for QSO points. Stations on county lines give and receive only one number per QSO, but each county is valid for a multiplier. Suggested frequencies are 3575, 7055, 21070, and 28070. It is requested that only portable or mobile category stations call CQ or QRZ on 40 meters below 7055 and on 20 meters below 14070 with all stations spreading out above those frequencies.

EXCHANGE:
QSO number, category (portable = P, mobile = M), RST, state/province/country, and US county.

SCORING:
QSOs with fixed stations are 1 point; portable or mobile stations are 3 points. Multiply the number of QSO points times the number of US counties worked. Mobiles and portables calculate their score on the basis of total contacts within a state.

AWARDS:
Certificates will be awarded in three categories: Fixed—highest fixed or fixed portable station in each state, province, and country with 1,000 or more points; Portable—highest station in each state operating portable from a county which is not his normal point of operation with 1,000 or more points; Mobile—highest mobile in each state operating from 3 or more counties with a minimum of 10 QSOs per county.

Trophies will be awarded to the highest single-operator station in the US in categories P and M. The awards committee will issue additional awards where deemed appropriate.

ENTRIES:
Logs must show category, date/time in GMT, station worked, exchanges, band, QSO points, location, and claimed score. All entries with 100 or more QSOs must include a checksheet of counties worked or be disqualified from receiving awards. Enclose a large SASE if results are desired. Logs must be postmarked by September 1 and sent to: CW County Hunters Net, c/o Jeffrey P. Bechner W9MSE, 673 Bruce Street, Fond du Lac WI 54935.

RHODE ISLAND QSO PARTY
Contest Periods: 1700 GMT Saturday, July 28 to 0500 GMT Sunday, July 29
1300 GMT Sunday, July 29 to 0100 GMT Monday, July 30

This contest is sponsored by the East Bay Amateur Wireless Association. RI stations work other RI stations and the rest of the world. Others work RI only. The same station may be worked once per band and mode. No repeater contacts are allowed.

EXCHANGE:
RS(T), QTH = RI county or state, province, or country for others.

SCORING:
RI stations score 2 points per QSO; RI Novice and Tech stations score 5 points per QSO. Others score 2 points per RI QSO and 5 points per QSO with RI Novices or Technicians. RI Novices and Technicians sign with /N or /T to designate license class. RI stations multiply total QSO points by the number of RI counties, states, provinces, and DX countries worked. Others multiply total QSO points by the number of RI counties worked (5 max.). All stations score 10 points for QSO with multi-op station operated by club members, N1RI.

FREQUENCIES:
CW—1810, 3550, 3710, 7050, 14050, 21050, 21110, 28050, 28110.

Continued on page 168

Calendar

June 30-July 1*	Seven-Land QSO Party
July 4	ARRL Straight Key Night
July 14-15	ARRL IARU Radiosport Competition
	Colombian Independence Day Contest
July 28-30	CW County Hunters Contest
	Rhode Island QSO Party
	New Jersey QSO Party
Aug 4	DAFG 10 Meter Contest
Aug 4-5	ARRL UHF Contest
Aug 25-26	All Asian DX Contest—CW
Sept 8*	DAFG Short Contest—VHF
Sept 8-9	ARRL VHF QSO Party
Sept 9*	DAFG Short Contest—SW
Sept 14-15	Kentucky QSO Party
Sept 15-16	Scandinavian Activity—CW
Sept 15-17	Washington State QSO Party
Sept 22-23	Scandinavian Activity—Phone
Sept 29-30	Delta QSO Party
Oct 13-14	ARRL CD Party—CW
Oct 20-21	ARRL CD Party—Phone
Nov 3-4	ARRL Sweepstakes—CW
Nov 10-11	CQ-WE Contest
Nov 11	OK DX Contest
Nov 17-18	ARRL Sweepstakes—Phone
Nov 24*	DAFG Short Contest—SW
Nov 25*	DAFG Short Contest—VHF
Dec 1-2	ARRL 160 Meter Contest
Dec 1-3	North Carolina QSO Party
Dec 8-9	ARRL 10 Meter Contest

* = described in last issue

Results

RESULTS OF THE COLOMBIAN INDEPENDENCE DAY CONTEST 1978

AWARDS

World Winner of the Contest—UK2GKW

Continental Winners of the Contest:
North America K5UR
South America HK4DF
Africa
Asia 9K2FX
Oceania
Europe UK2GKW

Multi-Operator/Multiband/One Rig Highest Scoring Station—UK2GKW

Single Operator/Single Band—9K2FX

Single Operator/Multiband—HK4DF

Microcomputer Interfacing

Christopher A. Titus
David G. Larsen
Peter R. Rony
Jonathan A. Titus

SAMPLE-AND-HOLD DEVICES

Sample-and-hold (S/H) devices or sample-and-hold amplifiers (SHA) are analog circuit elements that are the analog equivalent of the digital latch. They are used when we wish to sample an analog signal and then hold it steady at a particular point so that a voltage of interest may be measured or used elsewhere in a system. The operation of an ideal sample-and-hold device is shown in Fig. 1. In this example, the S/H output follows, or *tracks*, the input during the sample period and then holds the latest analog voltage when it switches to the hold mode. In the figure, the input and output voltage lines are offset slightly for clarity.

Sample-and-hold devices are widely used in conjunction with digital-to-analog and analog-to-digital converters. For example, they may be used to:

- Hold an analog signal steady so that an A/D conversion may be performed;
- Simultaneously sample many analog inputs for later measurement (requires one S/H device per analog input);
- Deglitch a D/A converter's output to eliminate output voltage spikes or settling transients; and
- Distribute one D/A converter's output to several points, where analog voltages must be constantly maintained.

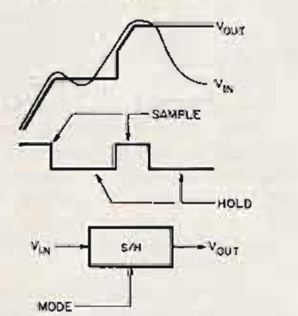


Fig. 1. Inputs and output for an ideal sample-and-hold device. Both the sample and hold modes of operation are shown.

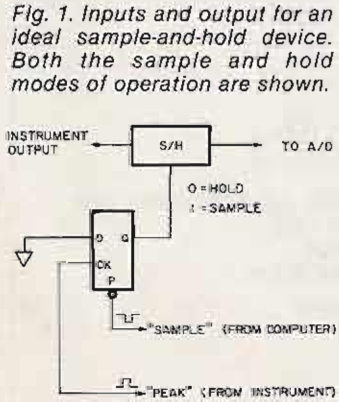


Fig. 2. Block diagram for a typical sample-and-hold microcomputer interface circuit. The instrument supplies the PEAK input pulse to the flip-flop. The SAMPLE pulse from the computer presets the flip-flop to logic 1.

The second and fourth uses listed above are becoming less important than they were two or three years ago. It is probably less expensive now to dedicate an A/D converter to each input to be measured and to have one D/A converter per output, depending upon the specific application.

The most common use of sample-and-hold devices is to sample and hold an analog signal at a particular point while it is measured with an A/D converter. A sample-and-hold device is particularly useful in situations in which a DAC and a comparator are being used in conjunction with microcomputer software to create an A/D converter.[1] When a sample-and-hold device is used prior to the input of the unknown signal to the comparator (or an A/D converter module if one is used), the digitization may proceed to give an accurate representation of the unknown voltage. For example, in Fig. 2 we provide a block diagram for a typical sample-and-hold computer interface that permits you to measure the peak voltage from an instrument. We have assumed here that the instrument provides a positive clock pulse, called PEAK, when the peak maximum is reached. The SAMPLE pulse from the computer allows the S/H module to sample the unknown signal from the instrument. When the peak is reached, the PEAK signal clocks a logic 0 into the output of the flip-flop, forcing the S/H device into the hold mode. Fig. 3 shows the timing diagram that would be generated by the interface circuit shown in Fig. 2. Again, the S/H output and the instrument output have been offset for clarity. Now, either a slow ramp A/D converter or a fast successive approximation A/D converter can be used to provide the correct value for the peak voltage since the S/H device will maintain the voltage until it can be digitized.

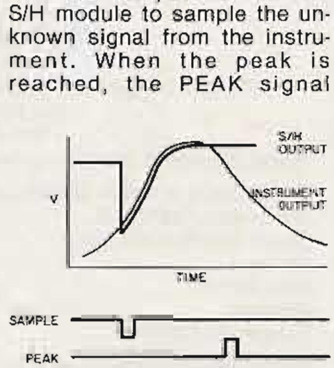


Fig. 3. Typical timing diagram for the interface circuit shown in Fig. 2.

acquisition time	The time required to go from the hold state to the tracking state, in which the output remains within a 0.01% range of the input. This may also be called the settling time when the S/H device is already in the sample mode. The acquisition time is generally a few microseconds. See Fig. 4.
aperture time	The time period required by the device to go from the sample mode into the hold mode once the hold command has been received. The aperture time is generally a few nanoseconds. See Fig. 5.
droop rate, decay rate	The rate of discharge of the sample-and-hold capacitor. The rate is a function of switch leakage current and the current required by other circuit elements connected to the capacitor. It is expressed as millivolts per second. See Fig. 6.
gain error, linearity	The variation of the observed output from the expected output over the entire sample-and-hold device's output voltage range. It is usually expressed as a percentage, say 0.01%. See Fig. 6.
offset	The difference between the input and the output voltages of the device when the input is ground. It is usually expressed as millivolts. The offset may be adjusted to zero using external components, but it will generally change with time and temperature. See Fig. 4.
slew rate	The maximum rate of change for the output, expressed as volts per second. It is a limitation imposed by the charging rate of the capacitors and the actual slew rates of the operational amplifiers present in the S/H circuit. See Fig. 4.

Table 1. Some important concepts associated with sample-and-hold devices.

Sample-and-hold devices are not ideal, and there are some terms that will help you better understand their limitations and uses. These are listed in Table 1, which is keyed to Figs. 4, 5, and 6. As can be observed, there are important limitations to the capabilities of S/H devices. Those devices that have short acquisition times use small capacitors and thus the voltage droop rate will be large. The use of larger capacitors means that the acquisition time will be longer, but the voltage droop will be less. When high acquisition speeds and long hold times are required in an application, two S/H modules may be used: The first quickly acquires the analog signal at the point of interest and the second acquires and holds the output from the first device. The second S/H device takes longer to acquire the voltage presented by the first device, but since a larger capacitor is used, its droop rate will be much lower. For further details, the reader is referred to reference 2.

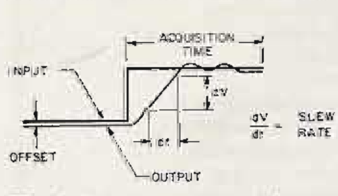


Fig. 4. Representation of the acquisition time, offset, and slew rate. (Courtesy of Analog Devices, Inc.[3] All rights reserved.)

There are a number of commercially available sample-and-hold devices which eliminate the need for you to construct your own. The following modules are representative of those available:

Analog Devices, Inc., Norwood, Massachusetts 02062—SHA-5, general purpose, $47; SHA-1A, general purpose, $150.

Burr-Brown, Tucson, Arizona 85734—SHC80KP, low cost, $34; SHM60, high speed, $104.

Datel, Inc., Canton, Massachusetts 02021—SHM-LM2,

Continued on page 77

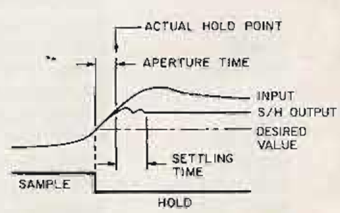


Fig. 5. Representation of the aperture time and the settling time. (Courtesy of Analog Devices, Inc.[3] All rights reserved.)

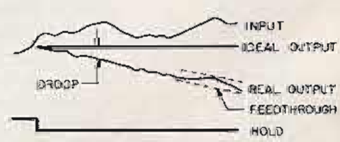


Fig. 6. Representation of the linearity, droop rate, and feedthrough. (Courtesy of Analog Devices, Inc.[3] All rights reserved.)

New Products

KANTRONICS' AMATEUR UPGRADE™

Kantronics' "Amateur Upgrade" is an educational board game that familiarizes players with FCC rules governing amateur radio and elementary radio concepts. The game comes complete with playing surface, playing pieces (coil, grommet, etc.), a die, a deck of exam cards, and corresponding answer sheets.

"Amateur Upgrade" is packaged in a colorful light blue box; it measures 1.5" high by 8.25" wide by 15.5" long. Game pieces and exam cards fit in a pocket adjacent to the support tray. The game surface is 15.4 inches square and is printed in five colors corresponding to beginner, Novice, General, Advanced, and Extra class.

Players roll the die to determine the number of spaces to move. Some spaces players land on have a consequence, such as "taught a Novice class—move again," or "exceeded 1000 Watts—answer question; if wrong, go to start," or "illegal third party traffic—lose one turn."

When a player lands on an exam space, he must take an exam card from the card pile corresponding to the license level he is trying to upgrade to. After three cards have been collected by one player, he must "take the exam." All three questions must be answered correctly to pass the exam. Answers can be checked against the answer sheets. If the exam is passed, the player moves up (upgrades) to the adjacent exam space on the next license level. If the exam is failed, the player remains on the same level and must collect another three exam cards.

The first person to progress through all levels to obtain the Extra-class license wins!

Novice, General, Advanced, and Extra-class questions are included. For a less advanced game, the Novice cards can be used exclusively for all license levels.

Kantronics, Inc., 1202 E. 23rd St., Lawrence KS 66044; phone (913)-842-7745. Reader Service number K13.

NEW COMMUNICATIONS RECEIVER FROM NATIONAL RADIO

National Radio now offers the latest version of its Model HRO-600 high precision/performance solid-state general-coverage communications receiver, conceived for applications requiring wide frequency coverage, high stability, sensitivity, and selectivity. The frequency stability of this professional receiver, over the temperature range of 0° to 50° C., will drift less than one part in one million, and, under normal operating conditions, it can be expected to drift less than one part in one hundred million. The receiver's fine-tune mode, using the Model 602 plug-in module, permits tuning to a fraction of 1 Hz without any loss of stability.

The HRO-600 was originally designed and built to the exacting requirements of the International Maritime Standards. With its versatile plug-in modules and accessories, the Model HRO-600 becomes a custom receiver designed to meet users' specific needs at the lowest cost. The manufacturer states, "The HRO-600 is unmatched in performance and versatility in its price range."

The receiver's excellent rf selectivity from 16 kHz to 30 MHz is achieved by a built-in tunable preselector. Depending upon the plug-in module selected, the receiver will operate at any frequency between 10 kHz and 30 MHz in any of the following reception modes: AM, CW, SSB, FSK, and FAX.

The basic applications of the HRO-600 include: commercial communication, ship-to-ship, ship-to-shore, ground-to-air, frequency/time measuring, process control, laboratory instrumentation, military, paramilitary, international monitoring, limnology, etc.

The HRO-600 meets applicable military standards as to shock and vibration, has an operating temperature range from 20° to +55° C., measures 5¼" high x 17" wide x 15½" deep, and is provisioned for self-supporting rack mounting. The approximate weight is 40 lbs., available from stock, FOB factory.

For additional information, write or call Robert Reeves, Sales Manager, *National Radio Company, Inc., 89 Washington St., Melrose MA 02176; phone (617)-662-7700.* Reader Service number N23.

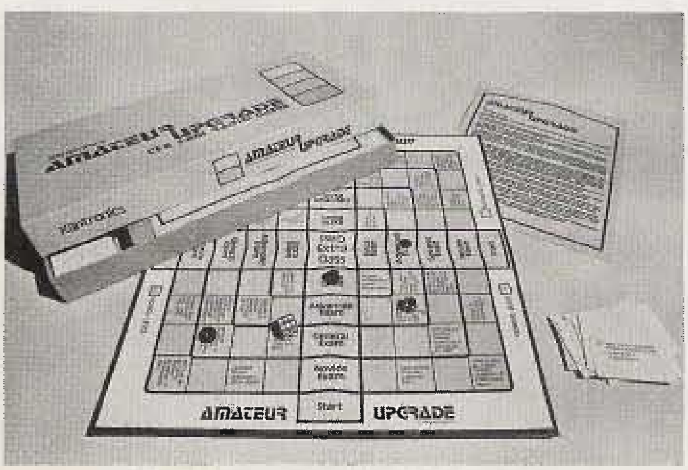
The Astro 150 from Swan.

SWAN'S ASTRO 150 TRANSCEIVER

Swan Electronics Corporation has announced its newest entry into the amateur radio market with the introduction of the Astro 150 transceiver, featuring microprocessor control and memory.

The new solid-sate transceiver, with its microprocessor control, provides more than 100,000 digital-controlled frequencies and variable rate scanning (VRS). VRS is a dramatic new method of tuning which provides ease and accuracy and works in conjunction with hand-held microphone scanning. With microphone "up" and "down" pushbuttons, the Astro 150 can be tuned in accurate 100-Hz steps or at a fixed rate scan. VRS is a supplement to the Astro 150's conventional tuning knobs.

The compact new radio also has additional features which include 235 Watts input power, full and semi break-in CW, narrowband CW filter, expanded frequency coverage, and microprocessor-controlled frequency memory.



"Amateur Upgrade" game from Kantronics.

National Radio's latest version of the HRO-600.

The Astro 150 will be sold through Swan's worldwide network of dealers. For further information, contact Gary Pierce at *Swan Electronics Corporation, 305 Airport Road, Oceanside CA 92054; phone (714)-757-7525.* Reader Service number S44.

METZ COMMUNICATION'S AMATEUR ANTENNAS

Metz Communication Corporation has broad experience in producing mobile-type antennas. However, until recently, the company has concentrated its sales efforts in the commercial land mobile and marine radio markets. Now Metz has entered the amateur marketplace with mobile antennas for the 10-meter, 2-meter, and 70-cm bands. I installed and operated the 2-meter version, the Mobile 2, in preparation for this review.

The commercial heritage of the Metz amateur antennas is readily apparent. Instead of the usual plastic tube to protect the base loading coil from the weather, the Metz coil is housed inside a machined stainless steel cylinder. This cylinder, in turn, is filled with epoxy to completely encapsulate the coil . . . no more worries about a leaky base coil.

The tapered stainless steel whip is held in place by a metal ferrule that is (would you believe?) gold-plated to prevent corrosion. Overall, the construction of the Metz Mobile 2 is so rugged that it will probably still be going strong when you and I are long gone.

The Mobile 2 is designed to operate as a half-wavelength antenna on the 2-meter band. This design makes the antenna a bit shorter than the more familiar 5/8-wavelength 2-meter antennas. I consider the reduced length a plus; in my case, it made the difference between being able to mount the antenna on the car roof (the best location) and being relegated to the trunk lip (for fear of bashing the whip against the garage door).

In operation, the Mobile 2 is a breeze. When cut for lowest swr in the center of the 2-meter band, it's possible to operate from 144-148 MHz with an swr of 2.5:1 or better. Of course, if you work primarily in one end of the band or another, you can optimize the performance for that portion of the spectrum.

I found the Metz to be equal to or better than my 5/8-wave antenna in every respect. Additionally, the completely weatherproof design of the Mobile 2 means that leaking and condensation around the coil are never going to be a problem; you get full performance even in the worst weather. The Mobile 2 is rated at 200 Watts for those who need the extra punch of a linear amplifier. Several mounting styles are available in addition to the excellent magnetic mount I used.

For those who demand quality construction in everything they own, the Metz antennas are going to be tough to beat. *Metz Communication Corporation, Corner Routes 11 and 11C, Laconia NH 03246.* Reader Service number M100.

Jeff DeTray WB8BTH/1
Assistant Publisher

A NEW CONSUMMATE DIGITAL VOLKSMETER

Non-Linear Systems' new Model LM-353 3½-digit digital Volksmeter was designed to include numerous advanced state-of-the-art features. The LM-353 is packaged in a small 1.9-inch-high by 2.7-inch-wide by 4-inch-deep attractive plastic case. It weighs only 9.2 ounces.

Basic functions include ac and dc volts, Ohms, and ac and dc milliamperes. Full-scale ranges are 1, 10, 100, and 1000 volts, 1, 10, 100, 1000, and 10,000 kilohms, and 1, 10, 100, and 1000 milliamperes.

In addition, a low-Ohms capability is present which provides for in-circuit test of resistive components. It is particularly useful for in-circuit test of resistors shunted by semiconductor devices because the low compliance voltage provided does not turn on the semiconductor.

The low-Ohms function adds other capabilities to the meter. It can be used to increase the sensitivity of the voltage ranges by a factor of 10. It provides a 0.1-kilohm resistance range having 100 milliohm resolution. In addition, the milliamperes function is enhanced in two ways. First, a .1-milliampere range is available. Second, the voltage drop across the internal current shunt is reduced by a factor of 10. Measurements from 100 nanoamperes to 100 milliamperes can be made in this mode.

The LM-353 utilizes an LCD display. Replaceable AAA-size batteries allow up to 100 hours of operation. Standard features include auto polarity, decimal location, input overload protection, and automatic zeroing.

Options include a tilt-stand case for bench use and a panel-mount flange case for installation into equipment. A 45-kV high-voltage probe and leather carrying case are also available.

The complete NLS digital Volksmeter line is sold through a worldwide network of leading electronic distributors. The Model LM-353 will be available from distributors in July. *Non-Linear Systems, Inc., PO Box N, Del Mar CA 92014; phone (714)-755-1134.* Reader Service number N22.

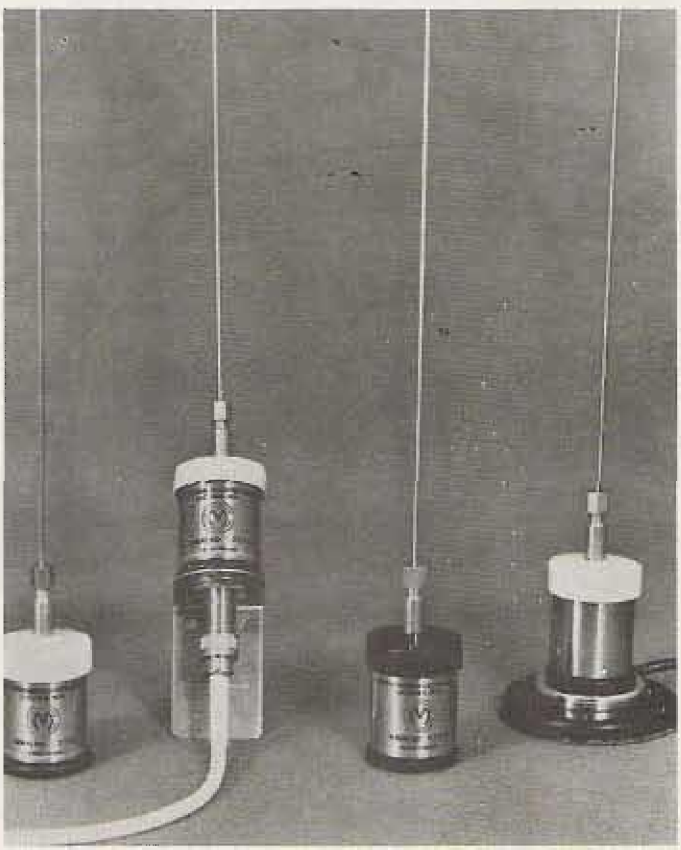
Model LM-353 digital Volksmeter from Non-Linear Systems.

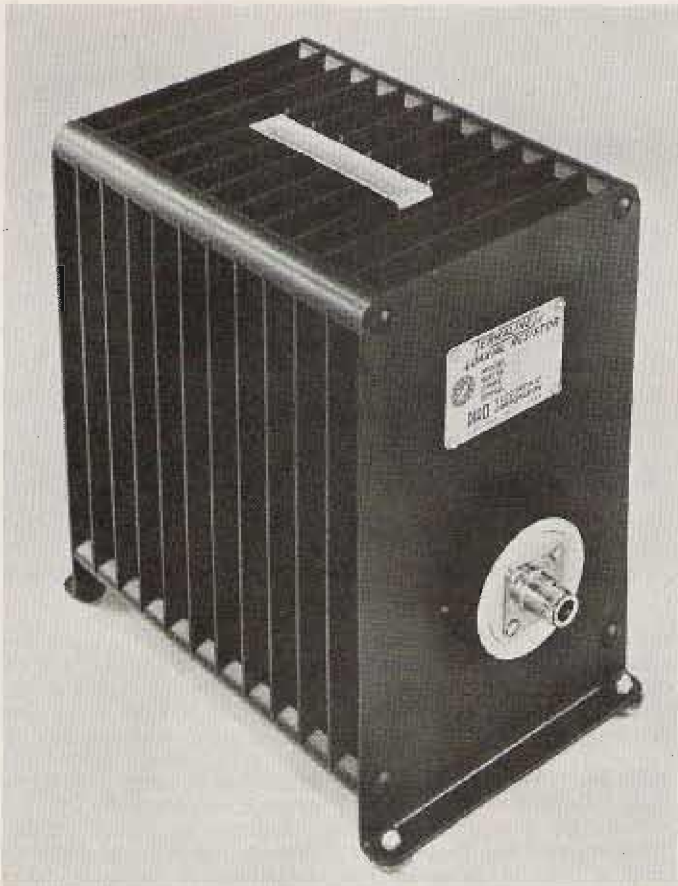
NEW 300-WATT DRY RF LOAD RESISTOR

The new Bird model 8173 TERMALINE® dry high-power coaxial load is designed for 50-Ohm rf-line and system termination during design, test, and alignment. At 300 Watts continuous duty, it complements the present Bird Dry Loads group ranging from 2 Watts through 600 Watts. The group, with its rugged construction and air dielectric (no liquid coolants), now includes 2-, 5-, and 10-Watt loads with fixed input connectors, and 25-, 50-, 100-, 150-, 300-, and 500/600-Watt loads with Quick-Change connectors.

The use of Bird QC Quick-Change connectors offers unsurpassed flexibility; a choice of any common rf connector either at the time of order or in the field eliminates adapters and degradation of performance.

Available from *Bird Electronic Corporation, 30303 Au-*


Amateur mobile antennas from Metz.



Model 8173 Termaline from Bird.

rora Road, Cleveland (Solon) OH 44139. Reader Service number B10.

CDE INTRODUCES TWO NEW ANTENNA ROTOR SYTEMS

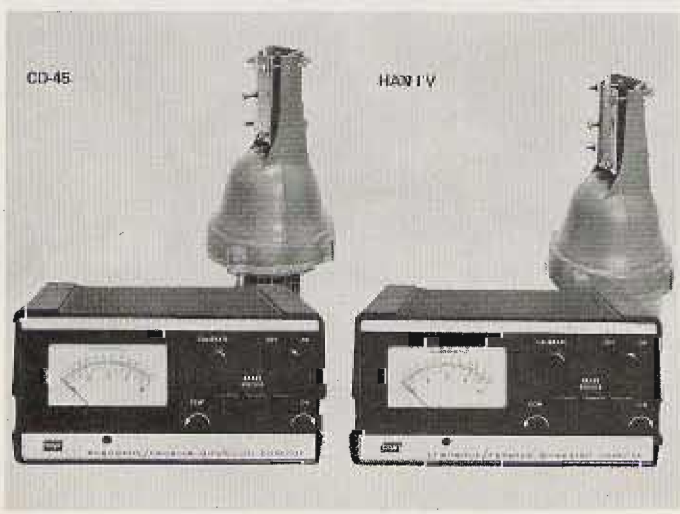
Two new models of high-performance antenna rotor systems, the Ham IV™ and the CD-45, have been introduced by Cornell-Dubilier Electric Corporation, Newark NJ.

The new Ham IV is designed for large communication antenna arrays up to 15.0 sq. ft. wind load area when tower-mounted. Highlights of the Ham IV include power braking, machined steel drive gears, dual transformer circuitry, and other design features that make it "the engineered choice" for serious communicators.

The new CD-45 accommodates antenna arrays up to 8.5 sq. ft. wind load area when mounted in a tower and features a professionally-styled control unit, illuminated metered readout, all-steel drive components, automatic disk braking, and more.

Both the Ham IV and the CD-45 operate at safe low-voltage control levels with reliable snap-action rotational controls for accurate, trouble-free operation.

For more information, write Leonard Sabal, *Cornell-Dubilier Electric Corporation, subsidiary of Federal Pacific Electric Corporation, 150 Avenue L, Newark NJ 07101; phone (201)-589-7500.* Reader Service number C143.



New antenna rotor systems from CDE.

ANTECK MT-1 MOBILE ANTENNA

Improved conditions on the HF DX bands has stirred increased interest in mobile operation on those frequencies by many amateurs. In mobile operation, the antenna is even more important than it is in fixed installations. For one thing, if you've got an inefficient antenna at home, you can always help to make up for its shortcomings by running more power. However, while there are a handful of mobile kilowatts around, most amateurs have to be satisfied with the output from their transceiver, usually in the 100-Watt range.

So, for effective mobile operation, an efficient antenna is of prime importance. It should also be easy to install and tune, weatherproof, and allow band changes without having to change coils. The new Anteck MT-1 certainly meets those requirements and, when properly installed and tuned, should provide a high degree of performance on the HF bands.

The frequency coverage of the MT-1 is 3.5 to 30 MHz, making it perfect for use on MARS and other non-amateur frequencies (in addition to the 10 through 80 meter amateur bands). Its power handling capability is 750 Watts PEP. The MT-1 consists of three main assemblies: mast or base section, loading coil, and whip. The overall length of the mast section and loading coil is 60 inches and the diameter is approximately 1 inch. The total antenna length is 116 inches at 3.5 MHz and 92½ inches at 30 MHz. The antenna is center-loaded on all frequencies except 29 to 30 MHz, where it works as a quarter-wave vertical.

Properly mounted and tuned, the MT-1 will display the vswr/bandwidth shown in Table 1.

The loading coil is tuned from the base of the antenna, using a non-inductive plastic rod which is attached to the base of the whip assembly and extends down into the bottom mast section. The antenna comes with a handy chart that correlates the numbers on the antenna's tuning scale to frequency. To set the antenna for a particular frequency, loosen the knurled nut in the slot in the base section four turns and push the tuning rod to the middle of the base tube so that the tuning rod will move freely without binding. Then set the top of the nylon collar to the position called for on the tuning chart for the frequency in use and retighten the knurled nut. That's all there is to tuning the Anteck MT-1.

The MT-1 mobile antenna is manufactured entirely in the United States using only the best-quality military-standard materials and components. Its three-piece modular construction (base section, loading coil, whip assembly) makes for ease of repair or replacement if damaged. There is a 90-day warranty. Factory service is available.

The net price for the MT-1 mobile antenna is $119.95. *Anteck, Inc., 239 Cedar Street, Box 543, Jerome ID 83338; (208)-324-3400.* Reader Service number A80.

Morgan W. Godwin W4WFL
Brattleboro VT

Band	*Vswr*	*Bandwidth*
80 meters	*Less than 1.2 to 1*	*25 kHz**
40 meters	*Less than 1.2 to 1*	*50 kHz**
20 meters	*Less than 1.2 to 1*	*300 kHz**
15 meters	*Less than 1.5 to 1*	*150 kHz**
10 meters	*Less than 1.2 to 1*	*500 kHz**

*Table 1. *From resonant frequency.*

MICRONTA 12-VDC 8-AMP POWER SUPPLY

Now available from Radio Shack is a new power supply that converts standard 120 V ac house current to 12 V dc at up to 8 Amps output for powering high-power auto sound equipment, mobile CB transceivers, and amateur radio equipment at home.

The Micronta 12-volt 8-Amp power supply includes a heavy-duty transformer and 35-Amp bridge rectifier for handling high current demand devices. Filtered output reduces "hum," and ripple is less than 2 volts peak-to-peak with a full 8-Amp load, according to Radio Shack.

A built-in manually resettable circuit breaker protects the supply and your equipment from damage. An LED indicates power on.

Manufactured in Radio Shack's own USA factory, the power supply is housed in a metal cabinet with rubber feet. Size—3-3/4" x 8" x 5-5/8".

The Micronta 12-volt 8-Amp power supply is available exclusively from participating

Continued on page 174

IC-701, Your Synthesized Passport

Enter the exciting world of HF DX with ICOM's outstanding, fully synthesized **IC-701**. Globe-spanning QSO's are as easy as hook-up and tune-in. Complete installation requires only a good 50 Ohm antenna and an AC power plug-in. Your **IC-701** comes with everything else you need for beginning DX transmissions, including the matching **IC-701PS** external speaker and power supply, the fine **SM-2** base microphone, and even two built-in VFO's.

Turn on the power, and the world's at your single fingertip. The **IC-701** lets you scan all the Amateur HF bands from 160M to 10M (plus some MARS coverage above and below some of the Ham bands) with one finger. No more fooling around with two or more tuning knobs, and no complicated retuning when you QSY.

When talking on your **IC-701**, you get a 200 watt PEP input signal whose punch is significantly increased by the high quality built-in RF speech processor. This makes your 200 watts sound like so much more that we recommend you leave the speech processor on all the time.

For adding on frequency memory and remote frequency control, the **IC-701**'s synthesizer is completely compatable with ICOM's **RM2** remote computer controller: and with ICOM's optional **EX1** extention, you can operate with the **RM2** and a linear amplifier at the same time.

Nothing else matches the value and ease of the **IC-701**. Plunge into the excitement of HF DX now, and get the whole HF world with ICOM's **IC-701** LSI system.

IC-701: DXterity

HF/VHF/UHF AMATEUR AND MARINE COMMUNICATION EQUIPMENT

ICOM

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All ICOM radios significantly exceed FCC regulations limiting spurious emissions.

DX

Chuck Stuart N5KC
5115 Menefee Drive
Dallas TX 75227

NOVICE CORNER

This month we want to pass along a little QSL advice that is aimed not only at the newcomer but to a lot of the oldtimers as well.

If you work a station, such as a DXpedition, several times on different modes at different times, please do not place a card for each contact in an envelope addressed to the QSL manager and include only one SASE.

Because there are often several logbooks involved and several different people or groups handling the QSLing chores, you will stand a much better chance of getting a fast return if you include a separate SASE for each QSL card. If the extra expense is too much to bear, then you really don't need the extra cards.

While we are on QSLing, we will remind you again to always use GMT/UTC time on your card including the date, be sure that your call appears plainly on the report side of your QSL, and to always include a self-addressed, stamped envelope when sending a card to a QSL manager. When sending a card overseas, either direct or to a foreign QSL manager, include a self-addressed envelope along with a dollar bill, foreign mint stamps, or sufficient IRCs to prepay the return postage.

CARIBE DX ASSOCIATION'S PLANS

The Caribe DX Association's Alex Kasevich W1CDC is presently in the process of engineering a large DXpedition to some rare place on the globe. All interested persons who feel they meet the requirements listed should apply for an interview. The time window for this adventure is August, 1980; exact dates will be made available when government legalities and logistics permit.

They have a large seaplane with a pilot and a co-pilot at their disposal. A large manufacturer of amateur equipment has endorsed their intentions by the loan of some top-of-the-line ham gear.

All persons who apply must hold a current amateur radio license, General class or higher; they must also have a doctor's endorsement indicating that they have no physical restrictions that could be affected by extreme heat, sun, humidity, sea/air sickness, possible physical exhaustion, and insect bites. All members shall be proficient CW/SSB contest-style operators and must have a secondary ability to contribute to the expedition in the following categories: 2 persons with some paramedic training; 1 doctor; 2 cooks; 1 navigator; 1 antenna specialist; 1 electronics (solid-state) technician; 1 mechanic, gasoline generator maintenance.

All members of the expedition must be able to swim and have some climbing ability.

These requirements have been made not to discourage anyone from taking part, but to ensure the safety of all members and make the DXpedition a success. It must also be clearly understood with all members that there is always the possibility of hidden dangers in pulling off a trip of this magnitude. I'm sure all of you will have various questions about this subject, and they will be answered in the best interest of all parties concerned.

Please send your reply with your remarks, phone number, and best time to contact you to: The Caribe DX Association, c/o Alex M. Kasevich W1CDC, PO Box 93, East Glastonbury CT 06025.

HEARD ON THE BAND

That 4W2AA being heard from time to time appears to be I2YO who travels to Yemen on a regular although infrequent basis. QSL to I2MVS.

GJ2LU is the official QSL manager for any Isle of Jersey stations.

PY1RO is the first DX station ever to make WAS on 160 meters.

A recent article in the Russian *Radio* magazine notes a decision by the USSR State Commission on Radio Frequencies to allow amateur activity between 1850 kHz and 1950 kHz. Although no date was given, it seems definite that you should be hearing the Russians on 160 meters any day.

Anyone wanting to learn more about the action on 160 meters should drop a note to W1BB along with an SASE and request a copy of Stu's very informative bulletin.

The African swing by N6VR and WA6VNR netted some 3000 contacts from C5ABX/C5ABZ and 2200 from /6W8. They had a 5T5 permit, but time and funds ran out before they got to Mauritania. QSL to 48 South Chestnut Street, Ventura CA 93001.

Slim has been pulling overtime lately what with the good band conditions and cheap airline rates. If you worked any of the following, then know that you have met Slim himself: 6B1B, J1A, 7O1AA, 9N1AB, BY1USA, CR9CB, XZ2BC, KL8AA, and, of course, VRØM from Malden Island. Being the bashful sort, Slim generally prefers CW, but on occasion he can be found on the phone bands. If you hear the generator whine, you know it's Slim.

SV9JI on Crete has a weekly schedule with W2TDQ on Tuesdays at 2100Z on 14288 kHz.

Lloyd and Iris Colvin, of YASME DX fame, report that with the end of their recent West Indies swing, they have held 104 different callsigns, visited 135 countries, and have made over 500,000 QSOs. They have a QSL file of over 250,000 alphabetized cards, probably the largest collection in the world. *Guinness Book of World Records* is missing out.

A station has been worked on fifteen signing HV2VO and giving his name as Brother Edmund. Said to QSL via IØGPY. This could be the Vatican Observatory station we mentioned a few months back.

Those EJ prefixes heard over the May 18/20 weekend were special calls issued for operation by several GI stations from Inishmurray Island. QSL to GI4FUM.

VR6HI was number 100 on 160 meters for PY1RO.

VP8SU from South Georgia can usually be found with WA2JUQ in a list-type operation every Tuesday/Wednesday/Friday on 14240 kHz around 0100Z. QSL to G3RCA.

After much waiting, the necessary documentation was forwarded to ARRL Headquarters and they are now accepting HZ1BS/8Z4 cards for DXCC credit.

For some time now, rumors have been thick concerning an upcoming Franz Joseph Land effort by some of the UA/UK types. Along this line, UA1OE advised W4ORT that there would be something coming this July. UK1ZAA advised KH6GI that UK1PAA was the only station on FJL and it was crystal controlled on 14030 kHz. Listen for Franz Joseph Land to be activated . . . someday . . . maybe.

9N1BMK was true blue. QSL to his home call JA8BMK.

YU2DX returned home from the Sudan where he was doing some educational work in the electronic field. A radio club has been organized in Khartoum and the club call is 6T1YP. Both 6T1YP and 6U1DX can be QSLed to YU2DX. Other new calls being heard out of the Sudan lately are ST2FF and ST2MM.

UØCR was Leo UA3CR, part of a seven-man skiing team headed for the North Pole. UØCR counts for the RAEM award.

That linear shipped to Father Dave CEØAE should be in use now and the signal should be much improved. CEØAE can often be found on the various DX nets such as the Family Hour on 14225 kHz at 1500Z or the Afrikaner Net, 21358 kHz from 1830Z. Overseas commercial interference has forced the Afrikaner Net to move up from its normal 21355-kHz spot.

4U1UN has moved its location to the 48th floor of the Secretariat at UN Headquarters in NYC. They still have only dipoles and a vertical, but they are working on permission to install a beam.

3B8DA has been inactive most of this year trying to clean up the backlog of some 20,000 cards received as the result of some of his recent operations.

The VR6HI operation from Pitcairn Island by ZL1AMO and ZL1ADI produced an almost unbelievable QSO total of better than 33,000 contacts spread out over six bands. The fewest contacts came on 160 meters with 170, and the most, 10,885, were made on 10 meters. During this same period, VR6BJ and VR6DX from the *Yankee Trader* made 753 and 1100 QSOs respectively. 193 of VR6BJ's contacts were on RTTY. These three operations should have dropped VR6 well down on the needed list.

New officers for the Mile-Hi DX Club are Roger Preece WBØRTZ—President, Bob Pierce WBØOGJ—VP, and Joe Hart WBØHAD—Secretary/Treasurer.

SV1JG expects to be on Rhodes in the Dodecanese group this summer signing SV1JG/SV5. Under the new call allocation scheme there in Greece, SV5 is Dodencanese and SV9 is Crete. This was done no doubt to aid the deserving DXer in his never-ending search for a new one.

Several VE types are working on the necessary permission to activate Sable Island during July or August. They have authorization from the DOC but were awaiting other required documents before firming up the details.

As this column is being written, the YVØAA DXpedition is going hot and heavy giving out a new one to deserving DXers all over the world. While we realize the DX bands are crowded these days, it seems a little ridiculous to spread the calling stations out over a forty kHz section of the band. Listening from 14200 kHz to 14240 kHz makes that section of the band useless for any normal DX activity and certainly does little to enhance our image among the sizable segment of our fellow amateurs who somehow fail to see the need to bring the normal day-to-day activities of amateur radio such as skeds, ents, SSTV, etc., to a screeching halt while we deserving ones strive to exchange signal reports with a temporary station located on an uninhabited island covered solid with birds and their natural residue. How anyone could fail to understand this and start complaining about *those DXers* is certainly beyond us. Transmitting below the American phone band and listening up is the only way for many DX stations to be able to make any contacts with USA stations, but it seems that listening over, at most, a fifteen or twenty kHz portion of the band should be sufficient. How do you feel about this practice?

Still nothing heard from China but a few phonies. A usually reliable source from Europe reports that one of the eastern Eurpean countries will be sending a team of radio technicians to help the Chinese develop knowledge in that area. Some among this team will be amateurs ready to demonstrate the finer points of amateur radio should the opportunity arise. The source seems rather definite that something will be heard this fall.

There are serious discussions going on between some of the biggest of the big-gun-type DXers concerning a concentrated effort this summer to wipe Mt. Athos (SY) from the face of the most needed lists. More information will come as plans gel.

If you think some exciting times can't be experienced in amateur radio, then you obviously were not in on the recent 1S1DX operation from Spratly. The initial landing was planned for Amboyna Cay. When the Spratly crew got close, they could see that there were people on the island and they cautiously came inside the reef to a point some 300 yards offshore. Through binoculars it was easy to detect military personnel in black uniforms grouped around what appeared to be weapons. One of the military types began signaling with semaphore signals, but unfortunately no one in the crew understood the signals. As the crew moved in closer, the message became somewhat clearer as four warning shots were fired across their bow. Feeling at this point they were not wanted and seeing that they could easily be blown out of the water with little effort, the little group again headed out to sea.

After this initial problem, the group returned to Brunei, regrouped, and decided to make another run, but this time to Pearson Reef, located some eighty miles northeast of Amboyna Cay and hopefully less inhabited since it had an elevation of only three feet above high tide. The approach to Pearson Reef showed how when it rains, it pours. Not only was the small reef occupied, but there were buildings and small craft around. Fortunately, the group had selected a third alternate, which they now headed for. It was from this spot, Barque Canada Reef, a sand bar some 150 feet in length, that the much-delayed, constantly-in-danger 1S1DX operation finally took place.

Most of the sixty hours stay on Barque Canada Reef was spent operating, often with more than one station on the air. Ten, fifteen, and twenty netted some 13,300 contacts with about half coming on fifteen. Phone seemed to result in a higher QSO/hour rate, so the concentration on this mode resulted in a 77%/23% phone/CW split. Forty percent of the contacts were with Japan, thirty-five percent were with stateside, fifteen percent were with Europe, and the remainder were scattered around the world.

QSL to Harry Mead, Box 85, Round Corners, 2158 Australia. Expenses were excessive due to the problems and any financial aid can go to K2TJ or via the Northern California DX Foundation.

The recent volcanic activity on St. Vincent Island in the West Indies found VP2SQ providing emergency communications for the local authorities. He is reported as having phone-patched Prime Minister Cato to other islands when there was a need for quick communications. It is this type use of amateur radio that we have been trying to demonstrate to the Third-World nations preceding WARC 79.

Rubin WA6AHF and his XYL Ferne have had to curtail their YASME QSLing efforts on the recommendation of their doctor. Although giving up the YASME effort, they will continue to handle cards for those stations they are QSL managers for.

Some EP stations are again being heard on a sometime basis, although the situation is far from being settled in Iran.

That 9N1YU being worked a few months back is reported by HS1ABD to be a true-blue type used by a Yugoslav mountaineering group in the Mt. Everest area.

S2BTF continues to show from Bangladesh on the weekends working a list-type operation. Look for him on 14226 kHz Saturdays from 1300Z and Sundays from 1200Z. QSL Peter via Box 108 in Dacca.

Father Marshall D. Moran, S.J., Kathmandu, Nepal, better known around the world as 9N1MM. Father Moran has been a regular fixture on the DX bands since 1961.

9N1MM has been keeping a fairly regular schedule around 14243 kHz after 0100Z. QSL to Ed Blaszczyk N7EB, 12802 Sun Valley Drive, Sun City AZ 85351. Ed has been handling Father Moran's QSL duties since 9N1MM first came on the air in 1961. Ed, who has also held the calls W3KVQ, W2KV, and KX6EB, asks that we remind those needing a 9N1MM QSL to please enclose an SASE. It makes the job much easier.

As we have often mentioned, it's usually easier and cheaper to just enclose a dollar bill (green stamp) with your QSL when a direct airmail reply is required than to go through the hassle of buying IRCs or foreign mint stamps. We also mentioned that there were situations when it was best not to enclose money with a QSL going overseas. A letter from Mansur AP2MQ brings up a case in point. Incoming mail is often checked by the Pakistani postal authorities, and since the importation of foreign currency is illegal in Pakistan, this often leads to embarrassing circumstances for the amateur to whom such mail is addressed. It is always best to follow the QSL instructions given by the DX station. In the future, do not send green stamps to Pakistan.

There is a report that the number of complaints to the FCC concerning the Russian "woodpecker" have risen sharply. It is sometimes a bit frustrating to report such interference and realize that the person on the other end has never heard of the "woodpecker." Check last month's column for the telephone number of your closest FCC monitoring station. Keep them advised of the "woodpecker's" activity and someday the "woodpecker" will vanish. Some claim that if we had reacted immediately two years ago, he would now be only a bad memory.

A couple of months back we mentioned the possibility of a Swedish group operating from Albania. The expected callsign was mentioned as being ZA5T. Late word on this operation has been zilch, but if anything new develops, we will certainly pass it along.

Those new Pacific area prefixes still seem to be causing trouble. It was sure easier to remember when KM6 was Midway, KW6 was Wake, etc. To help you learn the new designations, we will list them again:

KH1	Baker, Canton, and Howland
KH2	Guam
KH3	Johnston
KH4	Midway
KH5	Kingman if K suffix, Palmyra if not
KH6	Hawaii
KH7	Kure
KH8	American Samoa
KH9	Wake
KHØ	Northern Marianas

UKØYAH is being worked around 14050 kHz after 1800Z. We mention this as a reminder that Soviet Siberian stations whose suffix begins with a Y are located in Tana Tuva in rare Zone 23.

The Brussels Millennium Award is available to anyone working ten of the OS prefixes on at least two bands. Send log data and three IRCs to Brussels Millennium Award, PB 1000, B-1040, Brussels, Belgium.

Continued on page 172

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A Visit to Antenna Specialists

—Wayne tours the test range

Wayne Green W2NSD/1
Editor/Publisher

The science of measuring antenna performance as part of the design process has come a long way in the last twenty years. A recent visit to the Antenna Specialists test site in northeastern Ohio brought back memories of my past visits to other such sites . . . and the enormous changes in test equipment and procedures which have come about.

Let me tell you about my visit to Antenna Specialists' test site.

Sherry and I were met at the Cleveland airport by Al Dolgosh K8EUR, who led us out to the test site, over an hour's drive away. There we met Dick Leach WA3HSE/WB8ZAA, Tom Baker K8MMM, and Rick Davis K8DOC, the test site team. The lab was set up in a trailer with a reference dipole nearby. The test antennas were set up on a platform a couple hundred feet away.

This is the trailer with the laboratory equipment for running the antenna field strength tests. The tower to the left is for a ham station in the house to the rear of the trailer. It's nice to have a ham living right there to watch out for the test lab equipment.

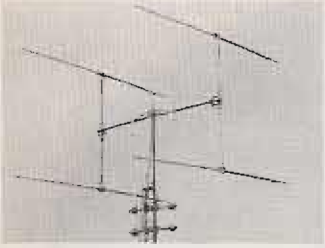
Was it only a little over twenty years ago that I visited a top manufacturer of ham antennas and watched them run tests on a long two-meter beam, measuring the signal strength every few degrees and writing down the figures? Today, this is all automatic. Today, they can run tests in a few minutes that used to take days, thus making it possible to design much more effective antennas. When you can make a small change in the antenna design and measure the results of that change quickly, it is relatively simple to explore many more variables for optimum performance.

With modern equipment at a test site, it is possible to measure the vertical and horizontal radiation characteristics of an antenna as well as the frequency response—all in a few minutes.

This is a small tower right beside the mobile lab. It is designed for mounting the transmitting antenna for the tests. Notice that this antenna can be raised and lowered to get the optimum vertical pattern of radiation.

You're looking at an enormous investment in test equipment. This gear is made just for labs of this nature and allows the automatic testing of the antennas, complete with the graphing system on the right.

Here Tom is showing the reference antenna which he set up by the receiving platform. This is a simple reference dipole.



The tests this day were going to be run on the Antenna Specialists 44-element beam.

This is the mechanism which is used to hold up the antenna to be tested and to turn it in time with the graph in the lab. The tilting gears allow the antenna to be brought down for mounting or changes. The whole mechanism is on the track and can be moved toward or away from the lab.

That's Tom on the left in back, Al on the right in back, Rick on the left in front, and Dick on the right in front.

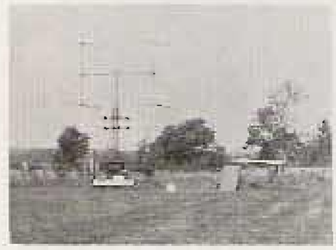
The test platform is being rotated so that the other two 11-element yagi antennas can be mounted on the boom. The rotating is all done remotely from the trailer.

Al Dolgosh K8EUR, who organized everything for us.

Rick Davis K8DOC, who is lucky enough to live at this extremely low-noise test site, complete with his ham rig and a good beam.

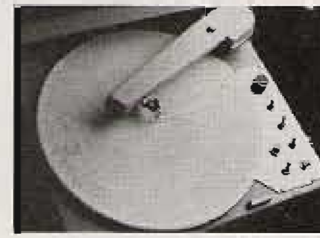
Tom Baker K8MMM.

Dick, Al, and Tom get the beam onto the boom and tightened in place for the tests.

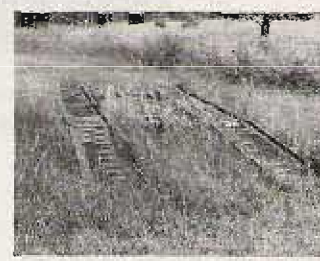


Here's the beam all set up and raring to go, about 300 feet from the source site.

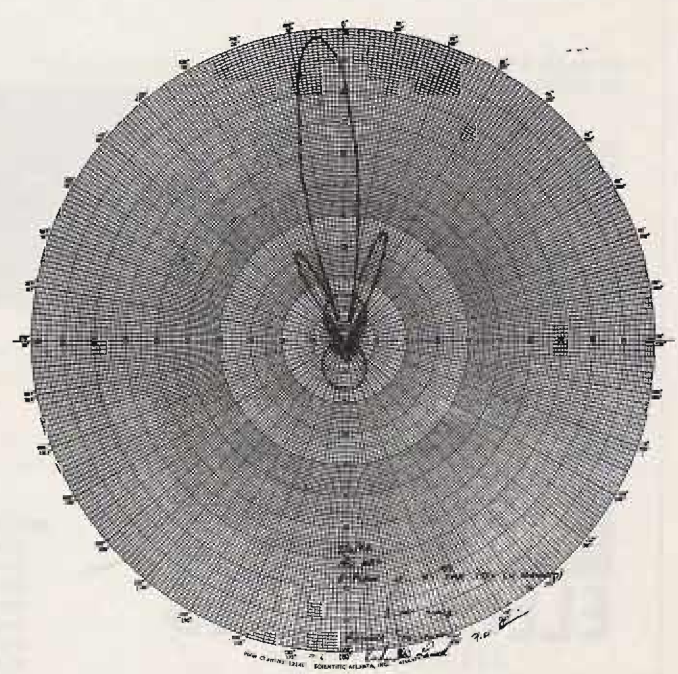
Dick runs the antenna array through a complete rotation, watching the pen on the chart as it traces the pattern of the beam.



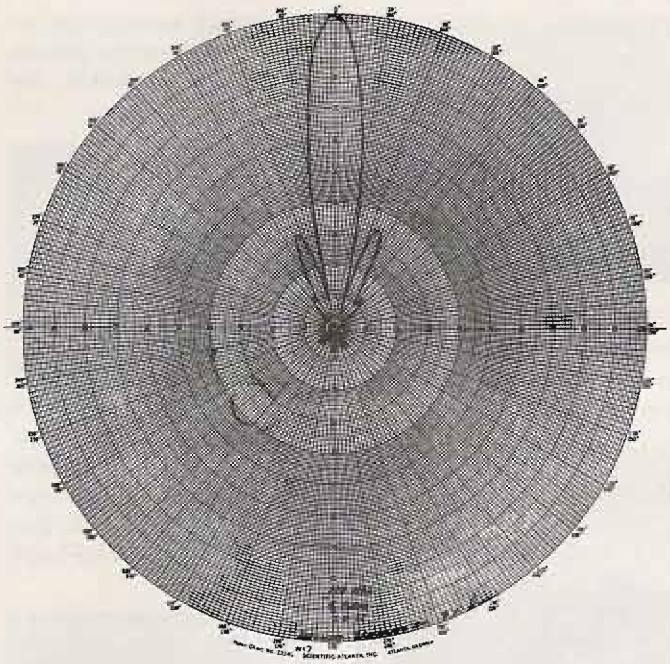
Here you see the finished pattern of the array. How about all that gain! And you surely can null out the interference with that incredible front-to-back ratio.



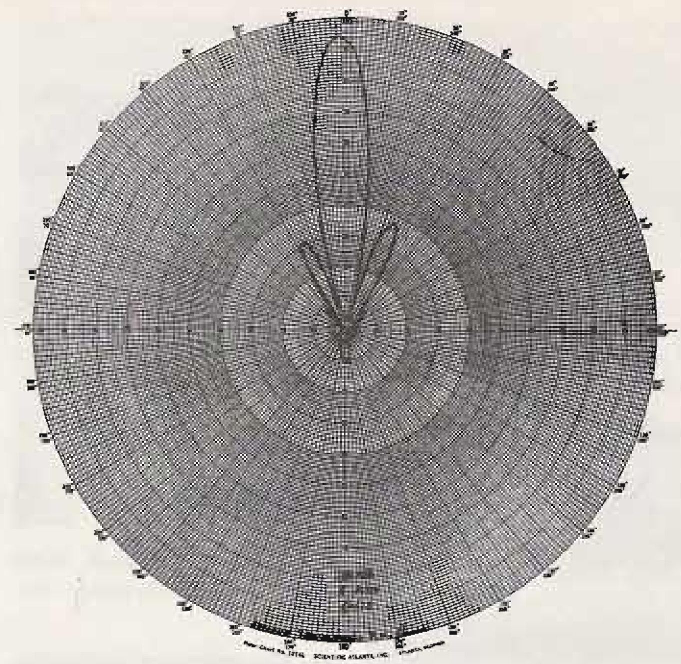
Over to the right of the test platform I found these tracks. They are for rotating cars to measure the radiation patterns of mobile antennas mounted on different parts of different cars. They drive the



This is the pattern drawn by the chart recorder for the 44-element array on 146 MHz with the comparison from a reference dipole (dotted line).



This is the same array, but measured at 148 MHz. Not a lot of difference—certainly none that you would ever notice in use.



One more run was made with the array on 144 MHz to make sure that it was capable of working over the entire 2m band. It takes a lot of careful design to make a high-gain array such as this work over a four-megahertz bandwidth with as little loss as this one shows.

car with the test antenna onto the tracks and then rotate the whole works to get the pattern. It's quite a complete test site facility.

After the test, Al had the 44-element array boxed up and shipped to the *73* lab. It took longer than we figured to get it airborne, due to some serious delays in getting a promised tower. The antenna puts out one whale of a signal, as you can see from the pattern on the graph. ■

Reader Service—see page 211

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PAI 50	1.6 dB	11 dB	2.5 MHz	+1 dBm	10 mA	$49.95
PA 144	1.5 dB	11 dB	2.5 MHz	+1 dBm	10 mA	$35.95
PAI 144	1.9 dB	10 dB	2.5 MHz	+1 dBm	10 mA	$49.95
PA 220	2.0 dB	11 dB	6 MHz	+1 dBm	10 mA	$35.95
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PA 432-2	1.6 dB	14 dB	150 MHz	-20 dBm	6 mA	$41.95
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PAE 432-5	1.0 dB	16 dB	180 MHz	-20 dBm	4 mA	$64.95

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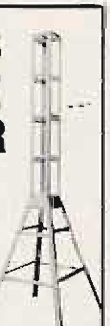

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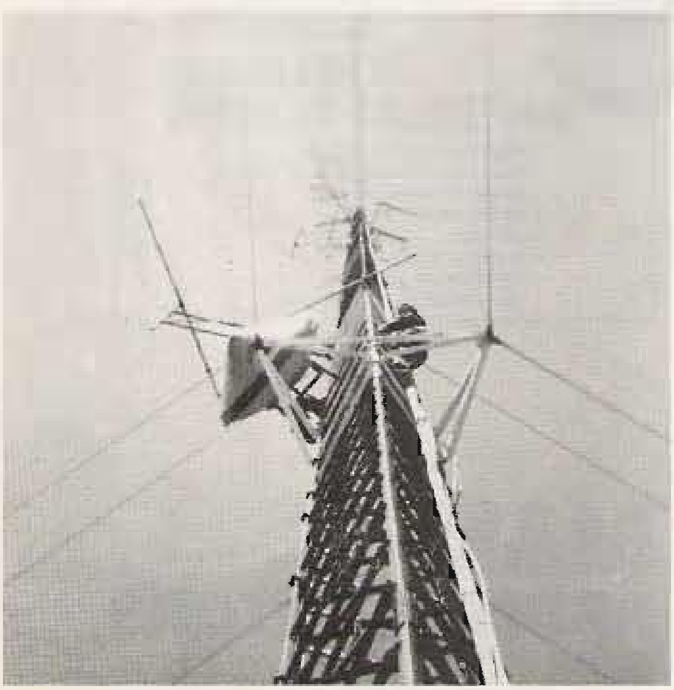
There is an old saying among hams that "if it stays up, it's too small." Who among us can truthfully say that on those long winter days we haven't spent a moment or two thinking how great it would be to have a five-element, 40-meter beam in the backyard, fed with 2 kW, and a hundred feet above ground? Dreams? Well, maybe. But it's sure that whatever your idea of the "ultimate" antenna array, it's got to be held up by something.

Since the best antenna farm starts with the support equipment, let's look at the best antenna support: the guyed tower. A tower is like a chain, in that it is only as strong as the weakest link. Self-supporting towers are linked to Mother Earth at one point—the base. Guyed towers, on the other hand, have four support points over which to spread the load—three anchors and the tower base. The penalty for this added strength is the larger chunk of real estate required to accommodate the guy-anchor supports.

In planning to erect a tower, there are some decisions and compromises to be made. One must be realistic about what will adorn the top of the tower and the worst case of wind loading that can be anticipated. The antenna load must be added to the wind loading to determine the total load environment in which the tower will be operating. Most antenna manufacturers publish load figures as part of their advertising, or will furnish data on request. The same goes for tower makers, and they also have data about



This is a commercial CATV tower. The dish at the left is a microwave receiving antenna. Mounted below it is a "star mount" anti-torque guy wire/frame system. The tower height is 500 feet.

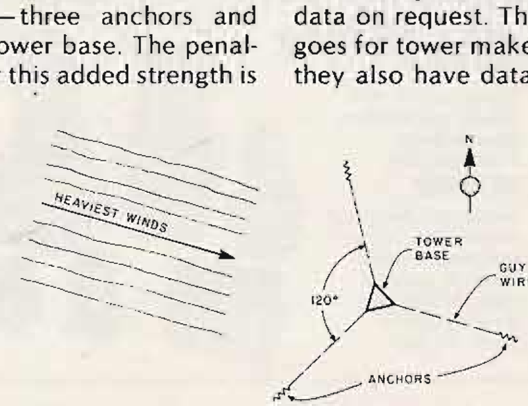


Fig. 1.

Here is a commercial tower anchor and "eyeplate." Note the length of guy wire laced through the turnbuckles to prevent loosening.

The bottom two guys shown here are attached to the anchor plate and to the "star mount" just below the microwave dish.

wind and ice conditions throughout the country to help in figuring the operating load.

As a rule of thumb, anchors should be placed out from the tower base a distance of between one-half and two-thirds the tower height. For a hundred-foot tower, this means the distance from base to each anchor will be from fifty to seventy-five feet. Since this distance determines the angle of the guys at the tower, it represents a compromise between the ideal one-foot-up for one-foot-out, or guy angle of forty five degrees, and some even sharper guy angle which conserves real estate. These considerations outline the practical limits of tower height.

Other factors which limit tower height are: surrounding objects like houses and trees, sloping terrain, local building codes, and neighbors. Each should be taken into careful consideration since towers are no less expensive to take down than to put up.

Since the load of a tower is in two parts, it is best to look at each in choosing a brand and model of tower. The side load is the force which is supported by the anchors and guy lines. The vertical load is supported by the tower and base alone. Most towers are triangularly shaped, and the wider the spread between the vertical legs and the larger in diameter they are, the greater the vertical load they will hold. Knowing the antenna loading figures and the weather conditions for your area, it is possible to have a tower manufacturer recommend the proper size tower for your needs.

Two last considerations should be figured into the choice of heights. How far will the rig be from the antenna, and what will the cable loss be, compared to the benefit of added height? In addition, who will service the array? It seems that the number of volunteer climbers varies inversely with the height of the work!

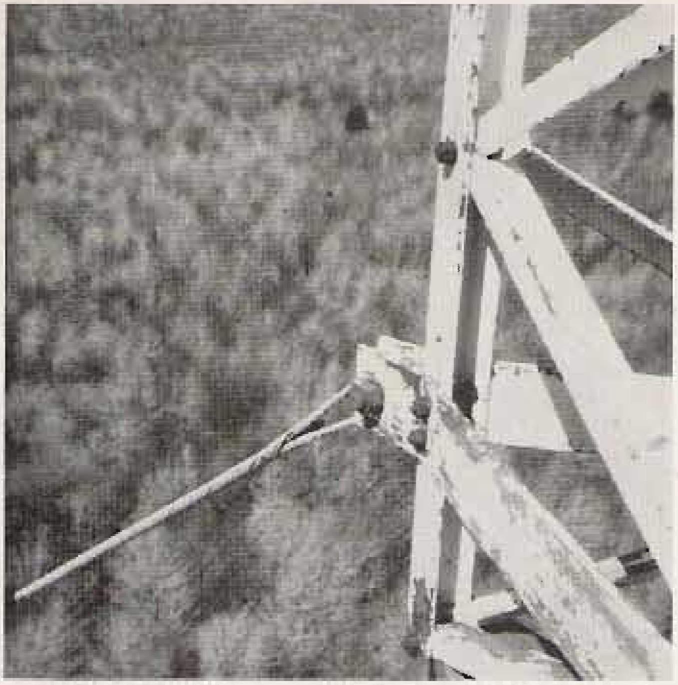
Planning the actual construction is the next step in the process. Survey the land for the locations of the base and anchors. Let's say you come up with a layout similar to the one in Fig. 1.

In this "helicopter" view of the project, we see that the anchors are laid out 120 degrees apart and that two of them are upwind of the tower base. This spreads the worst of the wind loading between two anchors.

The type of soil will determine what type of anchor should be used. There are screw-type units which don't need a hole but are screwed into the undisturbed earth. These are okay for smaller systems with light loading and with firm to slightly-rocky soil. The other type is the bell anchor which requires that a hole be dug. The bell-shaped bottom of this type of anchor is attached to a long rod which sticks out of the ground after the anchor is placed in the hole. When the bell is struck with a heavy bar, the anchor will spread out and dig into the sides of the hole. The hole is then backfilled using small rocks and well-tamped dirt. These bell anchors hold a larger load since they are bigger at the bottom and deeper in the ground than the screw type.

The tower base also is chosen after considering the type of soil at the construction site. Since the base has to support only the vertical load, it doesn't have to be very deep. It should be down far enough, however, so that frost will not cause it to shift position. Manufacturers' recommendations should be followed here so that a firm footing is assured.

Finally, make a list of the required tools and gear for the actual job. Try to obtain the services of someone who has done similar work before, and rely on his experience. If no hams are around to fill the bill, try the local power or telephone company. Their construction crews routinely handle projects similar to this, and probably will know where you can obtain the ropes, guy/jacks, strain dynomometers, and climbing equip-



Guy wires and preformed wrap-on grips are shown at the tower end. Note that the bolt acts as an axle for the grip. The height is 375 feet.

A Dill tower in CATV service is pictured here. The tower is 100 feet tall, in 10 foot sections weighing about 60 pounds each. The sections are 11 inches on a side.

ment you will need.

Before getting into the actual nuts and bolts of hanging up the tower, it's good to discuss various aspects of safety on the job. Advance planning on paper of each step in the process will allow each member of the crew to familiarize himself with the sequences involved. Line up enough people to do the job, and don't forget that at least one should be experienced. All climbing tools and small hand tools should be in first-class shape. Hardhats are a must for the ground crew, and no one should be closer than twenty feet to the tower base for any reason other than to attach gear to the ropes going up the tower. The auxiliary leg, which sometimes is used to hold the weight of a tower section as it is placed on already erected sections, should be inspected carefully. The combined weight of the leg and section can do considerable damage and injury if they fall.

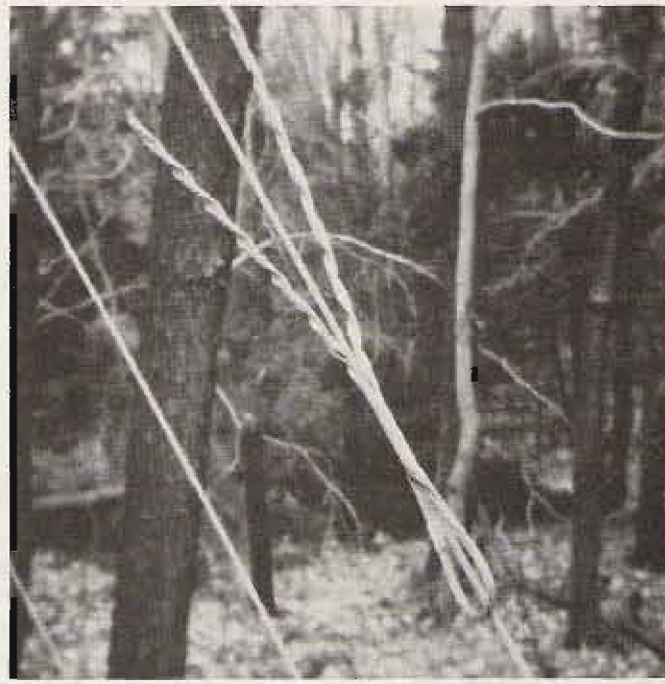
The Dill tower base rests on a large flat rock two feet down and buried in small rocks and well-tamped dirt.

When everything needed is on hand, the anchors are dug in, and the necessary personnel have been lined up, it is time to pick a day to complete the job. Weather is the main consideration here since to be safe the entire job should be completed in one day. The Flight Service Center at the local airport is an excellent source of weather information, and their forecasts of wind conditions are especially good.

On the morning of the big day, begin by bolting the first three sections of tower together on the ground. Attach to the top of the assembly three guy wires which have been cut to roughly the correct length. Set the bottom of the assembly next to the tower base (which is in the ground) and lay out the guy wires down the length of the three-section assembly, over the base, and straight out beyond. With one man holding down on the bottom to make it dig into the ground, and three more pulling at the guy wires, have the remaining people lift the top of the tower and raise it over their heads. As they walk toward the base raising the tower above them, the guy wire attendants will steady the tower side-to-side while at the same time helping to pull the tower vertical.

When this move is completed, the tower should be standing on the ground next to the base, stabilized by the guy wires. Next, lift the tower onto the base and install the three bottom bolts. Attach the guy wires to their respective anchors, and, using a spirit level, a plumb bob, or other sighting line, snug up the guys until the tower is exactly vertical. This operation is important since when later sections are installed, the tower will be put into a bind if it is not

The anchor rod holds three guys using preformed grips. The rod is six feet long and is buried nearly five feet down.



This is a partly installed preformed grip. No tools are needed, and it may be removed for re-tensioning of the guys and easily reapplied.

exactly vertical.

The climbing people are now sent aloft, and the auxiliary leg (or stiff-leg), pulleys, and hand ropes are made ready to raise the next tower section. Since it is very hard for a person to get good lifting leverage while leaning back in a line belt, the ground crew should raise each section while the climbing crew steadies it and guides its placement atop the last section erected.

Remember that during this operation those on the ground should not stand near the tower base, or in an area where dropped tools or parts might fall.

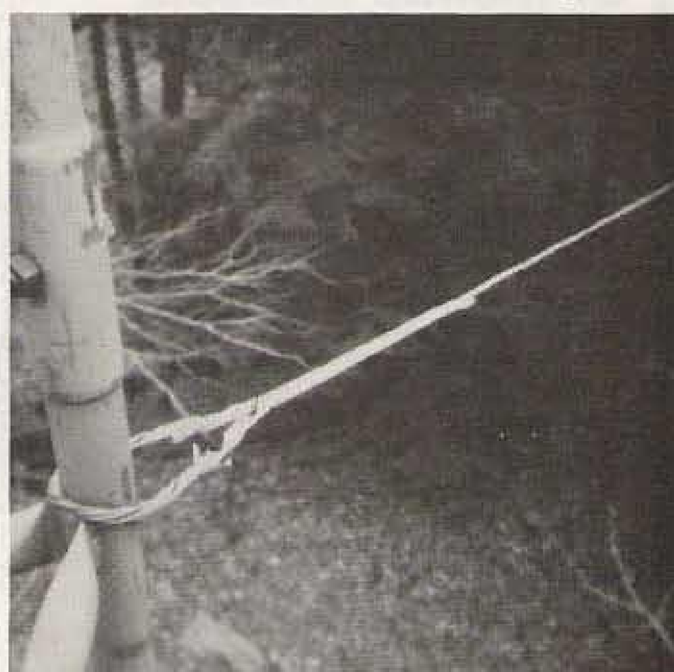
Continue adding tower sections and guy wire sets until the tower is complete. Since the last section normally is built to accept an antenna rotator and mast, these items are more easily installed before that section is raised.

Having aligned the tower each time that a set of wires was installed, the complete unit should be pretty close to vertical. By sighting upward along each leg of the tower, any bends will be seen easily and can be removed by adjusting tension on the appropriate guy wire.

Now that the tower is straight, the next step is to equalize the tension on each set of guy wires. A device called a strain dynomometer is used to read tension on a cable. If this is not available, the only recourse is to pull each guy wire slightly out of line and feel the tension by hand. Sighting up each guy wire from anchor toward the tower and judging the sag is another method, but it is not as reliable due to the varying lengths of the lines. The aim is that each guy wire should carry the same strain as every other.

The tower is now complete and ready to accept antennas and downleads. Even though it is ground-mounted and is attached to guy wires and anchors which also are at earth ground potential, it still is wise to electrically ground the tower. Most commercial installations use a six-foot ground rod at each tower leg, driven as close to the base as possible. This is sufficient to protect the tower, although lightning protection at the shack end of the downleads still should be used. In the event that lights are required, or any source of commercial power is used at the tower, the ground system should be tied into the neutral of the electric line.

When very large arrays are rotated on a tower, the torque will cause twisting of the structure. While this does not affect the life of the tower, it does affect the aiming accuracy of VHF directional arrays during windy conditions. The cure is to install another guy system by bolting to the tower a length of pipe or angle iron about six feet long, as per Fig. 2.



Guy wires and grip are attached to a tower leg.

Since this guy system carries only the twisting load applied to the tower, it need not be as heavily constructed as the main system. Screw-type anchors and number ten steel fence wire are more than adequate, along with TV-type U-bolts connecting the pipe to the tower legs. With this arrangement mounted about three-fourths of the way up the tower, it should remove most of the twisting action and considerably reduce the whiplash effect on the antenna elements.

There you have it. Guyed towers offer the most stable platform for large arrays and greater heights under the most extreme weather conditions. They also offer confidence in the knowledge that those expensive antennas are mounted up where they operate best and are supported by a system which will offer safe and reliable operating for years to come. ■

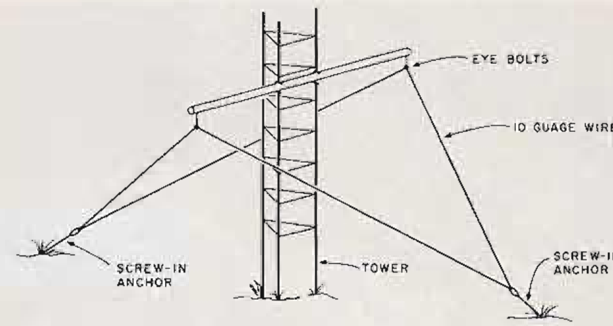


Fig. 2.

✓ Reader Service—see page 211

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Death-Defying PL Mod for the KDK 2015

—not for the squeamish

No more clipping.

Author's Note: Since this article was written, KDK has improved their "fix" by adding additional RC filters between the NOR gate and the base of the output transistor.

This article is not for the timid soul. It takes considerable courage to take a brand new rig and cut the circuit foil and drill holes in the PC boards. This statement is not intended to scare you off, but to forewarn you. The results, however, are well worth the effort.

A prerequisite for outlining any solution is to first define the problem. The basic complaint with the original KDK PL is that it may or may not activate a given repeater, and when it does, there are complaints of the PL being audible and clipping with modulation.

Investigation of the existing PL circuit reveals a CMOS 2-input NOR gate chip (MC14001) connected as a square-wave oscillator as shown in Fig. 1. They couldn't have planned it worse. The fast rise and fall time of the square wave produces many harmonics of the 100-Hz fundamental at 200, 300, etc., accounting for the audible complaint.

To make matters worse, the square wave is differentiated by the .01-uF coupling capacitor to the speech amplifier, producing narrow pulses from each edge of the square wave (pulse modulation, yet). This has to be a terrible shock to the preamp and is probably the reason why the repeater does not recognize the PL. Attempts to activate the repeater by increasing the PL level further aggravate the audible problem.

The official "fix" available as a modification kit from the US distributor of the KDK units leaves much to be desired, since it simply adds a 0.1-uF shunt capacitor from the base of Q3 to ground to drastically slow up the rise and fall times, making it a triangular wave.

The ultimate solution, of course, is to change the PL signal to a sine wave. This is where the timid souls can leave to purchase their ME-3. The hardy and courageous individuals, however, should stay while we discuss how to linearize the existing CMOS digital gate for analog operation to generate a sine wave.

Any digital logic-inverting element (NAND or NOR gate or inverter) produces a high-level output with a low-level input and vice versa. The input switching threshold for a CMOS logic element is approximately 45% of the supply voltage (9 volts in the KDK). When the input signal passes through the threshold (4 volts), the output switches. It is at this switching level that the gate is operating in the linear region. A feedback resistor connected from output back to input, as shown in Fig. 2, linearizes the gate since a high output fed back to the input would tend to drive the output low, which when fed back to the input tends to drive the output high, which . . . etc. The gate finally compromises itself with both input and output floating at the 4-volt switching threshold level.

This circuit configuration lends itself very well for a Wein bridge sine-wave oscillator (sometimes

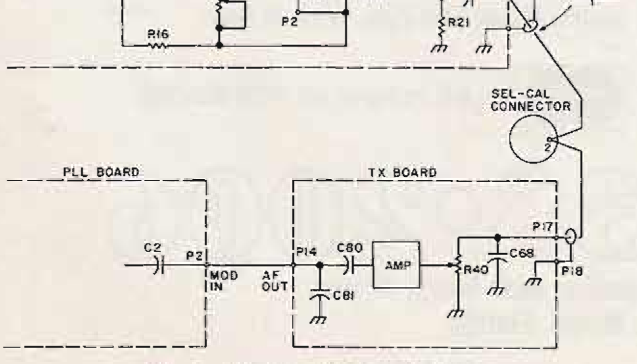

Fig. 1. Existing KDK PL circuit.

called a twin-T) by simply dividing the feedback resistor into two parts and adding the other necessary RC constants as shown in Fig. 3. The basic frequency of oscillation is given as $F = 1/(2\pi RC)$, but this is not exact and may vary considerably. A word of caution here: The capacitors must be a good quality ceramic or mica with good temperature stability, and the resistors must be 100 part-per-million temperature-coefficient units. One such circuit constructed with miniature plastic capacitors changed frequency by 50% when sprayed with Quick Freeze circuit cooler.

The final circuit design and KDK modifications are shown in Fig. 4. Note that the second gate is no longer used. The IC pad of pin 11 on the circuit board is still utilized, however, so the legs of the chip (pins 11, 12, and 13) were cut and a jumper added to connect circuit board pad 10 to 11 to complete the path to the output transistor. The legend for the various circuit modifications appears below the schematic. The 0.15-uF capacitor across the 287-Ohm resistor and 1k pot was required to eliminate a secondary high-frequency oscillation. The value of this capacitor, although not critical, will have some effect on frequency.

The major problem encountered was getting the PS board out far enough to work on it. There are a few wires from the PS board which are routed under the PLL board. This problem is solved by removing the four PLL mounting screws and tilting the board forward towards the front panel. A piece of masking tape will hold this board in the upright position.

The second problem is caused by the choke mounted on the rear plate and the ground wire from the power input connector. These leads are very short and make it impossible to move the PS board. It may be possible to unsolder the choke leads; however, I chose to unmount the choke, leaving it attached to the board. This is accomplished by gently removing the rear identification plate by lifting with a small screwdriver (sticky back) to expose the choke-mounting screws. The ground wire can easily be unsoldered at the power input connector.

The transceiver is then positioned on its side and the PS board separated as far as possible from the chassis with all other wires still connected. Not an ideal work situation, but tolerable.

The following is a complete step-by-step procedure for making the modification. Refer to the PS board layout diagram on page 12 of the KDK manual to locate the various points referenced.

1. Unsolder the two shielded audio cables from the PS board, cut them to a length sufficient for splicing, and cover the splices with shrink tubing. This disconnects the PL output and completes the microphone cable routing to the SEL-CAL connector and speech amplifier.
2. Cut the legs of pins 11, 12, and 13 on IC2.
3. Solder a jumper across pads 10 and 11 on rear of board.
4. Cut circuit foil between P1 and junction of R19 and C10.
5. Cut circuit foil between P2 and R18 potentiometer.
6. Replace R16 470k resistor with a 16.9k resistor.
7. Replace R17 33k resistor with a 14.3k resistor.
8. Replace R18 50k pot with a 5k pot.
9. Replace C9 .033-uF capacitor with a .15-uF capacitor.
10. Replace C10 .068-uF capacitor with a .15-uF capacitor.
11. Replace C11 .01-uF capacitor with a .22-uF capacitor.
12. Replace the combination of R20 4.7k and R21 470-Ohm resistors with a single 5k miniature potentiometer (about the size of a transistor). Mount this pot with one end in the R21 ground pad, the other end in the R20 pad which connects to the emitter of Q3, and the rotor in either of the two pads at the junction of R20, R21, and C11.
13. Drill a hole through the ground plane at the edge of the PC board in line with R16 and next to the nicad battery. Mount the .33-uF capacitor from the junction of R18 pot and R16 resistor to the ground-plane hole.
14. Position the 1k pot next to the nicad battery such that the rotor and one end are over the ground plane and the other end is over the open area (no ground plane). Mark the points, drill the holes, and mount the pot. Make sure the speaker clears the pot when the bottom cover is mounted.
15. Drill two more holes in the open area for mounting the 287-Ohm resistor next to the 1k pot. Mount the resistor in the holes and bend one lead over and solder it to the open pot lead.
16. Drill another hole in the open area next to the 287-Ohm resistor hole and also another hole through the ground plane for mounting the .15-uF bypass capacitor across the 187-Ohm 1k pot combination.
17. Connect a wire from

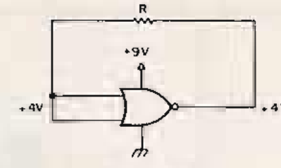

Fig. 2.

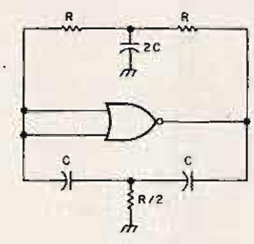

Fig. 3.

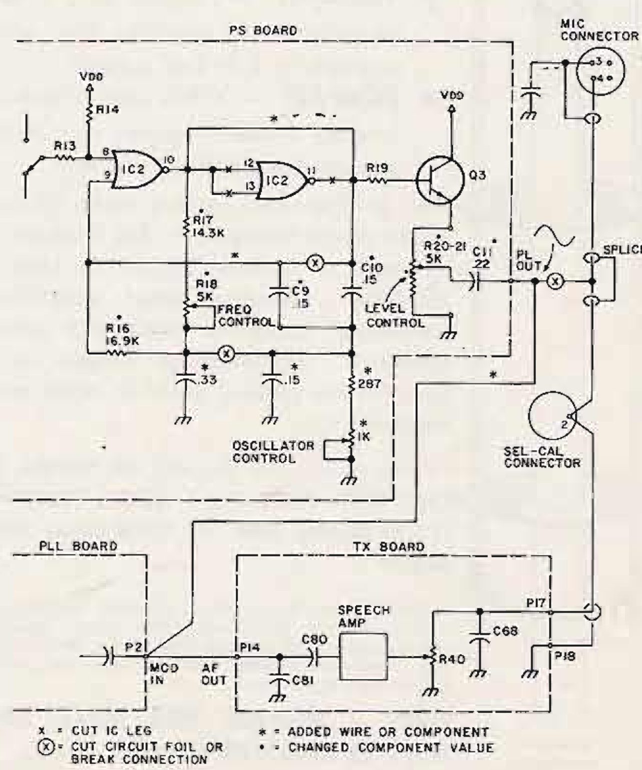

Fig. 4. Modified KDK PL circuit.

the junction of the .15-uF bypass and the 287-Ohm resistor to P2.

18. Connect a jumper wire from P1 to the pin 9 end of R16.

19. Connect a wire from "PL OUT" (open end of C11) to P2 "MOD IN" on the PLL board (terminal with green wire).

Adjustment is best accomplished with a scope and counter; however, it may be possible to "ballpark" the frequency adjustment by comparing it to a strong signal with PL on the repeater input with an auxiliary receiver. The 1k oscillation control should be adjusted for the maximum resistance possible that will sustain oscillation without distortion of the sine wave. A rough setting of the level control can be made by measuring the audio voltage level with a voltmeter at the "MOD IN" terminal under normal modulation and adjusting the PL "LEVEL" for 10% of this value. Final tweaking may require on-the-air tests with assistance from another operator.

This modification has been in use for several months with excellent results. Temperature stability is very good (±0.2 Hz) when sprayed with Quick Freeze circuit cooler (−50° F.) and heated with a heat gun. Both temperatures were well beyond my operating thresholds. Final results—no more clipping or complaints of audible PL with 100% solid QSOs.

Next project—slowing down the scanning rate so more than two words can be heard when continuously scanning the memory channels for familiar voices or calls. Maybe we can start a KDK "mod squad." ■

✓ Reader Service—see page 211

Feed-Horn Mounting Made Easy

—solution to a pesky problem

More on microwaves.

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Until you know a little bit about the subject, the antenna portion of a microwave project seems quite simple. The most difficult aspect is building or finding a dish—or so it seems! No matter how you acquire the dish, however, you will discover that your problems have just begun.

Photo A. This is a feed-horn assembly for use at the 1.7-GHz satellite frequency.

Next you must find a suitable feed, and if this search leads you into the literature, you will discover that that subject can be quite complex indeed.

In the final analysis, one of the simplest and most effective feeds in the low-frequency end of the microwave region is the horn feed. Rectangular horn feeds are superior, in the sense that the illumination pattern can be controlled with some precision. Their main drawback is that they are mechanically unwieldy.

Despite their reduced illumination efficiency, cylindrical feed horns are quite popular in that they can be constructed of metal pipe, tubing, or cans. A number of articles have appeared in the amateur literature describing the construction of horn-feed systems. They are quite non-critical in use—particularly in receiving applications.

Horn Mounting

Once you have obtained a dish and constructed a horn, you inevitably encounter the real problem—how to get the darn thing mounted! I have been working on antennas in the low microwave region (S-band) for the past two years now, in conjunction with a series of projects involving the GOES weather satellites. These satellites transmit pictures on a frequency of 1691 MHz, and thus I was forced to deal with the feed-horn mounting problem. The answer to it has proved to be quite simple and effective and should be applicable to similar situations involving operations on 1296, 2304, and 3300 MHz.

The key point in any mounting scheme is to avoid obscuring the open end of the horn with metal in any form. Any metal will serve to shield out a certain portion of the received rf, all of which will be focused into the mouth of the horn in a well-designed system. The two most common mounting schemes are shown in Fig. 1. One of these is excellent but largely impractical, while the second is very inelegant and somewhat inefficient.

The first involves the use of either three or four spider-arm assemblies running from the horn to the periphery of the dish. The arms do not impede the rf front reflected from the dish surface into the horn, and they can be made even of metal for, although they do intercept the wave front as it arrives at the dish, their area is quite small compared to the area of a typical dish; the gain reduction is not measurable.

This does, however, highlight why obstructions to the horn are so critical. *All* the rf energy reflected by the dish surface must pass into the relatively small opening represented by the mouth of the horn. Any metal obstruction here can cancel out a good percentage of the gain!

The primary disadvantage of the spider-arm system is the difficulty in fabricating it. One must have considerable mechanical ingenuity to devise fastenings to secure the arms to the horn and to the edge of the dish. The arms must be of equal length, provide rigid support, and must hold the horn at the proper focal length for the dish in use while also permitting rotation of the horn to match polarization with the transmitted signal. Since the precise position of a particular feed horn relative to a particular dish at a given frequency can be determined only approximately at first, one is in for a considerable period of tinkering to get everything right.

The second approach is to use a support rod at the center of the dish—usually fabricated of plumbing tubing and fittings—with an offset to accommodate the horn radius, as shown in Fig. 1(b). The horn is clamped to the tubing using large hose clamps or some other system. It is an easy system to adjust, since the horn can be moved up or down the tube for focusing prior to being clamped in place. The major disadvantage is that the tube does absorb rf coming in from the dish surface. Also, the system looks terrible!

Figs. 2 and 3 show a much better system. The horn is mounted to a square of unclad G-10 board material (no copper) using four small metal brackets outside of the horn. The G-10 square is just slightly larger than the outside diameter of the horn, and the horn brackets attach within the corner areas that extend beyond the edge of the horn.

Other materials may be used for the mounting square if they pass a simple test. Simply hold a sheet of the material across the mouth of the horn and observe the indicated signal strength on the receiver. If there is no noticeable drop in the signal level, you are getting minimal attenuation and the material may be used. Most plastics appear to work fine, but be sure to check them out anyway, as the composition of a few plastics or their additives can sometimes show unexpected rf absorption at some frequencies in the microwave region.

The mounting square is attached to a mast of PVC plumbing tubing (don't use metal!) that holds the horn at the proper focal point. The mast is mounted to the center of the dish by sliding it over a stub of metal pipe secured to the center of the dish with a pair of pipe-mounting flanges. The PVC mast is slit where it slides over the pipe, and the entire mast assembly can be moved both up and down the pipe to optimize focus and rotated to match polarization. Once the proper orientation is achieved, the mast is locked into place with one or more hose clamps.

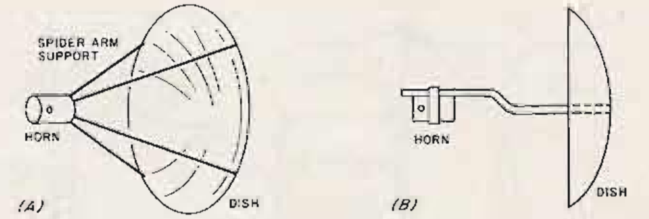

Fig. 1. Two common methods used to mount cylindrical feed horns. (A) shows the use of spider-arm support rods—an efficient system, but difficult to construct; and (B) shows the use of a support pipe, offset to accept the horn. This system is easy to construct but is unsightly and somewhat inefficient.

If the mast is quite long or the feed horn is heavy, the assembly can be guyed with dacron lines run from the corners of the G-10 mounting plate to screw-eye and turnbuckle assemblies attached to the rim of the dish.

Construction

The diagrams in Figs. 2 and 3 provide most of the information required, but a few points are worth discussing. First, the mounting plate *must* be attached to the PVC mast using nylon mounting brackets and hardware. If you use metal here, you will eliminate most of the advantages of this particular mounting scheme. The brackets and hardware can be obtained from hobby shops that carry supplies for radio-controlled airplanes.

The PVC tubing is cut about four inches shorter than the focal length of the dish. This permits the focal point to fall about 2 inches (5 cm) into the horn while

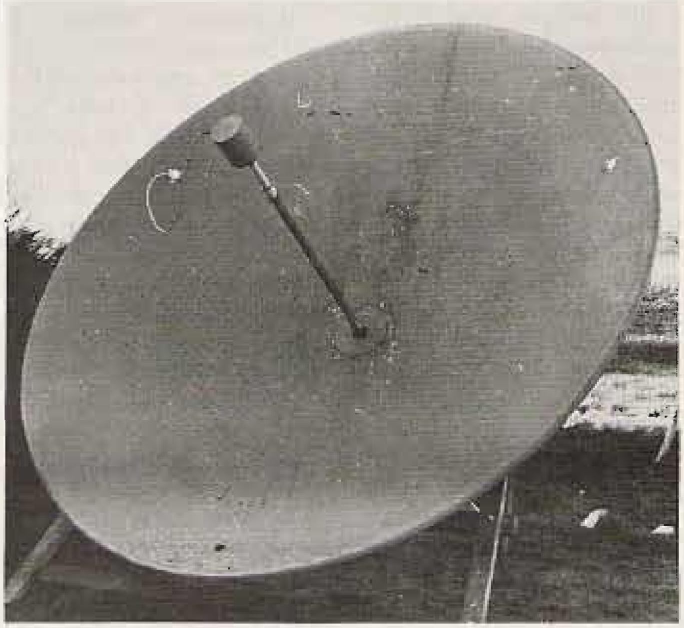

Photo B. Pictured here is a 10-foot (1.3 m) dish, complete with horn feed, used for GOES satellite reception. With a small dish in the 4- to 6-foot range, and depending on its weight, the horn may not require guying. With a larger dish of the sort shown here, the long mast does need dacron guys.

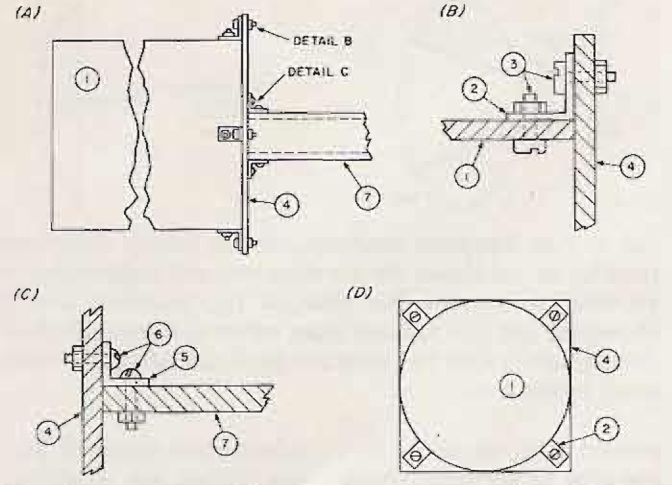

Fig. 2. (1): feed horn; (2): metal mounting brackets; (3): 6-32 pan-head hardware; (4): G-10 fiberglass mounting plate; (5): nylon mounting brackets; (6): 4-40 nylon hardware; (7): PVC pipe mast. (A) General view of the relationship of the cylindrical feed horn, mounting plate, and PVC mast. (B) Detail showing the attachment of the horn to the plate using metal brackets and 6-32 hardware. Use pan-head screws with the heads inside the horn to minimize metal protrusions into the cavity. (C) Detail of the attachment of the mounting plate to the PVC mast using nylon brackets and hardware. (D) End view of the horn, looking toward the dish, showing the relationship of the metal mounting brackets to the corners of the square G-10 mounting plate.

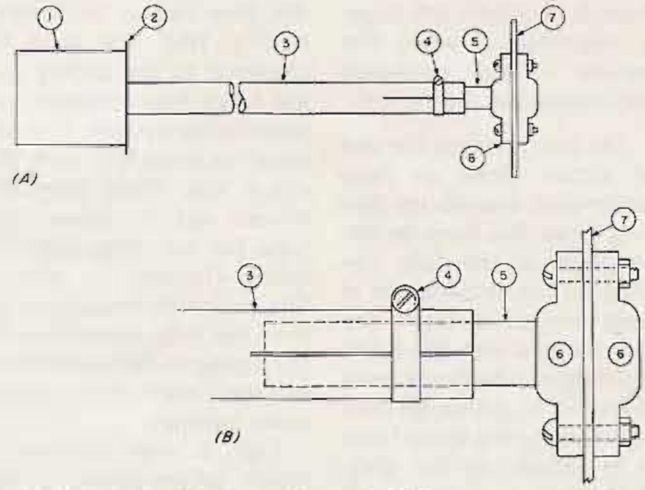

Fig. 3. (1): horn; (2): G-10 plate; (3): PVC pipe mast; (4): hose clamp; (5): steel pipe stub; (6): pipe mounting flanges; (7): dish surface. (A) The general relationship of the horn mounting-plate, PVC mast, pipe stub, and the pipe flanges used to secure the mast to the center of the dish. (B) Detail showing the attachment of the mast to the dish surface. Two pipe flanges, one on either side of the dish center, are used to provide rigidity. A pipe stub, which may be up to 1/3 of the dish focal length, is used to provide support to the mast. PVC and steel pipe sizes should be chosen so that the steel pipe is a slide-fit in the PVC pipe. The PVC mast is slit at the dish end and tightened down with one or more hose clamps.

still permitting about the same distance for downward movement of the assembly if required for focusing. The following assembly sequence should be followed:

(1) Mount the nylon mounting brackets to the end of the PVC mast. Doing this first lets you get pliers or fingers down inside the mast to tighten the hardware!

(2) The mounted brackets then can be used as a guide for marking the G-10 plate which can be drilled then and mounted to the end of the mast—again, use nylon hardware!

(3) The brackets (aluminum, brass, or other metal is OK) then may be mounted to the horn and the horn attached to the plate. In mounting the horn brackets, be sure to use pan-head screws with the heads inside the horn and the nuts outside. This minimizes metal protrusions into the horn which could distort the wavefronts in the waveguide horn assembly.

(4) The entire assembly is placed over the pipe stub, its position optimized, and then everything is tightened up with hose clamps.

If guying is required, it can be installed now. In the case of an antenna used for support of a satellite ground station, the guying system can perform a fine-tuning function in the alignment department. Large dishes (8-10 feet or larger) are quite critical in orientation, and it often is possible first to horse the dish into the best possible orientation, and then to use the guy adjustments to shift the horn position laterally as required to peak the signal level. If large displacements of the horn are required (more than an inch or so), it means that the dish was not aligned properly. The horn should be centered (guy lines of precisely equal length) and the alignment of the dish altered to bring up the signal. You then can fine-tune the alignment with the guy cables.

Since the pipe attached to the dish can provide some rigidity to the PVC mast, it is useful to know how long the pipe can be without absorbing significant rf. This is dependent upon dish focal length. Generally, if the pipe is about one-third of the focal length, it will not affect the signal level. This is because the horn obscures the center of the dish and the converging wavefront from other areas of the dish will not intersect the pipe as it would if the pipe were much longer.

If desired, you can run a bead of silicone seal around the edge of the horn where it attaches to the G-10 plate, to provide some weather-sealing. This is usually most important with antennas used for point-to-point ground service, as the horn is not likely to pick up water or snow when pointed up in the air at a satellite! In the latter case, it is not even necessary that the plate cover the entire opening to the horn. I have built several feed assemblies where the plate was simply a wide strip across the opening of the horn. In making an inspection of one GOES satellite installation, however, I discovered a nice wasps' nest in the feed horn! I suppose that if a bird decided to use the horn for its spring nesting ritual, it might result in some puzzling signal-level anomalies! It probably is best to seal up the horn—if only to exclude the local wildlife!

This mounting scheme has been used in a number of GOES satellite ground station installations, with antennas ranging from 3 to 10 feet in diameter, with excellent results in all cases. Cylindrical feed horns are certainly simple to construct, and they provide fine results. I think you will find that this mounting system will make them just as easy to use! ■

✓ Reader Service—see page 211

Antenna Tuning Joy Revisited

—remember the Tektronix 190B?

Amplifying K5QY.

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In the May, 1978, issue of *73 Magazine* there was an excellent article by Dick Sander K5QY entitled "Make Antenna Tuning A Joy." The article described the modification of a Tektronix 190B constant-amplitude sine wave generator. It is my intention in this follow-up article to add to Dick's comments and ideas and give a few basic details that he left out on the generator itself.

I can testify to the long-term worth of his unit, because I did the same modification 2 years ago. It has proven to be worth at least a hundred times the time spent on it. When I say I did the same modification, like any ham, I have to add an important word—almost. It is additional information and some of the ways I did things as a VHF ham that I believe will be of additional value to readers.

To keep this as short and to the point as possible, I'll first cover the additional specifications you may find of interest. We both started off with the 190B. This unit will run on 105 to 125, or 210 to 250 V ac, with a very slight wiring change similar to Heathkit® equipment (change jumpers, etc.). Further, it runs fine on 50 to 400 Hz. The latter part may not seem important, but I have found that I can use part of an old 6 meter AM mobile power pack unit that was designed to put out around 250 V dc. If you take out or disconnect the dc portion (mine was shot and burned up, anyway), you get, from the ac portion, about 230 V ac and 360 Hz, in my case. The 190B requires about 100 W on 120 V ac, 60 Hz, but the power pack only warms to the touch after about 30 minutes of use. Just a thought for those of you who really must be portable and dc only.

The gear is quite compact and portable compared to some of the older tube-type bench or rack-mounted equipment. It measures only 9-3/4" wide, 13½" high, and 11" deep. Its all-aluminum alloy construction gives it a total weight of only 24 pounds, so it is no surplus boat anchor.

The frequency indication specification for the dial readout is quite good at 2%. This is nice, even if you use the generator only as a generator, but invaluable if you modify it, as Dick and I did, into an antenna bridge.

The output amplitude is continuously variable over a 40-mV-to-10-V peak-to-peak range. Looking into a 50-Ohm load, you have 5 volts peak (times .707 for rms volts). Square that result over a 50-Ohm load, and indeed you have an output of about 250 mW.

This brings out the only point I question in Dick's article. I am a QRP power nut and a VHF/UHF ham. I often have worked another ham 63 miles away with only 16.5 mW on 6 meter CW. That's no great feat, but it all started by accident and has continued using the same setup: my transmitter coupled to a light bulb dummy load in the basement! All I am driving at is, while this may be the handiest device you have ever built for antenna work, remember: You are radiating! Use the minimum on-air time you need for antenna pruning and try to pick non-peak hours in your locale—especially on VHF.

The original ouput meter read the output peak-to-peak volts at that funny-looking connector your unit will come with and is accurate only to ± 10% of full scale. This is really no problem in the modified version, as the absolute value of forward power (voltage) is not important as long as it will drive the swr meter to full scale in the forward mode. Dick mentions changing to a plain voltmeter with a different scale from the original and using a chart supplied by him in the article to calculate vswr. I went one better, I think, and it is by total accident that we were working toward the same general ends at nearly the same time. I found the meter for the Heath VHF wattmeter (HW-2102) to be a great replacement in the $15 range, as it has a direct reading scale for swr. You can ignore the power output scales! I used the bridge basically out of the Heath wattmeter, but have constructed Dick's, too, and either seems to be fine for my VHF work. If you are HF inclined, stay with Dick's resistive version. The Heath meter has a white-on-black scale that is both very attractive and easy to read out in the bright sunlight.

If you contemplate operating at the stock upper limit of 50 MHz, for 6 meter work, by all means use an N-type (50-Ohm) panel-mount female connector to replace the weird little output connector on the front panel of the 190B. Dick used a UHF-type connector here, which is fine at HF frequencies. Unfortunately, due to the huge demand created by the CB market, some UHF connectors are showing up that are UHF in style and name only. Some are OK at CB frequencies and useless at 50 MHz and up. Some would be junk at dc! Why have your worst swr "lump" built right into your test equipment? The extra cost for the N connector is worth it.

If you are *un*fortunate enough to get the attenuator that plugs into that same weird little connector on the panel, do *not* get any ideas about using it for any kind of accurate readings on antennas or any other load with reactance. As you do the band-wandering trick to prune an antenna, as Dick describes, the output impedance of the attenuator wanders all over, and right on the specification sheet it states the following information: Output amplitude is constant ±5% from 30 to 50 MHz, *if* the load capacitance does not exceed 10 pF on the 10-V range. This can be a fixed C, or the antenna reactance! In the 1-V-to-.5-V range, it improves by allowing 50 pF for the same ±5%. Further, it is stated that all changes will be related to, and dependent on, the load capacitance, the length of cables (more on that later), the voltage range in use, and the frequency.

These facts are primarily for those of you who may want to use the generator as a generator with the attenuator. Dick comes right off the generator at the strange little plug you replace with the N fitting, and so did I. Speaking of the attenuator, and to further induce you to go buy a 190B, consider the following.

It's an old flea-market sales trick, but the truth is that you don't want the attenuator unless you intend to outboard the bridge in a box, and swap back and forth between it and the attenuator as the attenuator replacement accessory. So, why let someone run the price up on you by saying he is offering more, or something the unit won't work without? On the other hand, if he doesn't have an attenuator to sell with it, you may succeed in driving down the price by screaming that you must have one!

Fair? It all depends which side of the flea-market table you are standing on at the time, and I have spent 18 years on one side or the other. "*Caveat emptor*," no doubt, has a seller's corollary, too, and rightly so. The only good deal is where both parties feel they have a bargain—so bargain away!

Before we get away from the specifications on the stock 190B, there is one more thing you should know. If you are working with wideband or multiband antennas (log periodics, discones, trap dipoles or verticals, etc.), you should know that there is *no* specification made for the harmonic content of the 190B! I heard of a case where it was typically less than 5%, but that was a new unit in perfect shape.

If you are going to use your unit seriously, then it would pay to at least spot check it at your points of interest. Even a simple check on a shortwave/allband-type receiver will give you a good idea of where the unit is at. For instance, set the generator up on 7 MHz into a 50-Ohm resistor, with enough leads to radiate a little, and drive the generator up to where the S-meter reads S6 to S9 depending on the linearity of your particular receiver's agc system. Tuning the receiver to 14, 21, 28 MHz, etc., should produce readings in the range of S1 or at least as low as the meter reads, with the receiver input terminals shorted by a 50-Ohm resistor (or proper load to match receiver input impedance).

As for the unit you are looking for, I assume you are not rich enough to see Tektronix for a new one (and I doubt if they still even build it), and the used gear catalog prices are still quite high and are aimed at the small business user. This leaves the hamfests/flea markets. I mention this because the unit is easy to open up so you can look at the condition inside. You can plan on cleaning up a little dust, but beware of anything that resembles saltwater corrosion (white, chalky, lumpy), extreme rust, or missing, bent, or battered shields or covers. You want a piece of test equipment, not junk.

I got a real bargain on mine—fully working and intact, for $20, from a man who knew not what he had!

I sprayed over the slightly-scratched case with a forest green by Rust-o-leum, which is great for equipment you want never to rust or corrode. Besides, this is a nice match for the Heath meter, which has a black face and green plastic bezel, and it contrasted nicely with the brushed-aluminum panel.

My next modification will obviously be to get higher frequency operation out of this wonder of wonders. Even if I get a sudden interest in the low bands and get my Advanced license, I don't really need the .35- to .75- and .75- to 1.7-MHz bands. The 21- to 50-MHz band on my unit does make it usable on 6 meters, but a bit of coil adjustment may be required on some you might purchase. If you have to juggle, my suggestion is to move the whole band up by 1 MHz and recheck the tracking. Use the allband receiver again to align the tracking by adjusting C on the high end and L on the low end until the dial tracking is as close as possible.

That wraps up my way of attacking the 190B and achieving the joy Dick mentioned in his title. I got my first exposure to this instrument at work and know it is a good one. I kick myself for not seeing the full LC impedance bridge Dick goes on to mention, but you can bet I am working on trying it soon. If anyone has any ideas on putting the higher bands into this gear (at least 2 meters), please write it up or contact me.

I promised to cover more on the capacitance effects, cables, etc., and I left it for last because it really does not pertain only to the 190B. Dick touched briefly on using the modified generator to check old coaxial cable. A lot of bridge, swr, and loading problems can be eliminated or minimized by using the same general techniques. By using a *new* piece of RG-8 foam, commercial grade and quality (not the CB-grade junk), and cutting it to ½ wavelength or even 1 wavelength at the desired and most-used frequency (allow for the velocity factor of the cable), you can make a simple swr transformer. As you know, voltage and current repeat themselves in the cable at ½-wave intervals, and, therefore, so does the swr reading. By first cutting the coax close to the calculated length, but slightly long, and shorting out the far end from the generator, you can determine the exact resonance of the coax just like an antenna. When you have it properly trimmed for the frequency chosen and connectors are on it, hook it up to a good 50-Ohm load like a Heath "Cantenna." Your resonant point should remain the same (matched resistive load) and the swr should be 1:1. If the coax is good and cut to the correct length and the load is really 50-Ohms resistive, any remaining swr is the combined result of bridge unbalance, coax connectors, and coax reflections (bumps or imperfect cable); all, in total, should be very small. Note it on the generator panel for future reference if you can't eliminate it. If the unit won't get 1:1 with a perfect load, it will never get it with the antenna under test. A digital swr meter readout would make the unit perfect, and I am working on that very thing right now.

I can only repeat Dick's closing statement that the 190B in modified form is the ". . . most practical and economical antenna tuning aid I've used in my antenna experimentation . . ," and I hope my article will help make Dick's article and a great piece of gear more useful to all of you who try it. Drop me a note and an SASE if you have any problems with what I've written here.■

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Modern Solid-State Equipment Design: A Better Way

—sorry, tube fans

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5105 Holston Hills Road
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Most books and articles on solid-state design for rf stress the parallels between transistor/FET circuitry and tube circuitry. These parallels are accurate enough as far as they go, but they also are misleading. To the average reader, they imply that equipment design using transistors or FETs should parallel tube equipment. In many ways, especially for the amateur, this inference is wrong and accounts often for why we never get some piece of equipment to work.

In this article, I want to compare old-style tube techniques with some tried and proven principles for transistors. These principles are not for the engineer or the commercial manufacturer; they are for the home builder. They call for some changes in the way we think about building up a fairly complex piece of rf equipment. In this review of the similarities and differences between vacuum tubes and transistors, all of the ideas I give will be commonplace. But when set next to each other, they suggest new ways of doing things for the ham constructor.

Changing an old way of thinking is probably the hardest thing for any of us to do, but if you think through these ideas, and then take a look at some of the projects that have appealed to you (transmitters, vfos, receivers, and the like), you will be in a position to make the change. No longer need you believe that you can never get a bunch of transistors to do what the original author got them to do. By some simple redesign work, you can have confidence that you can do it, too—and maybe do it better.

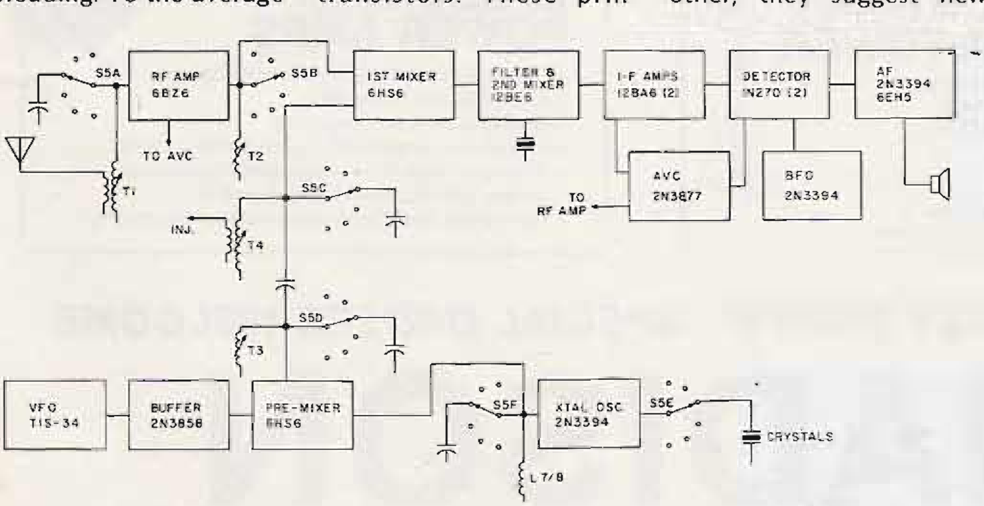


Fig. 1. Simplified block diagram of a tube-type receiver, adapted from the R-4B and drawn to show the methods of switching rf-tuned circuits for each stage prior to the mixer, i-f, and af stages. Note that a 6-pole, 6-position switch is required to accomplish band changes. Although the method of mixing frequencies to reach the i-f differs among manufacturers, the relationship of band changing to the various stages is common to almost all of them. In this late model tube-type receiver, some solid-state devices have been introduced. Tuned circuits have not been terminated because of complexities in the full schematic of this Drake receiver.

Designing with Vacuum Tubes

The design of rf equipment using vacuum tubes has changed little in the past forty years. Perhaps the major change—outside of improved tube construction and improved individual circuits—has been the introduction into amateur gear of the heterodyne vfo system of frequency control. The 5- to 5.5-MHz vfo heterodyned to the ham band of choice has eliminated most of the problems inherent in the bandswitching vfo or the vfo multiplied to frequency. The instability of vfos required to cover a ten-to-one frequency spread, as well as instabilities introduced by switching tuned circuits, held back single sideband and serious communication on VHF frequencies for many years. Likewise, when we used frequency multipliers, we also multiplied any flaws in the vfo.

Other than this, equipment design has changed little. To illustrate this fact, let us look at Fig. 1, a simplified diagram of a straightforward receiver. In the diagram, I have shown most of the switching circuits, but omitted other circuit details. In both amateur gear and commercially-made gear, this basic system design has been standard. With vacuum tubes, there are good reasons for this standardization.

Notice that most of the switching involves the replacement of one frequency-determining circuit for another. To switch bands requires the exchange of several tuned circuits, as well as a change of crystals. Here are some of the basic reasons for working out the system design in this way:

1. The system permits the least number of tubes, which is desirable because, (a) tubes are large—they take up space; and (b) tubes are heat generators, and this system minimizes heat.

2. Tubes, being high-impedance devices (high especially when compared to the frequency-determining circuits associated with them), usually require little attention to perfect matching, and are, therefore, reliable for a given biasing arrangement over a large frequency spread.

3. Tubes are large compared with tuned circuits and switches (especially at low power levels), thus making it more economical of space and cost to switch tuned circuits.

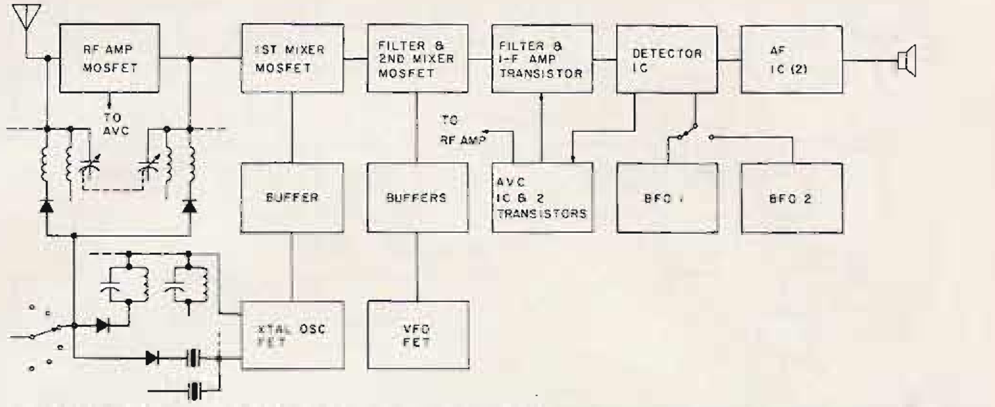


Fig. 2. Simplified block diagram of a recent commercially-manufactured solid-state hamband receiver. Note the similarities to Figs. 1 and 3: All use single devices in the critical rf circuits and switch-tuned circuits. Problems of lead length and switch expense are solved in this design by the use of a diode switching system. The switch handles dc, and all rf remains on the printed circuit board. This, plus the use of a high-impedance device, the MOSFET, minimizes some problems of multiband operation, but not all. Compare this to Fig. 4 in which the rf circuits are optimized for one band. This diagram, with modifications for simplicity, is based on the Heath HR-1680. Both the HR-1680 and the Drake R-4B of Fig. 1 are fine receivers in their respective price classes, but their design philosophies may not be best for the ham builder.

4. Tubes are inherently expensive; for receivers, five tubes can cost five times as much as one five-position switch section.

5. Tubes, as they come into the hands of either the commercial manufacturer or the building amateur, are reliably similar, varying well within a 20 percent range in characteristics within types.

6. Most modern tubes have input and output capacitances which are small enough to present no design problems in the 3- to 30-MHz range (unlike the old '24 and '27, so popular around 1930).

Fig. 2 shows a simplified diagram of a relatively recent piece of ham gear. The diagram has been drawn to bring out the similarities between tube and transistorized gear commercially available. Note that the switching arrangement is not materially different from that of Fig. 1. Single solid-state devices are used at each stage, and the frequency-determining circuits are switched with the traditional bandswitching arrangement.

Fig. 3 shows a simplified diagram of a piece of equipment taken from a recent ham publication. Notice that it, too, uses the very same system of switching and design.

Unless one is an engineer or has access to select components, circuit design of this order is difficult to replicate. Among the reasons for the difficulties we face in making a complex circuit work just as some article claims are these:

1. Transistors may vary greatly in characteristics from a design center. This problem is aggravated by the fact that hams generally have access to culls, hobbyist-grade devices, or surplus, any of which may vary by an even greater extent. For this reason, the amateur designer must do his own selection from among the batches of 20-cent transistors he has on hand, and he must be willing to rework bias and drive circuits to make the device work as it did in the original. To expect a complex group of transistors to perform reliably over a wide frequency range under these conditions often strains the imagination and the experimenter's patience.

2. Other materials of the system of circuits may not be available, and the amateur designer substitutes what he has on hand. He may use surplus or junk box coil forms or toroids of dubious ferrite or iron content. What this may do to circuit Q is anyone's guess. Capacitor quality is another overlooked problem, one aggravated by the uncertain history of the short lead parts in the junk box.

3. Those who attempt to reproduce equipment shown in articles and books often lack the test equipment necessary to perform the right measurements so as to find out what in a circuit may not be working correctly. Among our common building practices are these: tapping coils just as specified in the article, rather than determining the actual impedance to be matched; assuming that the bias circuitry of a transistor provides the correct parameters, rather than measuring actual currents drawn; and assuming that proper

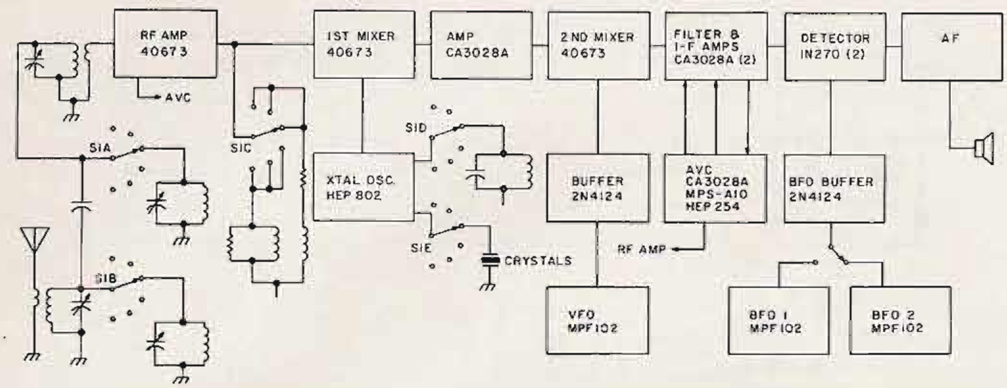


Fig. 3. Amateur receiver (simplified block diagram), adapted from the 1974 Handbook. *This particular unit was originally built in two pieces: a basic receiver from the CA3028A amp through the af board, and a converter section for all the HF bands. Note the attempt to use high-impedance devices—MOSFETs and JFETs—to minimize problems with switching-tuned circuits. Even so, a long five-section ceramic switch is required. Among the positive design features of this receiver are the provision of avc voltage to the first rf stage, upward conversion to minimize birdies, and switched bfos. Front end compromises would have been further minimized through the use of separate converters for each band.*

drive levels are present from stage to stage, rather than measuring rf voltage.

Add up all these conditions and practices, plus perhaps a dozen others peculiar to certain kinds of builders, and it is little wonder that the amateur who tries to build a receiver designed like one in Figs. 2 and 3 has little luck making it work.

Now, it is not reasonable to believe that every ham builder will spend the money it takes to obtain select components or to set up complete test facilities. Nor should we expect that in the near future, circuit reliability will increase to make every wide-range rf system easily repeated. Does this doom the amateur builder to failure? No, not if we change some parts of our design philosophy.

Some Useful Things to Remember about Transistors

Transistors and FETs resemble tubes in these two main ways: First, they may be operated Class A, AB, B, or C (plus some other ways to which experimenters have given new class names); second, any element may serve as the common element, so that we have corresponding common cathode/emitter/source amplifiers, common grid/base/gate amplifiers, and common plate/collector/drain (cathode/emitter/source follower) amplifiers. Knowing this much is important in determining the details of individual circuits. However, transistors also have significant differences from tubes, differences which are very important in the development of a design philosophy for complex pieces of equipment. As we did with vacuum tubes, let us set them out together:

1. Transistors and FETs are very small and take up little space on a chassis or circuit board. About fifty of them might fill the space taken up by one miniature tube and its socket. *Principle: Unless we are interested in the greatest degree of microminiaturization, it really does not matter how many transistors we use, so long as each is used well.*

2. Transistors and FETs create little heat at low powers, i.e., under a Watt. *Principle: No matter how many low power stages we use, heat will probably not be a factor in either the stable operation of a circuit or in the lifetime of the circuit.*

3. While MOSFETs are very high input impedance devices, transistors especially, and to some extent JFETs, will have lower impedances which require attention to matching. There are, of course, many more wide-range circuits for FETs than for transistors, which require little attention to matching. *Principle: For transistors, at least, matching to the individual device is still best.*

4. Transistors, especially in the hobbyist class available to most ham building, will vary in characteristics and require attention to operating levels. *Principle: Bias levels for transistors may need to be fiddled with, and may not work consistently across wide frequency excursions.*

5. Transistors and most FETs are cheap; to buy them five for a dollar is not uncommon, and even specified types like the popular 40673 or MPF 102 cost under a dollar. *Principle: The number of transistors and FETs in low power stages is not likely to make a ham project too costly to build.*

7. Compared to other components, such as switches, coils, and capacitors, transistors and FETs are small and inexpensive, and their associated biasing resistors may cost a nickel or less apiece. *Principle: It is better to substitute small, inexpensive components for big expensive ones wherever circuit reliability can be maintained or improved.*

From these points of comparison and their associated principles, you can see a design philosophy beginning to emerge. Since it is often (though not always) necessary to tweak a circuit up for an individual frequency band, and since the necessary components are cheap (and for other reasons which will become obvious in a few more paragraphs), it is better for the ham to build rf systems of circuits for one band at a time, and then to switch them in and out as needed, rather than to use the tried and true (for tubes but not necessarily for transistors) method of switching frequency-determining components. Not only can this method assure better circuit reliability, but it can also simplify the process of building, provide operational equipment before the entire unit is functional, and save money for the builder.

Some Examples

Let us look at a couple of examples of this design philosophy and see how they work out in practice. First, go back to the receivers of Figs. 1, 2, and 3. Fig. 4 shows how the receiver can be designed using the principles above.

The revised receiver employs converters for each band except 80 meters. This is a scheme used extensively and, with the exception of separate converters, goes as far back as the Drake 2 series of tube-type receivers. The i-f frequency is a matter of choice in accord with the design objectives, and can be a function of up or down conversion. The main design features to note are these:

1. No device operates at more than one frequency or band, thus allowing for optimization of all parameters. Among these are gain, bandwidth, oscillator-output level, stability, and avc action. For each converter, bias values, coupling capacitors, LC values, and the avc voltage-divider network can be juggled either to provide equal gain for all bands or to emphasize or de-emphasize some bands. (Maximum gain for 80 and 40 meters usually means more noise than signal.) The remainder of the circuit is standard, in the sense that almost all receivers operate i-f and detector stages at one frequency.

2. Note the switching system. Converters which are not in use are not powered, thus eliminating some potential birdies. Switching, however, requires only a three-pole switch, one each for antenna input, converter output, and Vcc. Moreover, by using shielded signal leads (and shielding the power lead is not a bad idea) and minimal inter-section shielding of the switch, the entire switching network can be made very compact. In some receivers using similar schemes, I have seen retained the classic long switch, running from front to rear on the chassis. It is quite unnecessary.

3. The avc system employs resistor-divider sections to limit or expand voltage excursions so that the avc action is controlled for each band. Many receivers of this design omit avc to the converters, relying upon the basic receiver sections to do the job. Given the gain of the converter sections, overloading can become a problem. Tailoring the avc action to each converter solves the problem. Avc voltage can be switched or not, depending on circuit design; it should be switched out unless the converter, when not in use, shows an open circuit to the avc voltage. Otherwise, it will load the avc system. A compact fourth pole on the bandswitch solves this potential problem.

4. Unlike many handbook designs, there is no need to make each converter identical. Single-ended rf stages operate well on all HF frequencies with MOSFET devices, but experimentation with a pair of grounded grid amplifiers in cascade, or with cascode circuits, is worthwhile. Moreover, one can try push-pull circuits, since the usual mechanical problems of band changing with balanced LC circuits are not present. I am often amazed at the lack of experimental ingenuity which appears in rf designs in the ham journals, despite the large number of possible circuits available for use, and the variety of devices which just might make one or more of them a good performer.

5. The main limitation on this design philosophy is that it does not produce the most compact equipment possible. For subminiature gear, perhaps another method of design should be used, but for home station use, miniaturization is not the ideal situation. The two main physical considerations should be experimental flexibility and accessi-

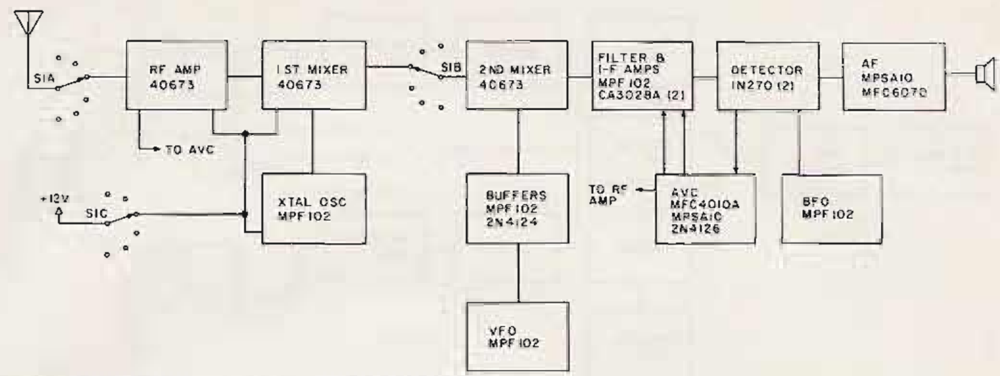


Fig. 4. Block diagram of a receiver most closely meeting the design principles enumerated in the article. In general, this is part of WA1JZC's receiver in the 1978 Handbook, *with some alterations. Unlike the original, avc is shown for the rf amplifier. My personal choice calls for different circuitry, but this design is readily available for study by the prospective home builder. Note the simplified switching of rf circuitry. The originator in fact optimized converter design for each band using JFETs in a grounded-gate circuit (except on 80, where he omits the rf amplifier) and a 2N4124 crystal oscillator. His commentary is worth repeating: "Separate converters were incorporated to eliminate the need for complicated bandswitching, and also to permit optimization of circuit values for each band of interest. The system used in this receiver calls for switching of only dc and 50-Ohm circuitry. Low-impedance switching eliminates problems caused by long switch leads. Switching at high impedance points, which is the usual technique in multiband receivers, can impair the quality of the tuned circuits and makes isolation of critical circuits more difficult." (See pp. 280-281.) Although some of these problems can be overcome by the diode-switching techniques of Fig. 2, optimizing performance and being able to assure full frequency range repeatability with home construction techniques require adoption of something similar to the design philosophy of this receiver.*

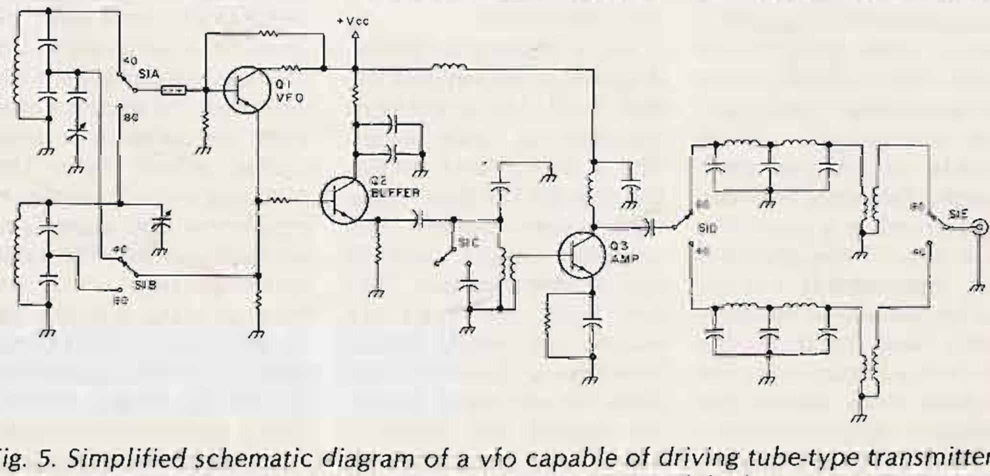


Fig. 5. Simplified schematic diagram of a vfo capable of driving tube-type transmitters. Note that LC combinations are switched by S1A and S1B, while the input to Q3 is tuned by switching a capacitor across a fixed coil with S1C. From the ARRL Handbook.

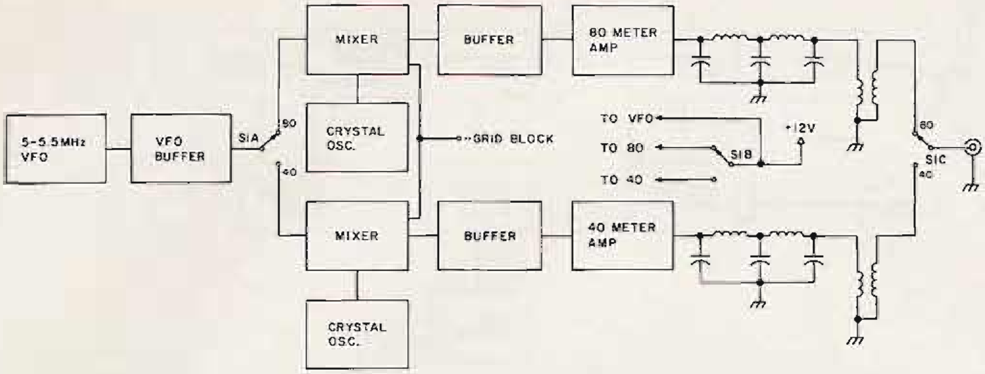


Fig. 6. Block diagram of mixing vfo for tube-type transmitters. Individual circuits are similar to those of Fig. 5. Buffers are untuned. Mixers are FETs with about −4 volts grid/gate block. Note especially the simplification of switching, which allows a single wafer to be used rather than the 8″ switch used in the original of Fig. 5. Notice also that either mixer-amplifier section may be removed for adjustment or experimentation without disabling the vfo completely. Total cost of the "extra" mixer-oscillator-buffer-amplifier devices was under $2.00.

bility, and operating ease. The mechanical size of easily read digital- or mechanical-readout systems is still the main factor limiting miniaturization. Within the size limits of most convenient readouts for main station use, there is plenty of room for the boards for each converter. In fact, many of the imported transceivers, when mobile use is not intended by the operator, appear to be excessively compact both for operating ease and for maintenance convenience. Heat is a constant worry with them.

The amateur designer, therefore, might well take a page from the notebooks of home computer designs. Within whatever case one uses, develop a main frame with plug-in units at every stage, along with space for future, more complex circuits. With careful attention to routing rf paths, you can use plug-in circuit boards or plug-in perfboards. Shielding between most boards is a must. The advantage of this system is that replacement circuits can be developed independently and tried in the receiver, without losing the receiver from service for long and without mechanical alteration to the basic unit. This not only ensures an operative receiver at all times, but also eliminates future mechanical costs for new versions. Your equipment will be as up to date as your latest experiments, however old the case may get.

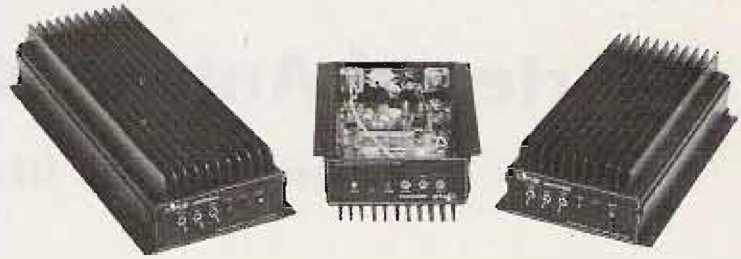
These advantages accrue not just to receiver design, but also to transmitter stages as well. Fig. 5 shows an 80/40 meter vfo that appeared in the *ARRL Handbook* for several years. Notice that the tuned circuits in the vfo are switched. Note, too, that the input circuit to the power amplifier is changed from 40 to 80 meters by the addition of a capacitor. Neither of these schemes is optimal, and their correction is hinted at by the design itself. The output filters are switched in their entirety. Why not the entire power train?

Fig. 6 shows a simplified diagram of the revised system built for a ten-Watt standby rig using tubes. The 5- to 5.5-MHz oscillator runs all the time. Separate mixer, buffer, and amplifier stages give 80 and 40 meter output. They are built on separate boards and require only a three-pole switch, one each for vfo input, amplifier output, and power. If one desires separate output jacks for each band, one pole of the bandswitch can be eliminated. Tuned circuit and bias values have been optimized for each band. Since the transmitter with which the vfo is used supplies not only the twelve volts, but also blocked grid-keying voltage, the mixers are keyed. Because of the transmitter design, more output was required on 80 than 40, a problem easily solved using this scheme. If I ever use the vfo with another rig, equalizing the vfo output will be no problem either. Despite the fact that the vfo uses an old ARC-5 tuning capacitor, the entire unit fits in a 4 x 5 x 6 case. Obviously, little is lost to compactness by the use of the design principles enumerated here.

The purpose of this article is not to get you to build what I have built. Instead, it is designed to encourage you to build what you want, by showing that there are some basic principles which take the scariness out of complex rf equipment that appears in the ham journals. The basic idea to get rid of is that you have to make a tricky device like a transistor operate all the way from 80 or 160 up to ten meters. Doing your work one band at a time and building your equipment one section at a time not only makes building for the amateur non-engineer possible, but also makes it fun. What you learn from trying new bias values and schemes, or from trying different LC values, will soon give you confidence that you can make almost anything work.

building, and that is to give you my personal prejudices about what test equipment the ham builder ought to have. A VTVM with regular and rf probes is essential—preferably one that has a range of about a volt and a half for reading partial volts. My trusty Heathkit has stood me in good stead for many years. A grid-dip meter for testing LC circuits or for a signal source is also very useful. A VOM for current readings is needed, but it need not be an expensive model. Beyond that, the rest is up to you. Oscilloscopes, frequency counters, impedance bridges, and the like are all useful, but with them I notice that I do not have to clean off my fingerprints nearly as often as I do with other pieces of test gear. Finally, station operating meters for swr, power output, and dummy loads are useful only for some projects. An all-wave HF receiver, however inexpensive and inexact in dial reading, can help a great deal, especially in testing things like heterodyne oscillators. For me, however, the big three are the VTVM (and rf probe), the gdo, and the VOM.

The principles I have given can be expressed in many ways. I welcome additions to the list, and new ideas to improve my own techniques. Hopefully, the ones given here are enough to encourage you to make the move from building station accessories to building your entire station. Then you can use that commercial rig as your standby. ■



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Shortened Antennas for 75 and 80

— designs which fit your QTH

Slopers exposed.

During 1975 and 1976, I tested various 75 meter antennas with several ZLs and VKs. This band is generally open from there to the United States during the early mornings (local US time) around 1000 to 1200Z. I have been trying to determine if there is any particular 75m antenna best suited for this 7- to 8-multihop 8000-mile-plus path. There are usually a number of US hams working the ZLs and VKs on SSB between 3775 and 3850 kHz. The ZLs are permitted to work this portion of the band. As the VKs' highest frequency end is 3700, they generally transmit SSB between 3680 to 3695; therefore, split operation must be used with them.

75m antennas tested here during 1975-76 were: several dipoles at various heights (40 to 70 feet); three delta loops; a two-λ horizontal quad at 70 feet; two ½-λs in phase, collinear at 70 ft. (broadside to NZ); several ¼- and ½-λ verticals; a 3-element yagi at 60 feet; and three horizontal monoband dipole log periodics (DLP), one 3-element, one 4-element, and one 5-element, all at 60 feet.

At times, I have had as many as 3 or 4 75m antennas up at the same time for making direct comparisons between the various types. During the tests, the best reports from the ZLs and VKs have been with the log periodics and the yagi. As all of my antennas are supported by pine trees, the maximum height above ground for the horizontal antennas is limited to 60 to 70 ft., or approximately only ¼ λ above ground at 3.8 MHz. These are, of course, fixed-wire beams.

At times, the yagi or the log periodic would be reported as much as 10 dB better than some of the other types being tested. The yagi and the LPs were all beamed west or SW.

The log periodics and

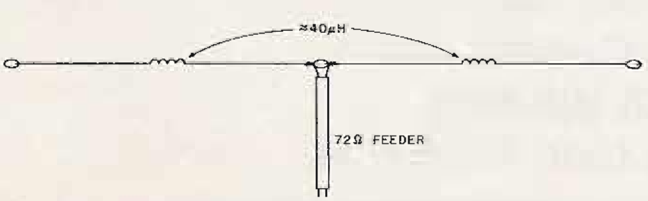

Fig. 1(a). Coil-loaded shortened ½-λ dipole.

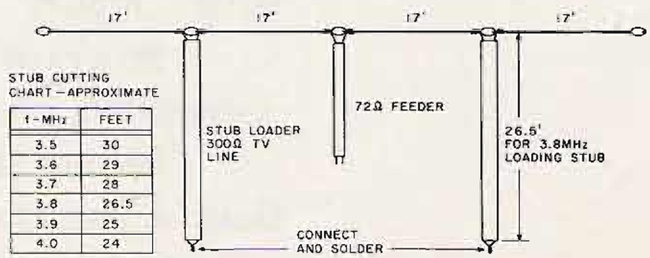

Fig. 1(b). Stub-loaded shortened ½-λ dipole.

the yagi, although producing the best reports from "Down Under," are quite large, requiring a width of approximately 150 feet and a boom length of at least 100 feet. The general design of the 5-element monoband log periodic is given in reference 1, Fig. 6, reference 2, Fig. 2, and reference 3, Fig. 4. The dimensions for the frequency range 3.8-4.0 MHz are given by reference 2, Table 1. This LP was supported at about 60 feet by 8 pines.

As an antenna of this size is generally impractical for the average ham on a city lot, during 1977 I tested 75m antennas requiring less space but still giving some gain and more directivity than the usual 75 or 80m dipole or inverted vee when limited to a height of only sixty to seventy feet. These are described in the following.

Shortened Dipole Slopers

During the tests with the ZLs and VKs, it was noted that W2GO, one of the more consistent early morning DXers, uses a single shortened (66-foot) dipole as a sloper to the west with very good reports.

Shortened dipoles using off-center loading coils were well covered by Jerry Hall K1PLP (*QST*, Sept., 1975, page 28). By use of two 40-μH loading coils, the 75m dipole was shortened to 66 feet. This is the type used by W2GO for his shortened 75m centerfed ½-λ sloper, which requires only a single 60- to 70-foot pole, tower, or tree support. It is sufficiently compact to be used on a small lot. This was the type which I selected as being the most simple and compact antenna requiring minimum space.

As I did not have a pair of loading coils as specified in the *QST* article and did not wish to take time to wind them, I used instead two lengths of 300-Ω TV line as loading stubs for the shortened dipole. See Fig. 1(b). As a start, I used 30-foot stubs which resonated the shortened 68-foot dipole at approximately 3.5 MHz. Resonance can be determined by a GDO or by running an swr.

Next, the stubs were each pruned about 6 inches and the resonance was again checked, and then another 6 inches were removed and the frequency checked. This procedure was continued until the dipole resonated at 3.8 MHz. A total of 3.5 feet had been removed from each stub, making them each 26.5 feet in length. These loaded the dipole to the desired center frequency, 3.8 MHz. An swr was then run to determine the usable bandwidth of the shortened stub-loaded dipole, illustrated in Table 1. It will be noted that the bandwidth is quite narrow but usable ±100 kHz covering the DX portion of the 80m phone band.

This shortened or loaded dipole was then suspended as a sloper (Fig. 2) from the top of a 70-foot tree and sloped SW for tests with the ZLs. Although the overall length of the sloper was only 68 feet, it worked surprisingly well, considering its simplicity and ease of construction. It was fed with 72-Ω twinlead connected via a 1:1 balun to a buried coax to the shack.

For a dipole-type sloper to be effective for DX, or rather to have a fairly low angle of radiation, it should form an angle of at least 60° to ground. 70° to 80° would probably be better. It, no doubt, acts as a ½-λ vertical or semivertical. Being centerfed, the necessity of an elaborate ground radial system as required with a ¼-, ½-, or basefed vertical is probably not as important. None was used during

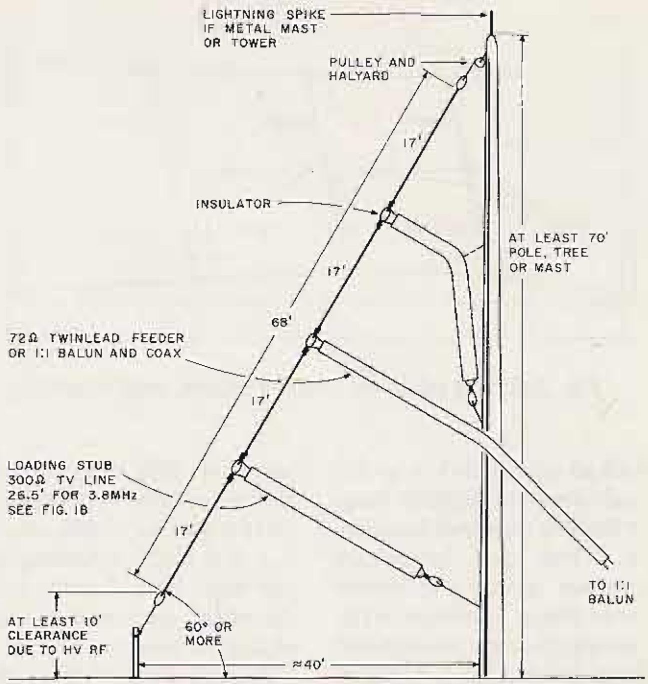

Fig. 2. Shortened ½-λ dipole sloper, stub-loaded.

these tests. If the slope angle is less than 60°, say 45°, it will probably have more horizontal polarization and higher angle radiation and would become more like a low horizontal dipole with the major radiation lobe at 90° or straight up. In this configuration, it would no doubt show an improvement with nearby stations up to a few hundred miles, but DX operation would suffer.

A second sloper using an old Hy-Gain 40/75 trap dipole (overall length about 110 feet) also was tried, suspended from a 100-foot tree and aimed SW. This sloper seemed slightly better than the original 68-foot stub-loaded sloper. This was no doubt due to greater overall radiating length, more effective height, and an angle of about 70°. It had the advantage of also being usable on 40, though no extensive tests have been made with it on this band.

Phased Slopers—Endfire Array

As above slopers gave fair results considering their simplicity and ease of construction, it was decided to try a 3-element phased sloper (all elements driven) in a log periodic, endfire sloper array configuration. This was constructed by using a nylon line catenary stretched between two high pines separated by about 200 feet and oriented to give a beam at about 225°. The higher, rear tree was about 75 feet in height and the forward tree was about 60 feet high.

As the use of stub-loaders was not desirable due to complications in suspending the stubs so that they would come off at about 90° with respect to the sloper elements, it was decided to use end loading instead of stubs. This was accomplished by folding about 25% of each element end to the rear and securing them to the top and bottom catenaries, as illustrated in Fig. 3(a).

As it was desired to operate this beam centered on 3800 kHz, it was adjusted so that the longest rear element, #1, resonated at 3.7 MHz, #2 at 3.8 MHz, and the short forward element, #3, at 3.9 MHz. The easiest

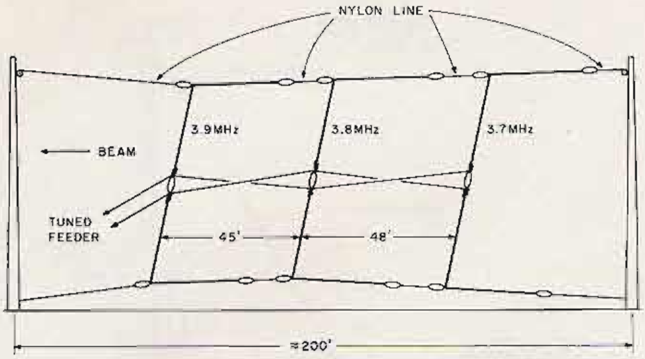

Fig. 3(a). Log periodic phased sloper, end-loaded.

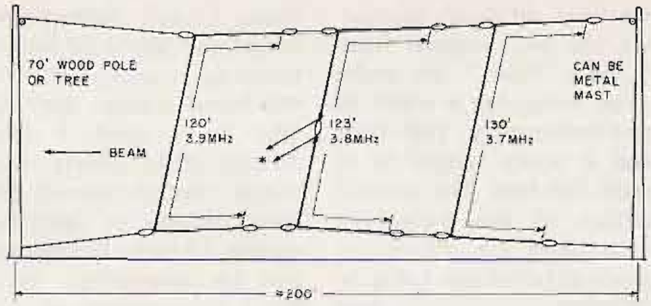

Fig. 3(b). Yagi phased sloper, end-loaded.

way to adjust this is to cut each element slightly longer than its required frequency. Then put temporary jumpers across the center insulators (feedpoints). Secure the ends of each element (folded back portion) to the catenaries and then raise the array to its normal suspended height. At this point, the 2-wire center feeder is not used.

Next, check resonance of each of the three elements separately by holding the GDO near the horizontal section at the bottom of the catenary, and pruning the ends as necessary to the three frequencies, 3.7, 3.8, and 3.9 MHz, as mentioned above. This must be done with the array suspended at its final location due to variations of resonance depending on the height of the three elements above ground. These three frequencies were selected so that the completed antenna would be centered on approximately 3800 kHz, and also to allow the array to operate as a log periodic.

Once the three elements are tuned, the array can be lowered, the jumpers across the three center insulators removed, and the 2-wire open feeder or phasing line connected as shown in Fig. 3(a). Note the transposition required for the array to perform as a log periodic or an endfire array. Each element must be out of phase with its neighbor, as required of any log periodic. The construction of the feedline is presented by the articles in references 1, 2, 3, 4, and 6, covering log periodic wire beam construction, and will not be repeated here.

A large array of this type for 75, even though using only 3 elements, must be assembled and tuned on site for its particular surroundings and height above ground. Table 2 is overall swr covering 3.5 to 4.0 MHz, after adding the center feeder to the array. It then centered on about 3.7. However, as the swr at 3.8 was only 1.25:1, no further changes were made since the beam was usable between 3.6 to 3.9 MHz.

Although this phased-sloper log periodic was only tested for about one week, it appeared to have gain and directivity as hoped. During one of the tests on 3808 kHz, Bob Tanner ZL2BT advised that it was about the same as the 3-element horizontal yagi at 60 feet which I was using at the same time.

The main advantage of the above phased sloper is that only two trees or masts are required, as compared to 6 or 8 necessary to support the 3-element yagi or an equivalent 3- to 5-element DLP. Further, the phased array, being primarily vertically polarized, should have a lower angle of radiation. Since the radiating elements are semivertical dipoles (centerfed), a ground screen or counterpoise was not used during the tests. Although the length requires about 200 feet of mast spacing, its width is less than 1 foot, compared with the 150-foot width of a 75m dipole log periodic or yagi.

For those who prefer yagis, the same 3-element sloper could, no doubt, be arranged as a 3-element yagi by deleting the open wire center feeder, deleting the center insulators from elements #1 and #3, and feeding the center of #2 element directly with 72-Ω twinlead or, better still, with an open tuned line. See Fig. 3(b).

The array would then become a yagi with #2 the driven element, #1 a parasitic reflector, and #3 a parasitic director. The yagi sloper array would, no doubt, have a more narrow bandwidth (possibly no more than ±50 kHz) than the bandwidth of the log periodic configuration. I have not tested the sloper array as a yagi, but, on previous tests comparing a 3-element horizontal monoband DLP with an equivalent 3-element yagi, a greater bandwidth was given by the log periodic.

Test Results

Shortened loaded slopers—

From the tests made with ZLs and VKs on these 75m antennas, and also from comparing notes with the previous tests with ZL1BKD during 1975-76, it appeared that the single shortened loaded-dipole sloper was equal to the larger delta loops, 2-λ horizontal quad, verticals, etc., which were tested then versus the large 75m yagi and/or log periodic (horizontal dipole-type) beams. The latter did average out about 10 dB better than the more simple antennas, including the slopers.

Considering the simplicity and ease of building the loaded sloper, and the fact that only one support is required as against 6 to 8 to support my large beams, it is believed the loaded sloper is the least expensive 75m DX antenna and about the only one suited for a city lot except, possibly, a single ¼- or ½-λ vertical, which can be quite expensive if a 60- or 120-foot tower or mast is used and the required 60 feet or more of ground radial system buried. The latter may also be a problem on a city lot.

During the tests, the large beams would show as much as 15-dB increase over some of the more simple antennas, but these differences would vary from day to day. The 10-dB gain over the more simple antennas was more the average.

Comparing the simple sloper with the delta loops, the type with apex topside requires only one high support but needs about 120 feet of space for the lower horizontal section. The type with the horizontal section up and apex down requires two supports spaced at about 120 feet.

Comparing it with the

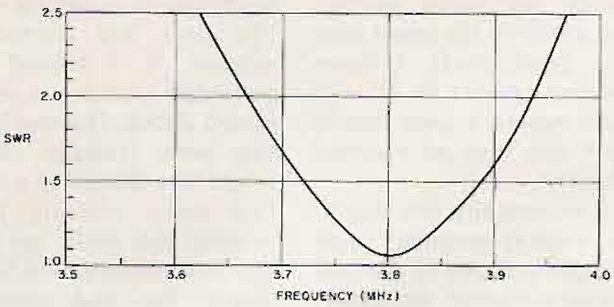

Table 1. Shortened dipole sloper.

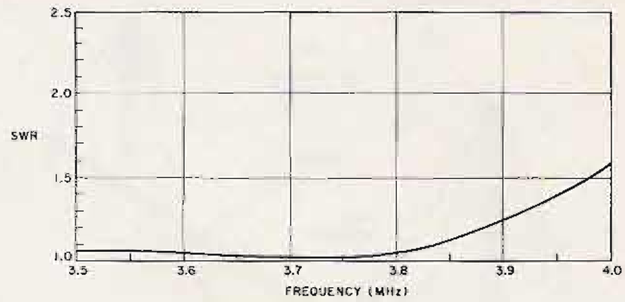

Table 2. Log periodic as in Fig. 3(a).

horizontal 2-λ quad, the latter requires four supports arranged in a square with about 130-foot separation, hardly suited for a city lot. The delta loops and quads also require more wire. 75m phased verticals are also impractical in a small space.

Therefore, the simple loaded-dipole sloper is recommended as a good all-around and inexpensive DX antenna if one does not have an open space of about 150 x 150 feet for a large beam to provide gain. Further, the latter, requiring 6 to 8 supports, also requires considerably more wire, insulators, etc., and a great deal more effort and labor!

For anyone not interested in 75m DX, a shortened or loaded sloper used as a high-angle radiator, either as a sloper at about 45° or as a low dipole at about ¼ λ or at approximately 60 feet above ground, will be a good average short-haul antenna for several hundred miles.

One suggestion would be to have two anchor posts for the bottom end, one to provide a slope angle of at least 60° for low-angle DX, and the other to give about a 45° slope for general short-haul communication.

The 3-element phased sloper—

Although this is a more elaborate beam, having gain, it is not generally suited for a city lot, since two masts with a 200-foot separation are required. It does have an advantage in that very little width is required, but it does require considerably more wire, insulators, and labor to assemble. It did appear to be about neck and neck with the yagi (also being used at the same time) from the ZL and VK reports. It may have been just a bit noisier on reception due to being more nearly vertically polarized. However, I did not have time to determine this for sure. It did make a good showing "down under" when compared directly with the yagi being used then.

A 3-element wide-spaced horizontal log periodic beamed west was set up later, which Bob Tanner ZL2BT advised was the best antenna tested here over the past 3 years.

I might add that, when comparing the various 75m antennas during this period, if the ZL or VK reported a 1 or 2 S-unit or 5- to 10-dB increase or difference between two antennas, the same difference on reception of their signal would generally be noted, as would be expected.

On this multihop 75m path, there is generally less QSB than on the higher bands. When there is fading, it is usually slow, unlike rapid QSB on 20.

For the information of those who do not work 75m DX, the VK and ZL signals generally have a slow buildup about 15 minutes before sunup, when they peak. They remain peaked for 15 to 30 minutes, and then start a decline for 30 minutes to 1 hour after sunup, local time.

As yet, I have not determined if the sunrise peak is due to "gray line" propagation or possibly due to a change in ionization of the F-layer, causing less attenuation at this end or possibly in the last hop (received at this end), thus giving the 5- to 10-dB signal increase which is generally noted at sunup.

It is doubtful that "gray line" affects the US-NZ path since they are in total darkness approaching midnight (sunup here in the east). "Gray line" might affect the W-VK path since sunup here is about sundown in certain parts of Australia.

To get more firsthand information on this, I am now (as of this writing) in the process of putting up two beverage receiving antennas, one N-S and one E-W. These are 2-wire reversible-direction beverages, each 520 feet in length, for use on 160, 80, and 40. Some very excellent data, suggestions, and material have been made available to me by Paul W6PYK for this test, for which I am very grateful. I had previously tested several simple single-wire beverages, resistor-terminated, to improve S/N.

The beverage project was started here originally to try to improve reception which is extremely poor, especially on 75, at this QTH. This is due to very poor ground conductivity, extremely high noise level (both QRN and manmade) on 75, and the fact that it is surrounded by high pine trees (60 to 90 feet) except to the NE and E. They extend for several miles to the SW and W.

For this reason, there is little open space for verticals, since trees higher than a ¼-λ vertical would surround it. There would be some trees separated from them by less than 50 feet, very thick in the direction of the ZLs and VKs. The two single-wire slopers which were tested were suspended from trees in open areas, although there were trees within about 100 feet to the W and SW.

For those who may become interested in 75m DX, there are some very good suggestions on propagation, "gray line," 75m antennas, receivers, a list of 75m DXers, beverage antennas, etc., presented in John Devoldere ON4UN's ham book *80 Meter DXing*, published in 1977. He includes a very complete list of 86 previously-published articles in the various ham publications covering these subjects.

Other Suggested Sloper Designs

In addition to the shortened loaded sloper and the 3-element phased sloper described above, the following are several suggested slopers and phased slopers. I have not actually tried these, but they are described briefly for anyone wishing to experiment or

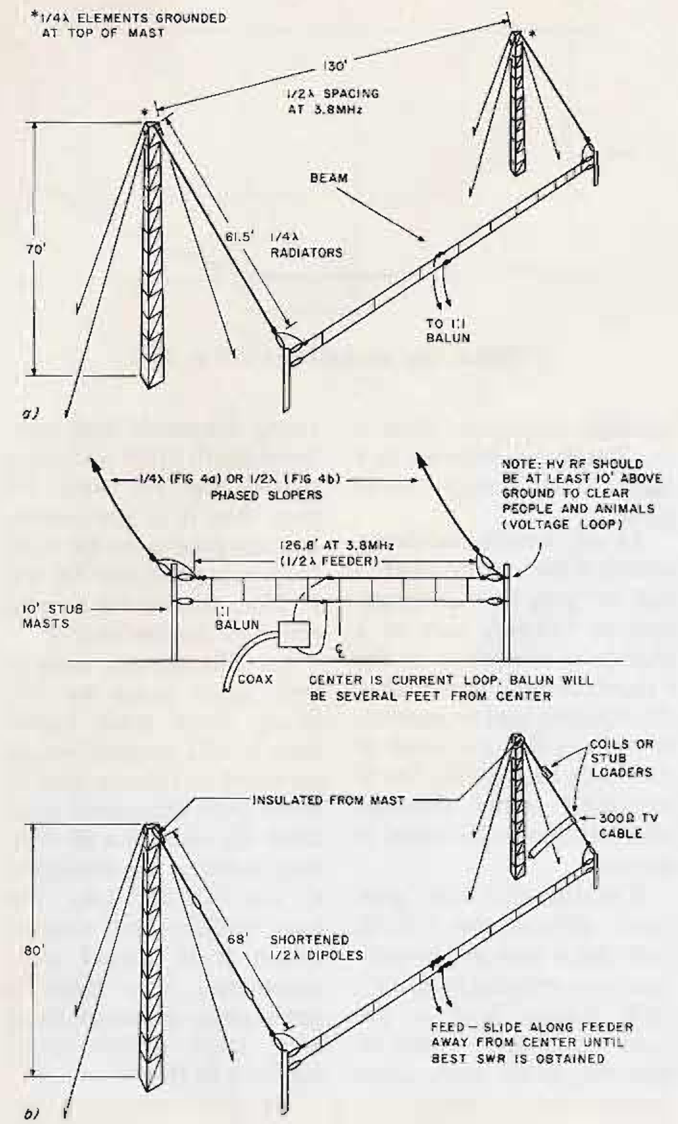

Fig. 4.(a) ¼-λ phased slopers. (b) ½-λ shortened phased slopers.

who is interested in antenna design.

Multidirectional slopers—

If there is sufficient open area around a single high mast or tree, 3 or 4 of the shortened 75m dipole slopers could be used for several directions as per K1THQ's 40m four-direction sloper described in the *ARRL Antenna Book* (Figs. 8-12, page 200, 13th edition). According to his measurements, the forward gain was about 4 dB and front-to-back up to 20 dB. Note that the coax to the relay box must be just over 3/8 λ. At 3.8 MHz, this length would be approximately 63.4 feet of RG-8/U or RG-58/U (VF = 66%), or 74.9 feet of RG-8/AU or RG-58/AU (VF = 78%).

I have not tried this 4-directional sloper, but it sounds interesting for anyone having the room and needing a lobe in more than one direction. If a mast at least 130 feet in height is available, full ½-λ sloping dipoles could be used without loading and would no doubt be more effective. The dimensions would then be about double those given for K1THQ's 40m switchable sloper.

¼-λ slopers—

Not having a tower, I have been unable to test a ¼-λ inverted sloper fed by coax at the top of the tower (with the coax sheath grounded to the tower near the feedpoint). I have worked several on 75 who have reported good results with this type of inverted sloper.

Theoretically, this should be a good antenna, since the current loop of the ¼-λ sloper is topside and generally in the clear. The tower provides a ground plane or acts as a reflector, which should give some directivity. However, this type appears to be tricky (and they either work or they don't). No doubt the ¼ wavelength and the angle between the sloper and the tower are critical, probably affecting the impedance at the top feedpoint, which is probably low. Possibly a matching network between the coax and the feedpoint would help, or possibly the top of the ¼-λ element could be grounded directly to the towers and the lower end voltage fed at the bottom with a tuner or a ¼-λ tuned line used to voltage or end feed, similar to the old Zepp. Using voltage feed at the bottom also saves the length of coax from bottom to top of tower.

I have one friend, YV5DLT, who put up two of these ¼-λ inverter slopers (topfed), one for 75 and one for 40. He said the 75 worked with no problem, whereas the 40m refused to work. I have noted that about 25% of those using the ¼-λ sloper have gotten them to work; the rest had problems or became discouraged if they did not work right away.

Possibly those using these successfully can give some suggestions. Also, the estimated angle of radiation, H-plane pattern, etc., would be interesting.

Dual ¼-λ phased slopers—

Possibly, using two of these side by side, in phase, spaced ½ λ broadside to the desired direction, might be of interest, as per Fig. 4(a). The two ¼-λ elements spaced ½ λ would be grounded topside, as mentioned above. The two bottom ends (voltage loop) would be voltage-fed with a ½-λ open phasing line feeding the ends, so the two ¼-λ radiators will be in phase. The ½-λ phasing line is current-fed, slightly off center directly with the coax or with a 1:1 balun. For 3.8-MHz operation, the two ¼-λ slopers would be approximately 61.5 feet and the 2-wire open phasing feedline approximately 126.8 feet long. This beam requires two 70-foot towers spaced about 130 feet apart and oriented broadside to the desired direction. A few wire reflectors between the towers might improve the lobe in the desired direction.

This array would be similar to the broadside or side-by-side phased slopers described below, except ¼-λ slopers would be used in place of the ½-λ shortened dipoles. See Fig. 4(b).

½-λ phased-sloper or vertical-dipole arrays—

If a mast at least 130 feet high is available, it could be used to support a full ½-λ phased sloper or vertical dipole endfire array. The elements would then be a full ½ λ (no endloading required), thus being more efficient and having greater effective height.

Another advantage of greater height would be the possibility of having the three elements near or exactly vertical, so the array would then become a 3-element vertical (dipole) log periodic or 3-element vertical yagi (whichever configuration is preferred) as was described above under "Phased Slopers—Endfire Array."

With the shortened dipole sloper or multi-element sloper arrays, the loaded elements probably reduce efficiency about

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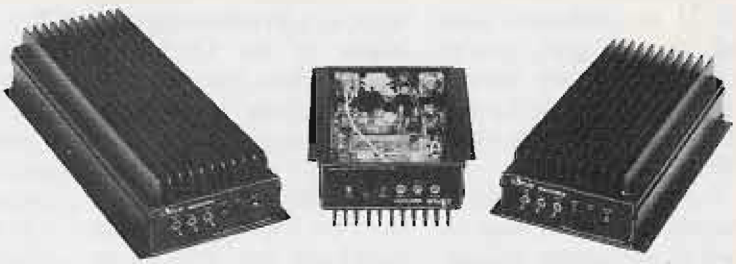

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Reader Service—see page 211

50%, as the shortened radiating portion is only approximately ¼ λ. Their ¼-λ radiating portion should be about the same as the vertical radiating portion of a Bruce array.

The end-loaded sloper array might be considered as a 3-element endfire array, as opposed to a 3-element Bruce array which is a bidirectional, broadside one using ¼-λ radiating elements in phase spaced ¼ λ. The 3-element endfire array would be unidirectional and should give greater gain. The Bruce would, however, probably have a greater null to the sides (180°).

If a single high mast is available, it could also be used as the center support for 3 or 4 separate phased endfire arrays, thus providing 3 or 4 separate beam headings or separate selectable lobes at 120° for 3 arrays or 90° for 4, for beaming N, E, S, or W.

Granger, Trylon, and Hy-Gain manufacture commercial or military fixed-wire monopole and vertical dipole log periodic wire beam arrays of these types for frequency ranges 2.5-32, 3.0-32, 4.0-32, and 6.0-32 MHz. These are recommended for long-haul HF circuits. See the Hy-Gain commercial catalog E, 1969.

Incidentally, if any hams are interested, these commercial wire beams are generally in the $20,000 to $50,000 class. However, this does include an 100- to 240-foot steel tower. A 3- to 5-element vertical (monoband) dipole log periodic for 75m can generally be ham-built for $100.00 or less for wire, insulators, etc., less tower and coax.

Broadside or side-by-side shortened slopers— Another suggested phased sloper could be the use of two shortened 78-foot ½-λ (loaded) sloper dipoles suspended from two 70-foot masts spaced ½ λ (approximately 130 feet at 3.8 MHz). See Fig. 4(b). The two slopers would be operated in phase with 130 feet of separation. A ½-λ tuned feeder/phasing line would be required for feeding and phasing the two slopers, similar to the dual ¼-λ phased slopers described above in Fig. 4(a).

Better still, if the two phased slopers could be a full ½ λ (requiring two 130-foot masts), they should give about maximum gain to broadside for an array of this type. I believe I have heard of some ham using this type of beam.

There are, no doubt, many phased-sloper-array combinations which can be designed. I again wish to point out that I have only built and tested the loaded sloper of Fig. 2 and the 3-element (end-loaded) phased sloper of Fig. 3(a).

I would appreciate hearing from anyone who is using or has tried any phased-sloper arrays or has any suggestions along this line. ■

References

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Frederick James Bartolomei N8AJA
19442 Rockport Drive
Roseville MI 48066

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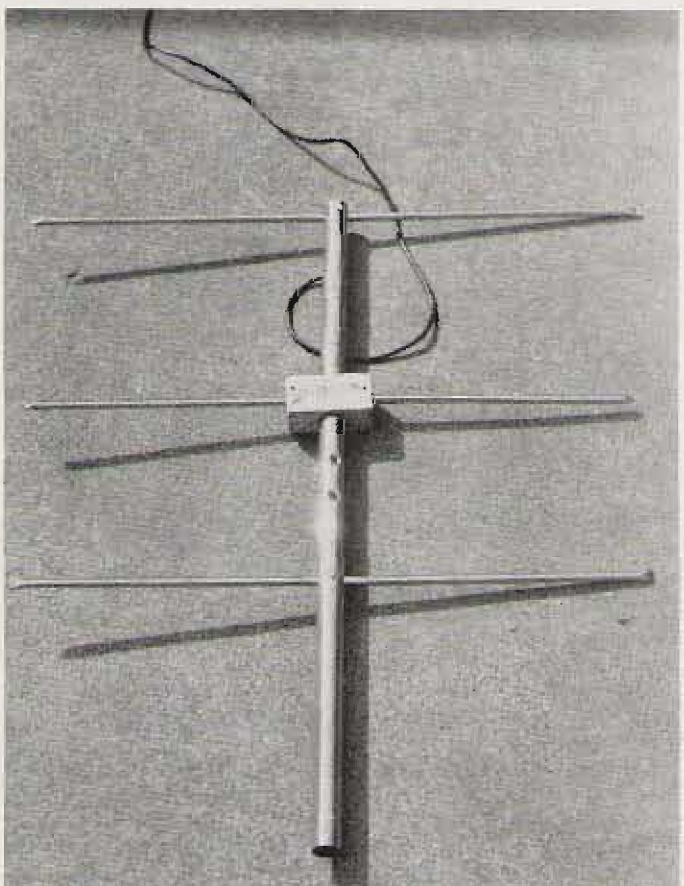

The completed 220-MHz beam.

If you're looking for an expensive, double-figure-dB gain HF antenna, try another article, because this construction project won't help you at all—especially if you want an HF skyhook. However, if the idea of a $5.00, 3-element yagi with about 6 dB of gain for 220 MHz suits you, then read on.

When the June, 1978, issue of *220 Notes* (volume 1, number 4) arrived at my doorstep, I was new to 220 MHz; in fact, the ink on my Tech ticket was still moist! So the blurb titled "Your Own Little 220 Beam" on page one captured my immediate interest. Although *220 Notes* included a marvelous sketch of the antenna (which they adapted from C. N. Zornes W9TAL), the newsletter contained no instructions for assembly. Fig. 1 is redrawn from *220 Notes* and shows antenna dimensions.

To build W9TAL's beam, I purchased a GEC-52 conical TV antenna, made by RMS Electronics, 50 Austin Place, Bronx NY 10462, for five bucks from a local radio-electronics store. I chose this model because of the cheap price, but any television antenna will do. Another route is to buy a boom and 1/8" or 3/8" aluminum rods separately.

Step 1: After taking the TV antenna from the shipping carton, remove the elements (secured to plastic hubs with pop rivets) by drilling out the rivets with a bit slightly larger than the head. Now you have several aluminum elements of various lengths and a boom.

Step 2: Measure the length of your boom. It must be at least 30 inches. The mast-cum-boom supplied with the GEC-52 is 31½ inches long. If your boom exceeds three feet, I recommend shortening it to 30 inches. A hacksaw or saber saw will do the job. Now mark a ¾-inch point in from either end; mark another ¾-inch point on the other side, i.e., directly behind it. You will be drilling through these points, so make sure they line up! Make similar marks 19½ inches in front of the first two. Measure the diameter of your elements, add 1/16 of an inch, and drill holes in each of the four marks. The drill bit will not slip if you first punch holes in the boom with a large nail.

Step 3: Make marks midway between the holes you drilled for the reflector element. These are perpendicular to and ¼ diameter away from the original holes. Stove bolts will drop through these points to secure the reflector. Repeat this procedure for the director. Once the spots are marked, drive a large nail through them and wiggle it around to ream out the aperture.

Step 4: Time to cut your elements. Measure and cut one element 27-1/8 inches long—this is the reflector. Measure and cut another 24-1/8 inches long—this is the director. Measure and cut two elements each 12 inches long—these are the driven elements.

Step 5: Crimp the open ends of the reflector and director and one open end of each driven element with pliers to prevent water from entering and rusting them. If the crimped ends are rough, a file or sandpaper will smooth them off. Locate the midpoint of each element (13-9/16 inches for the reflector; 12-1/16 inches for the director) and punch a hole, using the nail from Step 3, to allow a bolt to pass through it.

Step 6: Take a 4-inch piece of 2" x 4" and bore a hole in it as shown in Fig. 2, to accommodate the boom. Use a smaller bore (or large bit) to drill holes in the sides of the 2" x 4". These holes should be ¾ of an inch to 1 inch deep and under no circumstance should they intersect with the boom bore.

Set a driven element in each of the two side holes (make sure it is snug against the back) and screw a 1½-inch wood screw into the top of the 2" x 4" about ½" from the edge. The screw will secure the element and will later serve as a conductor between the coax and element. Slide the 2" x 4" on the boom so that the elements' centers are 10½ inches from the middle of the reflectors' holes.

Step 7: You're in the home stretch . . . final assembly begins here. Place the reflector (remember that's the longer element) in the large holes near the rear of the boom. Align the holes in the boom and reflector so that they match. Set a flat washer over the topside hole and drop in a bolt. Tighten the bolt with a lock washer and nut on the underbelly. Repeat this for the director.

Strip 1½ inches of the coax's outer covering off the end. Twist the shielding braid into a "wire" and remove the plastic insulator from around the center conductor. The total distance between the split in the coax to the end of each driven element is 12½ inches. Measure the length from one screw in the 2" x 4" to the tip of the corresponding driven element. Subtract this size from 12½ inches and wrap all but the difference of the twisted coaxial braid around the head of the wood screw. Drive the screw as deeply as possible into the 2" x 4". Repeat this part of Step 7 for the remaining screw and the cable's center conductor.

I wrapped silver duct tape around the 2" x 4" to isolate it from the nasty Michigan winters and to increase the beam's life.

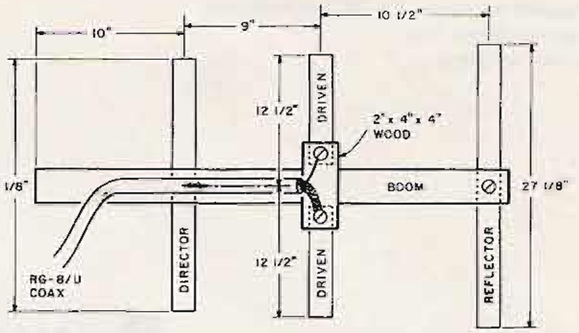


Fig. 1. Antenna and dimensions. Adapted from: 220 Notes, *volume 1, number 4, June, 1978, page 1.*

Bathtub caulking is another solution.

Results

In preliminary tests the yagi performed admirably. My first simplex contact was with Tom WB8GVC in Detroit (a distance of about fifteen miles), and the antenna was only ten feet above ground level. When I taped the beam on a twenty-foot makeshift mast (and had my father and Tom WD8OTN take turns playing rotor), I raised the WR8AOK repeater in Livonia, Michigan. WR8AOK sits forty-five miles from my home QTH—not bad for a ten-Watt Midland 13-509 rig and a twenty-five-foot run of RG-58/U. In the low power position (one Watt), I full-quieted the WR8AEF machine in Mt. Clemens, Michigan, a six-mile haul. All in all, I've been impressed with the results of W9TAL's design.

For maximum results, mount the beam as high up as possible—or, at least above surrounding trees—away from other metallic objects, and use RG-8/U coaxial cable to minimize transmission line loss.

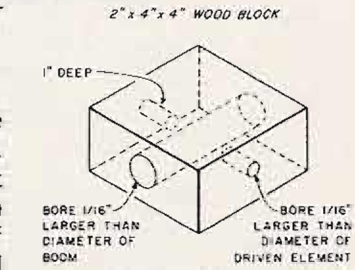


Fig. 2. Sketch of wood block holding driven elements.

I purposely neglected VHF/UHF antenna theory in this article. If you're curious about why it works, then consult one of these fine books: *VHF Antenna Handbook* from *73 Magazine* for $4.95 or *The Radio Amateur's VHF Manual* from the ARRL for $4.00. I felt the underlying theory was too much to tackle here and many hams, like myself, are more concerned with putting out a good signal. Any comments, questions, or objections you have on this fine, 6-dB, 220-MHz antenna at the minimal cost of five bucks will be answered, provided, of course, that you enclose an SASE.

As for me, I'm heading back to the radio . . . "QRZ rare DX from N8AJA in Roseville, Michigan." ■

Parts List

TV antenna (GEC-52) *or* 6½' of 1/8" or 3/8" aluminum rods and 30" boom
4" piece of 2" x 4" wood
saber saw or hacksaw with blade
2 wood screws (1" long)
2 stove bolts (1½" long) and lock and flat washers
wood bore and drill bits
electric drill
RG-8/U coax with 1 PL-259
rosin core solder and soldering iron

Alexander MacLean WA2SUT/NNN0ZVB
18 Indian Spring Trail
Denville NJ 07834

Beware of the Dreaded Phantom Ground

—exorcise those antenna gremlins

Avoiding the non-radiant antenna.

The article by John Cranston WB2DYU/2 in the March, '78, issue of *73* ("I Need A Contact!") brought back many unpleasant memories of past station operation and more than too many of how it works now. I, too, have a long history of inventing the non-radiant antenna. However, a few of the rules of thumb (or burned fingers, if you will) arrived at may be of help to other hams starting out.

If you don't read too much theory, it is harder to build an antenna that will not work than to build one that works.

From the description of what Cranston has, there seem to be a few old friends. One of my favorites is the phantom ground. All the books say that you should ground the equipment, particularly the transmitter, to avoid all sorts of troubles. Usually this leads to all sorts of troubles just like the ones you wanted to avoid, like TVI and rf burns when you touched the rig.

So what happened? Well, the ground was always shown in a picture-book station. There was all that beautiful gear, all hooked up together with a heavy copper braid ground bus to a conveniently located ground. It is the "conveniently located" that kills you. When they say ground, they mean ground, as in nice wet earth. To work, the direct earth connection must be quite close to your equipment and connected with a solid hunk of metal.

Many hams have some heavy copper water pipe that goes right through the basement shack and into the ground. Now that is a reasonable ground. If you don't have that, you don't have a ground. The further away from that you are, the less ground you have.

If your shack is on the first floor, or more probably the second floor or attic, you don't have any ground at all. What you do have is a hunk of far too thin wire draped all through the house to a water pipe and maybe a long run of that to the ground. For rf purposes, you aren't even connected to the ground. What your transmitter sees is what looks like another hunk of antenna. That, added to your nominal antenna, results in almost as good a radiator as your store-bought dummy load.

I have tried a number of different configurations of this basic circuit and can recommend it for tune-up purposes. It also is very impressive to show visitors how you can light a small neon bulb with your nose when you key the rig.

Let's get back to practical for a bit. There is no such thing as a long ground unless you can run something the diameter of a sewer pipe from the rig to the ground. I don't think that will work well, either.

So, forget the ground. Build an antenna that will work without the ground. This is not as hard as it sounds. Without the false ground to give trouble, many antennas will do the job without trouble.

Most rigs are coax-fed these days, so the basics will be for that type of output. The coax-fed antennas, dipole, beam, quad, etc., will work fine without the earth ground. Here you may want a balun or other matching device to go from unbalanced line to balanced, but it should not be critical.

If you can do it, the attic shack is the ideal location for the roof-mounted antenna. A simple mast with a small beam or quad will do nicely. From there it will be a short coax run to the rig.

So far, so good. What about that dipole you wanted to have? It doesn't matter that the rig is in the attic, but it usually happens that when you have met the condition that your rig is nowhere near a good ground, it probably is situated where you can't have a good antenna. Somehow the landscape has been carefully arranged so that there is no possibility of stringing a dipole, inverted V, or anything resembling the antennas shown in the book.

Now what? This is where the all-time easy antenna comes into its own—the classic random-length antenna. What this is is a long piece of wire. You make it as long and as high as you can. Nominally, you want it more than ¼ wavelength long. It would be nice if it was in a straight line, but it is quite accommodating to being bent into odd shapes. It would like to be free and clear of other objects, particularly metal ones.

With a little thought, it is almost impossible to not be able to meet the requirements of this antenna, but there are a few little hitches.

It runs from your transmitter to where it ends. That means there will be radiation in the shack; however, this should not be what is usually thought of as rf in the shack, i.e., burned fingers when you touch the rig. It just has to be hooked up right. Most rigs have a 50-Ohm output. The random is high impedance. You have to use an antenna tuner. This can be as simple as a coax jack, a variable capacitor (with insulated shaft), a coil and a few clip leads, or a fancy store-bought tuner. A short run of coax from the rig to the tuner and the antenna goes from there to the great outdoors. It works quite well.

It's hard to miss, but you're not home free yet. The books still say to ground everything together. This is how you get all that rf in the shack, plus assorted rf burns and minor jolts.

You still will have your phantom ground problem. It wasn't until I got rid of both the ground and connecting the various chassis together that my setup got tamed.

Don't connect anything to anything else that you don't have to. They fight with each other. This will leave you with only one problem.

There may be potential differences between the various chassis. If you are holding onto one and reach for another, you may get bitten. This is not pleasant, so learn not to do that any more. Don't grab two pieces of gear when both are live (or plugged in). This is a small price to pay for a reliable attic system. It may not happen that your particular gear does that. Some of mine does and some doesn't.

Of course, you are going to ground your antenna when not in use . . . or are you? You will have the same problem trying to ground your antenna to a phantom ground as your transmitter had working with it.

Antenna grounding is supposed to serve two purposes. It is fondly believed that it will protect your rig from a direct lightning hit.

Lots of luck. Even with the usual textbook ham ground setup, that is asking a lot. A direct lightning hit will go to ground, but it is probably going to take everything along the path with it. I don't know if the usual antenna, lead-in, and grounding setup is going to stay put for that, not to mention any gear connected to it. The best you usually hope for, and the usual case, is protection against the static charge buildup from a nearby electrical storm. While this is not usually big enough to turn your antenna into abstract artwork, it is often big enough to put a walloping charge into the front end of any rig that's there.

Here the solution is simple. It is not so much a direct earth ground you need as a chassis ground connection. Any of the antenna switching arrangements can usually be hooked up to short the antenna lead directly to the ground of the coax connector (chassis ground).

I haven't seen it mentioned in years, but there was a time when many schematics made a distinction between chassis ground and earth ground. There are different schematic symbols for each. The familiar ground symbol, Fig. 1(a), is the one for chassis ground. Fig. 1(b) is the symbol for earth ground.

If your shack location is such that you can't get a good earth ground for antenna grounding, the chassis ground will still work a lot better than leaving your rig there to get hit.

It also doesn't cost much to run a ground wire to your shack and try it for rf purposes. Then if you have trouble with operating, remove it when you use your rig and reconnect it just for electrical safety when you are not operating.

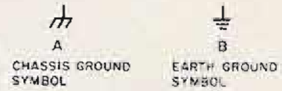


Fig. 1. Schematic ground symbols.

The key is to go by the book as far as you can and only make such modifications as you have to for your particular circumstances. Then do as much as you can to restore non-operating safety.

I hope these two particular techniques, the use of a tuned random-length antenna and the avoidance of a phantom ground, will help solve a few problems for those who are just beginning or not able to use a more conventional configuration.

It drove me nuts for quite some time until I got the hang of it. It's not the best, but it will be reliable when properly applied. ■

A Close Encounter With Voyager I

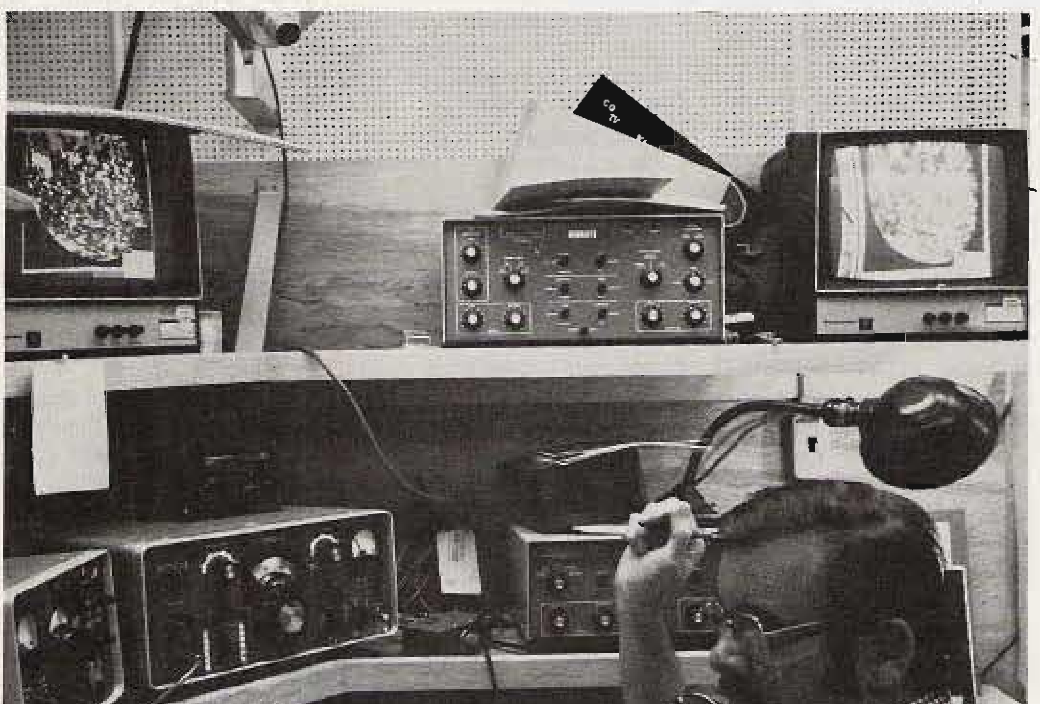
—the W6VIO story

Voyager II is next.

Dr. Norman L. Chalfin K6PGX
JPL Amateur Radio Club
4800 Oak Grove Dr.
Pasadena CA 91103

Jet Propulsion Laboratory Amateur Radio Club members gave up lunch periods, many after-work hours, and weekends during the period from March 1-11, 1979, to operate their club station W6VIO in celebration of the close approach of the *Voyager I* space probe to the planet Jupiter and its four Galilean satellites, Io, Europa, Ganymede, and Callisto.

Dick Piety K6SVP organized and managed the operation. He was assisted by Jim Lumsden WA6MYJ. Jim mounted a Herculean effort in getting the newly refurbished trailer which constitutes the W6VIO shack ready for the event. Equipment, stored in many locations during the refurbishing, had to be returned to the shack and reinstalled in the beautifully arranged shelves and decks.



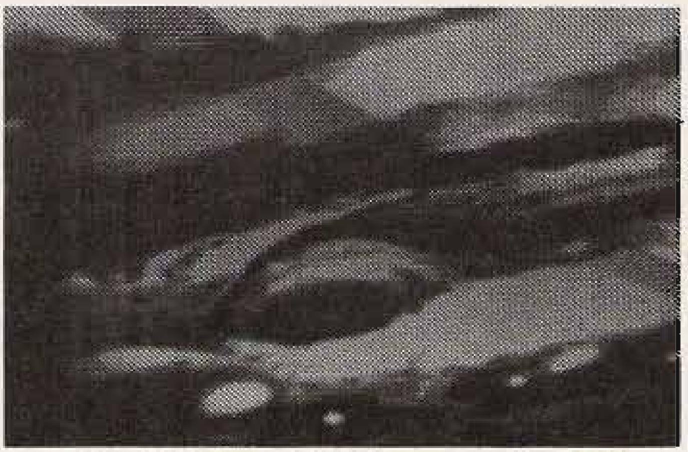
Dick Piety K6SVP at the SSTV position. The image on the screen is of Callisto, one of Jupiter's moons.

The 1540 contacts made in the various bands on which the operation was mounted include:

10m phone 281
(includes a number of SSTV contacts)
10m CW 21
15m phone 123
15m CW 164
20m phone 362
(includes many SSTV contacts)

20m CW 157
40m CW 10
75m phone 1

One of the SSTV monitor views of the W6VIO ID during the Voyager I commemorative.



A slow-scan image of the great red spot on Jupiter.

2m	FM	348

(includes check-ins to various JPL/Goldstone* nets run during the commemorative)

220 MHz	FM	72
OSCAR		1

There were 79 contacts outside the United States.

Interesting sidelights arose during the commemorative. Dick says he "doesn't believe" the contact on 2 meters who gave a K7 call and said he was speaking from Seattle. (Seattle to Pasadena on 2m?) Merv MacMedan N6NO began a CW contact with a Spanish amateur who wouldn't let him go on to others. Merv explained to him in Spanish about the *Voyager* commemorative. The Spanish amateur wanted to "rag-chew." Jim made a contact on SSTV with a Wichita Falls, Texas, amateur who said he was recording the pictures for his high school class of fourteen-year-olds. Dave Ingram K4TWJ telegraphed that he was recording the Jupiter images and sending them to the local press as fast as he received them. A Denver amateur contacted the Denver *Post*. They called K6SVP on the phone to interview him about the operation. A contact with F6KCP by W6VIO led to five or six other French amateurs joining the activity.

The promised QSL card, including Jupiter pictures made by *Voyager I's* cameras, was a magnet to pull in the contacts. All who contacted W6VIO during the March 1-11, 1979, period will receive QSLs if they send an SASE to W6VIO or QSL through their bureaus. The card also identifies the major discoveries about Jupiter and its moons made by the *Voyager I* spacecraft in its close encounter of the most spectacular kind. Those who remember the *Viking* commemorative card from N6V, operated by the JPL club during the landings on Mars, can appreciate the beauty of these very special QSLs.

From July 6-15, 1979, there will be a second Jupiter fly-by commemorative for the *Voyager II* Mission. It will have a somewhat different card. If you missed out on *Voyager I*, try for *Voyager II*.

The individual members of the JPL ARC (in addition to myself) who took part in the *Voyager I* commemorative are: Dick Piety K6SVP (chairman of the commemorative operation), John Repar WA6LWD, Stan Sander N6MP, Ron Zenone W6TUZ, Warren Apel K6GPK, Merv MacMedan N6NO, Jim Longthorne WA6KPW (off-lab member), Bob Gosline AE6S, Rich Soikkele WD6ERI (an Arcadia, California, high school student, 16 years old, who is communications associate on the Sunfire I project), George Morris W6ABW, Jim Lumsden WA6MYJ (facilities chairman for W6VIO), Mike Griffin N6WU (president of the JPL ARC), and Glenn Berry K6GHJ (who organized the reconstruction of the trailer). ■

*The JPL Amateur Radio Club (operating on 220 with WR6APS at La Canada CA) and its affiliated Goldstone Club (operating on 220 with WR6AZN from Table Mountain, near Wrightwood CA), are linked together for a general amateur radio news net on each Tuesday at 8:00 pm PST and for an AMSAT/OSCAR news net on each Wednesday at 8:00 pm PST. The combined net covers all of southern California.

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GIANT Wire Antennas

—impress the neighbors

Have you ever found yourself wanting an antenna that was easy to put up, had gain over a dipole, was simple to match, and could work on more than one band? Then read on. This article shows how to design and build wire antennas which are longer than a half wavelength. These antennas may be operated as dipoles or V-beams. By careful choice of leg length, it is possible to build an antenna which will work on several amateur bands, but requires only a single feedline. The input impedance is about 200 Ohms and may easily be matched to 50-Ohm coax with a 4:1 balun.

Background

One advantage of the half-wave dipole is its low feedpoint impedance. The reason for this is shown in the upper drawing of Fig. 1. This drawing shows the standing waves of voltage and current which are present on a resonant antenna. From Ohm's Law, the input impedance is equal to the voltage divided by the current at the feedpoint of the antenna. For a half-wave dipole, the voltage at the feedpoint is low and the current is high, which gives a low value of impedance—typically, 50 to 70 Ohms.

Many hams use half-wave antennas, but it is also possible to make a dipole in which each leg is much longer than a quarter wavelength. Fig. 1 also shows the voltage and current distributions for 1-wavelength and 3/2-wavelength dipoles. Notice that the current in the center of a full-wave antenna is low and the voltage is high, resulting in a very high input impedance on the order of several thousand Ohms. However, the 3/2-wavelength antenna has a voltage minimum at its center, similar to the half-wavelength dipole. The feedpoint impedance is again relatively low—around 100 Ohms or so.

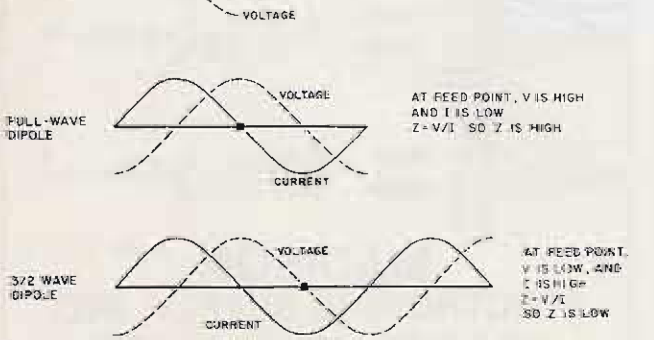

Fig. 1. Antenna impedance is determined by voltage and current at the feedpoint.

At the ends of each dipole drawn in Fig. 1, the current is shown to be at a minimum value and the voltage is maximum. This makes good sense if you think about it. The current flowing at the end of a piece of wire must be zero because it has nowhere to go. On the other hand, the voltage at the end of a wire easily can be quite high. The important point to remember is that to get a low value of input impedance, there must be a voltage minimum at the center of the antenna. In other words, each leg of the antenna must be an odd number of quarter wavelengths. For the half-wave dipole, each leg is ¼ of a wavelength, while for the 3/2-wavelength dipole, each leg is ¾ of a wavelength. Each of these antennas has a voltage minimum at its center, and each also has a low value of input impedance.

Determining the Correct Antenna Length

Table 1 shows the formulas to use in order to calculate the right length for each leg of the antenna at the frequency of interest, once you have chosen how many quarter wavelengths you want each leg to be. Notice that a ¾-wavelength leg is *more* than 3 times as long as a ¼-wavelength leg. This is because the influence of "end effect" diminishes as the number of quarter wavelengths in each leg increases.

The antenna may also be oriented as a V-beam rather than a dipole, if directivity is desired. Table 2 shows the included angle (angle between the two legs of the V) for several different V-beam leg lengths, as well as the approximate gain of each configuration.

For those of you with lots of real estate, Table 3 gives the data required to design and build antennas which are truly giants. The feedpoint impedance of these monsters is in the neighborhood of the 200-Ohm value given for the antennas of Table 1.

Leg Length in Wavelengths	Leg Length in Feet (f in MHz)
1/4	234/f
3/4	738/f
5/4	1230/f
7/4	1722/f
9/4	2214/f
11/4	2706/f
13/4	3198/f
15/4	3690/f
17/4	4182/f
19/4	4674/f
21/4	5166/f
23/4	5658/f
25/4	6150/f
27/4	6642/f
29/4	7134/f
31/4	7626/f
33/4	8118/f
35/4	8610/f
37/4	9102/f
39/4	9594/f
41/4	10086/f
43/4	10578/f

Table 1. Determining the correct leg length.

Leg Length in Wavelengths	Included Angle in Degrees	Gain in dB
11/4	60	5.3
13/4	56	5.8
15/4	52	6.3
17/4	48	6.8
19/4	46	7.2
21/4	44	7.6
23/4	42	8.0
25/4	40	8.4
27/4	38	8.8
29/4	37	9.2
31/4	36	9.6
33/4	35	10.0
35/4	34	10.3
37/4	33	10.5
39/4	32	10.7
41/4	31	10.9

Table 2. Gain and included angle for V-beams.

The formulas shown in these tables will give leg lengths which are approximately correct, but these values should be used only as starting points. All antennas should be cut a little bit long to allow for trimming to the exact length which is required. The actual resonant frequency of any antenna is affected by factors such as height above the earth and proximity to other objects.

Multiband Use

Certain leg lengths will resonate on more than one amateur band, which can be very convenient. I used to work in a small coal-mining town deep in the hills and hollows of southern West Virginia. I lived in a mobile home and had 340 feet of RG-8 coax which ran from my ham shack up the hollow to a hilltop behind my trailer. I badly needed an antenna which could cover several bands with a single feedline and which had some gain to make up for the cable losses.

While reading Ed Noll's book, *73 Dipole and Long-Wire Antennas*, I came across the information given here as Table 1. Ed explained that multiband operation was possible, so I got out my calculator and made a list of antenna lengths which would be resonant in the bands I wanted to operate (80 and 20 meters). Then I looked through my list to see if any of the numbers matched. It turned out that a ¾-wavelength leg on 80 meters was the same size as a 11/4-wavelength leg on 20 meters—about 190 feet in length.

This antenna was built from #12 copperweld wire and fed through a W2AU balun with a 4:1 impedance ratio. The swr was below 2:1 across the whole 20 meter band. On 80 meters, the resonant frequency was lower than I had planned (3.7 MHz versus 3.9 MHz), but I still was able to operate my Triton II on 75 meter phone with the swr around 3:1.

Other suitable combinations can be found by plugging desired frequencies of operation into the various equations and making a list of the resulting leg lengths. For example, a leg length of about 440 feet should resonate on both 80 and 40 meters, while 428 feet looks good for 20 and 15 meters. It has been my experience that the actual leg lengths on 80 meters are somewhat shorter than the formula values, so a leg length of 428 feet may work well on all bands from 80 to 15 meters. A leg length of 362 feet should work on 40 and 20 meters, 330 feet on 10 and 15 meters, and 310 feet on 80 and 15 meters. For really big antennas, a leg length of 710 feet looks good on 40, 20, and 15 meters, 943 feet for 160 and 80 meters, and 673 feet for 160 and 20 meters.

Conclusion

This article has described large centerfed antennas where the length of each leg is an odd number of quarter wavelengths. Multiband use of a single antenna is possible by a judicious choice of leg length, and low-standing wave ratios are achieved by placing a 4:1 balun at the feedpoint. These large antennas show gain over a normal dipole and may be oriented in either straight-line or V-beam configuration. ■

Acknowledgement

Formulas and tables in this article were taken from *73 Dipole and Long-Wire Antennas* by Ed Noll W3FQJ.

Leg Length in Wavelengths	Leg Length in Feet (f in MHz)
45/4	11070/f
47/4	11562/f
49/4	12054/f
51/4	12546/f
53/4	13038/f
55/4	13530/f
57/4	14022/f
59/4	14514/f
61/4	15006/f
63/4	15498/f
65/4	15990/f
67/4	16482/f
69/4	16974/f
71/4	17466/f
73/4	17958/f
75/4	18450/f
77/4	18942/f
79/4	19434/f
81/4	19926/f
83/4	20418/f
85/4	20910/f
87/4	21402/f

Table 3. Leg lengths for very long antennas.

This NEW MFJ Versa Tuner II . . .

has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built in balun. Up to 300 watts RF output. Matches everything from 1.8 thru 30 MHz: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balanced lines, coax lines.

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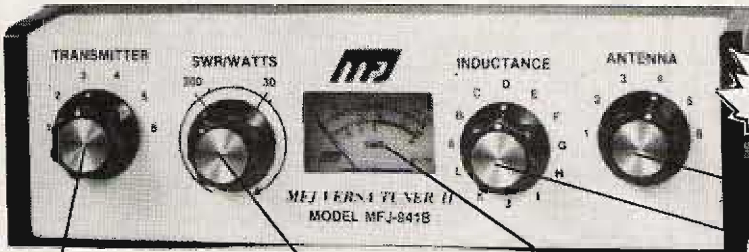


Transmitter matching capacitor. 208 pf. 1000 volt spacing.

Sets power range, 300 and 30 watts. Pull for SWR.

Meter reads SWR and RF watts in 2 ranges.

Efficient airwound inductor gives more watts out and less losses.

Antenna matching capacitor. 208 pf. 1000 volt spacing.

Only MFJ gives you this MFJ-941B Versa Tuner II with all these features at this price:

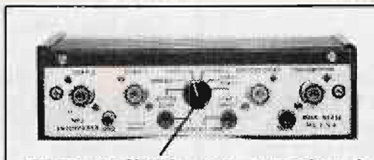
A SWR and dual range wattmeter (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

An antenna switch lets you select 2 coax lines direct or thru tuner, random wire/balanced line, and tuner bypass for dummy load.

A new efficient airwound inductor (12 positions) gives you less losses than a tapped toroid for more watts out.

A 1:4 balun for balanced lines. 1000 volt capacitor spacing. Mounting brackets for mobile installations (not shown).

With the NEW MFJ Versa Tuner II you can run your full transceiver power output — up to 300 watts RF power output — and match your transmitter to **any** feedline from 160 thru 10 Meters whether you have coax cable, balanced line, or random wire.



ANTENNA SWITCH lets you select 2 coax lines direct or thru tuner, wire/balanced line, dummy load.

You can tune out the SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, or whatever you have.

You can even operate all bands with just one existing antenna. No need to put up separate antennas for each band.

Increase the usable bandwidth of your mobile whip by tuning out the SWR **from inside your car.** Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

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This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

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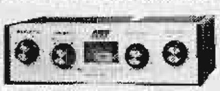

Same as MFJ-941B but less 6 position antenna switch.

NEW MFJ-944 HAS 6 POSITION ANTENNA SWITCH ON FRONT PANEL. NEW LOWER PRICE

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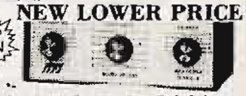

Same as MFJ-941B, less SWR/Wattmeter, antenna switch, mounting bracket. 7x2x6 in.

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MFJ-901 VERSA TUNER MATCHES ANYTHING, 1.8 THRU 30 MHz. NEW LOWER PRICE

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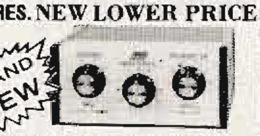

Same as MFJ-901 but less balun for balanced lines. Tunes coax lines and random lines.

MFJ-16010 RANDOM WIRE TUNER FOR LONG WIRES. NEW LOWER PRICE

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1.8 thru 30 MHz. Up to 200 watts RF output. Matches high and low impedances. 12 position inductor. SO-239 connectors. 2x3x4 inches. Matches 25 to 200 ohms at 1.8 MHz. Does not tune coax lines.

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Microcomputer Interfacing

from page 20

low cost IC, \$8; SHM-CM, general purpose, ±12 V, \$89.

Hybrid Systems Corporation, Bedford, Massachusetts 01730—SH703, low cost, \$22.

Intersil, Inc., Cupertino, California 95014—IH5110, low cost IC, \$9.

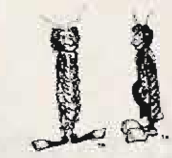
National Semiconductor Corporation, Santa Clara, California 95051—LF-398, low cost IC, \$5.

Teledyne Philbrick, Dedham, Massachusetts 02026—Model 4853, high speed, \$125.

Prices of the above S/H devices are subject to change without notice. However, keep in mind that the general price trend is down, as is true for almost all semiconductor devices.

References

1. Titus, J. A., *Microcomputer Analog-Digital Conversion Devices*, E&L Instruments, Inc., Derby, Connecticut 06418, 1977.
2. *LF-398 Data Sheet*, National Semiconductor Corporation, Santa Clara, California 95051, 1976.
3. Sheingold, D. H., *Analog-Digital Conversion Handbook*, Analog Devices, Inc., Norwood, Massachusetts 02062, 1972.



Corrections

It has been called to our attention that the breadboard shown on page 51 of our June, 1979, issue is indeed Continental Specialties Corporation's Model EXP-300 Experimentor Proto-Board®.

John C. Burnett
Managing Editor

In my article "Build the \$80 Wonder" (November, 1978), there was an error in the input amplifier shown in Fig. 6. The corrected portion is shown below.

Howard M. Berlin W3HB
Newark DE

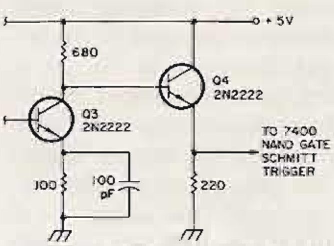


Fig. 6 (partial), "Build the \$80 Wonder."

In my article "12 Volts, 5 Amps, 3 Terminals" (April, 1979), there was an error in the schematic—the electrolytic cap should be somewhere in the range of 2500-4000 uF at 30 volts or so, not 500 uF at 1000 volts. My power supply has two 100-uF, 35-volt caps in parallel, but it should be emphasized that this was a commercially-built supply (minus the regulator which is what the article was intended to introduce). The designer of the supply took a shortcut in the cap's value in order to retain the small size of the supply. I am recommending the 2500-4000 uF, 35-volt electrolytics to those who have been writing, if they can get along with the extra space that is required.

Again, the intended purpose of the article was to introduce a very effective way to obtain regulation of a power supply with a minimum of external parts (one!). If anyone was to duplicate the circuit shown, it does work, and will make an effective supply at a small cost as long as the cap's value is changed as noted here. Any "computer-grade" electrolytic with a rating of 30 volts or more—and many are advertised at bargain prices in *73*—should work just fine.

Readers might also be interested in knowing that one supplier of the chip, Tri-Tek, has just dropped their price for the 78H12 to \$6.50. Fairchild has also introduced several other new regulator chips that might prove of value.

Gary H. Toncre WA4FYZ
Miami FL

Ham Help

I am looking for a schematic of a device which would allow me to tune in a CW signal and have the received Morse characters translated into Baudot and ASCII. Once translated, the signal could produce a teletype™ copy of the CW being received.

There did exist the Converter Shift Register Group AN/UGA-3A (designed and built in the 1960s) which translated CW to Baudot. This unit used discrete components and weighed some 110 lbs. Its CW speed capability range was 10-110 wpm, machine-sent. Two-level Morse-keyed dc, or Morse-keyed audio signal inputs were accepted and translated to 5-level Baudot, and then to TTY copy.

I would appreciate hearing from anyone who may have an arrangement such as this. Thank you.

C. H. Wiedeman K4KOE
204 Anne Burras
Newport News VA 23606

Would anyone who has had problems with the Sigma XR3000 linear please write to me and state the trouble and where they obtained parts?

Jack W. Greenwood WB7QDN
Box 249
Wolf Point MT 59201

I am looking for any modifications to the Collins R-388, especially in the area of a product detector.

W. Cooledge, Jr. W1IOO
15 Newport Dr.
Westford MA 01886

Microcomputer RTTY . . . a Software TU

—use your 8080 and very little else

Count frequencies, too.

Albert S. Woodhull N1AW
Enfield Road, RFD 2
Pelham MA 01002

Microprocessors are not just super calculators. They are general-purpose electronic circuits waiting only for programs to transform them into specialized devices. In this article I will describe how a computer can be used as a frequency counter, and I will show how the counting program can become the basis of a microprocessor-centered RTTY terminal unit. I am writing this also to show how easy it can be to replace hardware with software. Applications such as the one I will describe require only a fraction of the amount of memory that is needed to do calculations with a high-level language such as BASIC. And, for the experimenter, replacing gadgets with programs has another great advantage. No longer do you need to worry about the condition of your gear if a lengthy equipment modification doesn't work. Rewind your tape cassette and you can have the old version up and running in a few seconds.

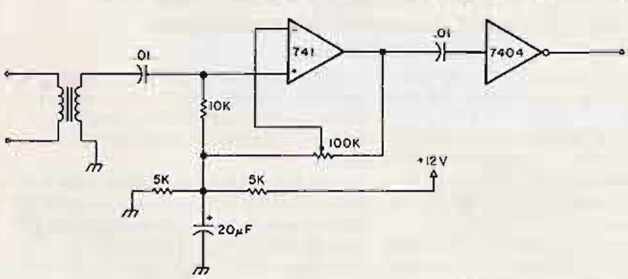


Fig. 1. Input interface. The pot is used to adjust the gain of the 741 amplifier until it drives the 7404 TTL inverter to the point of producing a clean square wave output of the same frequency as the input. 60- or 120-cycle hum is the villain that can make this difficult; the transformer may not always be necessary, but sometimes eliminating the common ground connection gets rid of hum.

Counting Frequencies With a Computer

The computer works with ones and zeros; counting is a very simple task for it. A little bit of external hardware help is needed, however, to get the signal from the outside world into the form the computer requires. Fig. 1 shows an adequate arrangement. An operational amplifier circuit boosts the input signal to a level adequate to drive a TTL inverter. The resulting square wave is applied to one bit of an input port of the computer. On most systems, the other seven bits can just be left floating, but, if you are picky, you can tie them to either ground or +5 volts. On my home-brew computer, I have a number of input and output ports that are implemented as single bits for applications like this. The transformer shown may not be necessary, but may help in keeping 60-cycle interference out of the system.

The easiest way to measure audio frequencies is to time the duration of a half cycle. Fig. 2 shows a flowchart, and Fig. 3 shows an 8080A program to do this. Two registers are used, one to hold the previous input, and one to count up the number of times the program loops between changes in the input. Suppose, at the starting time, the input signal from the inverter is in the 0 phase of the square wave. The unused seven bits will be read as ones, and 11111110 will be stored. Until the input changes to the 1 phase, the program will loop and the counter will count. Eventually, a time will come when the input is read as 11111111. When this happens, the count will be displayed and a new count started. If desired, a bit of programming could be done to calculate the frequency in decimal units from the binary representation of the duration of a half cycle, but, for many purposes, it is adequate to know what pattern on the LED display corresponds to a desired frequency.

For a typical 8080A system with a 500-ns clock, the instruction loop just discussed will require 14.5 μsec. If you were trying to measure the tones from an AFSK generator, this counter would produce a count of 16 (00010000 in binary) for a 2125-Hz input or a count of 15 (00001111) for a 2295-Hz input. That might be good for some purposes, but it obviously is not very accurate. The way to make a timer more accurate is to time longer intervals. The counting time can be doubled by timing whole cycles of the input instead of half cycles. This also will eliminate inaccuracy due to asymmetry in the square wave input. For the 8080A program illustrated, this can be accomplished by changing the JZ (jump on zero) instruction to JNC (jump on no carry). Following a comparison operation, the zero flag is set when the numbers compared are equal, so in the original version of the program, the loop is broken whenever the input changes from 1 to 0 or from 0 to 1. The carry flag is set when the number in the accumulator register is less than the comparison number. Thus, by using the no-carry condition to stay in the loop, the timer ignores transitions from 0 to 1 and the count accumulates until a transition from 1 to 0 occurs.

A second way to increase accuracy is to put the basic program inside a larger loop that counts down a predetermined number of cycles of the input signal. Figs. 4 and 5 show the flowchart and program for this approach. The inner loop again takes 14.5 μsec, but now the JNC instruction is used to keep the timer going for the entire duration of an audio cycle. The outer loop causes the inner loop to be repeated as many times as the value initially loaded into register D calls for. With this approach, standard AFSK tones in the range of 2000 to 3000 Hz can be measured to the nearest 10 Hz or so. This will suffice for adjusting an AFSK generator or calibrating an oscillator to be used in adjusting a RTTY demodulator. More accuracy yet can be achieved by timing a larger number of cycles and accumulating the count in a 16-bit register pair. Still other software frills could turn the computer into a fancy frequency meter indeed, but that is not my present goal. Instead, I would like to show how the basic timing program can be used to build a radioteletype terminal unit with capabilities not usually found in the simpler analog TU circuits.

The Software Terminal Unit

My home-brew computer decodes audio signals from an audio cassette recorder by means of a simple cycle timer program which is stored in read-only memory. Compared to the problems of decoding over-the-air RTTY signals, it is trivial to decode a tape. A few preliminary experiments showed me that the simple frequency measuring routines could work on clear and strong signals, so I set out to define the additional requirements for RTTY.

Essential features for RTTY are some kind of filtering to minimize the effects of interferences and some kind of tuning indicator. Another feature, not necessary, but very desirable, is a squelch or mark-hold provision to keep the printer from running wild when a useful signal is not present. Finally, an easy way of throwing in a locally-generated line feed or carriage return can sometimes prevent loss of print. Doing all this in software is easy.

The flowchart of Fig. 6 shows how all these provisions are included. Entry and exit from the program are through a control section which allows a local ASCII keyboard to direct operations. Next, a cycle timer section determines the frequency of the incoming audio. Decision routines cause execution to branch, first to display the current state on a tuning indicator, and then to take appropriate action. A "noise counter" disables the printer whenever the signal-to-noise ratio becomes lower than the preprogrammed acceptable limit. A "signal counter" takes over the functions of a post-detection low-pass filter, and the processed data then drives the printer magnet through an output port and very simple interface circuitry.

The details can be seen in the program listing. In my system, a surplus 8-bit parallel-output ASCII keyboard has its data lines connected to one input port and its strobe line connected to another. The control section of the program first examines the strobe signal and skips to the frequency-measurement section if no key is depressed. If a key is pressed, a subroutine in my monitor program is called which converts the ASCII to Baudot and drives the printer. The subroutine checks for control characters and returns immediately when one is encountered. The TU program then checks for ↑B (control B) or ↑E characters, which cause exits to either a RTTY transmit routine or the control level of my monitor program. ↑T, ↑N, or ↑R characters are stored for later reference; they signify Tune (no printing), Normal (low tone is mark), and Reverse (high tone is mark).

The frequency measurement portion of the pro-

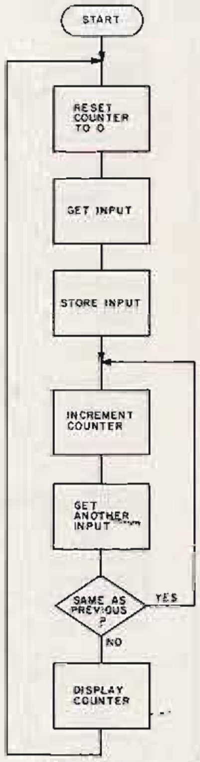


Fig. 2. Flowchart for frequency measurement by cycle timing. Note that this simple version times the duration of a half cycle of input.

```
START   MVI C 00        reset counter
        IN AUDIO        get input
        MOV B,A         store it
LOOP    INR C           increment counter
        IN AUDIO        get new input
        CMP B           compare with first input
        JZ LOOP         if same repeat cycle
        MOV A,C         otherwise display count
        OUT DISPLAY
        JMP START       and do it all again
```

Fig. 3. An 8080 program that times half cycles of audio according to the flowchart of Fig. 2. The DISPLAY output port can be a row of LEDs or 7-segment displays which show the count in octal or hexadecimal. The meaning of the count in real-time units will depend on the clock frequency of the processor.

gram works like the routines described in the first part of this article, with two refinements. It doesn't matter that a simple continuously-cycling routine gives a short count on its first cycle. For RTTY decoding, an accurate count is needed the first

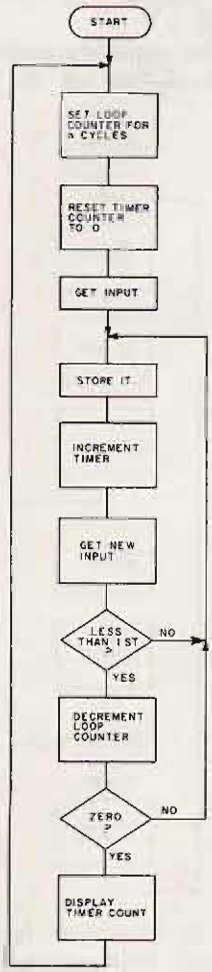


Fig. 4. Flowchart for an accurate frequency-measurement program that times the duration of n whole cycles of the input signal.

time. This problem is solved by an extra loop which causes the computer to wait for the cycle in progress to finish before the following five cycles of audio are timed. The other refinement is a more complicated nesting of the inner and outer loops which keeps the execution time constant regardless of which branch is followed. This is aided by inserting a "nonsense instruction" (MOV B,B) into one branch to compensate for the execution time of the DCR C instruction in the other branch.

All the information needed to accurately tune in a RTTY station and drive the printer is in the output of the frequency measurement section of the program. With analog circuitry, at this point one would use a comparator to decide whether a voltage was above or below a criterion level. Having a count, not a voltage, and having the power of the microprocessor makes possible a six-way decision. Try setting up comparators to do that at the output of a phase-locked loop! I use the various possible outcomes of this six-way decision to light up a row of LEDs on the front panel of my computer. As the receiver is tuned across a signal, the light appears to move from left to right as the audio tone goes from low to high. Fig. 7 illustrates the patterns

Constant	Locations In Assembled Listing
CRIT1	044A
CRIT2	044F
CRIT3	0454
CRIT4	0459
CRIT5	045E
KBDSTB	0401
KBD	0408
KBDW	04E1
PRINT	040A 04E8
MONITOR	0429
AUDIO	0430 0433 043A
PRINTER	0479 04CE 04DC
LEDDISP	0468 0480 0487 0499 04A0

Table 1. The above locations will probably have to be changed to make the TU program run on a different machine. The values for CRIT1, CRIT2, CRIT3, CRIT4, and CRIT5 will depend on the clock frequency of the computer being used. The other values listed are port numbers or, in the case of PRINT and MONITOR, routines in the author's ROM monitor.

observed. The effectiveness of the technique is due to the criteria for the comparisons having been chosen in such a way that a clear indication that the signal is not tuned in exactly on center is given before the error is great enough to cause inaccurate printing. With practice, it is also easy to spot shifts which are too wide, or stations transmitting "upside down."

The mark-hold and low-pass filtering techniques I use are also examples of simple software implementation of functions that would be relatively complex with analog circuits. Each of these features uses a counter. The mark-hold is controlled by the noise counter. This register is incremented when a tone too high or too low to be a valid RTTY signal is encountered. Valid signals decrement the same counter. Limits are placed on the maximum and minimum values the noise counter can hold, and, after each frequency measurement, the noise-counter value is compared with an intermediate criterion.

When the criterion is exceeded, operation of the printer is suppressed. With the values given in the listing, printing will proceed when a good signal is decoded one-third of the time. When the signal drops out, the printer is silenced almost immediately, but a fraction of a second of steady mark tone at the beginning of a transmission immediately enables the printer.

The low-pass filter also uses a counter, which I call the signal counter. Mark signals increment this counter and space signals decrement it. The counter is limited to a minimum value of zero and a maximum value of seven. A mark signal is sent to the printer when the value is four or higher; otherwise, a space signal is generated. Thus, at any time, the printer is given a signal corresponding to the majority of the eight previous samples of audio from the receiver. Without some

```
START   MVI D,n        set loop counter
        MVI C,O        reset timer counter
        IN AUDIO       get input
LOOP    MOV B,A        store it
        INR C          increment timer
        IN AUDIO       get new input
        CMP B          compare with first input
        JNC LOOP       if equal to or greater than first repeat cycle
        DCR D          otherwise decrement cycle counter
        JNZ LOOP       and continue timing another cycle
        MOV A,C        when done, retrieve the total count and show it
        OUT DISPLAY
        JMP START      and do it all again
```

Fig. 5. The 8080 program corresponding to the flowchart of Fig. 4. The count indicates the duration of n complete cycles of the audio input signal.

form of filtering of this sort, the information in 80% of the received signal is lost, since the printer itself samples only 20% of each bit.

The last part of the listing isn't really part of the RTTY receiving routine at all. This is a simple loop that enables me to use the ASCII keyboard for transmitting RTTY. It includes a test to recognize a ↑C character as a command to leave the transmit routine and return to the receive routine. It is not a misprint that the keyboard is called by a different port number here than that used in the control section of the program. I decode two different port numbers for my keyboard; the one used here initiates a WAIT state in the 8080A which is terminated by the falling edge of the keyboard strobe signal. This allows me to simplify the coding used for getting keyboard input in cases like this.

It would be cruel to present a program listing of this sort without pointing out the parts of the program that might need to be changed to make it run on another system. Table 1 lists the instructions which are unique to my own computer. For the most part, patching the program will require changing only I/O port assignments and relocating addresses, but it should be noted that a major and crucial difference between my computer and most others is the clock frequency. My junk-box crystal gives me a clock period of 694 ns instead of the usual 500 ns. The various criteria constants will need to be reevaluated to suit the timing of another system. This can be done experimentally by using a calibrated audio oscillator (calibrate it with the timer progam!) and trying different values for each criterion, using the tuning indicator to check results. For example, CRITERION3 should be a value that causes the low space and high mark lights to blink as the audio input is rocked around 2210 Hz.

Interfacing and Operation

A few pieces of hardware external to the computer are needed, of course. At the input, a circuit such as the one already described in Fig. 1 is needed to convert the receiver audio to digital levels. It will help if a bit of audio filtering precedes this. Fig. 8 shows a simple filter which gives good results when followed by the recommended 10k-Ohm load. The .05-uF capacitor should be chosen to give a peak at around 2200 Hz. The last external item

Program listing for RTTY TU.

```
TYPE RTTYTU.PRN
                 ;
                 ;
                 ;
                 ;                    DIGITAL RTTY TERMINAL UNIT
                 ;
                 ;THIS IS A PROGRAM TO DECODE AFSK SIGNALS AND DRIVE A BAUDOT PRINTER
                 ;WRITTEN FOR MIAW'S 8080A SYSTEM WHICH USES A 694 NSEC CLOCK.  OTHER
                 ;SYSTEMS WILL REQUIRE CHANGES OF THE TIMING BYTES.  THE PROGRAM
                 ;IS BASED ON NOMINAL AUDIO FREQUENCIES OF 2125 HZ FOR MARK AND 2295
                 ;HZ FOR SPACE.  FOR THIS 170 HZ SHIFT A MAXIMUM MISTUNE OF +/- 85 HZ IS
                 ;PERMISSIBLE.  FREQUENCIES ABOVE 2380 HZ OR BELOW 2040 HZ ARE ACCORD-
                 ;INGLY REJECTED AS INVALID.  OPERATION OF THE PRINTER IS SUPPRESSED BY
                 ;OUTPUTTING A CONTINUOUS MARK LEVEL TO THE MAGNET DRIVER WHEN AN EXCESS-
                 ;IVE PROPORTION OF INCOMING SIGNALS CORRESPOND TO INVALID TONES.  AS AN
                 ;AID TO TUNING PROVISION IS MADE FOR DISPLAY OF THE APPROXIMATE FREQUENCY
                 ;OF THE INCOMING TONE ON A ROW OF LEDS, SO TUNING BECOMES A MATTER OF
                 ;KEEPING THE CENTER OF THE LED ROW ILLUMINATED.   DIGITAL PROCESSING
                 ;ALSO SIMULATES THE EFFECT OF POST-DETECTION LOW PASS FILTERING OF THE
                 ;DRIVING SIGNAL TO THE PRINTER MAGNET.
                 ;THE FOLLOWING PROGRAM REQUIRES LESS THAN 256 BYTES OF MEMORY TO RUN,
                 ;EXCEPT THAT SOME CALLS ARE MADE TO A PRINTER-DRIVER ROUTINE FOR THE
                 ;PURPOSE OF ECHOING THE KEYBOARD THAT CONTROLS EXECUTION.  THIS IS
                 ;NECESSARY ONLY FOR LOCAL OVERRIDE OF INCOMING SIGNALS SO EXTRA CARR-
                 ;IAGE RETURNS OR LINE FEEDS MAY BE INSERTED.
                 ;   WRITTEN 23 MARCH 1978.COPYRIGHT 1978 ALBERT S. WOODHULL
                 ;
0400                         ORG 1024
0003 =           KBDSTB      EQU 3
0005 =           KBD         EQU 5
0020 =           PRINT       EQU 20H
0000 =           MONITOR     EQU 0
0001 =           AUDIO       EQU 1
007E =           CRIT1       EQU 7EH
0040 =           CRIT2       EQU 40H
0043 =           CRIT3       EQU 43H
0046 =           CRIT4       EQU 46H
0048 =           CRIT5       EQU 48H
0060 =           NOISEMAX    EQU 60H
0040 =           HOLDCRIT    EQU 40H
0011 =           PRINTER     EQU 11H
0000 =           LEDDISP     EQU 0            ;FRONT PANEL LEDS
0000 =           KBDW        EQU 0
                 ;CONTROL ROUTINES TO SAMPLE KEYBOARD
                 ;
0400 DB03        RECEIVE     IN KBDSTB        ;CHECK KEYBOARD STROBE
0402 E601                    ANI 1
0404 CA2B04                  JZ TIMER         ;SKIP TO TIMER IF KEYBOARD INACTIVE
0407 DB05                    IN KBD           ;LOOK AT ASCII KEYBOARD
0409 CD2000                  CALL PRINT       ;ECHO THE INPUT BY ROUTINE IN MONITOR
040C FE0E                    CPI 0EH          ;WAS IT ^N? (CONTROL N-NORMAL MODE)
040E CA1E04                  JZ STOW
0411 FE12                    CPI 12H          ;WAS IT ^R? (REVERSED MODE)
0413 CA1E04                  JZ STOW
0416 FE14                    CPI 14H          ;WAS IT ^T? (TUNE MODE, NO PRINTING)
0418 CA1E04                  JZ STOW
041B C32104                  JMP SKIPSTOW
041E 32EE04      STOW        STA FORMAT
0421 FE02        SKIPSTOW    CPI 2   ;WAS IT ^B? (TRANSMIT MODE)
0423 CAE004                  JZ TRANSMIT
0426 FE05                    CPI 5            ;WAS IT ^E? (EXIT TO MONITOR)
0428 CA0000                  JZ MONITOR
                 ;
                 ;TIMER ROUTINES TO DETERMINE FREQUENCY OF INCOMING AUDIO SIGNAL
                 ;
042B 0E05        TIMER       MVI C,5          ;PRELOAD CYCLE COUNTER
042D 1600                    MVI D,0          ;ZERO TIMER
042F DB01                    IN AUDIO         ;LOOK AT AUDIO INPUT
0431 5F          LOOP1       MOV E,A          ;STOW INPUT IN REGISTER E
0432 DB01                    IN AUDIO         ;GET ANOTHER SAMPLE OF AUDIO
0434 BB                      CMP E            ;SEE IF THERE WAS A CHANGE
0435 D23104                  JNC LOOP1        ;IF NOT KEEP LOOKING
                 ;
0438 5F          LOOP2       MOV E,A          ;STOW LATEST INPUT
0439 DB01                    IN AUDIO         ;GET A NEW SAMPLE
043B 14                      INR D            ;INCREMENT THE TIMER
043C BB                      CMP E            ;LOOK FOR END OF AUDIO CYCLE
043D DA4404                  JC CYCLECNT      ;CARRY FLAG WILL BE SET BY CHANGE FROM 1 TO 0
0440 40                      MOV B,B          ;IF NO CHANGE KILL SOME TIME
0441 C33804                  JMP LOOP2        ;THEN LOOK AGAIN
                 ;
0444 0D          CYCLECNT    DCR C            ;DECREMENT CYCLE COUNTER
0445 C23804                  JNZ LOOP2        ;AND KEEP ON TIMING UNTIL 5 CYCLES TIMED
                 ;
                 ;CRITERION ROUTINES DECIDE WHICH OF SIX POSSIBILITIES THE INCOMING AUDIO
                 ;REPRESENTS: TOO HIGH, HIGH SPACE TONE, LOW SPACE TONE, HIGH MARK TONE,
                 ;LOW MARK TONE, OR TOO LOW
                 ;
0448 7A                      MOV A,D          ;GET COUNT FROM TIMER
0449 FE7E                    CPI CRIT1        ;WAS FREQUENCY ABOVE 2380 HZ?
044B DA6504                  JC INVHI         ;IF SO IT IS INVALID, TOO HIGH
044E FE40                    CPI CRIT2        ;WAS FREQUENCY ABOVE 2335 HZ?
0450 DA9604                  JC SPHI          ;HIGH, BUT IN RANGE VALID AS SPACE TONE
0453 FE43                    CPI CRIT3        ;WAS IT ABOVE 2210 HZ?
0455 DA9D04                  JC SPLO          ;LOW SPACE TONE, OK
0458 FE46                    CPI CRIT4        ;WAS IT ABOVE 2085 HZ?
045A DA8404                  JC MKHI          ;HIGH END OF MARK TONE RANGE
045D FE48                    CPI CRIT5        ;WAS IT ABOVE 2040 HZ?
045F DA7D04                  JC MKLO          ;LOW MARK TONE
                 ;
                 ;IF NO JUMP TAKEN FROM CRITERION ROUTINES THIS POINT IS REACHED WITH AN
                 ;INVALID LOW TONE REPRESENTED BY THE DATA IN THE ACCUMULATOR
                 ;
                 ;FOLLOWING GIVES VISIBLE DISPLAY OF INVALID TONES AND CHECKS TO SEE IF
                 ;PRINTER SHOULD BE DISABLED TO PREVENT GARBAGE PRINTING, THEN DOES SO IF
                 ;REQUIRED
                 ;           MVI A,0CH        ;PREPARE VISIBLE SIGNAL FOR TONE TOO LOW
0462 C36704                  JMP INVDISPLAY
0465 3E03        INVHI       MVI A,3H         ;PREPARE VISIBLE SIGNAL FOR TONE TOO HIGH
0467 D300        INVDISPLAY  OUT LEDDISP      ;SHOW IT ON FRONT PANEL LEDS
0469 24                      INR H            ;INCREMENT NOISE COUNTER
046A 7C                      MOV A,H
046B FE60                    CPI NOISEMAX     ;CHECK AGAINST MAX VALUE PERMITTED
046D DA7204                  JC SKIPRESET     ;IF OK SKIP RESET
0470 265F        RESET       MVI H,NOISEMAX-1
0472 FE40        SKIPRESET   CPI HOLDCRIT     ;ALSO COMPARE WITH MARKHOLD CRITERION
0474 DA0004                  JC RECEIVE       ;JUST IGNORE AND START OVER IF BELOW CRITERION
0477 AF                      XRA A            ;OTHERWISE SET ACCUMULATOR TO ZERO
0478 D311                    OUT PRINTER      ;AND OUTPUT TO PRINTER DRIVER A LOW LEVEL
047A C30004                  JMP RECEIVE      ;THEN START OVER
                 ;
                 ;WHEN VALID TONES RECEIVED EXECUTION TRANSFERS TO ONE OF THE
                 ;FOLLOWING ROUTINES WHICH FIRST DISPLAY TONE RECEIVED THEN INCREMENT OR
                 ;DECREMENT THE SIGCOUNTER.  THE SIGCOUNTER IS PREVENTED FROM OVERFLOWING
                 ;OR UNDERFLOWING BEFORE THE NEW VALUE IS STORED.
                 ;
047D 3E20        MKLO        MVI A,20H        ;DISPLAY LOW MARK SIGNAL
047F D300                    OUT LEDDISP      ;ON FRONT PANEL LEDS
0481 C38804                  JMP MARKCNT
0484 3E10        MKHI        MVI A,10H        ;DISPLAY HIGH MARK SIGNAL
0486 D300                    OUT LEDDISP      ;ON FRONT PANEL LEDS
0488 3AED04      MARKCNT     LDA SIGCNTR      ;GET THE SIGCOUNTER
048B 3C                      INR A            ;INCREMENT IT
048C FE08                    CPI 8H            ;BUT KEEP IT BELOW 8
048E DAA904                  JC CNTSTORE      ;PUT IT BACK IF NOT OVERFLOWED
0491 3E07                    MVI A,7H         ;OTHERWISE RESET IT
0493 C3A904                  JMP CNTSTORE     ;THEN PUT IT BACK
0496 3E04        SPHI        MVI A,4H         ;DISPLAY HIGH SPACE SIGNAL
0498 D300                    OUT LEDDISP
049A C3A104                  JMP SPACECNT
049D 3E08        SPLO        MVI A,8H         ;DISPLAY LOW SPACE SIGNAL
049F D300                    OUT LEDDISP
04A1 3AED04      SPACECNT    LDA SIGCNTR      ;GET THE SIGCOUNTER
04A4 3D                      DCR A            ;DECREMENT IT
04A5 F2A904                  JP CNTSTORE      ;SKIP NEXT IF VALUE ZERO OR HIGHER
04A8 AF                      XRA A            ;OTHERWISE RESET TO ZERO
04A9 32ED04      CNTSTORE    STA SIGCNTR      ;PUT THE UPDATED SIGCOUNTER BACK
                 ;
                 ;THE SIGCOUNTER MUST BE EQUAL TO OR GREATER THAN 4
                 ;TO PRINT A MARK, LESS THAN 4 TO PRINT A SPACE.  THIS ACTS AS A LOW PASS
                 ;FILTER, PREVENTING SUDDEN CHANGES OF THE DRIVE TO THE PRINTER
                 ;
04AC FE04                    CPI 04H          ;COMPARE SIGCOUNTER WITH MK/SP CRITERION
04AE DAB504                  JC SPACE         ;IF LESS THAN 4 IT IS A SPACE
04B1 AF                      XRA A            ;OTHERWISE IT IS MARK, SET TO OUTPUT
04B2 C3B704                  JMP SPACESKIP    ;SO SKIP NEXT
04B5 3E01        SPACE       MVI A,1          ;SET TO OUTPUT SPACE
04B7 47          SPACESKIP   MOV B,A          ;BUT SET PRINTDRIVE DATA ASIDE FOR NOW
                 ;
                 ;BEFORE PRINTING WE CHECK FOR LOW VALUE OF NOISE COUNTER AND NORMAL OR
                 ;REVERSED FORMAT
                 ;
04B8 25                      DCR H            ;DECREMENT THE NOISE COUNTER
04B9 F2BE04                  JP CONT          ;IF ZERO OR ABOVE THEN CONTINUE
04BC 2600                    MVI H,0          ;OTHERWISE RESET NOISE COUNTER TO ZERO
04BE 7C          CONT        MOV A,H
04BF FE40                    CPI HOLDCRIT     ;COMPARE WITH MARKHOLD CRITERION
04C1 D2CC04                  JNC HOLD         ;IF ABOVE CRITERION GO TO HOLD
04C4 3AEE04                  LDA FORMAT       ;GET FORMAT INFORMATION
04C7 FE14                    CPI 14H          ;IF IT IS ^T WE ARE IN TUNE MODE
04C9 C2D204                  JNZ PRTDRIVE     ;IF NOT IN TUNE MODE GO ON
04CC AF          HOLD        XRA A            ;OTHERWISE OUTPUT LOW LEVEL TO SILENCE PRINTER
04CD D311                    OUT PRINTER
04CF C30004                  JMP RECEIVE      ;GO BACK FOR NEW START
04D2 FE12        PRTDRIVE    CPI 12H          ;SEE IF FORMAT IS REVERSED
04D4 C2DA04                  JNZ NORMAL       ;IF NOT GO TO NORMAL
04D7 78                      MOV A,B          ;GET PRINTER DRIVE DATA
04D8 2F                      CMA              ;COMPLEMENT IT FOR REVERSED MODE
04D9 47                      MOV B,A          ;PUT IT BACK
04DA 78          NORMAL      MOV A,B ;GET DATA
04DB D311                    OUT PRINTER      ;AND DRIVE PRINTER
04DD C30004                  JMP RECEIVE      ;THEN START OVER AGAIN
                 ;
                 ;TRANSMIT ROUTINE JUST ECHOES TO PRINTER, AN EXTERNAL SWITCH CAUSES
                 ;DATA TO BE ROUTED TO THE FSK MODULATOR.  A CTRL C RETURNS TO
                 ;RECEIVE MODE
                 ;
04E0 DB00        TRANSMIT    IN KBDW          ;THIS ALTERNATE ADDRESS FOR KBD WAITS FOR DATA
04E2 FE03                    CPI 3H           ;CTL C IS SIGNAL FOR RETURN TO RECEIVE MODE
04E4 CA0004                  JZ RECEIVE
04E7 CD2000                  CALL PRINT       ;PRINT ROUTINE IN ROM CONVERTS ASCII TO BAUDOT
                                              ;AND DRIVES PRINTER
04EA C3E004                  JMP TRANSMIT     ;JUST DO THIS IN A LOOP
04ED             SIGCNTR     DS 1             ;STORAGE FOR SIGCOUNTER BYTE
04EE             FORMAT      DS 1             ;STORAGE FOR TUNE/NORMAL/REVERSE FORMAT BYTE
04EF                         END

A>
```

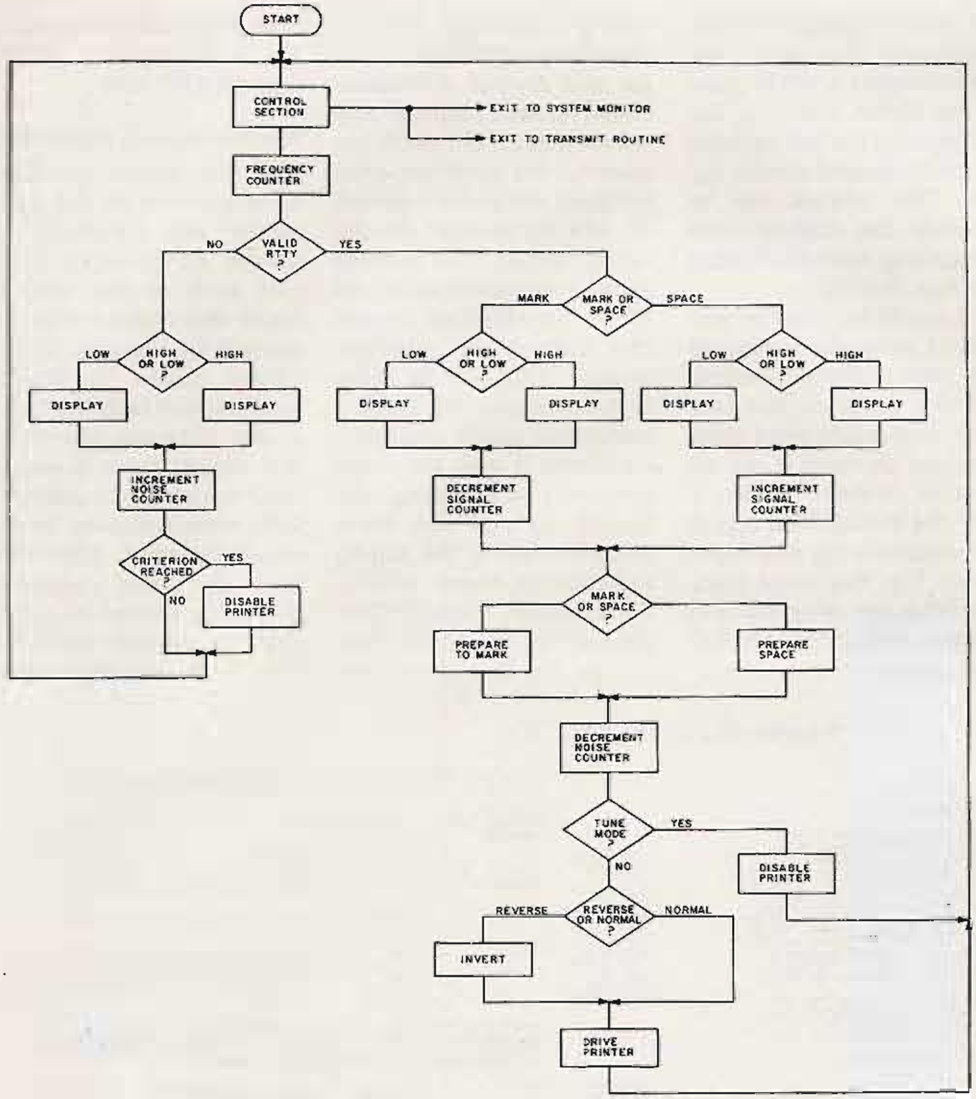


Fig. 6. Flowchart for complete TU program. Note the 6-way partition of the data for driving the tuning display. The noise counter squelches the printer when there is too much noise present. The signal counter acts as a post-detection low-pass filter.

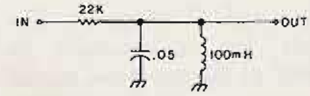


Fig. 8. A simple 2200-Hz filter. A lower-value resistor will widen the passband. Selecting capacitors from the junk box is the easiest way to tune the filter.

needed is a driver for the teleprinter loop. Fig. 9 shows how I do it. A high-voltage transistor can be used for the switch if one is available. The piggyback circuit shown allows the use of relatively low-voltage "experimenter grab bag" power transistors to switch the high-voltage loop current.

For initial setup, an oscilloscope is convenient to allow determination of the proper audio level. I usually use a simple audio monitor connected right at the computer input port. With this arrangement, I can tell by ear when the audio level is adequate. Tuning is simply a matter of watching the LED display and making corrections when the low mark or high space lights begin to flash.

As I said at the start, one of the advantages of software is the ease of modification. Just sitting down to type this manuscript made me think of four or five changes, and I just had to try them before getting back to the typewriter. I'm sure anyone who tries this method of copying RTTY will come up with other changes. I intend to do some experimenting with different amounts of averaging in the signal counter and different criteria in the noise counter. It also would be possible to add more control signals to instantly modify the criteria and allow for different shifts. Enough information is extracted to allow the generation of control signals for afc. I would enjoy hearing from readers who undertake some of these improvements. ■

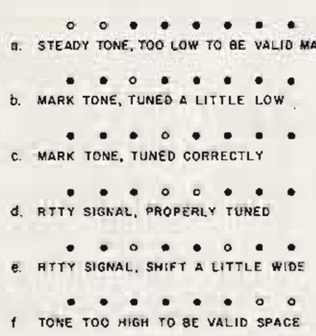


Fig. 7. Some of the possible combinations seen on the row of LEDs that serve as a tuning indicator. It is very easy to see which way the receiver dial should be tuned to maintain good copy. O = on; ● = off.

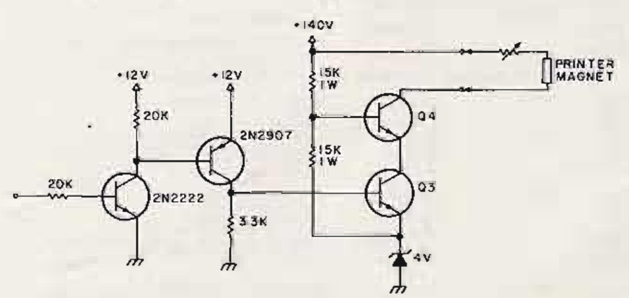
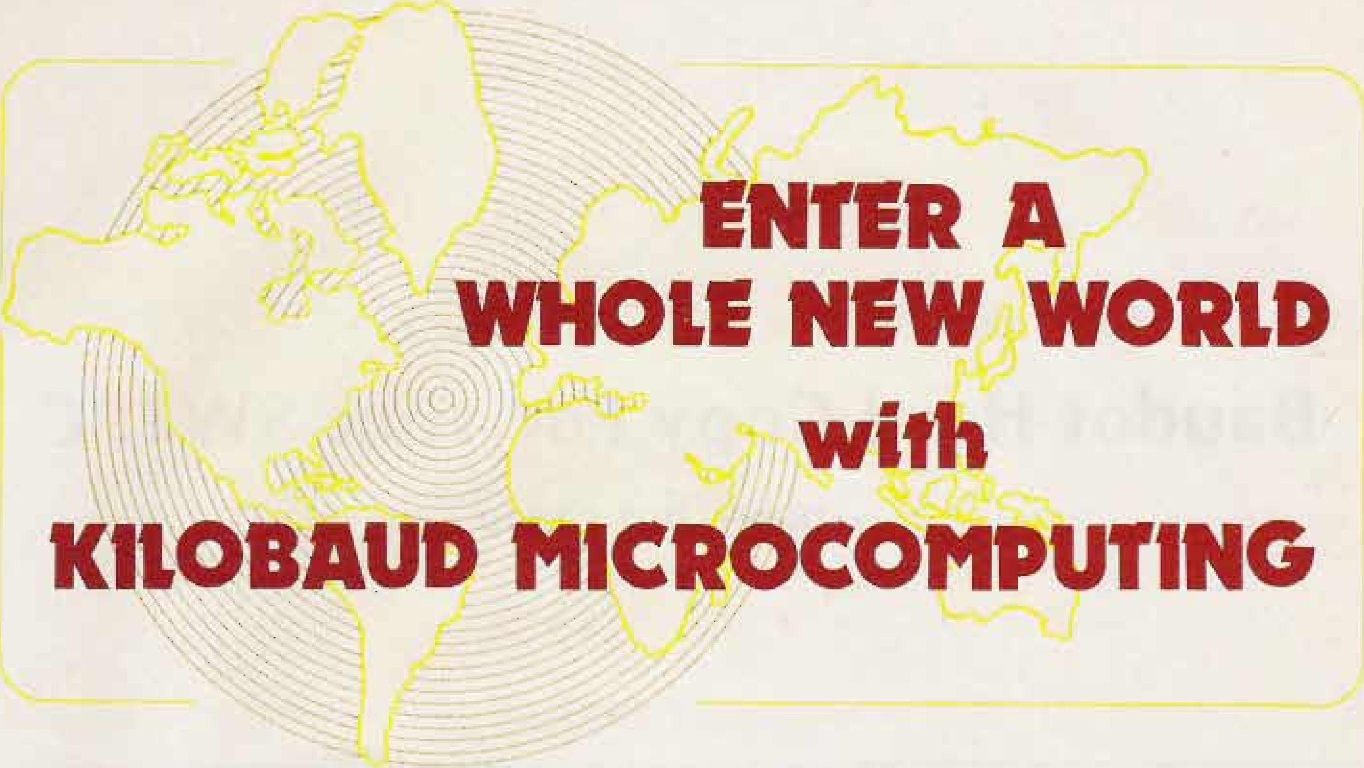


Fig. 9. A TTL-to-60-mA loop interface circuit. Q3 and Q4 could be replaced by a single high-voltage transistor. This piggyback circuit is a useful one for switching high voltages with low-voltage transistors. In my station, I use two unmarked TO-220-type power transistors from a "40 for $1.98" special pack.



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Baudot Hard Copy For Your SWTPC

— noisy, but cheap

Tie a 6800 to a five-level Teletype™.

Garry Caudell K4HBG
3125 Robin Lynn Drive
Ashland KY 41101

In an earlier article (March, 1978), I discussed the use of a simple search program. In this article, I'll explain hardware and software to tie an SWTPC 6800 to a Baudot Teletype™.

Everyone probably knows the disadvantages of the old Baudot machines, such as being slow, having a limited character set, etc. However, on the plus side, they are cheap and compatible with ham radio operation. If you want cheap (but slow) hard copy, or if you want to use the CRT terminal as a glass Teletype, keep reading.

The simplest way to get hard copy is to use the standard SWTPC MP-S board. All you need to build is the clock divider (see Fig. 2). Unfortunately, this board uses an ACIA (6850) chip, and there is no way to tell it that you don't need all eleven bits when you really need only seven (five data bits plus start and stop bits). If you are willing to slow down the already slow printer, it will think that the extra bits are just long stop bits. Trying to copy this way would not work on anything that was sent at near-synchronous speed. The program would need to be changed to accommodate an ACIA (see listing 2 in Fig. 4).

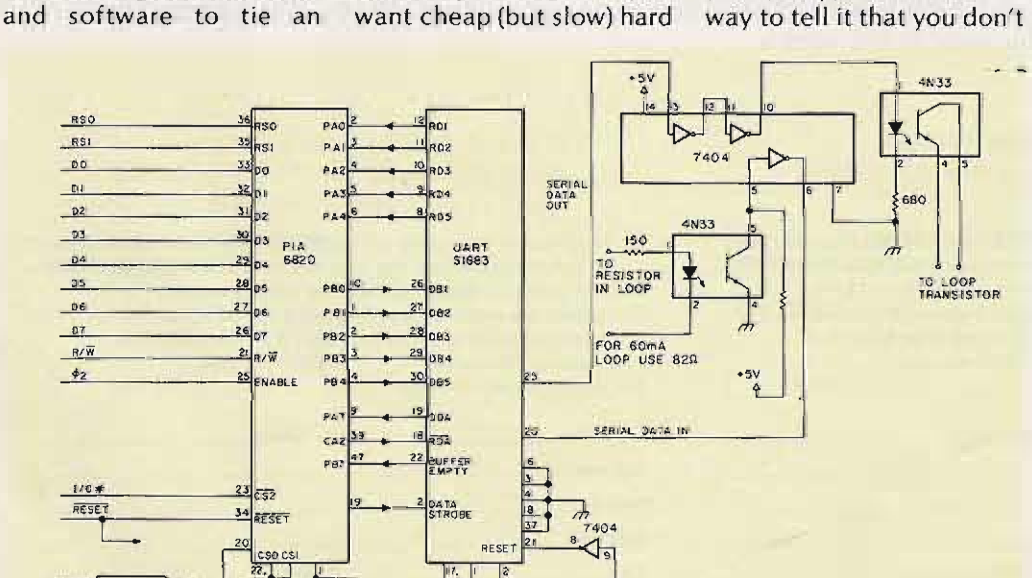


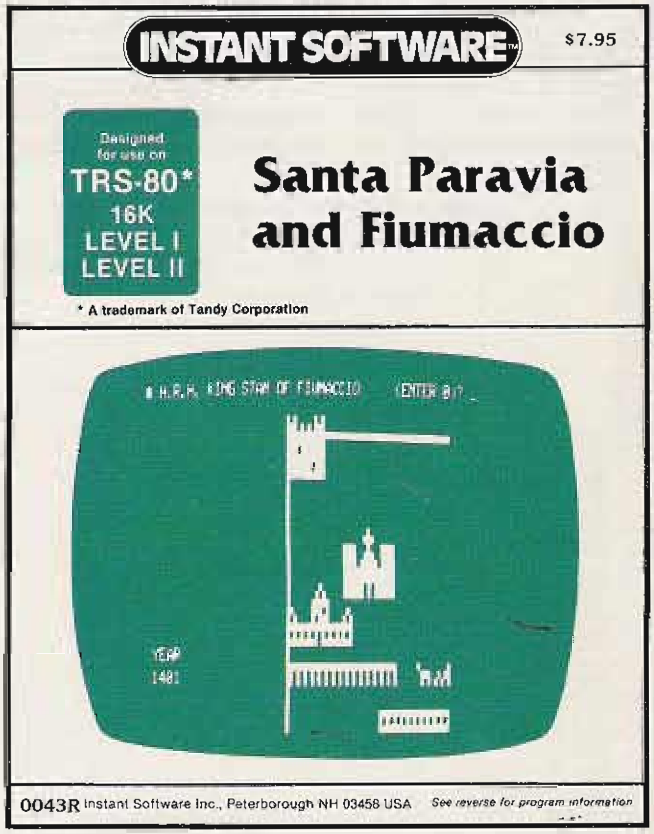
Fig. 1.

The circuit I used to interface my SWTPC 6800 computer to my Model 15 Teletype is an expansion of the circuit used by Mark J. Borgerson in his article in *73* (November, 1976). It has a PIA (6820) controlling a UART (S-1883). All connections into the PIA are identical to those used by the MP-L board.

The clock for the UART is derived from the 600-baud clock divided by 13. If you are using the 1.843-MHz crystal recommended by Motorola for the MC14411 baud generator chip, this comes out slightly high. If you are using the crystal which SWTPC rec-

Release Yourself

A broken tile, a rusty sword, the timeworn remnants of a medieval tapestry: Nothing sparks the imagination more than these fragile reminders of another place, another time, another way of life . . . nothing, that is, save the prospect of living it. That's why Santa Paravia and Fiumaccio is fast becoming a national fad among avid computer gamers and computer professionals alike. Why not get in on the fun today?



This superb simulation casts up to six lords and ladies as competitors in a race for the rule of their respective 15th century Italian city-states.

Each player begins with 1,000 Florins, a small parcel of land, a suitable complement of serfs, and a prewritten obituary and time of death. Life was short back then, so you'd better move quickly . . . from this point on you're on your own.

HARVEST

The winter ended, the grain steward reports the minimum grain amount necessary to feed your people; depending on how much of your reserves were eaten by rats, you may need to purchase additional grain. Underfeeding will cause many serfs to die, and will also severely lower the birth rate. If you fared the winter well, you may be in a position to sell surplus grain or to overfeed your people, which will cause a higher birth rate and attract serfs from less fortunate neighboring towns—something you should consider if you plan to purchase additional land for farming.

You can also speculate in land and grain at this time. The price may vary from year to year, but an average increase is certain.

TAXES

You must now decide the levels of taxation for your community. As in real life, the consequences of your decisions are far-reaching: Set the customs tax too high, and businesses will suffer; a high income tax won't sit well with the wealthy; and an overburdening sales tax has got to cut down receipts at your markets. Experiment, and you're sure to find a policy that will work well with your present economy—but changes will surely be needed as your community grows.

You've also got to decide a policy for justice. Will you be very fair (costs money, but is great for the economy) or outrageous (taking bribes, selling justice to the highest bidder)? A lenient stance will attract more serfs, while outrageous justice will soon have them fleeing to more pleasant surroundings.

MAP PHASE

The computer will now draw a detailed map of your area. From this map you will be able to determine the adequacy of your defenses, the ratio of workers to acreage, the number of woolen mills and market places, and the size of your castle and cathedral.

PUBLIC WORKS

Your treasury laden with the fruits of a year's labor, you can now purchase a woolen mill or two, or invest in more market places. Maybe you'll decide to increase the size of your castle. If you feel that more clergy support might hasten your rise to the throne, build another wing on your cathedral. If your land area has grown quickly, this might be the time to arm another unit of serfs for your regions' defense. Your computer will now look back at what you've accomplished in the last year, and decide if you merit a higher title.

OBITUARY

At this point, the computer will check to see if you've reached "the fullness of time." If so, it will print the year and cause of your death, and your highest rank obtained. Although the computer will no longer offer your turn, the statistics of your reign will be kept in the comparison table until the game's end. Since it's whoever reaches the throne first, or achieves the highest title before death who wins . . . you could still wind up the winner. In any case, you're sure to end the game a little wiser—and chomping at the bit to play again.

Available for the 16K level I and level II TRS-80 microcomputer. Order No. 0043R. $7.95. (See pg. 91 for order blank)

Instant Software Inc.

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ommends, it will be slightly low. In either case, it is as close as the rest of the baud rates, if you follow SWTPC recommendations. (I don't know why SWTPC did this.) This circuit works well and gives one less variable, as compared to using a tunable oscillator (one less confusion factor when trying to get the thing working).

The A-side of the PIA ties to the receive data side of the UART, with bit 7 used for a data ready indication. CA2 is used to clear the UART.

The B-side of the PIA is used as an output to drive the UART, with bit 7 used as an input to poll the UART for a buffer empty signal. CB2 is used to strobe the UART to tell it when to transmit data.

I found it useful to connect the UART reset to the SWTPC reset (through a 7404 inverting gate). This may not be necessary, as most UART circuits do not require a reset, but simply ground this pin. I felt that if the UART did need a reset, this would be well worthwhile to include.

Data in and data out are buffered by the 7404 gates and by 4N33 optical couplers.

In my system, the output is in series with the base of my loop-keying transistor. This allows the printer to

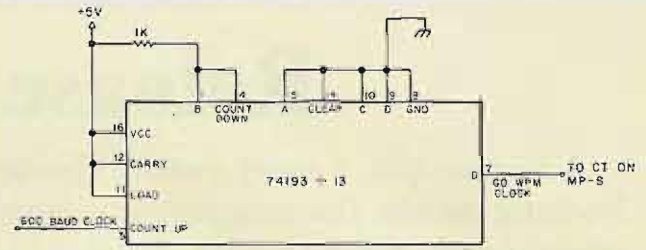


Fig. 2. Build this only if you are going to use the MP-S board. Don't jumper any baud rate on the board.

Fig. 3. Program listing 1.

```
00100                          NAM    OUTEEE
00110                          *****************************************************
00120                          *
00130                          *      PROGRAM TO CONVERT ASCII TO BAUDO
00140                          *
00150                          *      G. O. CAUDELL
00160                          *
00170                          *      JULY 1977
00180                          *
00190                          *****************************************************
01010                          OPT    O
01020                          OPT    S
01030 3F00                     ORG    $3F00
01040 3F00 00          TABLE   FCB    $00,$03,$19,$0E,$09,$01,$0D,$1A
      3F01 03
      3F02 19
      3F03 0E
      3F04 09
      3F05 01
      3F06 0D
      3F07 1A
01050 3F08 14                  FCB    $14,$06,$0B,$0F,$12,$1C,$0C,$13
      3F09 06
      3F0A 0B
      3F0B 0F
      3F0C 12
      3F0D 1C
      3F0E 0C
      3F0F 13
01060 3F10 16                  FCB    $16,$17,$0A,$05,$10,$07,$1E,$13
      3F11 17
      3F12 0A
      3F13 05
      3F14 10
      3F15 07
      3F16 1E
      3F17 13
01070 3F18 1D                  FCB    $1D,$15,$11,$03,$02,$04,$16,$04
      3F19 15
      3F1A 11
      3F1B 03
      3F1C 02
      3F1D 04
      3F1E 16
      3F1F 04
01080 3F20 04                  FCB    $04,$2D,$31,$34,$29,$04,$3A,$28
      3F21 2D
      3F22 31
      3F23 34
      3F24 29
      3F25 04
      3F26 3A
      3F27 28
01090 3F28 2F                  FCB    $2F,$32,$2B,$1A,$2C,$23,$3C,$3D
      3F2A 2B
      3F2B 1A
      3F2C 2C
      3F2D 23
      3F2E 3C
      3F2F 3D
01100 3F30 36                  FCB    $36,$37,$33,$21,$2A,$33,$35,$27
      3F31 37
      3F32 33
      3F33 21
      3F34 2A
      3F35 33
      3F36 35
      3F37 27
01110 3F38 26                  FCB    $26,$38,$2E,$3E,$27,$2E,$32,$39
      3F39 38
      3F3A 2E
      3F3B 3E
      3F3C 2F
      3F3D 2E
      3F3E 32
      3F3F 39
01120 3F40 86 FF       CINT    LDA A  #$FF        LOAD FLAG
01130 3F42 B7 3F83             STA A  LAST+1      STORE FOR UPDATE
01140 3F45 39                  RTS
01150 3F46 81 5E       OUTEEE  CMP A  #$5E        IS IT LOWER CASE
01160 3F48 22 5F               BHI    EXIT        YES -- GET OUT
01210 3F4A FF 3FA5             STX    SAVX+1      SAVE INDEX REGISTER
01220 3F4D CE 3F00             LDX    #TABLE      POINT INDEX REG. AT START OF
01230 3F50 84 7F               AND A  #$7F        GET RD OF PARITY
01240 3F52 E7 A8               STA B  XSAVB+1,X   SAVE B
01260 3F54 6D 83               TST    XLAST+1,X   TEST CASE FLAG
01280 3F56 2C 0C               BGE    CKCR        GO CHECK FOR CARRIAGE RETURN
01290 3F58 C6 7F       INT     LDA B  #$7F
01300 3F5A 8D 5B               BSR    XINT
01310 3F5C C6 1F               LDA B  #$1F        LOAD BAUDOT LETTERS
01320 3F5E E7 B6               STA B  XSEND+1,X   STORE B SO IT CAN BE SENT
01330 3F60 6F 83               CLR    XLAST+1,X   CLEAR CASE FLAG (LAST+1)
01340 3F62 8D 4A               BSR    BAUDO       GO SEND BAUDOT LETTERS
01350 3F64 81 0D       CKCR    CMP A  #$0D        IS IT CARRIAGE RETURN
01360 3F66 26 02               BNE    CKLF        GO CHECK LINE FEED
01370 3F68 86 5B               LDA A  #$5B        POINT TO BAUDO CARRIAGE RETUR
01390 3F6A 81 0A       CKLF    CMP A  #$0A        IS IT LINE FEED
01400 3F6C 26 04               BNE    CKSP        GO CHECK FOR SPACE
01410 3F6E 86 5C               LDA A  #$5C        POINT TO BAUDO LINE FEED
01420 3F70 26 0A               BNE    CKSHF
01430 3F72 81 20       CKSP    CMP A  #$20        IS IT SPACE
01440 3F74 26 02               BNE    CKCNTRL
01470 3F76 86 5D               LDA A  #$5D        POINT TO BAUDO SPACE
01472 3F78 81 1F       CKCNTR  CMP A  #$1F        IS IT A CONTROL CHARACTER
01474 3F7A 23 28               BLS    SAVX
01480 3F7C 84 3F       CKSHF   AND A  #$3F        CONVERT TO SIX BIT ASCII
01490 3F7E A7 AB               STA A  XLOOKUP+1,X   STORE IN LOOKUP+1
01500 3F80 84 20               AND A  #$20
01510 3F82 81 FF       LAST    CMP A  #$FF        COMPARE LAST
01520 3F84 27 16               BEQ    ASEND       IF SHIFT IS OK GO SEND CHAR
01540 3F86 23 0C               BLS    LTRS        GO TO LETTERS
01550 3F88 C6 20       FIGS    LDA B  #$20        LOAD FIGS FLAG
01560 3F8A E7 83               STA B  XLAST+1,X   STORE IN LAST+1
01570 3F8C C6 1B               LDA B  #$1B        LOAD BAUDO LETTERS
01580 3F8E E7 B6               STA B  XSEND+1,X   STORE IN SEND+1
01590 3F90 8D 1C               BSR    BAUDO       GO SEND IT
01600 3F92 20 06               BRA    ASEND
01625 3F94 6F 83       LTRS    CLR    XLAST+1,X   LEAR CASE FLAG (LAST+1)
01610 3F96 C6 1F               LDA B  #$1F        LOAD BAUDO LETTERS
01620 3F98 E7 B6               STA B  XSEND+1,X   STORE IN SEND+1
01630 3F9A 8D 12               BSR    BAUDO       GO SEND IT
01640 3F9C 8D 0C       ASEND   BSR    LOOKUP
01650 3F9E 20 04               BRA    SAVX
01660 3FA0 E7 B6       BSEND   STA B  XSEND+1,X   STORE IN SEND+1
01670 3FA2 8D 0A               BSR    BAUDO
01680 3FA4 CE 0000     SAVX    LDX    #$0000
01690 3FA7 C6 00       SAVB    LDA B  #$00        RESTORE B
01700 3FA9 39          EXIT    RTS
01710 3FAA E6 00       LOOKUP  LDA B  0,X         CONVERT CHARACTER TO BAUDO
01720 3FAC E7 B6               STA B  XSEND+1,X   STORE IN SEND+1
01730 3FAE F6 800E     BAUDO   LDA B  PIA
01740 3FB1 C4 80               AND B  #$80        IS UART READY
01750 3FB3 27 F9               BEQ    BAUDO       NO GO BACK AND WAIT
01760 3FB5 C6 00       SEND    LDA B  #$00        LOAD BAUDO CHARACTER
01770 3FB7 F7 800E     XINT    STA B  PIA         TICKLE THE UART
01780 3FBA C6 34               LDA B  #$34        TO LET IT KNOW
01790 3FBC F7 800F             STA B  PIA+1       TO DO SOMETHING
01800 3FBF C6 3C               LDA B  #$3C
01810 3FC1 F7 800F             STA B  PIA+1
01820 3FC4 39                  RTS
07000           0082   XLAST   EQU    LAST-TABLE
07010           00B5   XSEND   EQU    SEND-TABLE
07020           00AA   XLOOKU  EQU    LOOKUP-TABLE
07030           00A7   XSAVF   EQU    SAVB-TABLE
09000           800E   PIA     EQU    $800E
09999                          END
TABLE   3F00
CINT    3F40
OUTEEE  3F46
INT     3F58
CKCR    3F64
CKLF    3F6A
CKSP    3F72
CKCNTR  3F78
CKSHF   3F7C
LAST    3F82
FIGS    3F88
LTRS    3F94
ASEND   3F9C
BSEND   3FA0
SAVX    3FA4
SAVB    3FA7
EXIT    3FA9
LOOKUP  3FAA
BAUDO   3FAE
SEND    3FB5
XINT    3FB7
XLAST   0082
XSEND   00B5
XLOOKU  00AA
XSAVB   00A7
PIA     800E

TOTAL ERRORS 00000
```

Fig. 4. Program listing 2. If you reassemble the entire program, NOPs (lines 1290-1295) can be omitted.

```
00100                      NAM     PATCH
01282                      OPT     L
01290 3F58 01         INT  NOP
01295 3F59 01              NOP
01300 3F5A 8D 61           BSR     XINT
01310 3F5C C6 1F           LDA B   #$1F       LOAD BAUDOT LETTERS
01320 3F5E E7 B6           STA B   XSEND+1,X  STORE B SO IT CAN BE SENT
01330 3F60 6F 83           CLR     XLAST+1,X  CLEAR CASE FLAG  (LAST+1)
01340 3F62 8D 4A           BSR     BAUDO      GO SEND BAUDOT LETTERS


01722                      OPT     L
01723      800C     ACIA   EQU     $800C
01730 3FAE C6 02    BAUDO  LDA B   #$02       LOAD TEST FLAG
01740 3FB0 F5 800C  BIT    BIT B   ACIA       IS ACIA READY
01750 3FB3 27 FB           BEQ     BIT        NO GO BACK
01760 3FB5 C6 00    SEND   LDA B   #$00       LOAD BAUDOT CHARACTER
01770 3FB7 CA E0           ORA B   #$E0       SET EXTRA BITS TO MARK
01780 3FB9 F7 800D         STA B   ACIA+1     SEND IT
01790 3FBC 39              RTS


01800 3FBD C6 03    XINT   LDA B   #$03
01810 3FBF F7 800C         STA B   ACIA
01820 3FC2 C6 55           LDA B   #$55
01830 3FC4 F7 800C         STA B   ACIA
01840 3FC7 39              RTS

TOTAL ERRORS 00000
```

operate either from my ST-5 or the computer, without doing any switching. Similarly, the input is a resistor in the loop which allows either the keyboard or the ST-5 input to the computer.

Construction

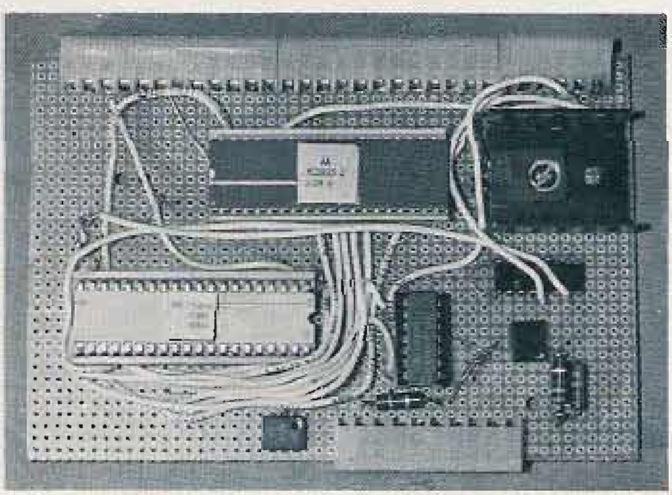
I am sorry to say that I do not have a nice printed circuit board to build this gadget on. Mine is hand-wired on a piece of vectorboard which is the same size as the SWTPC I/O boards and has the same plug arrangement. For no good reason, I put it on slot 3.

Program

The program to convert ASCII to Baudot (see listing 1) is noteworthy only because of the ease of relocating it. If you have a block-move program, only the memory locations in lines 1130, 1210, and 1220 have to be changed. From here on, relative or indexed addressing is used.

The first part of the program (1040-1110) consists of a lookup table to convert Baudot to ASCII. In the table, the conversion is accomplished by pointing the index register at the start of the table and using the ASCII character (6-bit form) as an offset. Line feed and carriage return are handled as exceptions. No other control characters are allowed (bell might have been useful).

Space is handled as an exception because some machines are set up for unshift on space. In the program, space is handled as a letters character only.



Home-brew I/O board.

The CINT (1120-1140) subroutine is used to restore the flag so that the PIA will be initiated after a reset.

OUTEEE (1150) is the point to branch to in order to output a character in "A" accumulator (just like MIKBUG). The first thing it does (lines 1150-1160) is reject any lowercase ASCII. Next, it stores the index register and points the index register to the start of the conversion table (lines 1210-1220).

In line 1230, the program makes sure that we are talking about 7-bit ASCII and then saves the "B" accumulator (line 1240).

The test in line 1260 is to see if the PIA has been initialized or not. It does this by checking to see what is stored in LAST+1 (line 1510). If it sees a negative value ($FF), it will go through the INT portion (1290-1340) which will initialize the PIA, clear the last flag, and put the printer in letters shift.

If it sees a nonnegative value, it will jump around this section. All this means that, if you have reset the computer, you need to restore the $FF in LAST+1. This is the purpose of the CINT routine.

Lines 1350-1470 check for carriage return, line feed, and space. If it finds them, it substitutes values for them so they can be printed. Line 1472 rejects all other control characters. Line 1480 converts the character to 6-bit ASCII, and then it is stored to be sent later (1490).

In 6-bit ASCII, if the character is less than hex 20, it is a letter of the alphabet, so we should be in letters shift.

If it is greater than hex 20, we should be in figures shift. Line 1500 reduces the character to either a hex 20 or a zero value. This is compared to the value in LAST+1 (line 1510) to determine if the printer is in the correct shift. If it is in the correct shift, the program jumps ahead to send the character; otherwise, the appropriate shift is sent (1550-1630).

ASEND (1640) branches to send the character then to SAVX (1680) to restore index register and "B" accumulator and return.

Lookup (1710) does the actual conversion and stores the Baudot character in SEND+1. In lines 1730-1750, the UART is tested to see if it is ready for a new character. 1760-1770 sends the character to the UART. 1780-1820 strobes the UART to tell it that the character can be sent.

Software to input a character is listed in the November article and will not be repeated here.

These two programs do not represent a complete system for RTTY operation, but rather a set of subroutines to be incorporated in such a system. A complete system would need a software FIFO and some form of sense switch operation, so you would automatically switch from the input program to the output program when your transmitter is keyed.

The program listed here can be used to give hard copy on your existing program.

The procedure for finding the correct places and the patching procedures were outlined in my earlier (March, 1978) article.

I would like to say that I am not sure how much of this is my own work and how much was Doug Schwab WA4ZV1's. Anyhow, thanks to Doug, and thanks to the repeater gang. ■

Reference

Mark J. Borgersen, "Baudot to ASCII," *73 Magazine*, November, 1976.

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KNIGHT'S QUEST/ROBOT CHASE/HORSE RACE This varied package of one-player games will give you hours of fun.
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- **Robot Chase**—Destroy the deadly robots without electrocuting yourself.
- **Horse Race**—Place your bet and cheer your horse to the finish line.

These programs require a TRS-80 Level I 16K. **Order No. 0003R $7.95.**

SPACE TREK III Let yourself go to the far ends of the solar system—and beyond. This package includes:
- **Stellar Wars**—Shoot down the Tie fighters and destroy the Death Star.
- **Planetary Lander**—Land your spacecraft and plant your flag across the solar system.

These one-player games require a TRS-80 Level I 4K. **Order No. 0031R $7.95.**

DESTROY ALL SUBS/GUNBOATS/BOMBER This package of three programs is fun for the whole family. Included are:
- **Destroy All Subs**—Hunt down enemy subs while avoiding mines and torpedoes. A one-player game.
- **Gunboats**—One or two players can try to blow each others ships out of the water.
- **Bomber**—Carefully release your bomb to destroy the moving submarine. A one-player game.

To enjoy these programs, you'll need a TRS-80 Level I 4K. **Order No. 0021R $7.95.**

FUN PACKAGE I Why call it "Fun Package?" Judge for yourself! This entertaining package includes:
- **Rocket Pilot**—Flying it is easy—it's the landing that's tough!
- **Paper, Rock, Scissors**—It's the time-honored game just as you remember it, played against your TRS-80.
- **Hex I**—Just when you master this puzzle game, the computer will increase the difficulty.
- **Missile Attack**—Use your missiles to protect your city from jet attack.

Requires a Level I 16K TRS-80. **Order No. 0037R $7.95.**

NEW

DOODLES AND DISPLAYS I Here's a mixed bag of programs that's sure to entertain:
- **Doodle Pad**—Draw pictures and save them on cassette tapes.
- **Symmetrics**—Turn your TRS-80 into a kaleidoscope.
- **Video Display**—Follow the bouncing cursor as your TRS-80 draws its own pictures.
- **Math Curves**—Bring those Geometry lessons to life as the computer draws six different geometrical curves.
- **Rug Patterns**—A never ending stream of symmetrical patterns that's sure to spark your imagination.

All you'll need is a 16K Level I TRS-80. **Order No. 0030R $7.95.**

NEW

BUSINESS PACKAGE I Keep the books for a small business with your TRS-80 Level I 4K. The six programs included are:
- **General Information**—The instructions for using the package.
- **Fixed Asset Control**—This will give you a list of your fixed assets and term depreciation.
- **Detail Input**—This program lets you create and record your general ledger on tape for fast access.
- **Month and Year to Date Merge**—This program will take your monthly ledger data and give you a year to date ledger.
- **Profit and Loss**—With this program you can quickly get trial balance and profit and loss statements.
- **Year End Balance**—This program will combine all your data from the profit and loss statements into a year end balance sheet.

With this package, you can make your TRS-80 a working partner. **Order No. 0013R $29.95.**

BUSINESS PACKAGE III This package can change your TRS-80 into a full working partner for any businessman:
- **Inventory**—Maintain a computer based inventory for a constant inventory system.
- **Discount and Commission Percentages**—Let your computer figure out mark up and discount calculations, sales tax and more. This is a perfect time saving package for any small business.

For the TRS-80 Level I 4K. **Order No. 0061R $7.95.**

CAVE EXPLORING/YACHT/MEMORY These three programs are not only fun, but stimulating as well:
- **Cave Exploring**—Search for fabulous treasures as you explore the magic cave. For one player.
- **Yacht**—A two player game of strategy and chance. The computer rolls the dice and keeps score.
- **Memory**—Two players can pit their memories in this program based on a popular television show. You'll need a TRS-80 with Level I and 16K. **Order No. 0010R $7.95.**

CAR RACE/RAT TRAP/ANTIAIRCRAFT Enjoy these challenging, fun-filled programs:
- **Car Race**—You and a friend can race on a choice of two tracks.
- **Rat Trap**—Trap the rat in his maze with your two cats. For one player.
- **Antiaircraft**—Aim and shoot down the enemy airplane. Requires Level I 4K TRS-80. **Order No. 0011R $7.95.**

STATUS OF HOMES/AUTO EXPENSES Two long-awaited programs that have got to save you money at work or in the home:
- **Status of Homes**—This program will allow you to keep track of all the expenses involved in building one house or an entire subdivision.
- **Auto Expenses**—Find out *exactly* what it costs you to drive your car or truck.

These programs require a TRS-80 Level I 4K. **Order No. 0012R $7.95.**

HEX PAWN/SHUTTLE CRAFT DOCKING/SPACE CHASE/SEA BATTLE This four-game package is sure to provide hours of fun for the whole family.
- **Hex Pawn**—Turn your TRS-80 into a model of artificial intelligence by playing a simple game.
- **Shuttle Craft Docking**—Land your shuttle craft on the starship—even through varying gravity fields!
- **Space Chase**—Seek out and destroy the enemy delta that's hidden in the star field.
- **Sea Battle**—You must find and destroy the enemy fleet.

This package requires a TRS-80 Level I 16K. **Order No. 0041R $7.95.**

DEMO I This package is just the thing to show your friends what your TRS-80 can do. Included are:
- **Computer Composer**—Compose and play music using only a standard AM radio.
- **Horse Race**—Place your bet and cheer your pony to the winner's circle.
- **E.S.P.** Test your powers of extrasensory perception.
- **Hi-Lo/Tic-Tac-Toe**—Guess the secret number or get three in a row.
- **Petals Around the Rose**—Can you figure out the secret behind the five dice?
- **Slot Machine**—Turn your computer into a one-armed bandit. These programs require a TRS-80 Level I 4K. **Order No. 0020R $7.95.**

PERSONAL FINANCE I Let your TRS-80 handle all the tedious details the next time you figure your finances:
- **Personal Finance I**—With this program you can control your incoming and outgoing expenses.
- **Checkbook**—Your TRS-80 can balance your checkbook and keep a detailed list of expenses for tax time.

This handy financial control package for the home requires only a TRS-80 Level I 4K. **Order No. 0027R $7.95.**

Level II

SPACE TREK IV Trade or wage war on a planetary scale. This package includes:
- **Stellar Wars**—Engage and destroy Tie fighters in your attack on the Death Star. For one player.
- **Population Simulation**—A two-player game where you control the economy of two neighboring planets.

You decide, guns or butter, with your TRS-80 Level II 16K. **Order No. 0034R $7.95.**

DOODLES AND DISPLAYS II Wait until your children get a hold of this package:
- **Doodle Pad**—Draw pictures and save them on cassette tapes.
- **Symmetrics**—An electric kaleidoscope that changes from black to white and back again. It's almost hypnotic!
- **Drawing**—like Doodle Pad, but for the serious artist. Over 40 user commands.
- **Random Pattern Display**—The computer does the drawing, but those with itchy fingers can tamper.
- **Math Curves**—Bring those Geometry lessons to life. Six different geometrical curves on the screen of your TRS-80.
- **Rug Patterns**—Yes, it does design rug patterns and, with a choice of user or computer control, it can do a whole lot more.

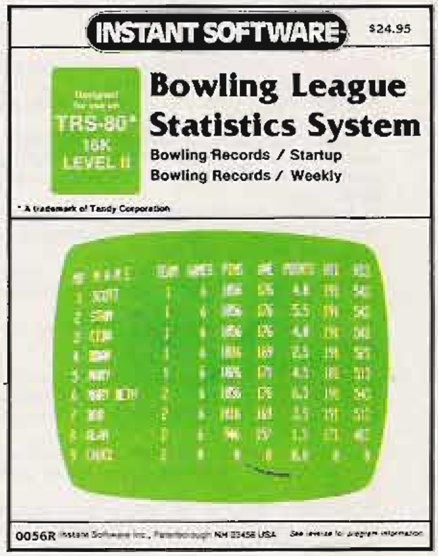
For the Level II 16K TRS-80. **Order No. 0042R $7.95.**

NEW

RAMROM PATROL/TIE FIGHTER/KLINGON CAP Buck Rogers never had it so good. Engage in extraterrestrial warfare with:
- **Ramrom Patrol**—Destroy the Ramron ships before they capture you.
- **Tie Fighter**—Destroy the enemy Tie fighters and become a hero of the rebellion.
- **Klingon Capture**—You must capture the Klingon ship intact. It's you and your TRS-80 Level II 16K battling across the galaxy. **Order No. 0028R $7.95.**

CARDS This one-player package will let you play cards with your TRS-80—talk about a poker face!
- **Draw and Stud Poker**—These two programs will keep your game sharp.
- **No-Trump Bridge**—Play this popular game with your computer and develop your strategy.

This package's name says it all. Requires a TRS-80 Level II 16K. **Order No. 0063R $7.95.**



BOWLING LEAGUE STATISTICS SYSTEM This package is the answer to the prayers of harried bowling league scorekeepers. The Bowling League Statistics System will keep a computerized list of league data, team data, and data for each bowler. It is extremely flexible and has a total of 16 different options to let you modify the program to suit your league's rules. The program is very easy to use and has extensive "built in" aids to help you along. Requires TRS-80 Level II 16K. **Order No. 0056R $24.95.**

Level I and II

BACKGAMMON/KENO Why sit alone when you can play these fascinating games with your TRS-80?
- **Backgammon**—Play against the computer. Your TRS-80 will give you a steady challenging game that's sure to sharpen your skills.
- **Keno**—Enjoy this popular Las Vegas gambling game. Guess the right numbers and win big.

You'll need a TRS-80 Level I or II. **Order No. 0004R $7.95.**

OIL TYCOON Avoid oil spills, blowouts and dry wells as you battle to become the world's richest oil tycoon. Two players become the owners of competing oil companies as they search for oil and control their companies. Requires a TRS-80 4K Level I or II. **Order No. 0023R $7.95.**

BOWLING Let your TRS-80 set up the pins and keep score. One player can pick up spares and get strikes. For the TRS-80 Level I 4K, Level II 16K. **Order No. 0033R $7.95.**

AIR FLIGHT SIMULATION Turn your TRS-80 into an airplane. You can practice takeoffs and landings with the benefit of full instrumentation. This one-player simulation requires a TRS-80 Level I 4K, Level II 16K. **Order No. 0017R $7.95.**

GOLF/CROSSOUT Have fun with these exciting one-player games. Included are:
- **Golf**—You won't need a mashie or putter—or a caddie, for that matter, to enjoy a challenging 18 holes.
- **Crossout**—Remove all but the center peg in this puzzle and your neighbors will call you a genius.

You'll need a TRS-80 Level I 4K, Level II 16K. **Order No. 0009R $7.95.**

HAM PACKAGE I This versatile package lets you solve many of the commonly encountered problems in electronics design. With your Level I 4K or Level II 16K TRS-80, you have a choice of:
- **Basic Electronics with Voltage Divider**—Solve problems involving Ohm's Law, voltage dividers, and RC time constants.
- **Dipole and Yagi Antennas**—Design antennas easily, without tedious calculations.

This is the perfect package for any ham or technician. **Order No. 0007R $7.95.**

BASIC AND INTERMEDIATE LUNAR LANDER Bring your lander in under manual control. The Basic version is for beginners; the Intermediate version is more difficult with a choice of landing areas and rugged terrain. For one player with a TRS-80 Level I 4K, Level II 16K. **Order No. 0001R $7.95.**

SPACE TREK II Protect the quadrant from the invading Klingon warships. The Enterprise is equipped with phasers, photon torpedoes, impulse power, and warp drive. It's you alone and your TRS-80 Level I 4K, Level II 16K against the enemy. **Order No. 0002R $7.95.**

ELECTRONICS I This package will not only calculate the component values for you, but will also draw a schematic diagram, too. You'll need a TRS-80 Level I 4K, Level II 16K to use:
- **Tuned Circuits and Coil Winding**—Design tuned circuits without resorting to cumbersome tables and calculations.
- **555 Timer Circuits**—Quickly design astable or monostable timing circuits using this popular IC.
- **LM 381 Preamp Design**—Design IC preamps with this low-noise integrated circuit.

This package will reduce your designing time and let you build those circuits fast. **Order No. 0008R $7.95.**

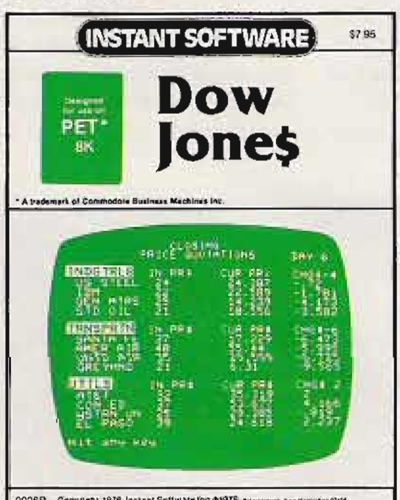
SANTA PARAVIA AND FIUMACCIO Become the ruler of a medieval city-state as you struggle to create a kingdom. Up to six players can compete to see who will become the King or Queen first. This program requires a 16K TRS-80 Level I & II. **Order No. 0043R $7.95.**

PET**

QUBIC-4/GO-MOKU Play two ancient games on your modern PET. The two programs included are:
- **Qubic-4**—Play a multi-dimensioned game of tic-tac-toe.
- **Go-Moku**—Line up five of your men while blocking the PET's moves.

These one player games require 8K of memory. **Order No. 0038P $7.95.**

TREK-X Command the Enterprise as you scour the quadrant for enemy warships. This package not only has superb graphics, but also includes programming for optional sound effects. A one-player game for the PET 8K. **Order No. 0032P $7.95.**



DOW JONES Up to six players can enjoy this exciting stock market game. You can buy and sell stock in response to changing market conditions. Get a taste of what playing the market is all about. Requires a PET with 8K. **Order No. 0026P $7.95.**

DUNGEON OF DEATH Battle evil demons, cast magic spells, and accumulate great wealth as you search for the Holy Grail. You'll have to descend into the Dungeon of Death and grope through the suffocating darkness. If you survive, glory and treasure are yours. For the PET 8K. **Order No. 0064P $7.95.**

NEW

MORTGAGE WITH PREPAYMENT OPTION/FINANCIER These two programs will more than pay for themselves if you mortgage a home or make investments.
- **Mortgage with Prepayment Option**—Calculate mortgage payment schedules and save money with prepayments.
- **Financier**—Calculate which investment will pay you the most, figure annual depreciation, and compute the cost of borrowing, *easily and quickly*.

All you need to become a financial wizard with an 8K PET. **Order No. 0006P $7.95.**

CASINO I These two programs are so good, you can use them to check out and debug your own gambling system!
- **Roulette**—Pick your number and place your bet with the computer version of this casino game. For one player.
- **Blackjack**—Try out this version of the popular card game before you go out and risk your money on your own "surefire" system. For one player.

This package requires a PET with 8K. **Order No. 0014P $7.95.**

CASINO II This craps program is so good, it's the next best thing to being in Las Vegas or Atlantic City. It will not only play the game with you, but also will teach you how to play the odds and make the best bets. A one player game, it requires a PET 8K. **Order No. 0015P $7.95.**

CHECKERS/BACCARAT Play two old favorites with your PET.
- **Checkers**—Let your PET be your ever-ready opponent in this computer-based checkers program.
- **Baccarat**—You have both Casino- and Blackjack-style games in this realistic program.

Your PET with 8K will offer challenging play anytime you want. **Order No. 0022P $7.95.**

TANGLE/SUPERTRAP These two programs require fast reflexes, and a good eye for angles:
- **Tangle**—Make your opponent crash his line into an obstacle.
- **Supertrap**—This program is an advanced version of Tangle with many user control options.

Enjoy these exciting and graphically beautiful programs. For one or two players with an 8K PET. **Order No. 0029P $7.95.**

DIGITAL CLOCK Don't let your PET sit idle when you are not programming, put it to work with these two unique and useful programs:
- **Digital Clock**—Turn your PET into an extremely accurate time-piece that you can use to display local time, time in distant zones, and as a split time clock for up to nine different sporting events.
- **Moving Sign**—Let the world know what's on your mind. This program turns your PET into a flashing graphic display that will put your message across. **Order No. 0083P $7.95.**

NEW

PENNY ARCADE Enjoy this fun-filled package that's as much fun as a real penny arcade—at a fraction of the cost!
- **Poetry**—Compose free verse poetry on your computer.
- **Trap**—Control two moving lines at once and test your coordination.
- **Poker**—Play five card draw poker and let your PET deal and keep score.
- **Solitaire**—Don't bother to deal, let your PET handle the cards in this "old favorite" card game.
- **Eat-'Em-Ups**—Find out how many stars your gobbler can eat up before the game is over.

These six programs require the PET with 8K. **Order No. 0044P $7.95.**

MIMIC Test your memory and reflexes with the five different versions of this game. You must match the sequence and location of signals displayed by your PET. This one-player program includes optional sound effects with the PET 8K. **Order No. 0039P $7.95.**

PERSONAL WEIGHT CONTROL/BIORHYTHMS Let your PET help take care of your personal health and safety:
- **Personal Weight Control**—Your PET will not only calculate your ideal weight, but also offer a detailed diet to help control your caloric intake.
- **Biorhythms**—Find out where your critical days are for physical, emotional, and intellectual cycles.

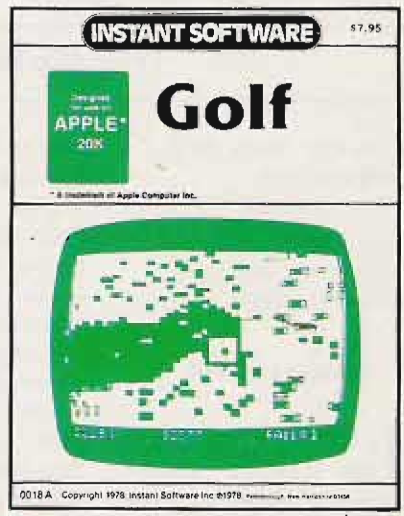
You'll need only a PET with 8K memory. **Order No. 0005P $7.95.**

BASEBALL MANAGER This pair of programs will let you keep statistics on each of your players. Obtain batting, on-base, and fielding averages at the touch of a finger. Data can be easily stored on cassette tape for later comparison. All you need is a PET with 8K. **Order No. 0062P $14.95.**

Apple***

BOWLING/TRILOGY Enjoy two of America's favorite games transformed into programs for your Apple:
- **Bowling**—Up to four players can bowl while the Apple sets up the pins and keeps score. Requires Applesoft II.
- **Trilogy**—This program can be anything from a simple game of tic-tac-toe to an exercise in deductive logic. For one player.

This fun-filled package requires an Apple with 20K. **Order No. 0040A $7.95.**



GOLF Without leaving the comfort of your chair, you can enjoy a computerized 18 holes of golf with a complete choice of clubs and shooting angles. You need never cancel this game because of rain. One or two players can enjoy this game on the Apple with Applesoft II and 20K. **Order No. 0018A $7.95.**

DATA TAPES Use these high quality data tapes to record business or personal data. Four tapes per package. **Order No. 0067 $7.95.**

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The 9-Element Duoband DX Attention-Getter

—when you call, they listen

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Robert H. Walker K4FK
400 Tivoli Ave.
Coral Gables FL 33143

Roy D. Mazzagatti N4OG
18551 S.W. 204th St.
Miami FL 33187

Photos by WA4KIL

Hy-Gain's "tiger on 20," the popular 204BA 4-element monoband yagi, exhibits the excellent performance which can be obtained from a relatively small close-spaced yagi array. For over a decade, the one at K4FK has been performing flawlessly and giving no maintenance problems. Originally, the antenna was up 77 feet on a Rohn tower. A move to a new QTH in 1971 limited us to mounting it on a telescoping TV mast at heights between 12 and 20 feet (see Walker and Mazzagatti, "The Towerless 'Tower,'" *73 Magazine,* June, 1978). Even at such low heights, the 204 has proven itself competitive in pileups.

With the recent upturn in the sunspot cycle, we decided to try interlacing a 15 meter yagi with the 204BA on the Hy-Gain boom. According to *The ARRL Antenna Book*, "It is generally accepted that interaction, if any, is very minimal between bands which are not harmonically related." Would this hold true in practice? Our empirical experimentation has essentially validated that quotation. The result has been a much more versatile antenna, with no degradation in 20 meter performance.

We began by constructing one 15 meter element and placing it near the boom. The swr on 20 meters immediately jumped to 1.7 to 1 from 1.3 to 1. Moving the 15 meter element along the boom and rotating it in and out of the plane of the 20 meter elements produced no further changes. As soon as the 15 meter element was placed within a yard of the boom, the swr climbed. We moved it further away, and the swr returned to normal. We tried the same experiment using a 10 meter ele-

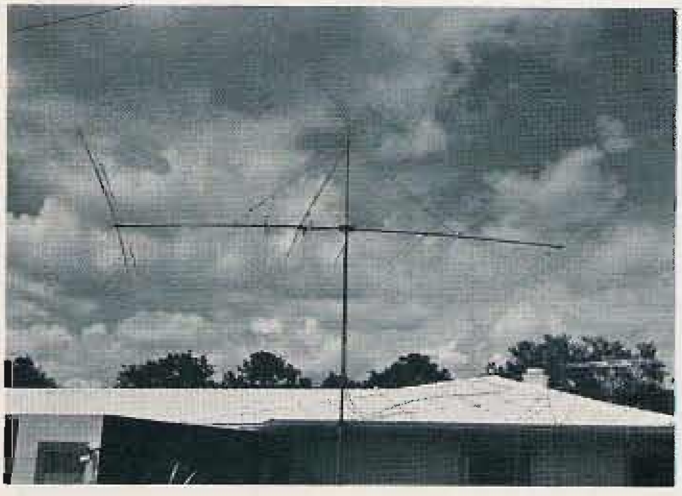

Photo A. A most unorthodox 204BA. Nine elements and two gamma matches radically alter its appearance!

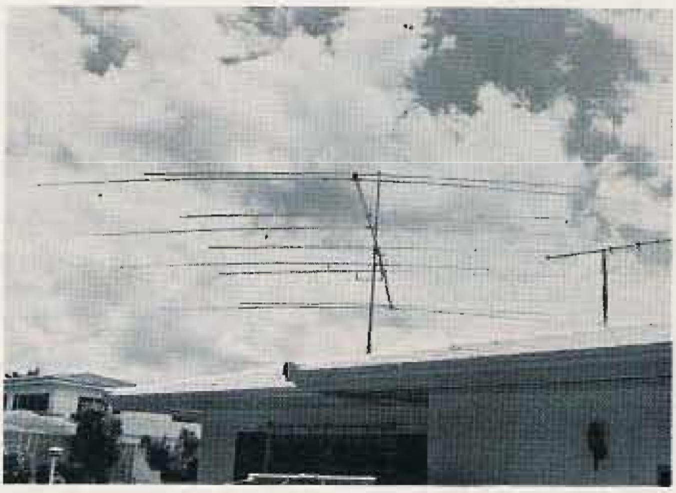

Photo B. A view of the "business end." The result is usually heard around the world.

✓ *Reader Service—see page 211*

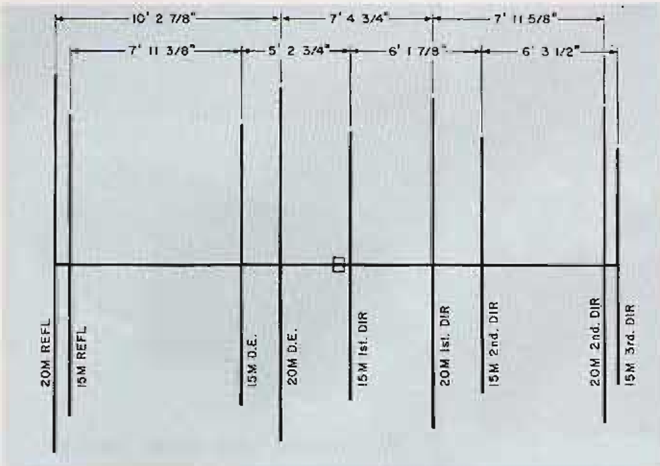

Fig. 1. Element spacing.

ment, and, interestingly enough, this had no effect on the 20 meter swr. Bringing a Hy-Gain DB10-15A 3-element trap duobander close to the 204 produced a similar effect to that produced by the 15 meter element alone. Obviously, there was some interaction. Was it sufficient to reduce the 20 meter efficiency?

We tested for any 20m degradation by mounting three 15m elements on the boom and then using the beam normally on 20m over a period of several weeks. The additional elements did not increase the interaction over that introduced by the initial element, and we could detect no difference in the beam's 20 meter operation. If the 15 meter beam would function correctly, there appeared to be no reason why we couldn't interlace it with the 204BA. It would be desirable to provide an easily-adjusted matching system for each of the yagis, however.

One thing which we had noticed over the years of using the antenna at extremely low heights was how profoundly its capacitive coupling to the building was reflected in impedance excursions during rotation. Most annoying—rotate the array a few degrees, and then retouch the transmitter tuning. The better the antenna and feedline are matched, the less pronounced this effect becomes.

20 Meter Modifications

Hy-Gain's beta match is an inductive "hairpin" type of matching device. We decided to replace it with a more easily adjusted gamma match. Commercially manufactured coaxial capacitor-style gamma matches are much easier to install and maintain than are those which require a separate air variable capacitor in a waterproof enclosure. Viking Instruments* and Gotham Antennas** both market such a gamma match. We settled on the Gotham unit because it is a lower-Q device, which makes adjustment easier and less critical. Additionally, the Gotham gamma match is mechanically stronger and doesn't tend to fill with water and short out, as did two of our Viking matches.

The Hy-Gain driven element is split at the center for use with the beta match. We made it into a one-piece element by wrapping heavy-duty aluminum foil over the plastic center insulators and out over the element.

*Viking Instruments, 73 Ferry Rd., Chester CT 06412.

**Gotham Antennas, 2051 N.W. 2nd Ave., Miami FL 33127

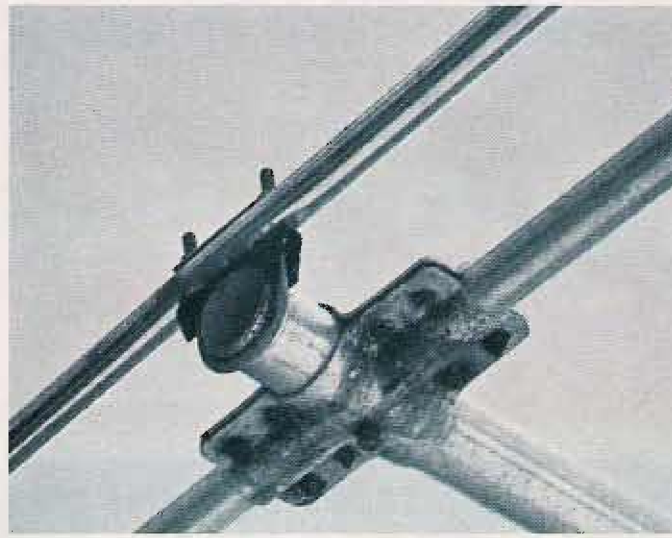

Photo C. Despite using just one muffler clamp per element, there has been no difficulty maintaining alignment.

An ohmmeter check showed that once the driven element halves were installed in the element-to-boom bracket, continuity was excellent. The aluminum foil should be covered with electrical tape and waterproofed by coating the tape with a sealant such as a popular uncured silicone rubber compound. For good measure, we attached a piece of coax braid between the two element halves as well.

Make sure you obtain good continuity between the driven element and the boom as well, if you plan to attach your feedline braid to the bracket which mounts the gamma match to the boom. Otherwise, attach the braid to the center of the driven element, not to its mounting bracket. It's also a good idea to run a bolt through the gamma tube itself for attaching the coax center conductor rather that relying on the U-bolt as the instructions suggest.

The length of the driven element wasn't altered from Hy-Gain's CW specification. The beta match, being an inductive device, probably requires a slight shortening of the driven element. Our method of making the driven element into an electrically one-piece element effectively lengthens it slightly. Therefore, resonance does not noticeably change. One additional benefit occurs as a result of this conversion. The 204BA will now display better bandwidth characteristics across the entire 20 meter band.

15 Meter Construction

Fig. 1 shows the spacing of both sets of elements along the boom. We had originally constructed the antenna with the 20 meter reflector mounted at one end of the boom, and the remainder of the elements spaced according to Hy-Gain's instructions. This left 2 inches of boom unused beyond the 20 meter second director. We chose to mount the 15 meter third director in this area to maximize its spacing. If you don't have room to do this on your particular 204BA, you can move that director inside of the 20 meter second director

Element	Length
Reflector	23' 5-1/2"
Driven Element	22' 6-1/2"
1st Director	21' 6-1/2"
2nd Director	21' 1-3/8"
3rd Director	20' 8-1/4"

Fig. 2. 15 meter element lengths.

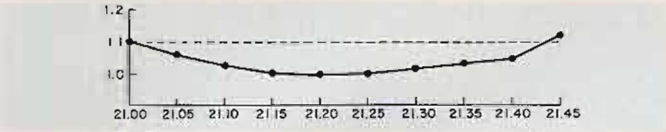

Fig. 3. Swr curve across the 15 meter band.

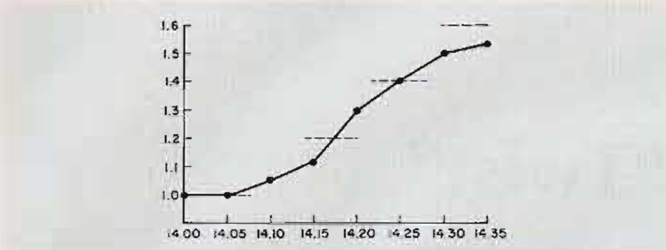

Fig. 4. Swr curve across the 20 meter band.

without affecting performance.

The boom of our 1968 vintage 204BA measures 26 feet, 2 inches. We needed to use it all if we were to mount 5 elements. Also, we had to locate some of the 15 meter elements very close to existing 20 meter elements. For these reasons, we dispensed with the usual aluminum element-to-boom mounting plates such as those used by W8ZCQ in his article, "Working 15m with a 20m Beam," *73 Magazine*, June, 1978.

Photo C shows how a single 2-inch muffler clamp can be used to mount each element. If you can't get muffler clamps with a long U-bolt, you may have to use hardware-store U-bolts with the saddles from your muffler clamps. The U-bolt must be long enough to come up through the element. We have had no trouble with elements slipping or otherwise coming out of alignment, and the array has withstood winds gusting to 56 mph.

Each 15 meter element is constructed of two 12-foot lengths of 3005 aluminum tubing. Make the center of each element from a single 1-inch diameter run. Cut a single run of 7/8-inch tubing into two 6-foot lengths. These are inserted into the ends of the center section. The ends of the center section should be Xed with a hacksaw so that hose clamps can pull it down snugly over the end sections. Our 1-inch tubing has a wall thickness of .041 inches, while our 7/8-inch tubing has a wall thickness of .035 inches. This combination produces a nicely telescoping assembly.

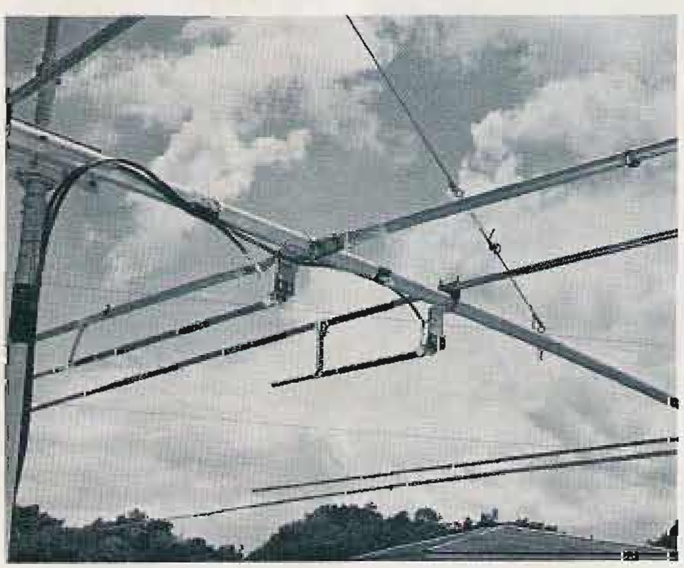

Photo D. White material on the gamma matches and over the electrical tape is GE Silicone Seal.™ It also protects the aluminum foil on the 20 meter driven element.

Adjustment

The gamma matches are adjusted in the normal manner, 20 meters first, and then 15. A good starting point for the shorting strap is a distance of 10 percent of the total length of the driven element, out from the center of the driven element. Preset in this fashion, both sections displayed an swr of less than 1.8 to 1 prior to any additional adjustment. Slide the coaxial capacitor part of the gamma match in and out until lowest swr is obtained. Then move the shorting strap a half inch and readjust the coaxial capacitor. By alternating these adjustments, you should easily find a combination which yields an swr of 1.2 to 1, or less.

It is ideal, of course, to adjust the gamma matches with the antenna in its final operating position. Most of us cannot accomplish this. We have found that the swr changes only slightly once the antenna is installed if it has been carefully adjusted either on top of a ladder or pointed vertically into the air with its reflector resting on the ground.

Performance

Figs. 3 and 4 show the swr curves on the 15 and 20 meter bands, respectively. It is quite permissible (although purists may disagree) to use the gamma matches to "fudge" the resonant frequencies a bit, if desired. Our matches were adjusted for lowest swr at 21.125 and 14.025 MHz. The 20 meter performance remains, as far as we can observe, absolutely unchanged except for the previously mentioned improvement in bandwidth.

We have no way to measure the forward gain on 15 meters. However, "if you point it at 'em and give 'em a call . . . you usually get a reply." The front-to-back ratio on 15 meters runs about 20 to 25 dB and the front-to-side is just about 40 dB.

Some Thoughts

We were so pleased with this project that we decided to try to add 10 meters as well. Predictably, the interaction was so bad that we had to forego our attempts to triband the 204BA. The 10 meter elements didn't affect the performance on either 15 or 20 meters. We were just unable to make the 10 meter section perform as a beam. One set of adjustments gave us a slight bit of gain—off the reflector! Another set provided an omnidirectional pattern with signal levels about three S-units under a dipole. In no case did it make any difference whether the 10 meter elements were insulated from the boom or not. We would very much like to hear from anyone who successfully adds both 10 and 15 meter elements to a 204BA. That would surely be a most impressive tribander!

Parts Availability

In cooperation with Gotham Antennas, we are offering a complete kit to interlace five 15 meter elements with an existing 204BA. Elements, hardware, both gamma matches, and instructions are included. Please send an SASE for details. ■

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3. Orr, William I., *Beam Antenna Handbook*, 1976 edition.
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Here's a "Twist"

— an OSCAR antenna with a difference

Introducing the 8XY/2M.

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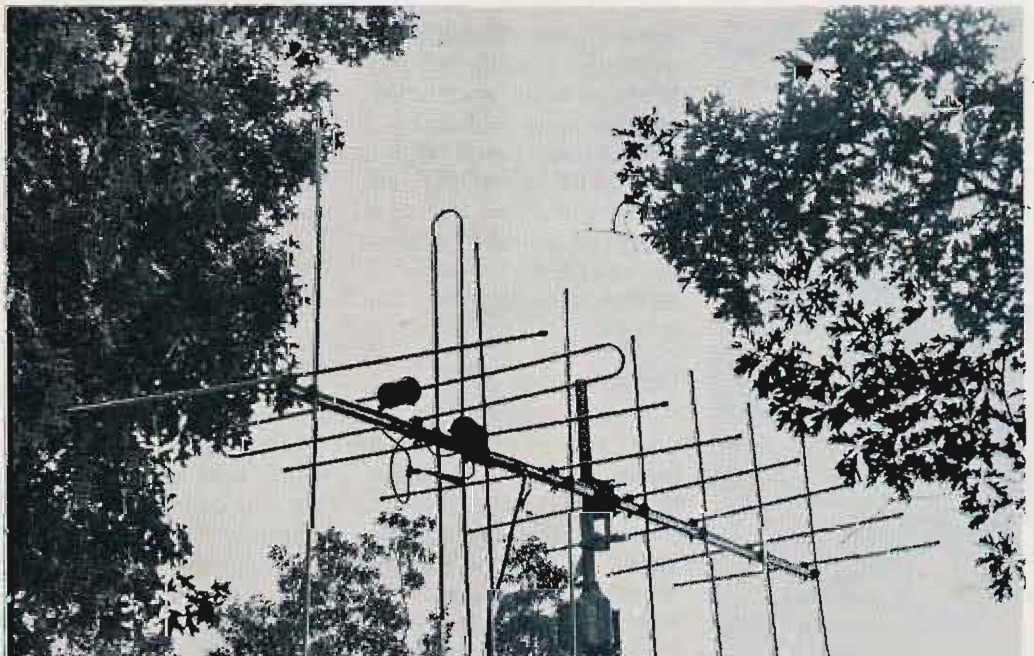
If you are one of the many amateurs who has experienced communication via our OSCAR orbital satellites, you know the challenge and enjoyment of satellite operations. The various aspects of OSCAR communications have something to catch nearly everyone's fancy: convenient operating times, orbital calculations and tracking systems, duplex style operating, unobtrusive antenna setups, low TVI levels, etc. Amateurs with limited time available to enjoy on-the-air operations truly appreciate the pinpoint-accurate communication times synonymous with satellite passes. What else could one ask?



The Spectrum International 8XY/2M OSCAR antenna is mounted on a 30-foot push-up mast which is tilted 30 degrees. This "skyward tilt" bypasses elevation rotor needs.

As with any station setup, the antenna system plays a major role in its performance. Quite simply, it's what's "up top" that counts! A poor skywire can undermine the most elaborate amateur setup, while an efficient antenna can make a mediocre setup perform like a million dollars. OSCAR setups are no exception to this rule. If you plan to fully enjoy OSCAR, you'll definitely benefit from using an antenna designed for satellite operations. Such an antenna is the 8XY/2M 8-element, 2-meter "Twist" antenna distributed by Spectrum International.

I found that assembling the 8XY/2M antenna was a refreshing change from the usual time-consuming task of rigging clamps and measuring element mounting locations. This gem went through smoothly in an hour's time, with heavy-duty bolts and wing nuts making hand-assembly a snap. Not a single tool was required until transmission lines were connected to the driven elements. Each element of the S.I. "Twist" is ¼-inch aluminum tubing which is precut and capped with color-coded tips to aid assembly. The boom is also predrilled and color-coded to ensure quick, foolproof assembly. *All* hardware for the antenna is *preassembled*, and an extra element-mount is included in case one becomes lost or broken. The massive boom-to-mast clamp could support a triband beam. Very nice! I must admit that this was the first time I've enjoyed (sort of) constructing an antenna.

The 8XY/2M antenna can be fed four different ways to obtain either vertical, horizontal, right-hand circular, or left-hand circular signal polarization. A ready-to-install phasing harness for circular polarization is available from Spectrum International, or you can fabricate your own harness from details supplied in various antenna books. Since I didn't care to kill time building a harness, I used the S.I. unit—and I'm glad I did.

If a fixed polarization is desired, the harness can be mounted at the antenna proper. If various polarizations are desired (for operating various modes of OSCAR), two transmission lines can be run from the antenna's driven elements and the phasing harness placed at the operating position. A coax switch can then be used to select the required polarization.

My Spectrum 8XY/2M antenna replaced a 2-month-old, 3-element array previously used for satellite work, and a significant signal improvement was realized. Suddenly, I was able to easily access the satellite and "stay into" the transponder for a longer period of time during each pass. I also noticed that my signal wasn't as prone to the heavy fades which were apparently due to polarization shifts during passes. This gain alone was worth the change to Spectrum's 8XY/2M antenna, as it allowed me to successfully operate slow scan TV via satellite.

When OSCAR 8 was placed in orbit, I decided to remove a few director elements from the 8XY/2M to reduce my erp to this new "bird." This antenna change worked very well, but a couple of days later, OSCAR 8 lost sensitivity and I had to replace the removed elements. Hopefully this satellite problem is merely an overloading situation which will soon be rectified.

I truly feel that the 8XY/2M antenna was a prime factor in my operations of successfully transmitting the first SSTV pictures via OSCAR 8 during orbit 102. Since I have only one small TV rotor to use with the 8XY/2M, I bent the rotor-to-boom mast approximately thirty degrees. This tilt allows the antenna to "look skyward," and bypass elevation rotor requirements.

In conclusion, I think amateur satellite communication and Spectrum's 8XY/2M are an ideal combination which all amateurs would thoroughly enjoy experiencing. There's no better way of renewing one's interest in amateur radio than by trying a new aspect of communication.

The 8XY/2M antenna is available from Spectrum International, Inc., P.O. Box 1084, Concord MA 01742. This 16-element array (8 elements vertical, 8 elements horizontal) is in the $45 to $50 price class. ■

✓ Reader Service—see page 211

A Fortified 2m Whip

—won't bend in the breeze

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Are you in need of a good 2 meter mobile antenna? How about an antenna for your base station? Or, do you just plain have the feeling that your station has become too commercialized and that a portion of your setup should be home-brewed? Then, why not try this antenna project? In actual checks, it was found to compare favorably with the commercially-made antennas tested. Whether you decide to use the antenna for mobile or base station operation, you'll be pleasantly surprised with its performance. The antenna is easy to construct and tune, and, best of all, it's inexpensive.

Photo A. The coil protective cover has been removed in this picture to show details of the base coil.

Design

One unique feature of this antenna is the construction of the whip. It consists of a 1/4"-diameter fiberglass rod with a shield of copper braid. This design was selected because it provided rigidity to minimize deflection during high winds or mobile operation. Research has shown that deflection of the flimsy-type whip causes degradation of the vertically polarized signal. In some instances, the efficiency of a 5/8-wave antenna actually becomes less effective than a 1/4-wave antenna.

The fiberglass rod is from the pennant-topped-type whip that is made for mounting on bicycles. Many retail stores have given away these whips as promotional items. They also are readily available from department stores and bicycle shops for approximately $1.25.

The impedance matching coil is 3 turns of no. 14 tinned copper wire wound on a wood thread spool from your XYL's sewing basket. It is tapped 1-1/8 turns from the ground end. A small ceramic trimmer capacitor across the coil provides a precise match in conjunction with the base coil tap. The impedance matching circuit is protected from the weather by enclosing it in an empty plastic container. Fish food had come in the container we used.

Construction and Assembly

Since no tricky construction or special tools are needed, no problems should be encountered. The fiberglass rod is prepared by drilling the 1/16"-diameter hole from the bottom as indicated in the diagram. Another 1/16"-diameter hole is drilled on the side of the rod at point A. This should be drilled at a slight angle towards the bottom to make the routing of the coil tap wire easier. The depth of this hole is only to the extent of meeting with the hole previously drilled from the bottom. When drilling these holes in the fiberglass rod, it is important to use a sharp drill and not allow the drill to heat up. It is best to cut the whip to proper length after the coil form is secured in place.

Prepare the coil form and other parts as indicated. Check that the hole in the spool is of the proper diameter to permit the spool to slide on the rod. The notches filed into the coil form prevent the coil from slipping. The hole for the coil tap is displaced 1/8 of a turn from the alignment of the bottom notch.

After the coil form is prepared, feed the 20-AWG tap wire through the tap-wire hole and out the bottom of the spool. Slide the form over the fiberglass rod and carefully route the tap wire through the drilled hole at point A and downward through the rod, out the bottom. Allow sufficient length for the tap wire to be soldered later in the PL-259 connector. Apply epoxy glue to the appropriate rod area, slide the coil form into its proper position on the rod, and take up any slack in the top wire. The final position of the coil form should be such that the tap-wire holes in the spool and the rod line up with each other and the rod extends sufficiently below the bottom of the spool to accept the UG-176 adapter. To hold the tap wire securely in position, apply a small amount of epoxy to the tap-wire opening in the spool and at the bottom of the whip.

Two holes must be drilled in the cover of the coil protector. A 1/4″ hole in the center will permit it to be slipped over the bottom of the whip. With the cover in position on the whip, use the notch of the coil form for determining the position of the second hole. This is a 1/8″ hole and should be drilled in the correct position to allow the ground end of the coil wire to pass through the cover and be soldered to the PL-259 connector. After both holes are drilled in the cover, epoxy the cover (threads towards the coil form) to the bottom of the wood spool. Position the feedthrough hole in the cover so that the tap occurs at 1-1/8 of a turn when the coil is added.

With epoxy applied to the bottom of the fiberglass rod, slide the UG-176 reducer onto the rod and up against the container cover. Check that none of the other parts has slipped from its proper position. At this point of construction, it is best to allow the epoxy to harden before proceeding.

After the epoxy hardens, the UG-176 reducer can be screwed into the PL-259 and the tap wire soldered in the center pin. Measure 42½ inches from the top of the coil form and cut the whip to length.

The next step is to slide the copper braid shield over the fiberglass rod. Tinned braid is recommended. However, if this is not readily available, the shield from RG-8/U coax cable will work fine. If the braided shield is too snug to readily slip over the rod, the diameter of the shield can be enlarged by squashing the braid together a little bit at a time. If the diameter of the shield has to be enlarged to any extent, be sure to allow for the shrinkage in length that will occur. The braided shield is slipped over the full length of the rod down to the coil form. The shield can be snugged to the rod by running your hand tightly along the braid.

One end of the coil is secured by routing a 24″ piece of 14-AWG wire through the hole in the cover and soldering it to the side of the PL-259 connector. With the one end secured, the 3-turn coil can then be easily wound on the form and soldered to the whip shield. Solder the tap wire 1-1/8 turns from the coil bottom (ground) and the trimmer capacitor across the entire coil. Cut off the braid shield so that it extends 3/8″ above the top of the rod; twist and

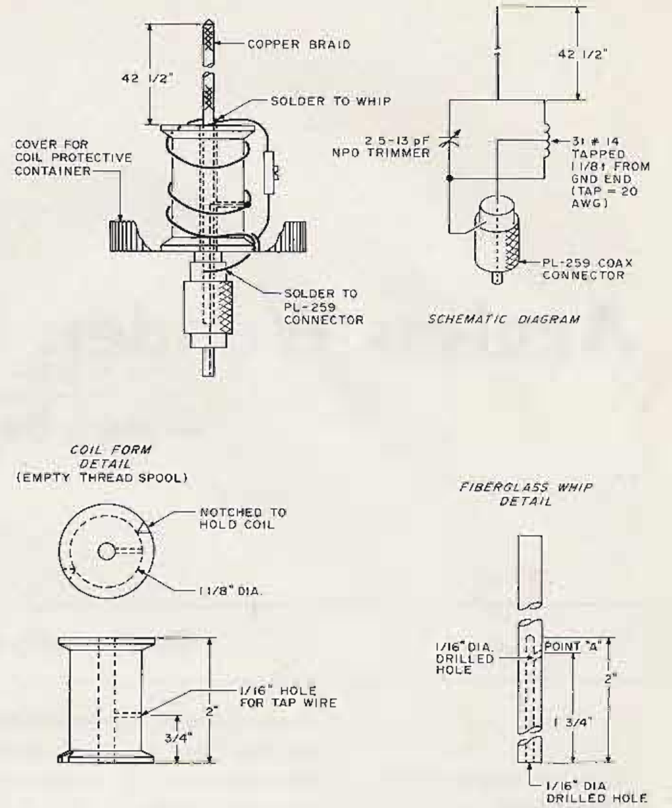

Fig. 1. A rigid 2 meter antenna for base or mobile operation.

solder. To protect the whip from the weather, shrink tubing, plastic electrical tape, or a protective spray can be used.

Mounting

For base station operation, I used a simple L-shaped aluminum bracket with an SO-239 connector, RG-58 coax, and four 19¼″ ground radials. This arrangement is secured with U-bolts to the mast above a triband beam. For mobile operation, the bracket design is dependent on the type of car and individual desires. For my mobile operation, I mounted a simple bracket and connector arrangement directly to the luggage rack.

Tuning

The easiest method to tune the antenna is with a field-strength meter at a distance of approximately 2 to 3 feet. With the antenna connected and the transmitter keyed on an unused simplex channel, adjust the trimmer capacitor with a non-metallic screwdriver for a peak field-strength indication. The vswr will be minimum at this point. Numerous antennas have been built, and, on all occasions, vswrs of less than 1.2 to 1 were obtained. The antenna, of course, should be situated away from all objects and as high off the ground as practical during tuning procedures.

With a 5/16″-diameter hole drilled in the bottom of the plastic container to accommodate the whip, slide the container over the whip and screw it into its cover. If the container affects the tuning of the antenna, drill a hole in its side and retune the antenna with the container in position. With RTV, seal the top opening of the container, but not the bottom. The hole in the cover will help prevent any moisture from accumulating.

Do you want to generate conversation? Just mention on your local repeater the fact that you're using a home-brew antenna. ■

Ageless Wonder: the Collinear Beam

—sure beats a dipole

Good results for a few dollars.

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Higganum CT 06441

Ever since the ready availability of aluminum tubing after the second World War, yagi beams have been popular with hams. More recently, quads have joined as popular antennas for the HF bands. These parasitic array antennas have a number of attractive features, including high gain, unidirectional radiation, and rotatability. Realization of their full potential, however, requires relatively expensive support equipment, including tower and rotor.

I have enjoyed using collinear wire beams, which give reasonably narrow bidirectional radiation patterns. These arrays are composed of elements arranged in a straight line. Each element is connected to the next by a phasing stub so that all elements operate in phase. The collinear antenna is often used at VHF and UHF in vertical orientation, but at HF it is only practical to erect horizontal collinear antennas. Collinear antennas have long been used in military applications, or in any situation where need exists for a rugged, directive HF antenna which can quickly be erected and which can deliver good performance. Especially for the Novice or for the ham on a budget, the collinear should be considered because it is easy to construct and it is inexpensive.

Many antenna texts discuss collinear antennas, but few provide complete design information. Particularly omitted is information on impedances. Collinear antennas may use elements of varying electrical length, but most common is the one-half wavelength element. Collinears may have as many as 6 elements. Because of mutual coupling and increasingly uneven current distribution obtained as one adds elements, most hams have built collinears with 2 or 3 elements. Highest gain is obtained if the antenna elements are spaced with 0.4 or 0.5 wavelengths of space between the ends of the elements, but this introduces construction problems. Less gain but much simpler design results from separating the elements only by use of an insulator.

I give design criteria below for 3-element 20 meter and 5-element 15 meter collinears, each of which requires less space to erect than an 80 meter dipole. I also give data on impedance characteristics at and near resonance to aid in selecting a suitable feedline. Many collinears are fed between the ends of the elements, where a very high impedance exists. In the antennas described below, feed occurs in the center of an element at a relatively low impedance, high current point. This permits a good match to 300- or 600-Ohm balanced lines. If one prefers, a 4:1, 6:1, or 9:1 ratio balun may be inserted so that the antennas may be fed directly with coax. My collinears are fed with balanced line, and a balun is introduced just outside the shack.

I was not able to find information on the impedances met when feeding collinears at current points, so I performed measurements on 3- and 5-element collinears suspended ¾ to 1 wavelength above ground. The impedances were measured on my Boonton 250-A "RX" meter. The impedance at resonance of the 3-element centerfed antenna was found to be 372 Ohms resistive; the 5-element antenna showed an impedance at resonance of 600 Ohms. Each of these antennas operates across an entire ham band with vswr of less than 1.5:1 (±1% of design frequency), using no matching device except a

Frequency	Dimensions			½-wavelength in feedline	
				coax V = 0.66	twinlead V = 0.82
	A	B	C		
21.2 MHz	11' 4"	22' 7½"	9' 6"	15' 4"	19' 0"
14.15 MHz	16' 6½"	33' 1"	14' 3"	22' 11½"	28' 6"

Table 1. Dimensions as measured for 15 and 20 meter collinears. A = halves of center element; B = outer elements; C = matching stubs.

properly chosen balun. The transmission line is chosen to be an integral number of half wavelengths. Of course, a balanced line tuner may be employed and the balun omitted. One can also tap up and down the transmission line for impedance matching purposes if this method is desired.

It is worth pointing out that the velocity of propagation of electromagnetic waves along transmission lines varies with the dielectric material used in constructing the line or cable. This velocity factor (V) must be included in calculating electrical wavelength in various types of lines. For example, open-wire line can be assumed to have a velocity factor of nearly 1.0 (or perhaps more exactly, 0.95 to 0.975). Thus, a wavelength in free space is nearly the same as one measured along open-wire line. The coax cable usually used by hams has a V of 0.66, and most 300-Ohm polyethylene balanced line ("twinlead") has a V of 0.82. This means, for example, that a wave of 15 meters length in free space has a physical length in coax of about (0.66 × 15m) = 10 meters and a physical length in 300-Ohm twinlead of about (0.82 × 15m) = 12.3 meters. In the designs below, I use 300-Ohm twinlead for the ¼-wave matching sections.

The 3-element collinear achieves a gain of about 3.3 decibels over a simple half-wave dipole and has a beamwidth to the half-power points (where the field strength voltage drops to 0.707 of its maximum value) in the horizontal plane of about ±18°. This is for a horizontally oriented antenna, of course, and the radiation is greatest at right angles to the axis of the array. The 5-element antenna achieves a gain of about 5.3 decibels and a beamwidth of about ±10° or so. Each antenna's horizontal radiation pattern is bidirectional with minor side lobes. I have designated the centerfed element halves as "A" in the drawing (Fig. 1) and in Table 1, the pairs of outer elements as "B", and the matching sections as "C", for the case of the 3- or 5-element centerfed collinear.

Construction Hints

All half-wave elements should be of equal length in a given antenna. One can erect the centerfed element and adjust it to exact resonance, if desired, then add the stubs and outer elements. Velocity factor V was found to be 0.95 for the 3-element collinear. The 5-element collinear resonated slightly higher than the calculated frequency; evidently a V of 0.95 overcorrects for end effects. I found V here to equal 0.975, and I give the actual determined dimensions for each antenna in Table 1.

I used home-brew nylon insulators which are 2 to 3 inches long and cut out of scrap. They are light and tough. One could also use Plexiglas™ or some other material or commercially-made ceramic insulators.

The phasing sections could be of open-wire line (remember, then, V would be about 0.95), but I chose 300-Ohm twinlead because the stubs tend to blow around in high winds and ladder line might twist up and short. (Also, I had a few scrap pieces of 300-Ohm twinlead in the shack.)

The antenna elements themselves I made of odds and ends of #16 and #14 hard-drawn copper wire, but almost anything will do here.

Care should be taken to fasten the phasing stubs to the insulators so that they do not fatigue and break off. Solder the stubs closed at the ends. I suspended the collinears high in some maple trees using clothesline pulleys and ¼-inch nylon line. One has been up for two winters and has survived numerous ice storms and high winds. You might wish to silicone or wax the twinlead to minimize swr changes during rainstorms. I'm not fussy about these antennas, except that I make sure that I never erect an antenna near, over, or under a power line.

In Table 1, I have given actual dimensions for center frequencies of 14.15 MHz for the 3-element and 21.2 MHz for the 5-element antenna. I use these collinears for working into Europe with my Triton IV. The 15 meter collinear would make a dandy antenna for Novice DXing. If one has the space for an 80 meter dipole, then 2 or 3 hours invested in construction and erection of a multi-element collinear will probably result in surprise and pleasure that such a simple antenna brings such good results for only a few dollars. ■

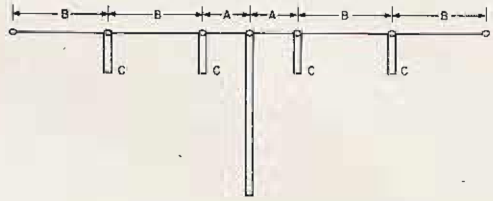

Fig. 1. Centerfed multi-element collinear wire beam. A = ¼ wavelength (ft.) = 246 (0.95)/f_{MHz}; B = ½ wavelength (ft.) = 492 (0.95)/f_{MHz}; C = ¼ wavelength (ft.) = 246 (0.82)/f_{MHz}.

Three Baluns for a Buck

—go find yourself a junked TV

Better than mail-order.

Editor's note: This article was written while the author was in Iran. He has since returned to the United States.

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Activating an HF radio station in areas of the world where hamming is not too common calls for a certain amount of improvisation. This is particularly true if station logistics have not been carefully planned prior to leaving home base.

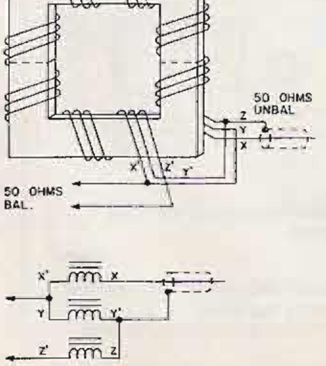

Fig. 1.

Material Selection and Preparation

The problem facing this station was that of acquiring a balun for a three-band dipole and then a three-element beam. Experiments with a homemade balun in the US using the ferrite core of a defunct TV flyback transformer had been quite successful on 80 and 40 meters. It was decided, therefore, to see if the same approach would do for 20, 15, and 10. It figured that a core material able to handle the TV horizontal retrace without significant loss should be fairly good for HF radio transmission. Actual measurements through the finished balun at 28 MHz and lower frequencies show less than a ½-dB attenuation.

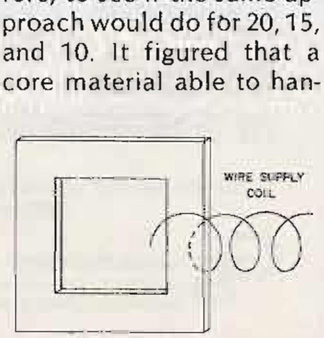

Fig. 2.

Initial Construction

Actual construction was started in the following fashion. A burned-out flyback was obtained from a TV service shop, and all of the windings, plus sealing compounds, were removed. After disassembly, two C-shaped core halves remained. These are normally mated at their highly polished surfaces and clamped together to form a solid O-shaped rectangle. To avoid any shorted turn effects from the clamping arrangement, and to make unobstructed space for windings around the full core circumference, the two core halves are held together with an epoxy compound. A very thin film of steel-filled epoxy is used for this purpose—hopefully this minimizes discontinuities in the magnetic circuitry of the core.

Some further core preparation is still needed before putting windings in place. This includes removal of any sharp edges with a fine file or abrasive cloth (to avoid scratching the enameled wire). The last step of preparation is to place two layers of plastic or glass tape over the core—this gives a very smooth surface for the winding process.

The actual winding calls for considerable care if a low swr is to be realized. Considerable experimentation took place to get best results—and two precautions turned out to be important in getting good balance and low loss: symmetrical placement of the turns and uniform "turn shape." The results of this care are uniformly distributed capacity within and between turns and equal inductance for each of the three trifilar windings.

The way the tight and uniform turns are achieved is to employ a modification of the "bobbin" technique (see Fig. 2) used on commercially-wound toroids. For this application, start with a single piece of about no. 20 gauge wire approximately 18 inches long. Thread the wire repeatedly through the core center until eight turns are in place. Distribute the turns evenly and clip all but about two inches on each end of the winding. Remove this temporary winding, straighten it, and measure its length. This will be the length of the permanent windings. Cut three lengths of no. 14 Formvar or similarly insulated copper wire and wind each one around a D-cell battery or similarly sized form to create the "wire supply coil" for the finished balun.

Next, take one of these coils and "screw" it onto the TV transformer core. Do this by spreading the turns and placing an end through the center hole, rotating the coil until it is all on the core. Straighten one end of the coil so that the 2" excess extends out from the core, then press tightly against the core this first turn of the "wire supply coil." Use your thumb to force each turn of the balun into shape against the core. Form each turn diagonally so that two turns are placed on each side. (Depending on where you wish to make your connection to the antenna and transmission line, you may start and finish at a corner or a side.)

Repeat the process for each of the next two windings. To keep the turns tight so that their final spacing can be evenly positioned, temporarily twist the two ends of each coil together. This will prevent any unwinding. Place a few drops of 5-minute epoxy glue at the point where windings start. When the windings are firmly set and evenly spaced, wire and solder them as shown in the diagram of Fig. 1. Be especially careful to make the connections between the windings symmetrical (to ensure equal inductance and coupling). Failure to do this will create a poor swr and increase loss. (An associate of mine has run tests on several commercial baluns and found that inattention to this matter accounts for fairly wide variations in performance, particularly at the higher frequencies.)

You are now ready to attach the leads on the balun which connect it to the feedline and antenna. Mount a coax fitting at one corner, and for the feedline, and the flexible leads (short lengths of coax outer conductor braid) for the dipole connection.

Final Adjustments

With a short length of coax, connect the balun through an swr bridge to a transmitter with variable output carrier. Connect the flexible leads to a dummy load, being careful to keep them straight, symmetrical, and evenly spaced. (Pieces of RG-58 outer covering can be used to protect the leads from the weather and to avoid shorts during the tests.) Next, set the rf source on 28 MHz and apply enough power to get a good reading on the swr meter in the forward direction. (Run the power high enough to ensure that the transmitter output "looks like" its transmission-line drive impedance—with some solid-state rigs, this may vary at very low power settings.)

Switch the swr meter to reverse and observe the reflected power level—it should read 1:1.2 or less. If it's higher, remove the rf power and try evening up any irregularities in the windings or significant spaces between adjacent wires in the individual turns. With careful dressing of the turns and connecting leads, this kind of performance can be realized.

The transformer (balun) is now ready for final assembly and mounting. Numerous schemes are appropriate. For my application, no enclosure was used, but just encapsulation in epoxy with a piece of vinyl tubing threaded through the center to tie the unit to the beam boom. (This was because an earlier model placed in a metal can arced to ground from a nearby lightning strike.) An appropriate form to contain the epoxy while it sets was made from the sides of a polyethylene detergent bottle. This material can be "welded" using a soldering iron to melt and join edges of individual pieces to form the desired shape of container.

Incidentally, the 30¢ cost refers to the wire—it has to be purchased locally. The epoxy is, of course, optional and is an added expense. The TV transformer core was a gift from a friendly Iranian TV repairman—a similar acquisition is no doubt possible anywhere.

The balun has worked fine and is superior to a mail-order kit which has been rebuilt numerous times but which has never given a satisfactory 10 meter swr when connected to a very load-match-sensitive Atlas 210X. ■

So You Want to Raise a Tower

—do it safely, do it right

A simple guide to an important subject.

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513 W. 10th St.
Casa Grande AZ 85222

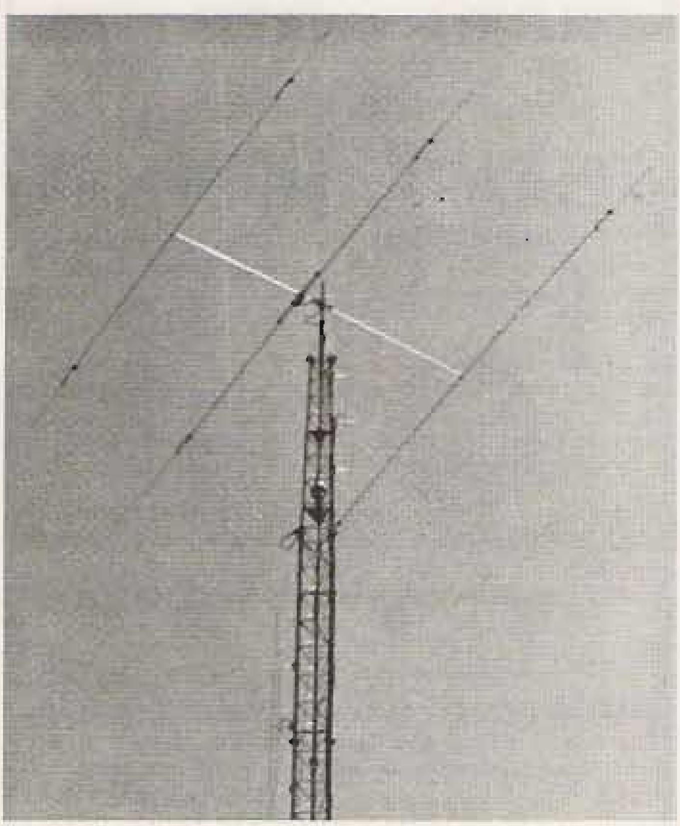

Photo A.

Sooner or later every ham has the desire to put up a tower. The intent of this article is to save you from some of the problems you can have by improper installation of your tower. These problems can result in loss of your tower and antennas, loss of your ham shack (a falling tower can do a great deal of remodeling to your shack), and last, but not least, loss of your or someone else's life. The first two losses can be corrected; the third can't!

First off, let's establish some basics. There are only two *safe* ways to erect a tower: with a crane or with a gin-pole. If you have the money, the first is the easiest. The second method is the one used by those of us who have more time than money.

Assuming that you have decided on the second method, you will have to do some tower climbing. There is one very important principle involved in tower climbing. Simply stated, it is: "If you are unable to strap a safety belt on the tower, let loose with both hands and lean back comfortably for a short nap, then keep both your feet on the ground."

If your legs are shaking, your hands are white from hanging on, and all you can think of is "I'm going to die," then you have no business on a tower!

Try the technique that I use. Tell yourself that once you have climbed more than ten feet, you probably will be killed if you fall. If you don't like this approach, you should get someone else to do the climbing.

Once you have doubled your life insurance—or found some tower rigger to do the climbing—you now have to decide where to put it. The ideal place is right next to the window in your shack, but this doesn't always turn out to be possible. Considerations governing tower location are as follows:

1) The guy-line anchors should be kept within your property boundaries, if at

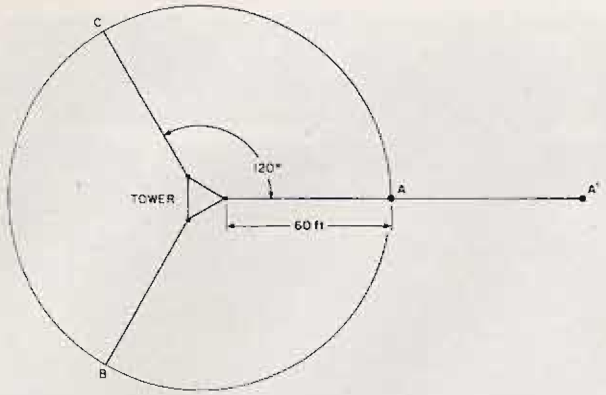

Fig. 1. Diagram for 60′ tower and guys.

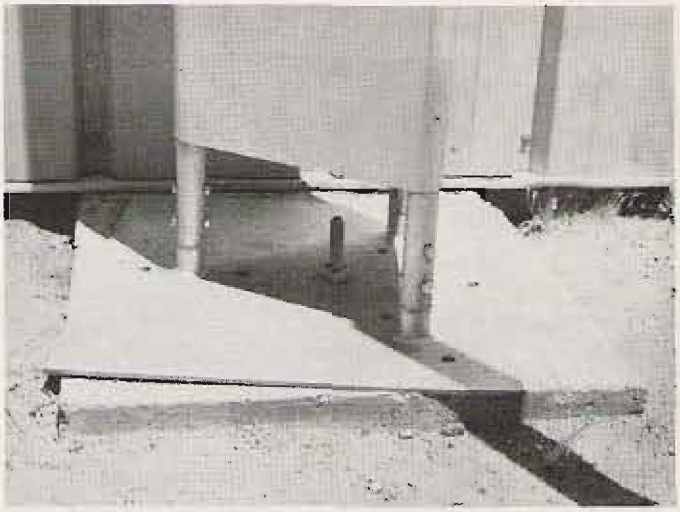

Photo B. The base plate is anchored to the tower foundation with one bolt.

all possible.

2) The anchors should be at a distance of at least two-thirds of the tower height away from the base of the tower, and, preferably, a distance equal to the tower height. Example: A 60′ tower should have guy supports at a distance of 40′ to 60′ from the base. Three guy lines are generally used.

3) The guy-line anchors should be at 120° spacing from each other. If available, a surveyor's transit should be used to site their locations. Fig. 1 demonstrates this. Note that it is not necessary to have all the anchors in a circle (i.e., equal distance from the base). This is shown by point A′ of Fig. 1. Every effort should be made to keep the anchors as close to 120° apart as possible. The more you deviate from this, the more vulnerable is the tower to twisting torque.

4) Guy lines should not be obstructed by power lines, trees, or parts of any building.

5) Be sure your community has no restrictions on tower erection; obtain a building permit if one is required.

6) Make sure there are no buried water, gas, or power lines in the areas where you plan to dig your base- and guy-anchor holes. Call the utility companies; they will locate them for you free of charge.

7) If at all possible, attach the tower to your house or shack. In most cases, this will classify it so that your home-owner's insurance will cover it. Check with your agent to see if this applies to your policy, and, if it does not, ask him about a separate liability policy. In most areas, a tower is considered an attractive nuisance for juveniles, and if a child is hurt on your tower, you are at fault even though it is on private property. If your tower falls on a neighbor's house, more than "Gee, I'm sorry about that!" is usually required to fix the damage.

8) Determine that the ground where your base and anchors will be is solid enough to hold them in place. Freshly-excavated ground should be avoided. (Quicksand, mud, and earthquake faults also should be avoided.)

Now that we have the basics out of the way, let's get started on putting this thing up. The tower foundation and the guying are the two most important parts of your whole installation. Don't take short cuts in either of these areas. A few bucks saved on cheap concrete or junky guy lines could cost you thousands of dollars in the long run.

The type of ground (clay, sand, soft dirt, or whatever) and the height of the tower will determine how much concrete you need for the base and guy-line anchors. A very good place to get this information is in the Rohn tower catalog. You can probably obtain a copy of it from Rohn or your Rohn dealer. This will give you a lot of valuable information on how and where to guy your tower and how big to make your holes for concrete. Under no circumstances should the base or anchors contain less than ¼ yard of concrete.

The specific information in this article is pertinent to most towers, but it is specifically related to the Rohn 25G tower. This is one of the most popular ham towers and the one with which I have the most experience.

In Photo B, you can see what I prefer for the tower base. Note that the concrete sticks up above ground level. This is accomplished by making a frame out of 2 × 4s, with the 4″ side vertical. There are a number of reasons for doing this: looks, maintainability (grass trimming), and, most important, leveling. If your base plate isn't level, it will be nearly impossible to level the tower.

Speaking of the base plate, it is a good investment to make. At $40 to $45 per section, it is a very expensive practice to bury part of the tower in concrete. With my system, should you decide to move, the base plate can be taken with you. (Most people would rather not take a yard of concrete with them to get the tower section cemented in it.)

You will notice that the base plate is held in place by one 5/8″ x 18″ galvanized bolt in the center. If you are unable to find one at your hardware store, try your local power company. These bolts are used quite extensively for power-pole hardware.

After you have poured the concrete in your base hole and tamped the air out of it, the bolt is inserted. Don't wait too long to put the bolt in or your concrete won't hold it too well. If you are a pessimist, a 3″ flat washer welded to the end of the bolt before putting it in the concrete will add holding power.

Do not attempt to put the base plate in place until after the concrete has set. Also, be careful not to bump your cement form when pouring the concrete.

Two-inch pump rods were installed to stop cars from running into the tower.

Once the base has cured (at least a week, and preferably longer), the

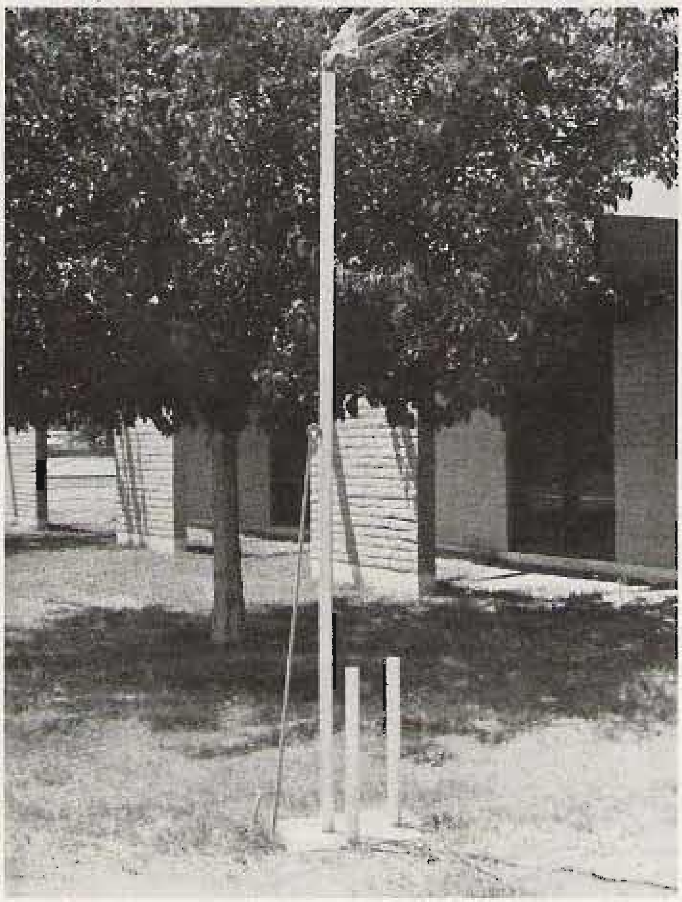

Photo C. Two types of guy-line supports are shown here.

Photo D. Guy lines are attached to equalizer plates, one of which is welded to the pump rod.

tower can be bolted to the base and set in place. Generally, the first two sections can be bolted together and set on the base without too much trouble.

Next, let's look at the guy-line supports. Photo C shows two types of guy-line supports. At the bottom of the picture is a Rohn guy anchor. This piece is cemented into the ground with just a few inches of shaft and the eye sticking out above the ground. (See your Rohn catalog for recommended installation of this device.)

Also in the picture is a pole with the lines attached to it. In this case, a 2″-diameter solid-steel pipe (a well pump rod) is used. If you check with a local pump repair company, you will find that pieces of rod that have been removed from wells are available for a couple of bucks each. Don't take your Volkswagen over to load up three lengths of this pipe, however. A 10′ piece of pump rod weighs over 300 pounds!

If you are unable to find the pump rod, a piece of 3″ or 4″ pipe will do equally well, with the pipes filled with concrete for extra strength, if desired.

The use of the pole has several advantages over the use of the guy anchor. The main advantage is that the lines are above ground so that people won't trip on them or hang themselves on them.

The hole for the anchor was 2′ × 2′ × 2½′ deep. This left 7½′ of pipe above ground, and, in most cases, this is plenty. If a driveway is crossed, you may need to go higher than that. If so, I recommend you use concrete-filled 4″ pipe rather than a pump rod. In any case, to make sure that they don't move, the pipes should be placed in the hole before pouring the concrete. The pipe also can be guyed with wire or rope attached to stakes in the ground.

Before calling your Redi-Mix company for a load of concrete, be sure that you have everything prepared. If the driver stands around while you put the pipe in the ground and guy it, you'll find that your bill will have a substantial charge for "stand-by" on it.

Photo D shows a close-up of how the guy lines are attached to the pipe. The piece of metal welded to the pipe is one of the equalizer plates in the Rohn EP-2534-3 package. When ordering, get 5 EP-2534-3 packages. There are 2 plates and hardware in each kit. Three sets will be used as standard equalizer plates, three of the remaining four plates will be welded to the pipes and the last plate always can be used as a paper weight.

Unless you are an extremely good welder, you should have the plates put on at your local welding shop. Tell the welder you want a *very* strong weld, to hold guy wires which will hold up a tower.

A few more points and tips: (1) All of the hardware shown comes with the equalizer plates, but, when ordering, be sure you get the correct plate for the number of guys that you will have. An EP-2534-3 is for two or three guys. An EP-2534-5 is for four or five guys. (2) When you set the guy-line pipe in the ground, be sure that the equalizer plate is facing toward the tower. It is very hard to rotate the pipe once the concrete has set. (3) If you want a little extra safety, you can weld a 12″ × 12″ plate to the bottom of the pump rod to make it harder to pull out of the concrete.

Once you have the base and guy supports poured in concrete, the next thing is to sit back and take a well-deserved break while the concrete cures. This will give you time to catch up on your reading of those back issues of *73*. After a couple of days, you can sand the rust off your guy pipes and spray them with Rust-o-leum, or some other rust-inhibiting paint. The silver paint seems to last the best of the colors I've tried.

Now that you are well rested and raring to go, we will start putting the tower up. We previously men-

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					17° - 40°C	0° - 40°C	100 Hz - 250 MHz	50 MHz - 250 MHz	250 MHz - 450 MHz	No.	SIZE IN INCHES	.1 SEC	1 SEC
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CONTINENTAL SPECIALTIES	MAX 50	$ 89.95	100Hz-50MHz	Non-Compensated	3 PPM @ 25°C	8 PPM	100 MV	NA	NA	6	.1	100 Hz	NA
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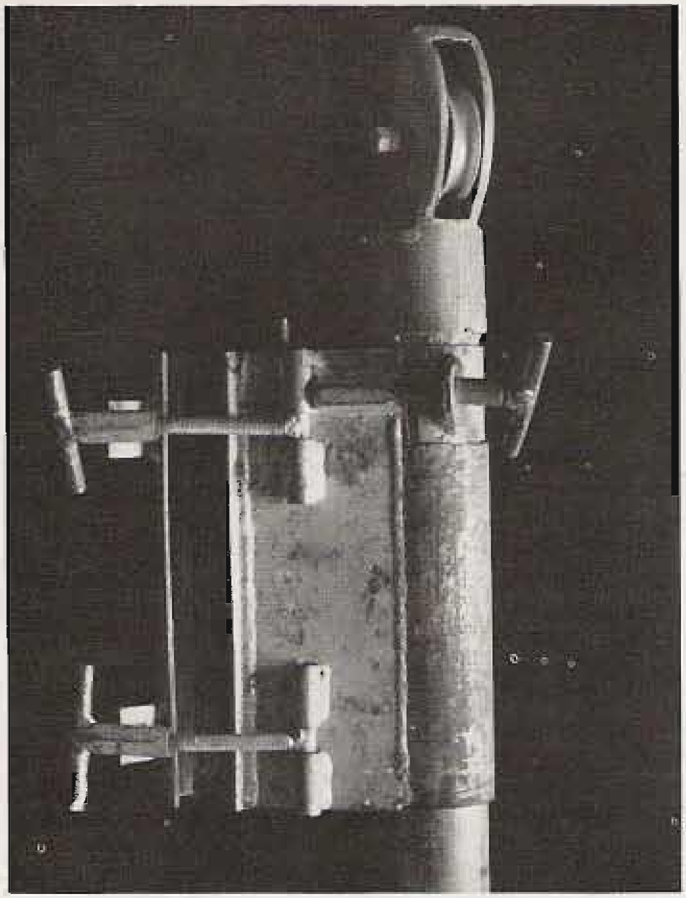

Photo E. *This is what a gin-pole looks like.*

Photo F. Clearing excess galvanizing from the tower legs will make joining easier.

tioned the gin-pole. Photo E shows a picture of the gin-pole, for those of you who don't know what one is. It consists of an aluminum pipe about 13' long, a clamping device, and a pulley at the top of the pole. (If you know someone who works at a radio shop, you may be able to borrow their gin-pole.)

While you are out scrounging around, you also will need a *good* safety belt (not a World War I surplus job). Remember, your life literally depends on the belt. If it goes, you go; if your belt breaks, you will be in for a big letdown. Another need is good rope. You will need a piece as long as twice the height of the tower, plus about 30'.

Before you get gung-ho to start putting up the tower, take a few minutes to inspect the tower sections. If any of the mating ends appear to be at all bent, check to be sure that they will mate with another section of tower. If severe damage is evident, turn in a claim to the trucking company and request replacements. While you're checking out the tower, locate the mounting hardware. You will find a plug in one of the lower legs of the tower. Pry it out, tilt the leg, and catch the nuts and bolts as they slide out. There should be two sizes of nuts and bolts, and three of each size. Be sure to count all the hardware to make sure you're not short, and then place it in the pouch of your safety belt.

Two other things can be done to make the tower sections easier to put together. The first is to take a 1½" piece of rod a foot or so long and grind a blunt point on it. Very gently drive this into the female (lower part of tower) ends of the tower sections. (Don't get carried away or you will split the tower legs open.) Photo F shows this being done. The second is to drive a drift punch through each of the bolt holes in the tower. Drive the punch in from both sides of the holes. The reason for these steps is to clear out any excess galvanizing that may be clogging the holes. (All Rohn towers are hot-dipped galvanized after they are assembled.) Under no circumstances should you use a drill to ream out the holes.

You now are ready to start putting up the tower sections. If you are doing the climbing, be sure that your ground man is reliable. Your life literally rests in his hands. If *you* say "whoa" and *he* "let's go," you have a big problem.

The man on the tower *always* calls the shots—he is the boss. If you can get hold of a pair of walkie-talkies, it will save you from laryngitis from yelling to each other. And let your ground man do as much of the physical work as possible.

The number one rule is safety. Tower work is no place to be horsing around. Before you take one foot off the ground, make the following point emphatically clear to everyone: If anything breaks, comes loose, or drops, don't try to stop it or catch it. Should anything go wrong, get your butt out of the way. A piece of mangled-up tower can easily be replaced. A mangled body is not so easily replaced.

The man on the tower should have the following equipment with him before he starts climbing: (1) Safety belt, boots, and gloves. (2) Two wrenches for *each* of the two bolt sizes on the tower. (A ratchet and socket help a lot.) (3) A drift punch and hammer. These are used to help align the bolt holes. (4) All of the nuts and bolts for all of the tower sections. (5) A small pulley which can be used to raise the gin-pole from one section of the tower to the next. (6) A work platform, if used.

Item six is not a requirement, but it can make the tower work a lot easier and save a lot of wear and tear on your feet and back. (See Photo G.) Once again, I wish to emphasize that very important point: If you can't relax while doing tower work, *stay on the ground*. There is no way

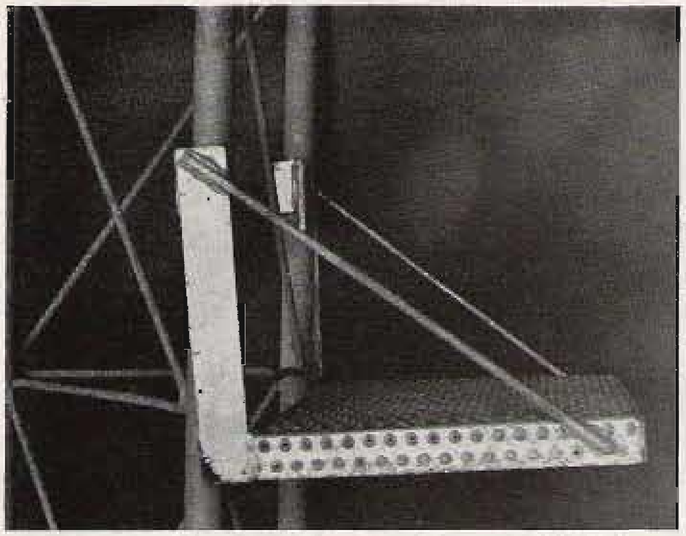

Photo G. A work platform can make tower erection much easier.

that you can hold on with one hand and work with the other. Tower work requires both hands and all of your attention.

Your first job is to place the gin-pole at the top of the first section. Carry the pole up the tower with the pole in the lowered position, or use the small pulley. Once you have it in place on the tower, you can raise the pole. Be sure to place the clamp on a tower leg so that sections can be pulled up without obstructions being in the way.

The clamp should be positioned so that it faces away from the tower. The pulley should be rotated so that it faces toward the inside of the tower. Do not use pliers to tighten any of the clamp screws on the gin-pole; hand-tight is sufficient on all three screws. Photo H shows a picture of the gin-pole clamped in place on the tower.

While you are mounting the gin-pole, your ground man should be tying the rope to the next section of the tower. The rope should be tied approximately two-thirds of the way up the section. If it is tied too high, you will have trouble placing the sections in place. Photo I shows how I tie the rope on. You will notice that this is a slip knot. Many people have looked at this and said, "It won't work." I have used this knot to send up over 500' of tower sections and never has it come loose.

Once you have the third section of tower in place, the first set of guy lines should be attached. I personally recommend that if you put up thirty feet or more of tower, it should be guyed. The Rohn catalog gives recommended guying heights for various tower heights. While you are working on the third section of tower, have your ground man getting the guy lines ready. Each line should be prepared as shown in Photo J *before* it is sent up to you. The loop should be about three inches long, and two cable clamps (minimum) should be used at each loop.

When you have the gin-pole ready (you can do this before moving the pole if you want), have the loop sent up to you on the gin-pole line. Each line should be taken to the turnbuckle it attaches to and measured to length before cutting. The turnbuckles should be screwed to the maximum *out* position before measuring. *Do not* try to pull the guy line tight when you are measuring it, but leave plenty of slack. The lines can't be tightened until all three lines are attached.

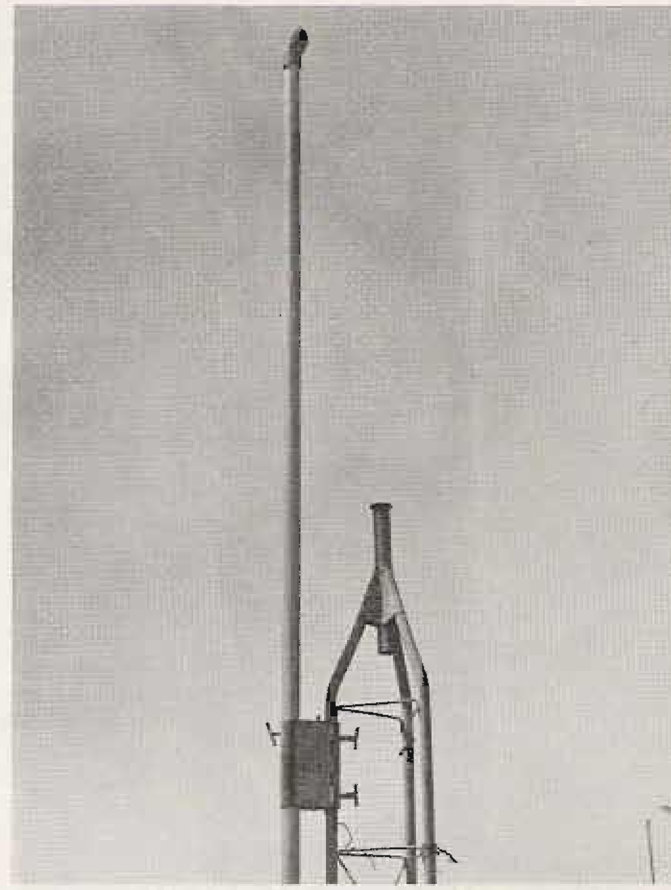

Photo H. The gin-pole is clamped in place at the top of the tower.

Leave a couple of feet extra so that the cable clamps can be fastened. When you cut the guy cable, be sure to tape both sides of the cut with electrical tape before you cut it. A small pair of bolt cutters does a good job of cutting the cable.

After the first line is attached, have the second one prepared and sent up. After all three guys are attached, the tower man should come down, because the next job is easiest when done by all hands—preferably with four men. Have one man on each of the guy lines, and the fourth man at the tower, with a two-foot or longer level. It is best to use a ladder, so that the level can be placed on the middle of the second section or higher (15' from the ground).

The level man should not stand on or hold onto the tower when he is leveling it. Each turnbuckle should be tightened until the tower is level. Take at least two perpendicular readings (90° from each other) on each leg to ensure that the tower is level. The first set of guys is very important. If the tower is not properly leveled at this point, you may never get it straight.

If you turn the turnbuckle all the way in and still need more tightening, then back it all the way out, loosen the cable clamps, pull the cable until it is tight, re-clamp, and start tightening the turnbuckle again. When properly tightened, the guy lines still should have a fair amount of slack. You should be able to shake the cable and have a small amount of ripple in it.

If the cables are too

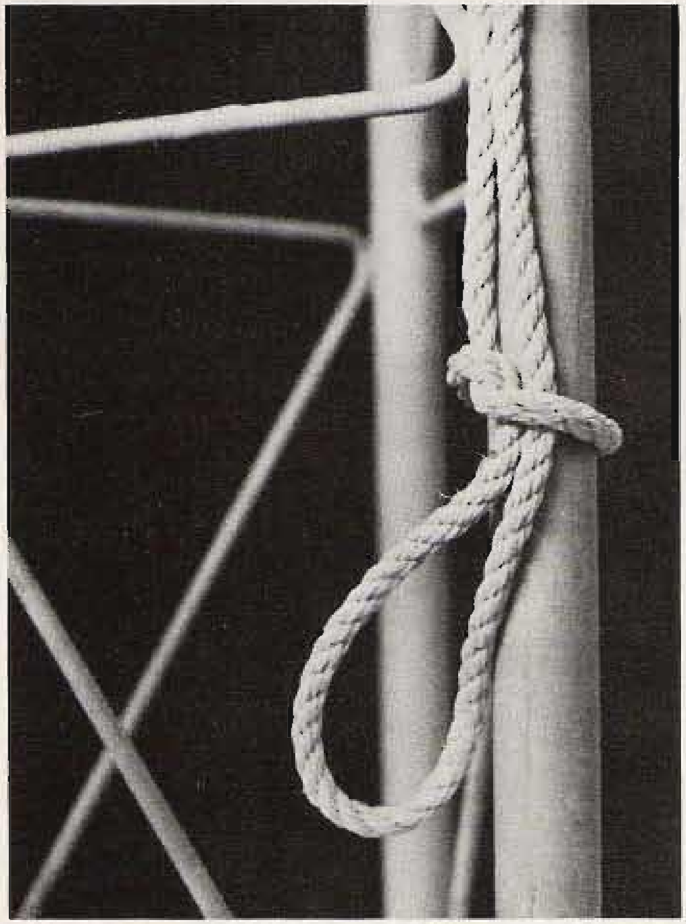

Photo I. *A good knot to use when lifting tower sections.*

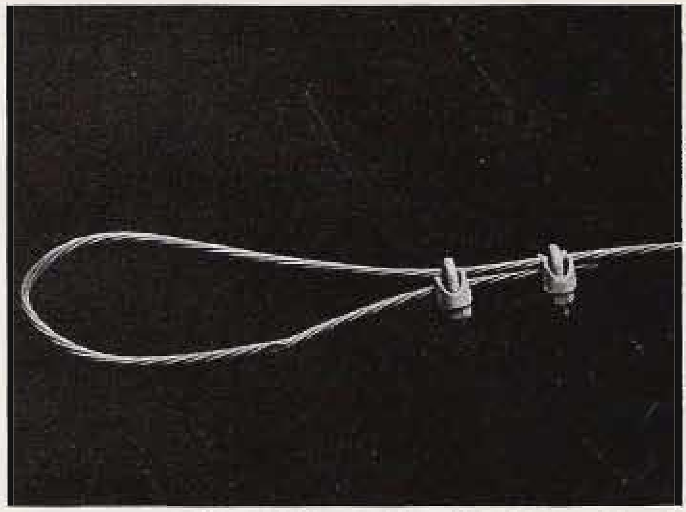

Photo J. The three-inch loop should be prepared before the guy line is lifted up to the tower.

tight, you stand a good chance of losing your tower. The theory is that of the reed in the wind. A reed will bend in the wind and not be broken, but a rigid plant will snap off because it is unable to give. A properly-guyed tower will have a small amount of sway to it. And remember that if you put up your tower in winter, you will need *less* slack than you would in the summer!

Continue to put additional sections of tower and guy lines on until the tower is completed. Additional sections of tower are leveled in the same manner. The only exception is that, rather than using a level, the level man should look up each leg of the tower. A section that is not level will stand out very noticeably. If you're not sure, have several people sight up the tower and level until the general consensus is that it is straight.

When all sections of tower have been installed and leveled, the turnbuckles should be safety-wired. This prevents movement of the lines from working the turnbuckles loose. The method I prefer to use is the "figure-8" safety wiring. This can be seen in Photo K.

Another feature you may want to add to your tower is a skirt on the bottom section. Remember, your tower is classified as an "attractive nuisance." The skirting I used can be seen in Photo L. The best way to make this is to take a section of tower to a local air conditioning contractor and ask him to make you a piece of metal 8' long to cover the tower. You can have him attach it to the tower, or do it yourself. The best way to attach it is to use pop rivets. Be sure to leave space at the top and bottom of the section so that the mounting bolts can be installed.

The only remaining part of the job is the antenna and feedline installation. Since there are so many types of antennas and mountings, I will not attempt to go into installation of them. If you intend to use a rotor, contact your Rohn dealer. He probably can fix you up with a rotor mount and thrust bearings that are made for the tower.

Two words of caution on feedlines: (1) There seems to be quite a bit of unjacketed Heliax® available that has been removed from commercial service. If you run across any of it, take it if it is given to you, proceed to your nearest scrap metal yard, and sell it for the value of the copper. Under no conditions do you want to use it on your tower. When you place two dissimilar metals together and place them in an electromagnetic field, you have created a fantastic TVI generator. This is the reason that it was removed from commercial service. And (2), watch for kinks in the outer shield. If it is kinked, there is a 98% chance that the cable is ruined. If you need a good attenuator, it is fine. However, most people find it to no advantage to have a 3-dB attenuator in their feedline.

If you are planning to buy a complete tower, you can buy a package that has the tower, guy lines, turnbuckles, equalizer plates, and cable clamps. This could save you some time and money. Check with your Rohn dealer about the package tower before you buy all the pieces individually.

Be sure that the tower you buy will handle the wind loading and weight for the antenna system that you plan to use. If you plan to use the pump-rod guying technique, be sure to order two extra equalizing plate kits. Also, check to see that there is sufficient guy line to meet your guying needs. The packages are set up for the ideal guying, but there is a very good chance that your installation will need more cable.

I hope that this article has given you some insight into the proper methods of erecting a tower. I claim neither to have covered every possible condition you may encounter nor that this is the only way to put up a tower. All I can say is that these are some of the most acceptable methods I've tried in 15

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Antenna Output Impedance:
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Operating Modes:
LSB, USB, CW
Power Requirements:
100/110/117/200/220/234 volts AC, 50/60 Hz; 13.5 volts DC (with optional DC-DC converter)
Power Consumption:
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Image Rejection:
Better than 60 dB (160-15 meters); Better than 50 dB (10 meters)
IF Rejection:
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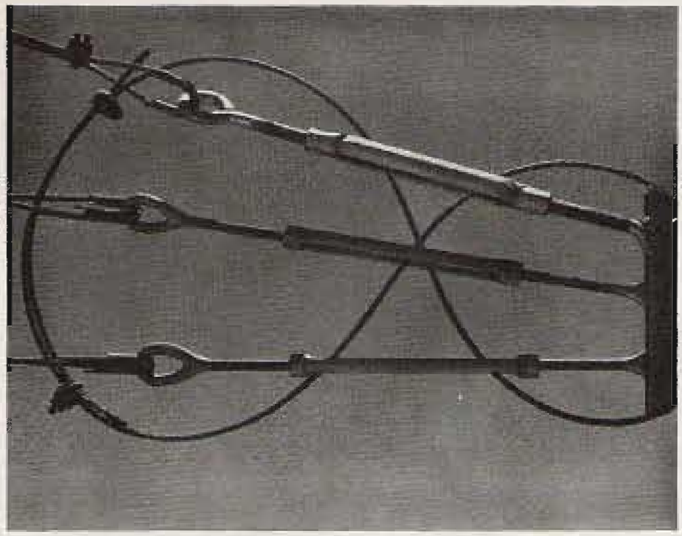

Photo K. A "figure-8" safety wiring for turnbuckles.

years of putting up ham and commercial towers.

If you have any suggestions or questions, I will be glad to respond to them. If you wish and expect a reply, send an SASE. Good luck, and remember the final words of Harry Splash, the tower rigger: "I knew that I should have replaced that worn strap on my safety belt!"

Note: Thanks to Deborah Coyle for proofreading and typing this article, and to Sue (WB7CXE's YL) for help with the photo work. ■

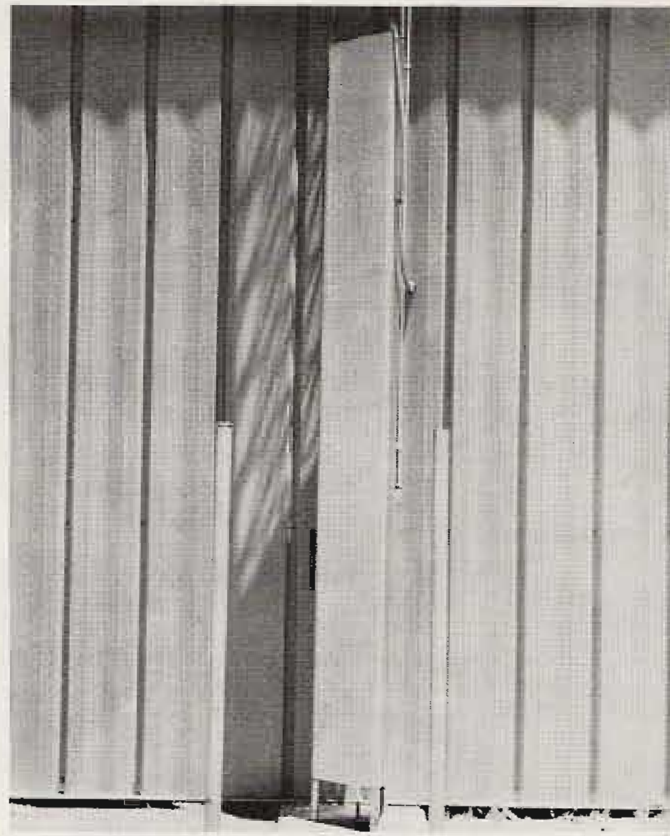

Photo L. A skirting at the bottom of the tower lessens the "attractiveness" of your "attractive nuisance."

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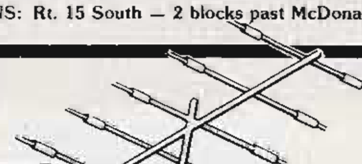

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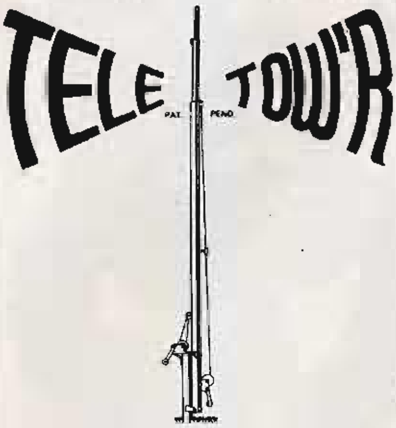

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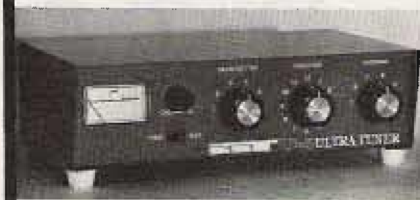

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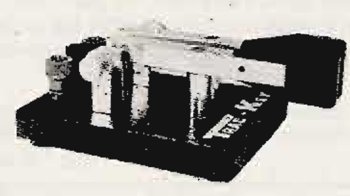

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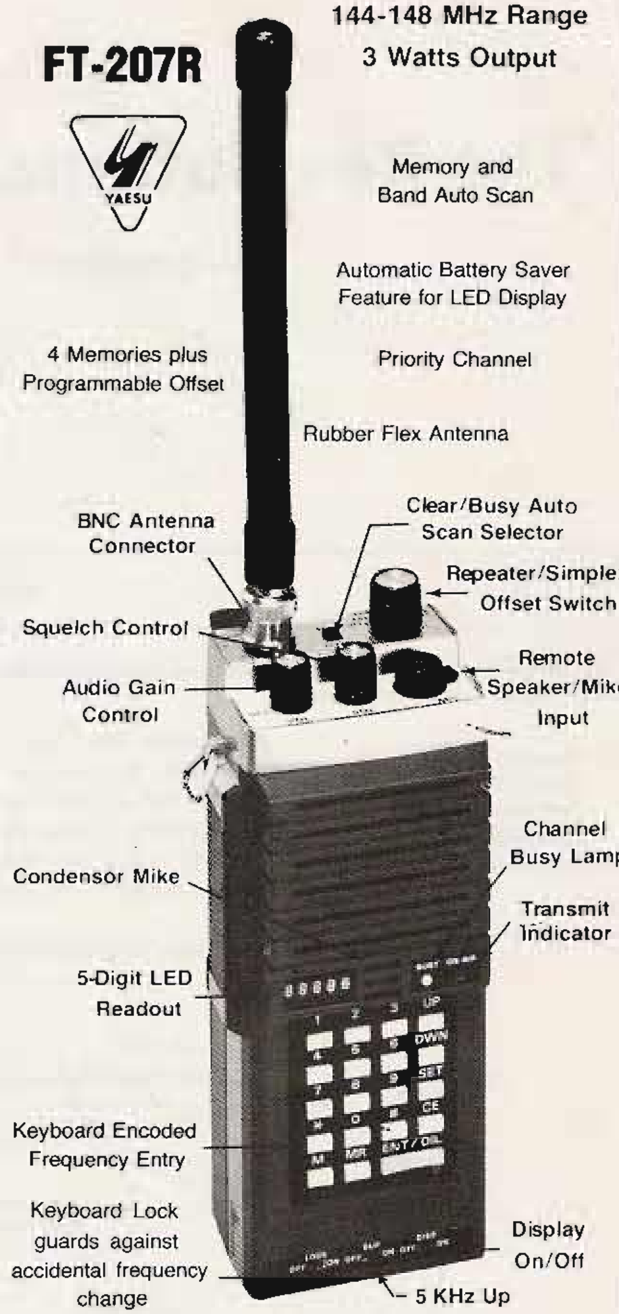

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Author's Note: To prevent possible adverse heating effects in the arm tissue, it is important that power input to antenna described in this article be limited to 10 mW.

James C. Gaddie
Russell T. Wolfram
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Ames Research Center
Moffet Field CA 94035

A human arm may be made to act as an antenna for a communications system. It has been done by using an energy coupler made of two strips of copper foil fastened to a strap and wrapped around the wrist. Apparently, the wrist strap can efficiently transfer radio-frequency energy to or from the arm.

Reprinted from NASA Tech Briefs, Summer, 1978.

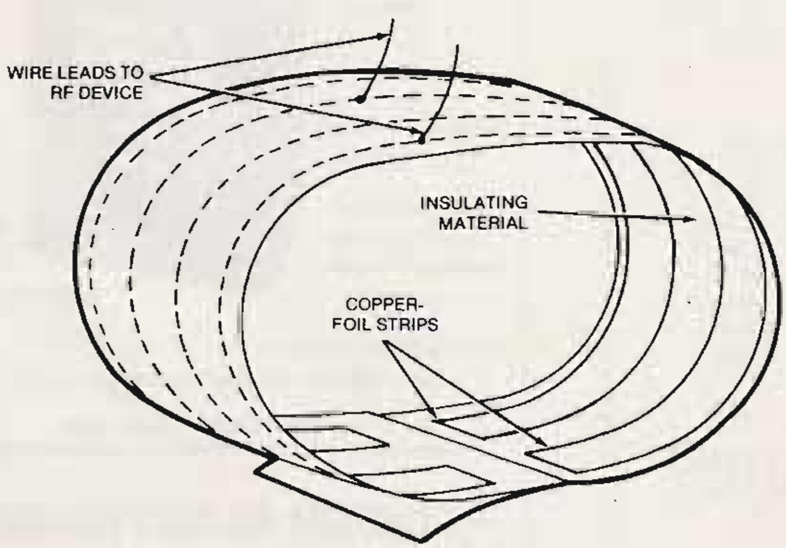

Fig. 1. Wrist-strap coupler of radio-frequency energy consists of two strips of copper fastened to an insulating material. Wires at the midpoints of the strips lead to the radio-frequency device that can act as a transmitter or receiver.

A prototype of the antenna coupler was built and found suitable for both sending and receiving very-high-frequency signals. The goal of the developers is to build a body-worn communications system for the deaf blind, and it was with this purpose in mind that the prototype unit was built and tested. Other potential applications for the compact coupler include body-worn two-way local communications systems for police and as part of a portable personal communications system that could communicate via satellite.

The copper-foil strips of the wrist-strap coupler shown in Fig. 1 are rectangular, 5 in. (13 cm) long and ½ in. (1.3 cm) wide. They are placed 7/16 in. (1.1 cm) apart and are fastened to the underside of a wrist strap made of an electrically insulating material. A thin insulating strip is also placed over the straps as a protective cover. Such an insulator can be added to the wrist strap because the copper strips need not be in direct contact with the skin for the rf signals to be coupled to or from the arm.

For connecting the coupler to a transceiver, or receive- or transmit-only unit, a small wire is attached to the edge of each copper strip at a point equidistant from the ends of the strip. Each wire is then routed through a hole in the insulating material to the upper surface of the strap. In addition, a fastener must be attached to the strap so that it can be pulled snugly against the wrist.

Radio-frequency energy couples to or from the arm through the electrical capacity between the arm and the copper strips. Electrical impedance characteristics of the antenna are shown in Fig. 2. The radiated field strength, with the strap driven by a 170-MHz, 10-mW transmitter, was found to be slightly greater than that from a well-designed loop antenna built with a 16- by 11- by 3-mm ferrite core and driven by the same transmitter. ■

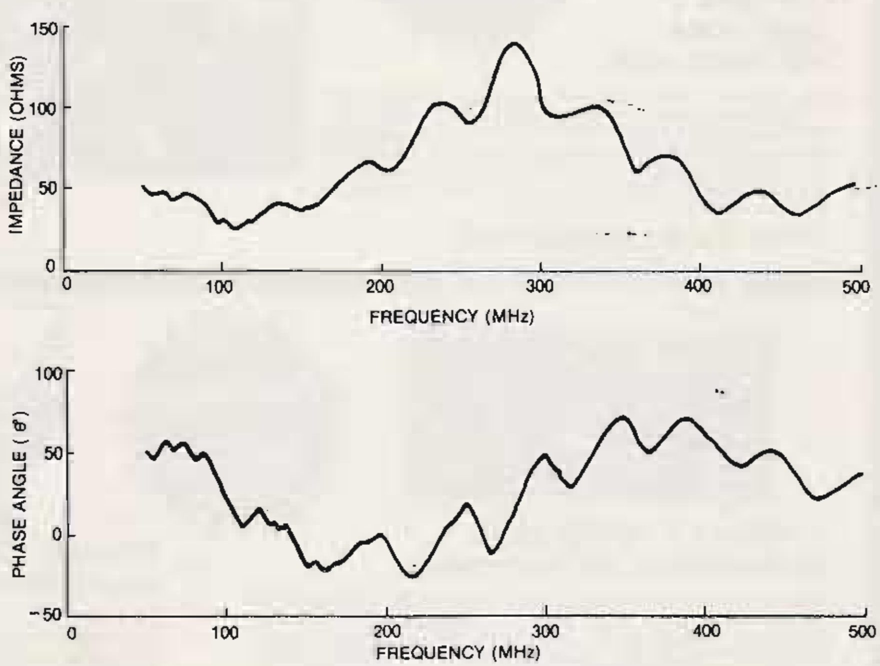

Fig. 2. Electrical impedance characteristics of the wrist-strap antenna coupler were measured with a General Radio 1710 rf network analyzer. Varying the widths of the copper strips will produce somewhat different characteristics.

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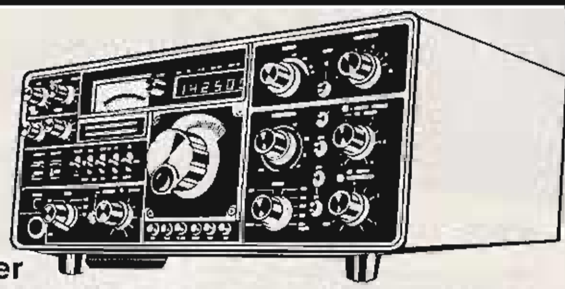

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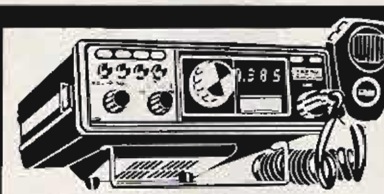

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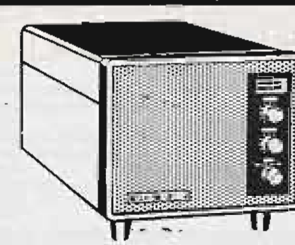

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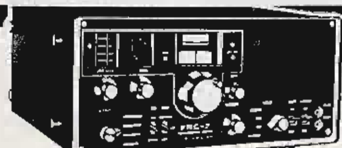

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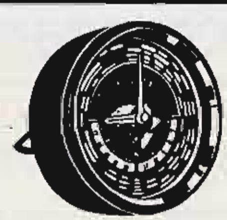

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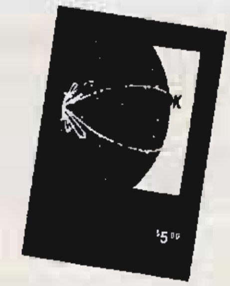

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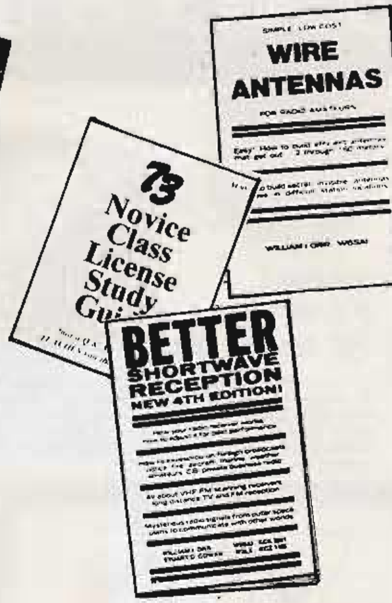

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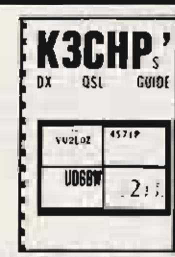

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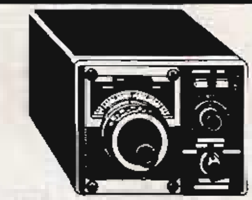

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139.00 Call for quote.

KENWOOD AT-120 antenna tuner

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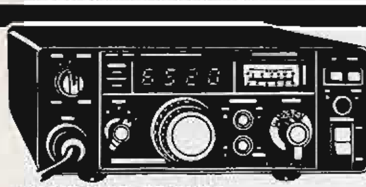

KENWOOD TR-7625 25W transceiver

The unit has memory channel with simplex or repeater operation ±600 KHz transmitter offset, mode switch for switching the transmit freq. up or down, full 4 MHz coverage on 2m (144.00-147.995), 800 channels, 5 KHz offset switch, MHz selector switch, digital freq. display, unlock indicator for transceiver protection.

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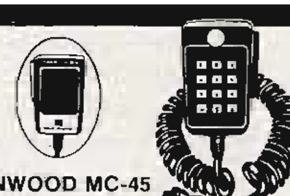

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The touch tone circuit provides PTT with only ½ second hang time. It is an omnidirectional, dynamic mic with 500 ohm impedance, very good frequency response, and adjustable tone output level. Power requirement: 8 VDC, 20 mA. Complete with connector and coiled cord. Compatible with the TR-7600 and TR-7625 with no modification.

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Listen to foreign broadcasts or ham operators from around the world! It has a 3-way power supply (AC/batteries/external DC). In case of an AC power failure, it automatically switches to DC so is ideal for emergency use. The receiver frequencies (180 KHz to 30 MHz) are all covered by 6 bands. There is a 500 KHz marker on the receiver.

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KENWOOD TL-922A 2000W linear amplifier

Features: 2 3-500Z final tubes, time delay fan circuit, frequency range 160 thru 15 meters, drive power: 80W or more for full output, RF input power: SSB 2000W PEP, CW & RTTY 1000W DC, power requirements: 120/220/240 VAC 50/60 Hz.

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DDRR Dipole for VHF

—experiment!

Seeking selectivity.

Dave Atkins W6VX
130 N. Westgate Ave.
Los Angeles CA 90049

Selectivity in an antenna is becoming increasingly important as the bands compress under the load of more and more stations. Reception is where this is most desirable. Front-end overload, we have learned, will cause big problems to a communications circuit when off-channel signals are strong. Directional-type antennas, of course, are the answer unless we need to cover everything around us. The DDRR, or directly driven ring radiator, developed by its inventor, J.M. Boyer (with patents assigned to Northrop), has high selectivity. Because of this, it also is a low-noise device. This makes two good reasons for its superior performance. (*73 Magazine* for August and September, 1976, goes into detail of its design and advantage. There have been many other articles written about it over the years.) Two drawbacks are noted when the chips are down. One is the size of the ground plane for the monopole design; the other is the cost of the conductor material for low-frequency use. Tuning can be another problem where its use for high-power transmission is contemplated. Very high voltage and current are the prices of the trade-off for high selectivity.

What Is It?

Boyer suggests the DDRR dipole in his September (part two) article. This version does without the big ground plane, as would any dipole. So here we have a quarter-wave open transmission line formed into a shape which "leaks" and radiates rf. I first built one of these for ten meters and made it so it operated on its highest frequency (no added capacitance) and at a fixed frequency. A/B checks with the spaced rings mounted vertically compared very well with those of a horizontal folded dipole at the same height and with the same orientation. Pretty good for an antenna on ten meters which is 30 cm "long" and 84 cm in diameter (see *73*, April, 1965, "Double Hula," Peter Lovelock).

The Two Meter DDRR Dipole

To make the two meter model, I dug out an old ¼-inch tubing coil from a long-forgotten final and annealed it in the fireplace, then cleaned and polished the surface after stretching it between a car bumper and a stout post. 33 inches comes to a half wave. This is then folded on a one-inch-diameter rod or mandrel at exact center. The quarter-wave line is formed on a can to make a circular double ring or transmission line of about 5 inches diameter. This will resonate above the 148 MHz end of the band. I made a simple tuning arrangement of a 4-inch piece of #20 (0.8 mm) Teflon™-covered flexible wire. This is formed into a U to slide into the open ends of the line. When

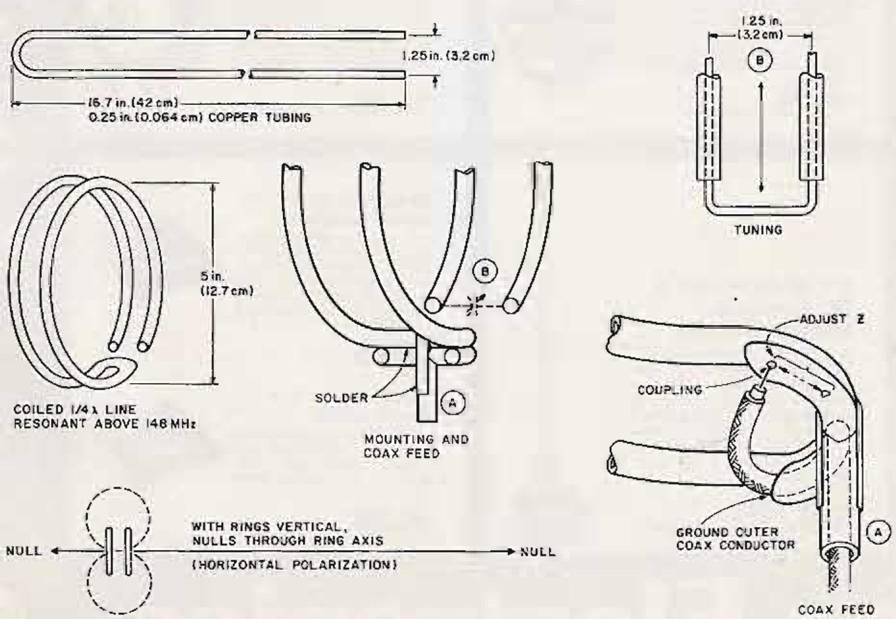

Fig. 1. Two meter DDRR dipole.

pushed in, the frequency should more than cover the 2 meter band. See detail B in Fig. 1.

A length of small-diameter coax may be coupled tightly to the closed end of the open line. Mine was fed through a separate matching U-shape of the same tubing soldered to the closed end of the line. A good match was obtained by varying the size of the link (see drawing). A 50-Ohm match comes at an area of less than that formed by the 180 degree half turn at the closed end of the line. The ¼-inch line thus formed needs no insulators for support.

Mounting of the completed antenna may be done in several ways. Mine was to make a pedestal a few inches long and to feed the coax through. This was mounted breadboard fashion on a piece of hardwood. A BNC coax connector was fastened to this piece. A tuning arrangement was made to slide the Teflon tuning U in or out to cover the band of interest. The selectivity curve was measured using a signal generator, a counter, and an FM receiver. The antenna frequency was left fixed and the receiver and generator were moved together across the antenna frequency.

While vertical polarization is the way most of our present two meter signals leave the antenna, things happen that make the polarization somewhat different at the receiving end. By orienting the receiving antenna, it is often possible to null out an interfering signal. By going a step further, I made the mounting adjustable in azimuth and elevation. This also can be done in various ways—mine is a breadboard way to test the idea. Aiming it works well and can reduce multipath *and* QRM.

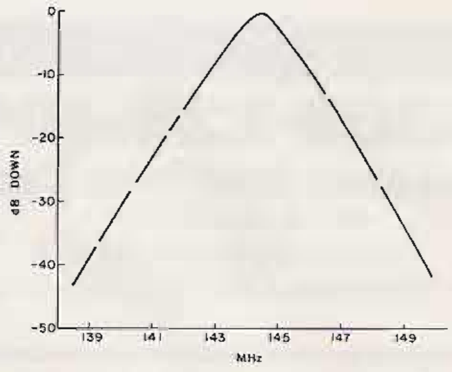

Fig. 2. Two meter DDRR dipole antenna selectivity.

Conclusions

While the amount of selectivity afforded by the DDRR will not come up to that of a multipole filter, it is worthwhile in that it is ahead of the front end—aiding in the signal-to-noise problem. An undesired signal off to one side is noise, too.

Do not try transmitting with the device with the tuning method described except with very low power. It will not pass the smoke test.

Broadband antennas are very convenient (discones, rhombics, and tribanders), but who needs all these unwanted signals going up and down the feedline? Phased DDRR elements could improve selectivity as well as gain.

A selective antenna should make a big difference to you. ■

Reader Service—see page 211

Social Events

Listings in this column are provided free of charge on a space-available basis. The following information should be included in every announcement: sponsor, event, date, time, place, city, state, admission charge (if any), features, talk-in frequencies, and the name of whom to contact for further information. Announcements must be received two months prior to the month in which the event takes place.

LOUISVILLE KY
JUN 29-JUL 1

The Louisville Area Computer Club will hold its 4th annual Computerfest™ 1979 from June 29 through July 1, 1979, at the Bluegrass Convention Center, Louisville, Kentucky. Activities include a flea market, seminars, and exposition, as well as activities for the entire family. Seminar and exposition admission is $4.00. Pre-registered Ramada Inn guests ($29.00, single; $34.00, double) receive free admission. For advance mail information, write Computerfest '79, Louisville Area Computer Club, PO Box 70355, Louisville KY 40270, or phone Tom Eubank, Chairman, at (502)-895-1230.

BATESVILLE AR
JUN 30-JUL 1

The Arkansas Army MARS meeting will be held on June 30-July 1, 1979, at the Independence County Fairgrounds, Batesville, Arkansas. There will be a fish fry on Saturday and a pancake breakfast on Sunday. Camping and motel rooms will be available. For further information, contact Robert Glines WB5KUI/ADN2MH, Box 97, Floral AR 72534, or phone (501)-345-2880.

BELLEFONTAINE OH
JUL 1

The Champaign Logan Amateur Radio Club, Inc., will hold its annual hamfest on Sunday, July 1, 1979, at the Logan County Fairgrounds, South Main Street and Lake Avenue, Bellefontaine, Ohio. There will be free admission and door prizes. Trunk and table sales are $1.00, and there will also be a bid table. Talk-in on 146.52. For more information, contact John L. Wentz W8HFK, Box 102, West Liberty OH 43357, or Frank Knull W8JS, 402 Lafayette Ave., Urbana OH 43078.

DUNKIRK NY
JUL 1

The Northwestern New York Repeater Association and the Northern Chautauqua Amateur Radio Club will hold their Lake Erie International Hamfest on Sunday, July 1, 1979, at the fairgrounds in Dunkirk, New York. A large flea market area and plenty of free parking will be provided. Tickets are $4.00 at the gate or $3.00 in advance. RV hookups are available. For information on advance sales or for a map showing easy directions from I-90, write to Dick Brinkerhoff WB2HEF, 123 5th St., Dunkirk NY 14048.

HARRISBURG PA
JUL 4

The Harrisburg RAC will hold its annual Firecracker Hamfest on Wednesday, July 4, 1979, at the Shellsville VFW picnic grounds, I-81 north, Exit #27 or #28, Racetrack Exit, Harrisburg, Pennsylvania. Look for the large balloon. Admission is $3.00, with no charge for tailgating. Tables will be available in the pavilion. Talk-in on .52/.52.

WELLINGTON OH
JUL 7

The Northern Ohio Amateur Radio Society will hold its second annual NOARSFEST on Saturday, July 7, 1979, at the Lorain County Fairgrounds, one mile west of Rte. 58 on Rte. 18, Wellington, Ohio. Admission tickets are $1.50 in advance and $2.00 at the gate and are good for all prize drawings. Children under 12 are admitted free. Gates open for the sellers and dealers at 6:00 am and to the public from 7:00 am to 5:00 pm. Indoor dealer tables are $4.00 each by advance registration. Drawing-only tickets are available by mail or at the gate for $1.00 each. Flea market spaces are $1.00 each. There will be over 100 prizes, including a DenTron HF-200 transceiver, a Ten-Tec 509, a DenTron GLA-1000, a Wilson Mark II, and an Optoelectronics counter. There will be plenty of food and free parking. Featured will be a large indoor exhibit hall for dealers and a huge blacktopped midway for flea market and trunk sales. There will be free camping outside the gates on Friday night, but no hookups. For advance registration, information, or tickets, write NOARSFEST, PO Box 354, Lorain OH 44052.

INDIANAPOLIS IN
JUL 8

The Indianapolis Amateur Radio Association will sponsor the Indianapolis Hamfest on Sunday, July 8, 1979, at the Marion County Fairgrounds, on the southeast corner of Indianapolis at the intersection of Interstates 74 and 465, Indianapolis, Indiana. There will be commercial exhibitors and dealer displays for a fee of $30.00 per booth. The commercial building will be open from 12:00 noon until 9:00 pm on Saturday and will reopen at 7:00 am on Sunday. Camper hookup facilities are available on the fairgrounds for overnight parking if you arrive on Saturday. A food and drink vendor will have a setup outside, while a professional caterer will have facilities inside. For more information, write to the Indianapolis Hamfest, PO Box 1002, Indianapolis IN 46206.

OAK CREEK WI
JUL 14

The South Milwaukee Amateur Radio Club will hold its annual Swapfest '79 on Saturday, July 14, 1979, at American Legion Post #434, 9327 S. Shepard Avenue, Oak Creek, Wisconsin. Admission is $2.00 and includes a happy hour with free beverages. Prizes include a $100 first prize, a $50 second prize, and a variety of other prizes. Activities will begin at 7:00 am and continue until 5:00 pm. Parking, a picnic area, hot and cold sandwiches, and liquid refreshments will be available on the grounds. Overnight camping is also available. Talk-in on 146.94. More details, including a map, may be obtained from the South Milwaukee Amateur Radio Club, Inc., Robert Kastelic WB9TIK, Secretary, PO Box 102, South Milwaukee WI 53172.

BEAVER PA
JUL 15

The Beaver Valley Amateur Radio Association will hold its 2nd annual hamfest on Sunday, July 15, 1979, from 9:00 am to 5:00 pm at Brady's Run Park on Rte. 51 west from Beaver, Pennsylvania. Shelters 12 and 17 will be used. There will be free space for vendors. Tickets are $3.00. Talk-in on .52 and directions on 146.25/.85. For information, write WB3FKE, 3414 47th Street, New Brighton PA 15066.

TERRE HAUTE IN
JUL 15

The 33rd annual WVARA Hamfest will be held on July 15, 1979, at the Vigo County Fairgrounds, one mile south of I-70 on US 41, Terre Haute, Indiana. Overnight camping will be available. There will be a free flea market, a covered flea market at $2.00 for a 12' x 12' space with some tables and ac available, XYL bingo, food, refreshments, and valuable prizes. Advance ticket sales are $1.50 or 4 for $5.00. Tickets at the gate are $2.00 or 3 for $5.00, with children under 12 free. Talk-in on .25/.85 and .52. For tickets and information, send an SASE to WVARA Hamfest, PO Box 81, Terre Haute IN 47808.

ALLENTOWN PA
JUL 15

The Delaware-Lehigh ARC, Inc., the BGYE, Inc., and the Lehigh Valley ARC, Inc., will hold their Tri-Club Hamfest on July 15, 1979, from 8:00 am to 4:00 pm at the Allentown Police Academy pistol range on Lehigh Parkway South at Allentown, Pennsylvania. Admission is $2.00 for lookers and $4.00 for sellers. Talk-in on .34/.94 and .52.

WILKES-BARRE PA
JUL 15

The Broadcasters Amateur Radio Club will hold its 2nd annual hamfest on July 15, 1979, from 9:00 am to 4:00 pm at Pocono Downs Racetrack, Rte. 315, four miles north of Wilkes-Barre, Pennsylvania. Setup begins at 8:00 am. Admission is $2.50, with no additional fee for sellers. XYLs and children are free. The event is all indoors. Talk-in on 147.66/.06 or 146.52. For more information, write John Soha W3KU, 62 S. Franklin Street, Wilkes-Barre PA 18707, or phone (717)-823-3101.

CANTON OH
JUL 15

The fifth annual Hall of Fame Hamfest will be held on Sunday, July 15, 1979, at Stark County Fairgrounds, Canton, Ohio. Tickets are $2.50 in advance and $3.00 at the gate. Mobile check-in on .19/.79 or .52/.52. For information, contact Max Lebold WA8SHP, 10877 Hazelview Ave., Alliance OH 44601.

GUANAJUATO MEX
JUL 19-21

The first annual ARARM-LMRE will be held in Guanajuato, Mexico, from July 19-21, 1979. Guanajuato is located 230 miles north of Mexico City. Registration will be US $13.00. A package will be available for US $40.00 and will include 2 banquets, 1 dinner dance, sight-seeing, theater, and gifts. Drawings will be held, with a grand prize being an SSTV setup. A total of 500 prizes will be given away. The US $40.00 includes registration. Hotels are available with prices ranging from US $10.00 and up for a double room. English-speaking guides are available from the University of Guanajuato. Talk-in on 147.63/.03, 146.10/.70, and 149.22/.82. HF/SSB frequencies will also be operating, and we

Continued on page 182

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73 Magazine • Subscription Dept. Box 931 • Farmingdale NY 11737

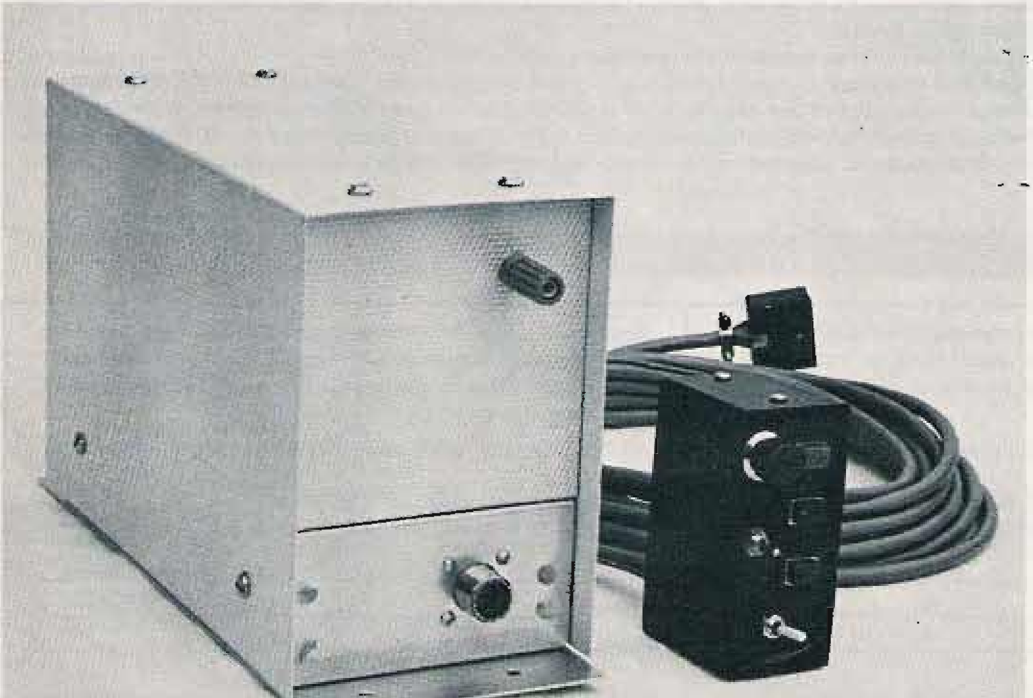
Tennamatic: An Auto-Tuning Mobile Antenna System

—works all of 40 and 75

Farewell to fading.

B. F. Brown W6TWW
1241 Arroyo Seco Dr.
Campbell CA 95008

Would you like to operate your mobile station over the entire 40 and 75 meter phone bands with a vswr not exceeding 1.15 to 1? With a Tennamatic, you can convert a high-Q narrow-bandwidth mobile antenna into a wide-bandwidth system. This means that you can use transceivers having solid-state finals and obtain full output power on any frequency in the 40 or 75 meter phone bands without any manual tuning operations. All you have to do is select frequency, start talking, and the Tennamatic will tune your mobile antenna system to resonance automatically, ensuring maximum field strength. Of course, if your transceiver has tubes in the final, you will still have to retune it when you QSY. Specifications for the Tennamatic are listed in Table 1.



The neat packaging of the Tennamatic can be duplicated easily. The control head, tuner cover, and end pieces are 0.040-inch soft aluminum cut in a paper cutter and folded in a vise using wood blocks. The chassis is described in the text.

History

About two years ago, I met Don Johnson W6AAQ, and I adopted his "big DK" mobile antenna system. He subsequently described it in his October, 1976, *73 Magazine* article entitled "Build a Weird 2 Band Mobile Antenna." His antenna neatly solved the problem of needing to change antenna loading coils when band-hopping between 40 and 75 meters. It also proved to be an exceptionally efficient radiator compared to the commercials, but it was still limited to only a few kHz of usable bandwidth on each band, and I wanted full band coverage.

To obtain full band coverage, I added a motor-driven roller inductor at the base of the antenna and a control switch at the driver's seat, allowing me to QSY the antenna resonant frequency. This worked beautifully for about six months until I ran off a freeway one day while watching a field strength meter as I was peaking the antenna. Luckily, no damage was done, but the experience convinced me that for safety's sake I had to get out of the loop. This conclusion required me to design a servo system.

Design Requirements

I decided that the tuner would be required to tune automatically over all of the 40 and 75 meter phone bands and use easily-obtainable parts. The parts count was to be minimized to keep reliability high, complications associated with limit switches were to be avoided, and the power handling capability had to be at least 350 Watts PEP. It had to be easy to duplicate, present a pleasing appearance, and the control head had to be capable of being mounted on the side of an Atlas and be visually compatible. Last of all, the servo system had to be uniquely simple, have a 3- or 4-kHz deadband so it would not hunt or jitter around in the voice pass band, provide constant motor torque while tuning, and operate reliably over a plus ten-to-fifteen-volt supply voltage range.

The System

These design requirements led to a system consisting of two units. One unit is a control head and the other is the tuning unit. The tuning unit contains a phase detector and a servo system which drives a permanent-magnet dc gear motor. The motor turns a roller inductor taken from a surplus T21/ARC-5 or T22/ARC-5 command transmitter. The tuning unit also contains a toroidal impedance-matching transformer which ensures a good impedance match between the antenna and coaxial line. The control head has directional indicators, an automatic/manual operation switch, an automatic/manual indicator, a manual slewing switch, and an impedance-match selector switch. The units are shown in the photographs.

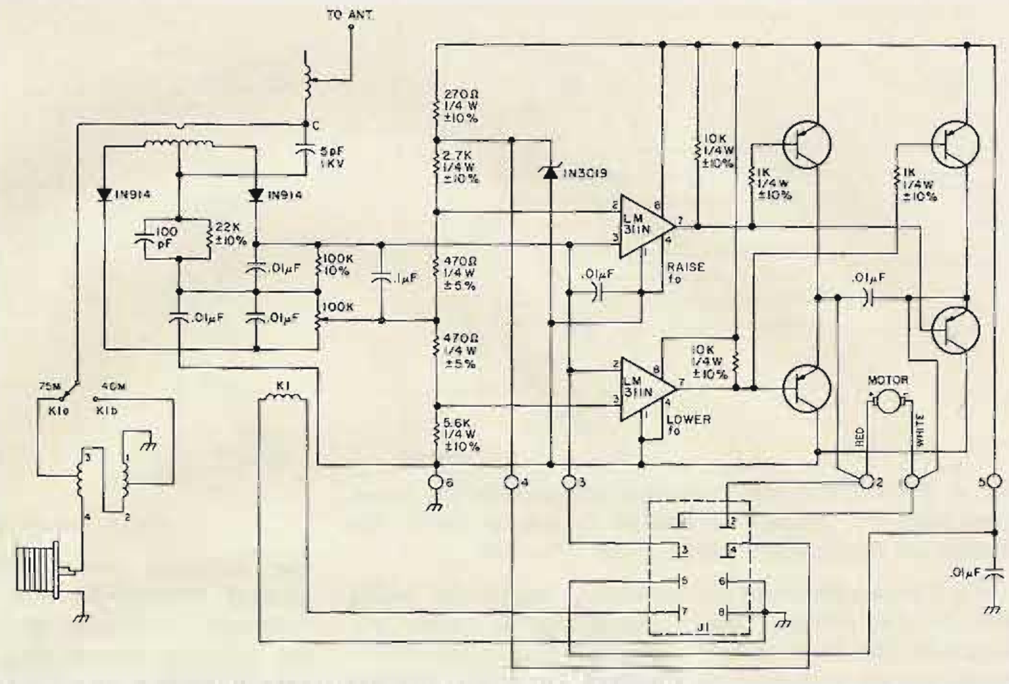
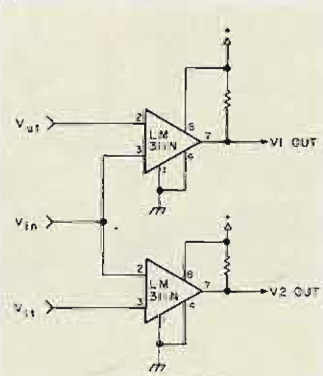


Fig. 1. Tuning unit schematic. The output transistors and motor are discussed in the text. The jack is a male chassis-type Jones plug.

The Circuit

The circuit which I designed is depicted in Fig. 1. To understand its operation, it is best to start with an explanation of the servo system and work backwards toward the input. The system that I selected is known as a "bang bang" servo system in aerospace circles. It is either off or on in one direction of rotation or the other and provides full motor torque when on. Fig. 2 is a simplified diagram of the servo. It uses two LM311N voltage comparator integrated circuits connected as a window comparator. The circuit states listed in Fig. 2 simply say that if the input voltage (V_{in}) is a positive voltage between the upper and lower threshold voltages, the outputs of both comparators will be at supply voltage. If V_{in} either exceeds the upper threshold voltage or is less positive than the lower threshold voltage, one or the other comparator's output will be low. The low-state output is about one-half volt positive.

Referring back to Fig. 1, it will be seen that the comparator outputs are connected to diagonally-opposite transistors. When a comparator switches on and its output goes low, it turns on the associated transistors, resulting in one side of the motor being clamped to ground while the other side is clamped to the positive supply, turning the motor on. The upper comparator drives the motor in the direction which reduces inductance, raising the antenna system resonant frequency. The lower comparator drives the motor in the opposite direction, increasing inductance and lowering the antenna system resonant frequency.



Circuit states

$V_{in} < V_{ut}$: V1 out is high
$V_{in} > V_{lt}$: V2 out is high
$V_{in} > V_{ut}$: V1 out is low
$V_{in} < V_{lt}$: V2 out is low

Fig. 2. Window comparator servo simplified diagram.

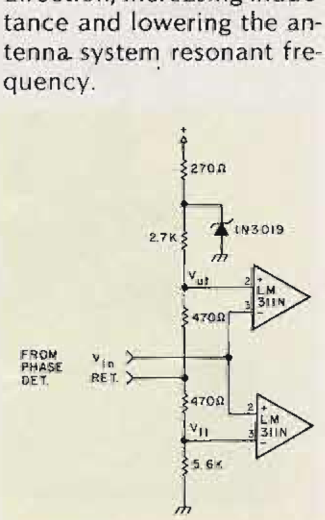


Fig. 3. Window comparator regulated-voltage divider.

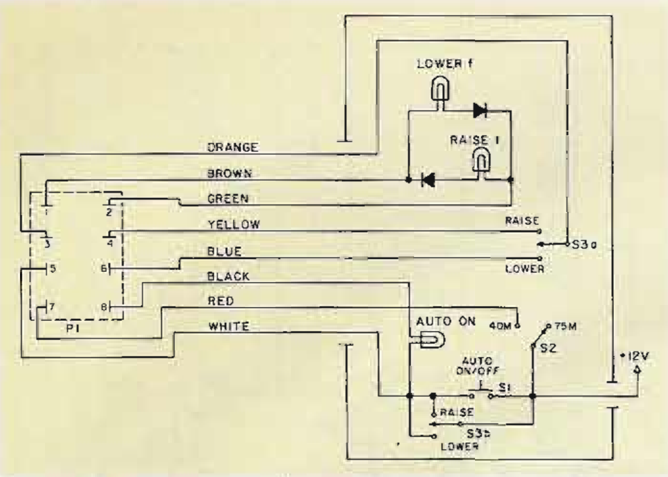


Fig. 4. The control head assembly connects to the Jones-type plug, P1, through 20 feet of TV rotator cable. The diodes are Radio Shack part number 276-1101.

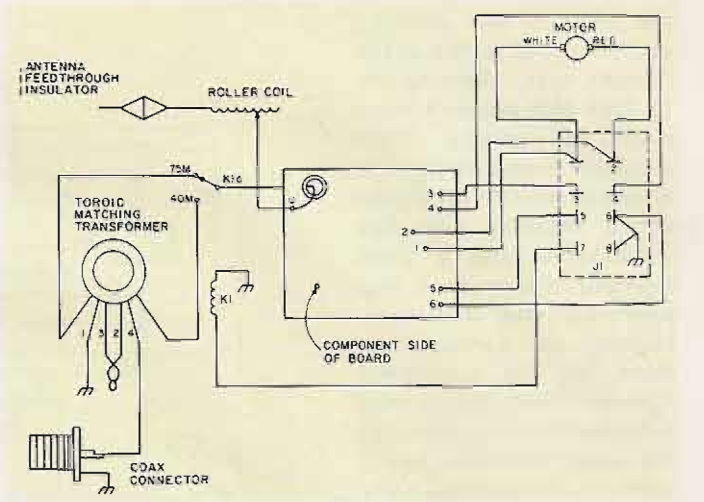


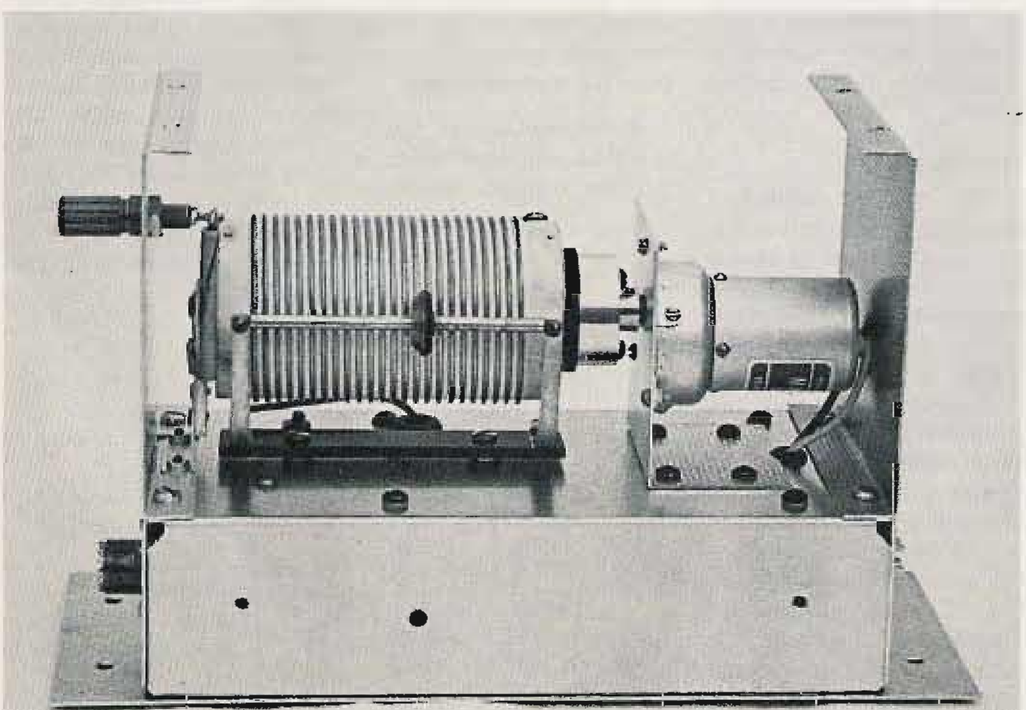
Fig. 5. Tuner unit wiring diagram.

Fig. 3 shows the input circuit to the voltage comparators. The comparators must operate with their inputs positive with respect to ground, making it necessary to reference the phase detector to a point above ground. This reference point is the junction of the two 470-Ohm resistors. The output of the phase detector is connected to V_{in} and will be a voltage which will swing positive or negative with respect to the reference point, causing the comparator inputs to swing above V_{ut} or below V_{lt}, depending upon the off frequency condition existing at the time. The voltage divider is zener regulated to hold the switching thresholds constant. The voltage drops across the two 470-Ohm resistors set the width of the deadband to 3 kHz on 75 meters and 4 kHz on 40 meters.

The phase detector compares the phase relationship between the current flowing in the antenna circuit and the voltage from the antenna circuit to ground. When the input frequency is higher than the antenna system resonant frequency, the phase detector produces a dc output voltage across the two 100k load resistors which is positive with respect to the slider on the trimpot. Conversely, if the input frequency is lower than the antenna system resonant frequency, the output dc voltage is negative.

The trimpot is adjusted in operation to cause the phase detector to find exact resonance. It compensates for the inductive reactance inserted by the toroidal antenna impedance-matching transformer. The reduced output from the low side of the phase detector caused by the trimpot results in need for incremental downward QSY on 75 meters with pauses to allow the servo system to catch up. Even so, a QSY from 4000 kHz to 3800 kHz takes less than 30 seconds.

The impedance-matching transformer is necessary with the DK antenna because of its low input impedance at resonance. The taps are set at the 10-Ohm point for 40 meters and at the 14-Ohm point for 75 meters. These low input impedance values are excellent indicators of the low-loss characteristics and high performance of the antenna. Relay K1, a Potter and Brumfield KT11D 12 V dc 5-Ampere contact relay, selects the appropriate tap and is controlled by a manual switch on the control head.



Mounting details of the roller inductor, gear motor, and shaft coupler illustrate the mechanical simplicity of the unit.

Fig. 4 depicts the schematic of the control head. All of the switches, diodes, and 12 V dc indicator lamps are from Radio Shack. Switch S1 provides for switching the tuner into the automatic or manual mode and is a push-on/push-off switch. S3 provides capability to manually slew the tuner up or down in frequency. It is a DPDT center-off-type switch. I have found that I use it rarely in operation, but it is nice to have in case you need it. It is needed during the installation adjustments. S2 operates the antenna-matching transformer tap-selector relay. No power on/off switch is provided, as power is taken directly from the transceiver. This prevents inadvertently leaving power on the tuner unless, of course, you forget to turn the transceiver off when you leave the car.

Construction

The photographs of the tuner reveal how simple the unit is to duplicate. It is built on a standard 2″ × 4″ × 8″ aluminum chassis, and the motor bracket, end panels, cover, and bottom plate are easily constructed in the home workshop. Several W6s have built the tuner and made Plexiglas™ covers so that they can see the roller coil go into operation when they QSY. The layout I selected results in minimum antenna-circuit wire length and should be duplicated as closely as possible.

Don't get innovative by trying to reduce conductors in the control cable. You can quickly get into trouble because the voltage comparators are sensitive to rf and to ground loops and will go "ape" if you unknowingly build in a ground loop as a result of a circuitry change. Also, keep some spacing between the control cable and the coaxial line, as rf pickup in the control cable can lead to erratic operation. The wiring diagram is shown in Fig. 5. The only precaution here is to note the direction of the antenna wire as it goes through the hole in the toroidal phase-sensing transformer. If it goes through from the wrong side of the printed circuit board, the tuner will drive away from resonance.

Antenna-Matching Transformer

A T-106 red toroidal core, obtained from either G.R. Whitehouse or Amidon Associates, both of which advertise in several amateur magazines, is the heart of the transformer. Fig. 6 provides all necessary details for construction. The sleeve for securing the taps is a model airplane copper gas line obtained from a hobby shop and cut to length with a hacksaw. Should you desire to use an antenna other than the big DK, you must determine the antenna input impedance in Ohms at resonance with an antenna noise bridge and then determine the correct tap position from Table 2. If you don't use the DK, you will still have to change loading coils when changing bands.

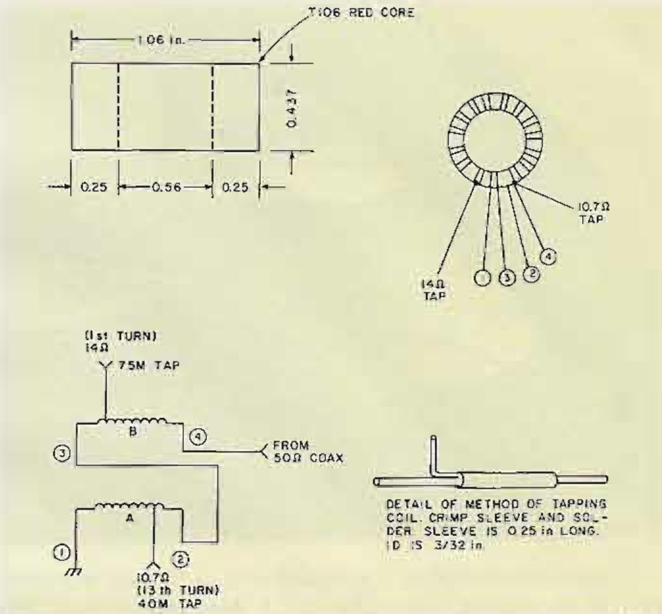


Fig. 6. Toroidal impedance-matching transformer details. Notes: Cut two wires 24″ long and wind in parallel for a bifilar winding. Each winding is to have 14 turns. Taps and wires 1 and 4 are to be 2″ long. Wires 2 and 3 are to be twisted and soldered and not to exceed ½″ long. All wire should be AWG #18 enamel. Dip it in General Cement Red Glypt and hang up to dry before use.

Phase-Detector Transformer

Construction details of this transformer are depicted in Fig. 7. When winding the transformer, be sure that the wires remain parallel to each other without any crossovers. Also, count each pass through the hole as a turn.

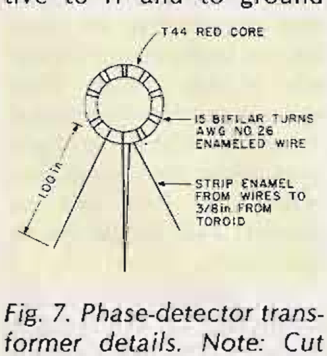
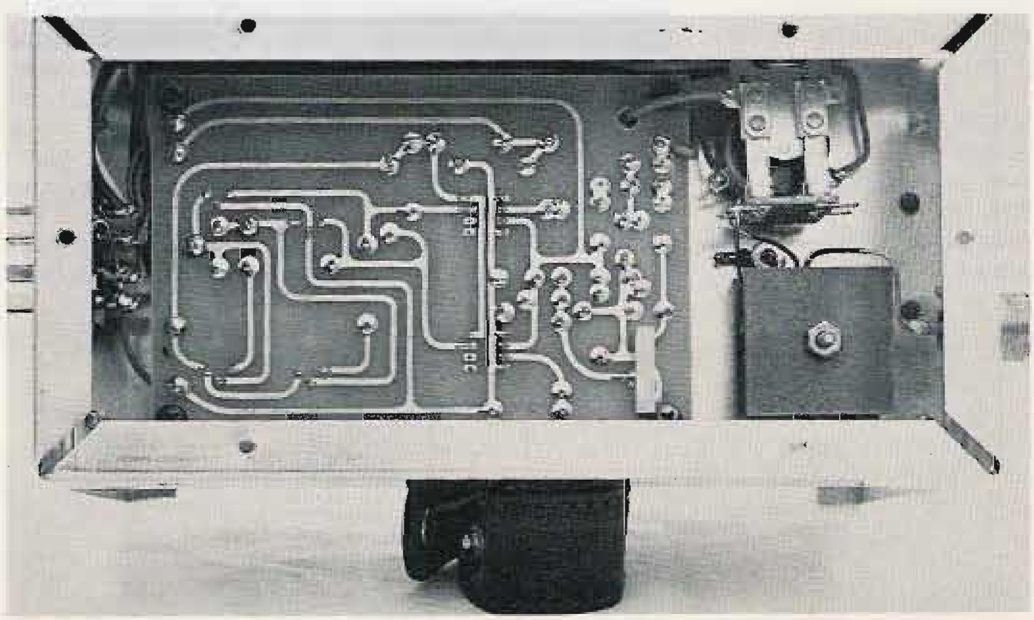


Fig. 7. Phase-detector transformer details. Note: Cut two wires 12″ long and wind in parallel for bifilar winding. Connect the opposite ends together as shown for center tap.



The under chassis view further illustrates the mechanical as well as the electrical simplicity of the unit. The toroidal antenna impedance-matching transformer is hidden by the masonite clamping pieces. The prop under the chassis is a photographic lens case.

This neat installation of the tuning unit in the left rear window of my station wagon permits a short lead-in from the ball mount outside.

Frequency range:	75m—200 kHz 40m—300 kHz
*Slewing rate:	75m—6 kHz/sec. 40m—40 kHz/sec.
Minimum Δf:	75m—requires 3 kHz QSY to activate tuner 40m—requires 4 kHz QSY to activate tuner
Maximum Δf:	75m—50 kHz (QSY of 200 kHz in four increments of 50 kHz requires less than 30 seconds.) 40m—200 kHz (QSY of 200 kHz requires less than 5 seconds.)
Vswr:	typically 1.15 to 1 or better after tuning completed
Modes:	automatic/manual
Input voltage:	10 to 15 V dc, negative ground
Input current:	420 mA at 13.8 V dc while tuning; 125 mA at 13.8 V dc after tuning completed
Power rating:	350 Watts PEP

*Table 1. Tennamatic specifications. *Full carrier inserted. On SSB, the slewing rate is slightly slower due to speech pauses.*

Remember that it is impossible to wind a half turn on a toroid. This transformer need not be dipped in General Cement Red Glypt, although you may do so if you wish.

Gear Motor

The gear motor which I used and recommend is a Magna-Torc™ permanent-magnet 24 V dc motor with a type B gear reduction unit. Operated in the Tennamatic, this motor will turn the roller inductor at approximately one revolution per second. The motor is manufactured by the Hansen Manufacturing Co., Princeton, Indiana 47670. It may also be obtained from Hartfield, Kennan, and Freytag, PO Box 328, Fremont CA 94536. The motor is expensive at about $21.50 per copy; however, it is the smallest and neatest solution to the drive-motor problem and well worth it.

Others who have built this tuner have found various surplus motors or used window crank-up motors obtained from auto wrecking yards. These high-current motors are quite bulky, do not allow neat packaging of the system, and also require the addition of relays to the output of the tuner, since the transistors can not drive them directly. These surplus motors do have the advantage of being cheap, however.

Shaft Coupler

The shaft coupler mates the gear motor drive shaft to the thumbwheel on the end of the roller inductor. It is made of aluminum turned out on a lathe and is simply bolted with three 6-32 machine screws to the thumbwheel. Fig. 8 provides the dimensional details. One of the photographs shows how it looks when the motor and roller coil are coupled together.

Printed Circuit Board

Fig. 9 depicts the printed circuit board. Be sure that you watch the polarity of the phase-detector diodes when you insert them. Also, it is a very good idea to use integrated circuit sockets instead of soldering the integrated circuits directly into the board. The four output transistors can be Poly Paks green-body PNP power-tab transistors, part number 92CU2227, or Radio Shack PNP power-tab transistors, part number 276-1641. Both types are rated at 35 Watts with suitable heat sinking. Heat sinking is not required in this application.

If you use the Poly Paks transistors, bend the tabs at right angles to the body of the transistors to ensure that they clear other components mounted on the board. Make the bend about a quarter inch from the body of the transistor. Test them carefully for leakage before you solder them because I have found that about 25% of them are too leaky to work properly in this circuit. They will cause the directional indicator lights to light even when the system is at resonance. I've had no trouble with Radio Shack transistors.

The photograph of the underside of the chassis shows the printed circuit board as installed in the tuner. The trimpot was mounted on the foil side of the board because, when three-quarter-inch stand-

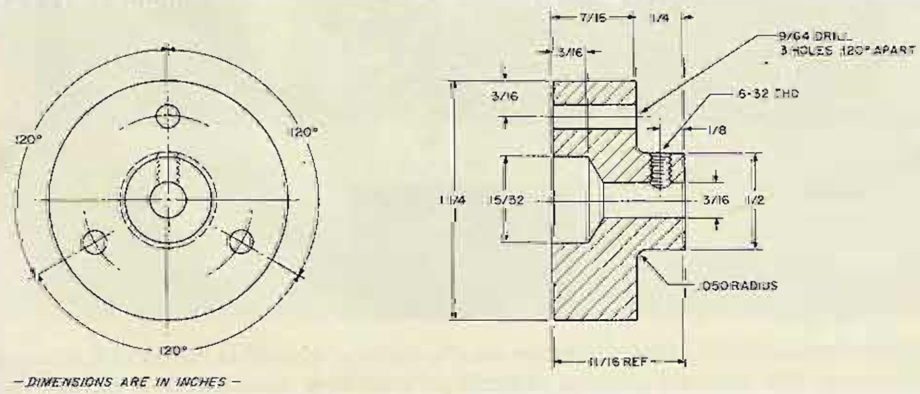


Fig. 8. Shaft coupler.

offs for supporting the board are used, the screwdriver access hole in the side of the chassis falls midway in the side.

I have a few extra printed circuit boards available at $5.00 each for those who prefer not to make their own.

Installation

Mount the tuning unit as close as possible to the base of your antenna. Connect the base of the antenna to the tuning unit with insulated AWG #12 or #14 wire. Do not under any circumstances use coax to connect the antenna to the tuner! Make sure that you ground the tuning unit to the car body by means of sheet metal screws or a short bonding strap. Use 50-Ohm coaxial cable to connect the tuning unit to your transceiver. RG-58A/U is satisfactory, and the length is not critical.

One photograph shows how I mounted the tuner in my station wagon. After mounting the control head to the transceiver (I used Velcro® fastening tape), connect the control head power lead to the transceiver so that the transceiver power switch will control application of power to your Tennamatic.

DK Antenna Adjustment

After installation of your Tennamatic, your DK antenna (or other antenna) must be retuned to be resonant on approximately 4025 and 7325 kHz. For this adjustment, the roller inductor must be slewed to minimum inductance using the manual slewing switch. Next, you must determine the antenna resonant frequency on both 75 and 40 meters using your vswr bridge or field-strength meter. Resonance will be lower than it was before the Tennamatic was installed. Don't overlook changing the impedance-matching tap when you change bands looking for resonance.

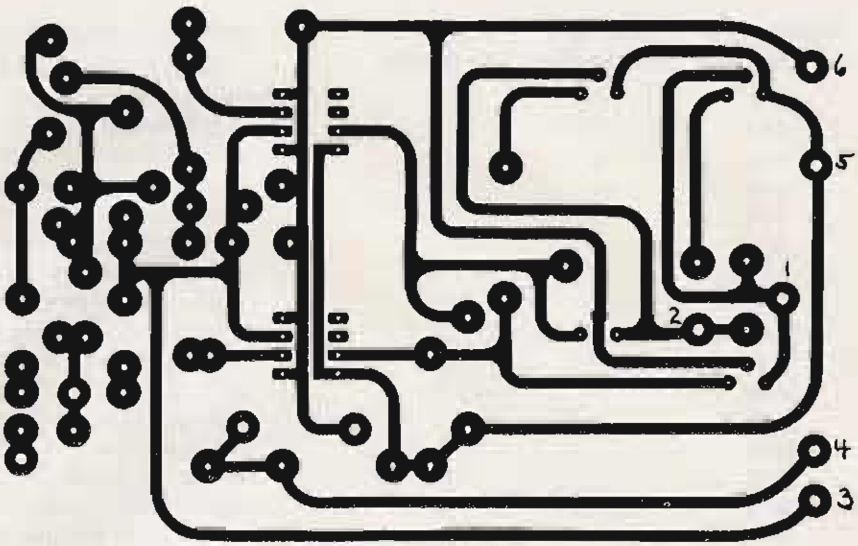


Fig. 9(a). PC board.

Now that you know where the antenna system resonances are, you can proceed to raise them by removing turns from the loading coil, shortening the whips, or by a combination of both methods. If the two resonances are as low as 3900 kHz and 7150 kHz approximately, you may find it better to remove a turn or two from the bottom of the loading coil and one or more turns from the top of the loading coil in order to minimize the amount that must be trimmed off the whips. Remove turns only one at a time. Be sure to check the resonant frequency on each band after each adjustment because they interact, and it is essential that you do not go too far. By the time resonance is approaching the upper band edge on 75 and 40 meters, you should have determined the number of kHz per inch of frequency change you get with each inch cut off. The kHz-per-inch figure will be different for each whip. After reaching 3995 kHz and 7295 kHz, cut off an additional increment from each whip determined by dividing 30 kHz by the number of kHz per inch for each band. This will complete the antenna tuning procedure.

Tuner Trimpot Adjustment

This adjustment is made to cause the tuner to tune for maximum field strength (coincident with minimum vswr). When adjusted on 40 meters, it will also be correct on 75 meters. Adjust as follows:

1. Make sure your vehicle is at least fifteen feet away from other vehicles, trees, buildings, or metallic objects.

2. Turn the trimpot fully counterclockwise, and

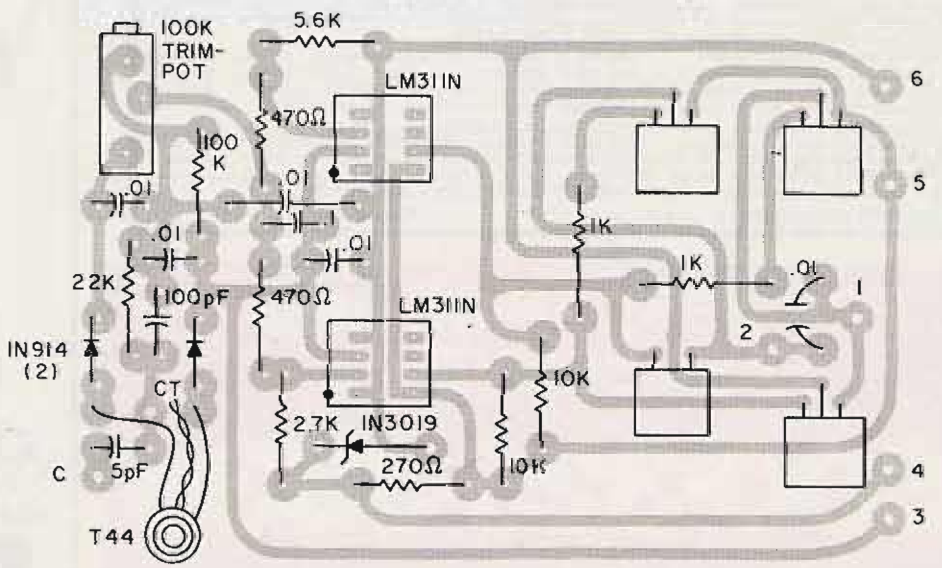


Fig. 9(b). Component locations viewed through the foil side of the board. When installing the LM311N integrated circuits, line up the dot on the IC with the dot shown on the outline of the board. The T-44 phase-sensing transformer may be glued to the board. The four output transistors are mounted against the board.

Antenna input impedance	Winding A turn number	Winding B turn number
3.13	7	
4.08	8	
5.17	9	
6.38	10	
7.72	11	
9.18	12	
10.78	13	
12.5	14	
14.34		1
16.33		2
18.43		3
20.66		4
23.02		5
25.51		6
28.13		7
30.87		8
33.74		9
36.73		10
39.86		11

Table 2. Transformer taps required for various antenna input impedances to match 50-Ohm coaxial line.

then preset it six turns clockwise.

3.Turn on your transceiver. Place it in the tune mode with carrier inserted on the 40 meter band.

4. While watching a field-strength meter or vswr indicator, tweak the trimpot until you observe maximum field strength or minimum vswr. The Tennamatic must be in the automatic mode for this adjustment. Your unit is now ready to operate.

Operating Results

With a year and a half of operating experience, the Tennamatic has demonstrated that high-Q mobile antennas are extremely sensitive to the environment around them. For example, a dense fog will lower the antenna system resonant frequency on 75 meters by as much as 25 kHz, but the Tennamatic will compensate by rolling the inductor to less inductance. I leave it in the automatic mode at all times while driving, and, as long as I am talking, it will compensate quickly for the detuning caused by passing trucks, cars, trees, freeway overpasses, bridges, and residential power line drops as you drive under them. The result is that most of the characteristic mobile fade, which I now realize is due to antenna detuning, is eliminated. The result is such a strong steady mobile signal that I frequently have to convince my contact that I am really mobile!

There is one thing that the Tennamatic cannot compensate for. That is another 75 or 40 meter mobile parked up to twenty feet away. The mutual coupling between antennas, reflected signal, and phase shifts cause it to go "ape." So, if you build one, don't proudly try to demonstrate it when parked near another mobile.

Acknowledgement

I would like to acknowledge with my thanks the numerous suggestions made by Don Johnson W6AAQ as this project proceeded through the breadboard, prototype, final design, and evaluation phases. I also wish to express my grateful appreciation for the photography provided by Jerry Fulstone WA6EJV. ■

✓ Reader Service—see page 211

KENWOOD — TECH TALK 7B79

TS-120S

ALL SOLID-STATE HF TRANSCEIVER

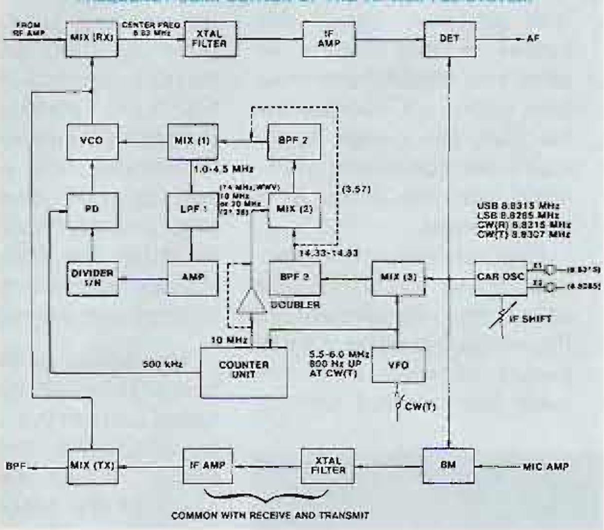
TS-120S

What's unique about the PLL circuit in the TS-120S?

A single-conversion PLL (phase-locked loop) system is employed in the TS-120S. Only one crystal is required, instead of a heterodyne crystal element for each band, resulting in simplification of circuitry, and a marked improvement in overall stability. The single-conversion PLL system also improves the spurious characteristics during transmission and reception, and makes IF shift operation and mono-dial indication available on any model.

The VCO frequency is obtained from the PLL circuit by synthesizing the VFO and CAR frequencies and reference oscillating frequencies of 10 MHz and 500 kHz supplied by the counter. Bandswitching is accomplished by changing the preset value of the programmable divider in the PLL. Therefore, when switching bands, the frequency (except, of course, the 1-MHz and 10-MHz order digits) remains the same. The frequencies for each band and PLL stage are shown in the table.

FREQUENCY COMPOSITION OF THE TS-120S PLL SYSTEM



First, MIX (3) mixes the CAR and VFO frequencies, using a double balanced mixer to reduce spurious signals. The output of MIX (3), after passing through a bandpass filter (BPF 3) is applied to the input of MIX (1) on the 3.5 and 7.0-MHz bands. On the 14-MHz and WWV bands, MIX (2) mixes the output of MIX (3) with a 10-MHz signal from the counter-unit oscillator. On the 21 and 28-MHz bands, MIX (2) mixes the output of MIX (3) with a 20-MHz signal from a doubler connected to the counter-unit oscillator.

The output of MIX (2) - or MIX (1) on the 3.5 and 7.0-MHz bands - is mixed with the VCO output at MIX (1), providing output frequencies shown in the table. The output passes through a lowpass filter (LPF 1) and is amplified, and the resulting digital signal is divided by a programmable divider, producing a 500-kHz output.

"Information" from the band switches is converted into BCD signals in the counter and the division ratio as shown in the table is preset. The loop-filter consists of transistors mounted on the outside to minimize signals. A Motorola MC4044P functions as the phase comparator. Five VCO circuits with high-output transistors cover all of the bands.

If the output of the phase comparator unlocks, VCO output is switched off to prevent emission at unwanted frequencies and, at the same time, the digital display blanks to warn the operator.

What is the concept of the TS-120S digital counter for displaying frequencies?

The TS-120S digital counter employs a VFO frequency counting system: First, the VFO frequency is mixed with a 5-MHz signal obtained from the reference oscillator chain and is converted to 0.5 to 1 MHz. This signal passes through a lowpass filter, is amplified, buffered, and shaped into a digital (square) wave, passes through a 0.1-second gate circuit, and is applied to a four-digit counter. The signal is counted from 10 Hz to 100 kHz and is fed to a preset counter to derive the carrier output.

The 100-kHz order digit presets at 5 to display the operating frequency on the 3.5, 28.5, 29.5, and WWV bands, and at 0 for ~~display on~~ 7.0, 14.0, 21.0, 28.0, and 29.0 MHz. The 1-MHz and 10-MHz order digits are determined by a matrix operating with bandswitch information.

The counter outputs are switched by the multiplexer and converted from BCD to seven-segment information by the decoder to light the fluorescent display tubes. The large digits have good luminous intensity and a dark filter, providing fatigue-free viewing over long operating periods. The display can be read easily, even in the car and other sunlit locations.

The reference oscillator produces a 10-MHz signal and performs time-base division, and generates gate pulses, latch pulses, and-reset pulses, which are applied to the counter. The PLL circuit produces 10-MHz and 500-kHz outputs. The marker circuit produces a 100-kHz signal which synchronizes the 25-kHz multivibrator to obtain a marker signal as accurate as the reference frequency.

The 1/10 division at the first stage of the count-down chain utilizes low-power Schottky TTL, and other divisions use CMOS ICs for low power consumption and minimum spurious emission. With the IF shift circuit, the CAR frequency is independent of both transmitting and receiving frequencies.

When the VFO frequency is counted, the operating frequency is indicated as accurately as the reference oscillator frequency, provided that the 10-MHz reference is calibrated to WWV.

True operating frequencies are displayed accurate to three digits (100-Hz order), regardless of CW transmitting and receiving frequencies or the position of the band switch or mode switch. When the VFO is tuned to the extent that the 1-MHz and 10-MHz orders are switched (beyond the band edge), these digits are blanked out.

FREQUENCIES FOR EACH BAND AND PLL STAGE

BAND	RANGE (MHz)	VCO (MHz)	MIX (1) INPUT (MHz)	MIX (1) OUTPUT (MHz)	DIVIDER RATIO	DCBA
WWV	14.5-15.0	23.33-23.83	24.33-24.83	1.0	1/2	1 1 1 0
3.5	3.5- 4.0	12.33-12.83	14.33-14.83	2.0	1/4	1 1 0 0
7	7.0- 7.5	15.83-16.33	14.33-14.83	1.5	1/3	1 1 0 1
14	14.0-14.5	22.83-23.33	24.33-24.83	1.5	1/3	1 1 0 1
21	21.0-21.5	29.83-30.33	34.33-34.83	4.5	1/9	0 1 1 1
28	28.0-28.5	36.83-37.33	34.33-34.83	2.5	1/5	1 0 1 1
28.5	28.5-29.0	37.33-37.83	34.33-34.83	3.0	1/6	1 0 1 0
29	29.0-29.5	37.83-38.33	34.33-34.83	3.5	1/7	1 0 0 1
29.5	29.5-30.0	38.33-38.83	34.33-34.83	4.0	1/8	1 0 0 0

William Epperhart, Jr. WB2DTY
7 Sampson Street
Oyster Bay NY 11771

Add Solid-State Braking to the T²X

— a worthwhile improvement

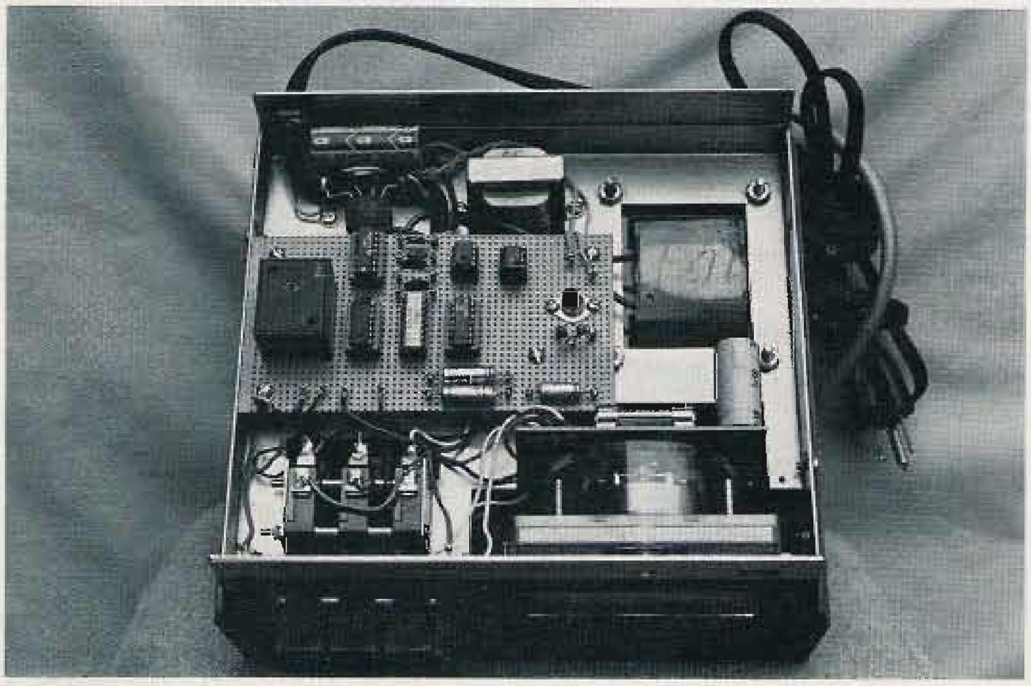
Tame your Tailtwister.

The T2X "Tailtwister" rotor by CDE is quite a piece of machinery. It's a heavy-duty rotor capable of turning an antenna system with 26 square feet of wind load, has a coast-down pre-brake action, and has a wedge brake system that keeps the rotor from slipping when not in use. As an added safety feature, power is not delivered to the directional controls until the wedge brake has been released.

In order to get the rotor to turn, you must press the brake release switch on the control unit, holding it down while pressing either the clockwise or counterclockwise direction switch. Once the antenna reaches its destination, the direction switch must be released first, followed by the brake release switch after the antenna has coasted to a stop. If you should let go of the brake release switch before releasing the direction switch, or if both switches are released simultaneously, the wedge brake will immediately engage, bringing the system to an abrupt stop, placing undue strain on the rotor, mast, antenna system, and the tower itself.

Holding onto the brake release switch until the rotor has had plenty of time to coast to a stop is much easier in theory than in actual practice. What this means is that sooner or later you could have troubles, unless you can guarantee that the wedge brake won't be constantly slamming into the gears of a moving rotor.

One solution to this problem is to electronically delay the engagement of the wedge brake for a small period of time after the rotor has stopped turning. The circuit I designed to accomplish this consists of four ICs, one optoisolator, a small power supply, and a solid state relay. All the parts, with the exception of the power transformer, filter capacitor, and bridge rectifier, are mounted on a 5¼" x 2¾" perfboard using standard wire-wrapping techniques. The entire circuit fits in the rotor control unit, and no modifications to either the rotor or the outside appearance of the control unit are required.



The power to the rotor's brake solenoid and directional circuitry is switched by a Grayhill Solid State Relay, which takes the place of the brake release switch in the original schematic—see Figs. 1(a) and 1(b). The SSR is ideal for this application for a number of reasons:

1. Its zero voltage turn-on and zero current turn-off characteristics plus its 3000-volt-per-microsecond transient protection allow it to switch a 110-V-ac inductive load at 4 Amps without the contact arcing found in a mechanical relay.
2. It will switch with 5 V dc of control voltage and draw less than 5 mA of current, making it compatible with TTL.
3. It physically separates

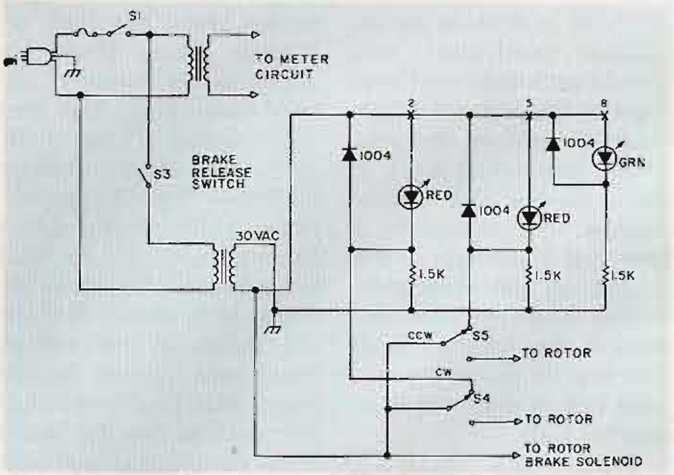


Fig. 1(a). Detail of control unit (original version). All resistors ¼ Watt. "X" denotes wiring connection to the control unit PC board.

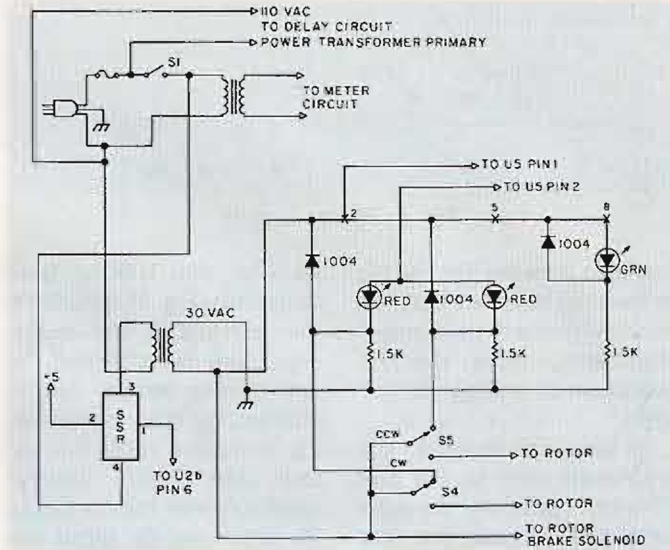


Fig. 1(b). Detail of control unit (modified version). All resistors ¼ Watt. "X" denotes wiring connection to the control unit PC board.

the digital control circuitry from the load by means of optoisolation, protecting the logic from any spikes that might be generated by the brake solenoid.

4. Its small size (1 cubic inch) enables it to be mounted directly on the perfboard, producing a very compact modification in the rotor control unit.

The rest of the circuitry on the perfboard (Fig. 2) determines the amount of time the SSR will remain energized. When the brake release switch (S_3) on the front panel is closed, the reset (pin 4) on the NE555 timer goes low, as does pin 6 on the 7409, turning on the SSR, releasing the wedge brake, and applying power to the rotor's directional controls. When the switch is released, the 74121 (which is triggered on the negative-going edge of its input pulse) applies a one-shot to the NE555, which in turn goes high at its output. This keeps pin 6 of the 7409 low, allowing the SSR to remain energized for approximately five more seconds. The five-second delay is determined by the RC combination of the 3.3-megohm resistor and the 1-uF capacitor on the NE555 and can be lengthened or shortened by increasing or decreasing the values of these components.

The input to the digitial circuitry is physically separated from the rotor's direction control voltage by an optoisolator (U_5) whose diode is wired in series with the LED directional indicators on the control unit—see Fig. 1(b). By the way, the optoisolator drops the total current in each directional LED by only 1 mA and therefore does not affect the original brightness of the indicators. If either one of the rotor's directional controls is pressed while the wedge brake is released, current will flow through the diode of the optoisolator. This causes the output of the optoisolator to go low (Fig. 2), resetting the NE555 and keeping the SSR energized. Releasing the directional switch triggers the 74121 which pulses the NE555 and holds the SSR on for another five seconds. As a result, it is no longer necessary to hold down the brake release switch once the circuit has been energized. The wedge brake will not engage unless all three front panel switches have remained open for five seconds. Closing any one of the switches during the five-second delay resets the timer and repeats the cycle upon release of the switch.

In building this circuit, I used a 1k resistor network in place of mounting separate pull-up resistors, but there is room to mount the ¼-Watt resistors separately on the perfboard if you don't have a network handy. It should be noted also that I have connected the primary of the digital logic power supply transformer—Fig. 1(b)—before the rotor control unit "Off/On Switch" (S_1) so that power is supplied to the ICs continuously. Although you might prefer to make the connection after the switch, this will tend to energize the brake solenoid as soon as power is applied to the box. Powering the ICs constantly (the digital logic draws considerably less than 100 mA) not only prevents this,

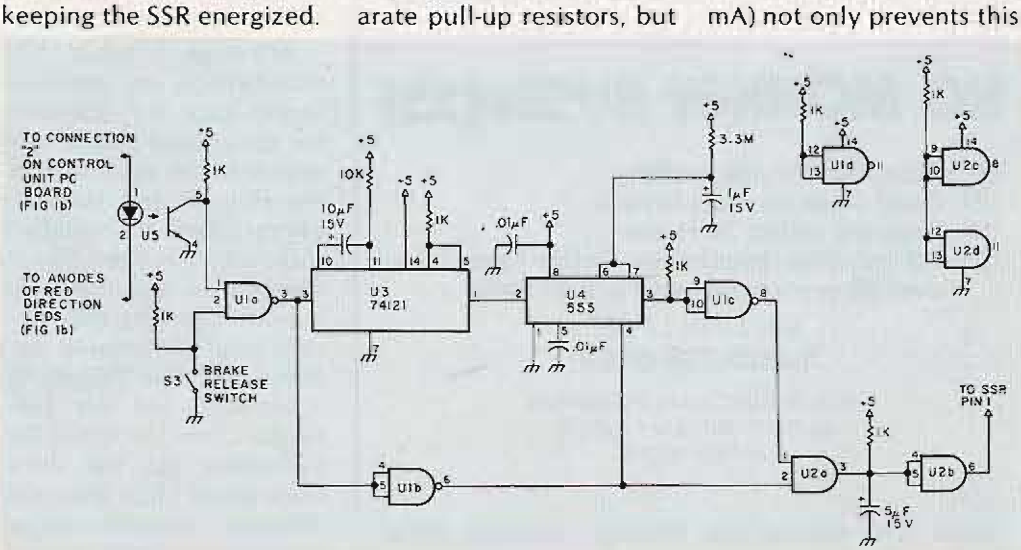


Fig. 2. Delay circuit. All resistors ¼ Watt. All capacitors measured in uF.

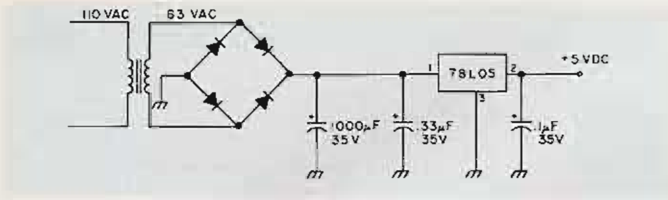


Fig. 3. Power supply.

but also is better for the ICs in the long run since they are not subjected to surges that accompany the application of voltage to the unit.

When connecting the wire-wrap wire to the SSR "control" pins, use the wire-wrap tool to make the connection, but make sure you solder the wire to the pins. Normally, solder is not necessary with the wire-wrapping technique, but the pins on the relay are round as opposed to the square wire-wrap pins, so solder should be used to ensure a solid connection.

Since all of the circuitry, with the exception of the power transformer, bridge rectifier, and 1000-uF filter capacitor (Fig. 3), is built on the perfboard, the digital logic can be checked for any wiring errors before connecting it to, or mounting it in, the rotor control unit. The 78L05 voltage regulator will handle up to 35 volts on its input (although it runs much cooler with the 6.3-volt supply used in this project) so you can temporarily power the perfboard with the output of a standard 12-V-dc supply. Attach a logic probe or voltmeter to pin 6 of the 7409 (since the 7409 has an open collector output, pin 6 must be connected to pin 1 of the SSR and pin 2 on the SSR must be connected to +5 V dc in order to get the proper readings). You should get a high-level logic state on the probe or a little under 5 volts on the voltmeter. Grounding pin 1 or pin 2 on the 7400 should change the reading to a low-level logic state (under 1 volt on the voltmeter). When you remove the ground, the reading should stay low for about 5½ seconds before returning to its original state.

If the circuit checks out correctly, disconnect the leads on the brake release switch (S3) and solder them to the "load" pins on the SSR. Now you can mount the board on the bottom side of the control unit's chassis and hook up the power supply as shown in the schematics in Figs. 1(b) and 3. Connect a lead from one contact on the brake release switch to pin 2 of the 7400 and a lead from the other contact to ground. Unsolder the leads from connection points 2 and 5 on the control unit's printed circuit board (the board is numbered) and connect them both to pin 2 (the cathode) on the optoisolator (U5). Connect a lead from pin 1 on the optoisolator (U5) to connection point 2 on the printed-circuit board. Connection point 5 is not used. This completes the modification of the rotor control unit.

Although I made this modification on the Tailtwister rotor, the schematic for the control unit is very similar to the schematic of the Ham II and Ham III rotors. I have not modified these rotors, but this circuit should work with them and is worth checking into. The only real difference between the Ham II/Ham III schematics and the Tailtwister schematic is that the Tailtwister has the three front panel LEDs (two red ones for direction indication and one green one for an indication that the wedge brake has been released). These could be added quite simply if desired—see Figs. 1(a) and 1(b)—using three 1.5k ¼-Watt resistors and three HEP1004 (1N34A-type) diodes. Although the direction indicators are not really necessary, the brake release LED does indicate the status of the wedge brake and I would recommend that you install it if you plan to use the brake delay circuit. It should be a simple matter to mount the extra components on the perfboard.

In all, the addition of an electronic brake delay circuit makes a good rotor better and may save you from the headache of rotor troubles at a later date. ■

Parts List

ICs

1 SN7400 (U_1)
1 SN7409 (U_2)
1 SN74121 (U_3)
1 NE555 (U_4)
1 IL 1 or equiv. optoisolator (U_5)
1 uA78L05 5-volt voltage regulator

Resistors

7 1k, ¼-Watt, 10%
1 10k, ¼-Watt, 10%
1 3.3 megohm, ¼-Watt, 10%

Capacitors

1 1000 uF, 35 volts
1 10 uF, 15 volts
1 5 uF, 15 volts
1 1 uF, 15 volts
1 .33 uF, 35 volts
1 .1 uF, 35 volts
2 .01-uF disc ceramic

Miscellaneous

1 Power transformer, 6.3 V at 300 mA (Radio Shack 273-1384)
1 Bridge rectifier (Radio Shack 276-1151 or equiv.)
1 SSR Grayhill Inc., 561 Hillgrove Ave. La Grange IL 60525, Part no. 70S2-04-B-04-F ($21.00)

Sockets

2 8-pin wire-wrap sockets
3 14-pin wire-wrap sockets
1 Transistor socket for voltage regulator (Radio Shack 276-548)

Reader Service—see page 211

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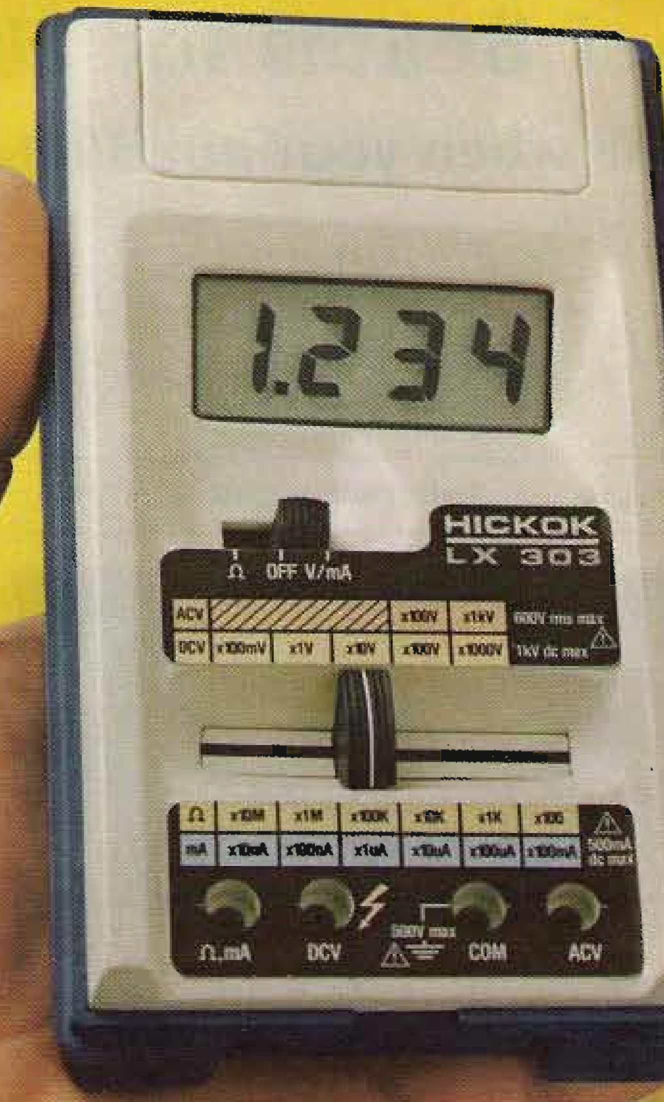

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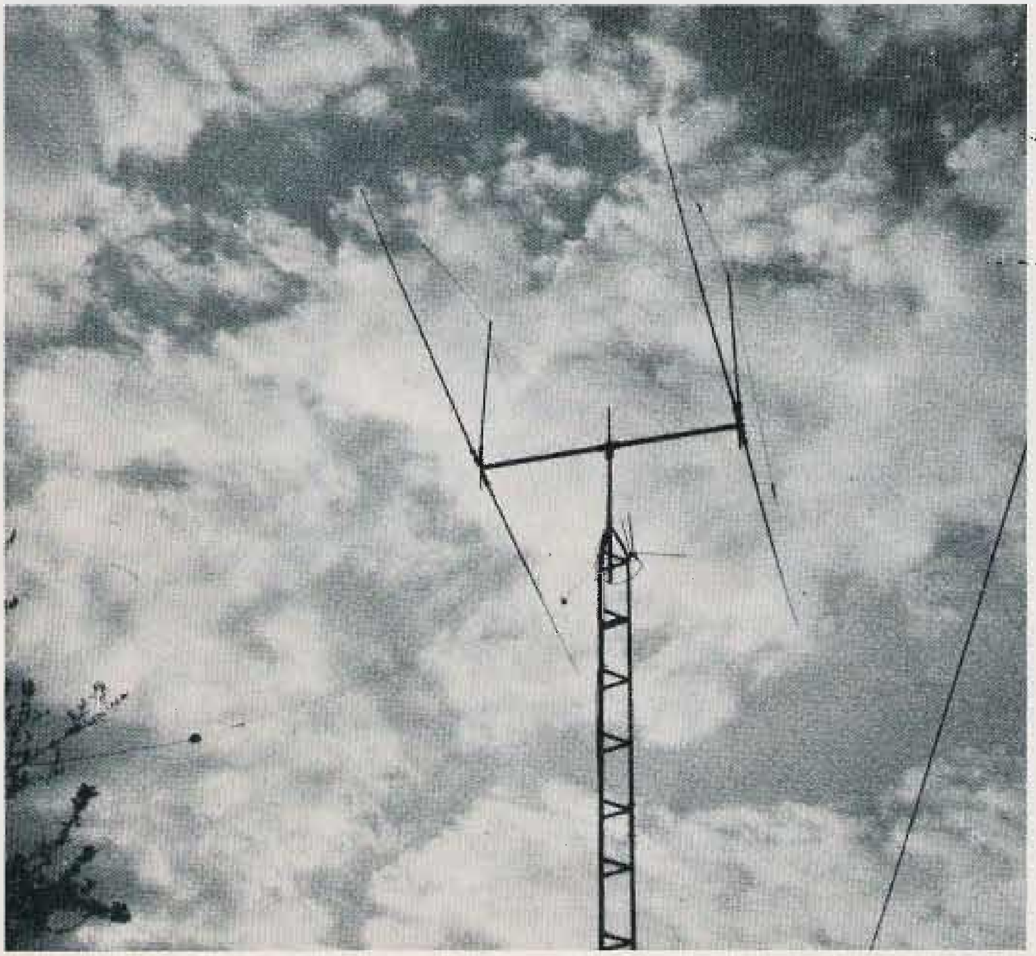

Jerrold A. Swank W8HXR
657 Willabar Drive
Washington Court House
OH 43160

My tower is just 11 feet from my neighbor's property line. The further I stay away from his television antenna, the better, lest I cause him TVI. I, therefore, have long wanted a 20 meter beam that, while a monobander, would not have a spread so long as to go outside my yard.

I do not like the regular 20 meter quad, as it is too big and floppy and somewhat unsightly, besides being easily damaged by the wind. I did not want to buy a triband beam, since I cannot operate 15 or 10 meters. I have only a three-band rig.

At one time, I had a 15 meter quad up for a couple of years, and it worked fine, but since I cannot now work 15, I wanted to make a 20 meter beam out of my quad.

Everyone told me that this plan would not work, including one nationally-known antenna expert on quads. They said that bending back the ends of the elements would make it act like a transmission line.

I could have used loading coils, but most of all I did not want to have to buy an expensive beam. I had my quad put away and also had some parts of quad arms from another quad which I had once cut from 20 to 15 in my DX days. It was heavier, but a fellow ham had cut it down to 6½ feet to make a CB quad. Three of the arms had been broken when it fell while being taken down after he became a ham.

I decided to telescope one arm into a larger arm, and found that this would give me 11 feet per arm. I put epoxy on the smaller arms, or spreaders, and put them together. I was thus able to make four good arms and still have two usable short spreaders 6¼ feet long, by inserting aluminum tubing in one of the best broken arms. The 15 meter spreaders were still a full 8 feet long.

The reason I am telling you all of this is to make you think about ways of getting material for your beam. It would be possible to use bamboo or even wooden arms. If the arms are not hollow, you could tape the wire to the wooden arms. I actually tried this at first with the arms I am using, and then decided to see if the proximity of the aluminum spider would change the tuning of the beam elements. I found that it made no difference, so I removed the taped wires and fed the wires through the center of the fiberglass tubing.

I might mention a few booby traps I found as I went along. The first was that the stored tubing had been stopped up by insects and egg sacs. I used a 5/8 λ two meter mobile whip with the ball removed to poke out some of the debris. I then put my mouth to the small end, holding fingers over the hole which had been cut for wire in the old quad, and blew.

This worked with one arm, but not with two others. I tried poking wire through, but the wire was not stiff enough. I finally banged the large end on the concrete floor of my patio, and finally 8 cocoons fell out. I know now that I should have cleaned out the 15 meter quad arms before putting the two arms together. It would have been easier to handle them.

I then tried to push some #14 stranded wire through, but it kept catching on the end of the smaller inside arm. I took some #18 tinned wire and poked it through from the small end of the tubing, and it didn't buckle as it did when trying to force it the other way. I ran it through, twisted the end to the #14 Belden 8000, and pulled it back through.

I put a length of nylon tubing over the wire to keep it from being shorted to the bolts which held the clamps on the fiberglass arms.

I had cut the wire by formula to 16½ feet for the 14,200 MHz. I thus had 5½ feet left after reaching the end of the 11-foot arm. This I had to bend back. I put one of the short arms into the spider after placing the other 11-foot arm in the clamps. This I used in the upper arm of the spider. The lower arm of the spider was not used.

I could have left the upper arm unused and put the 6½-foot arm in the downward position. This I

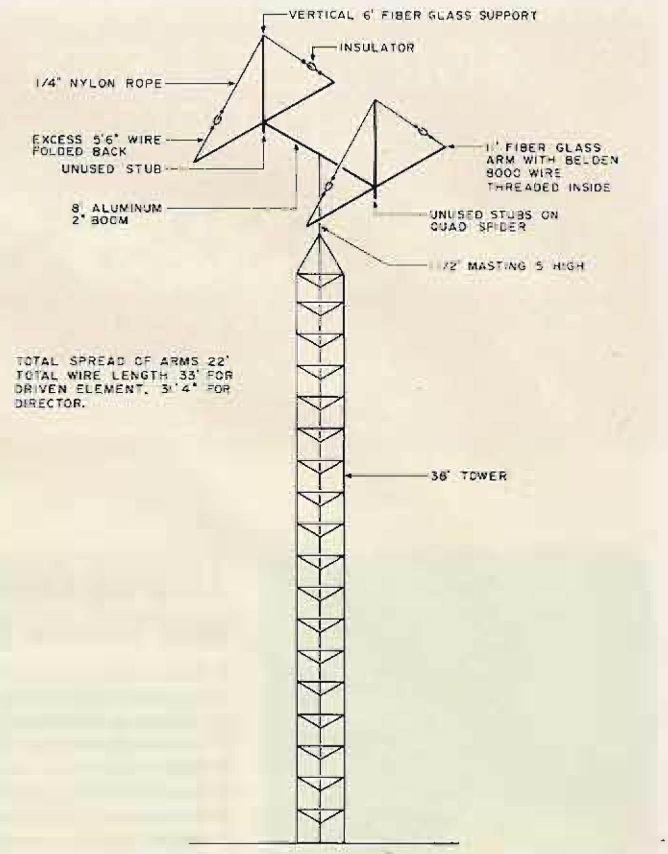

Fig. 1. Small light 20 meter beam.

decided against for two reasons. It would have brought the 5½ feet of excess wire back toward the metal tower, and by using the upward position, it furnished a support for the ends of the 11-foot arms. They did not sag, but I felt that they would be subject to more wind vibration if turned down.

I pounded a 3-foot length of 1½-inch pipe into the ground and placed the 8-foot boom with the attached spiders and center T-fixture in the pipe. This gave me a position for attaching the arms and stringing the ¼-inch nylon rope supports. The patio was too short, and the egg crate roof was so low that I could never have gotten the completed beam out. Even in the yard I was short of space, but I managed, even with shrubs and trees.

I drilled a ¼-inch hole in the tops of the vertical arms and threaded ¼-inch nylon rope through. I pulled enough through to reach the ends of the wire, and then tied a knot each side of the vertical arms to keep the rope from slipping. I used a 6-inch length of 7/8-inch PVC pipe with holes drilled in the ends for insulators. I probably did not need the insulators with about 7 feet of nylon rope and a fiberglass support, but habit made me use them. I would probably not use them again, so I suggest you don't bother.

I fastened a Kirk balun to the lower quad spider arm, and it made a fine installation. However, after spending several hours trying to figure out why the swr was about 10:1, I opened up the balun and found that one of the wires, after 20 years of use, had finally broken. I just put it up without a balun. I think a balun might have helped in some ways, but it seems to work well, anyway. I had used a hose clamp to attach the balun to the arm, and it was a neat job. If you use a balun, try this.

I used 31 feet, 4 inches for the director, which is 95%

Reader Service—see page 211

of the 33-foot length of the driven element. I used a director instead of a reflector because it requires less boom length for the same gain and needed less extra wire pulled back toward the support. There was about 4 feet, 8 inches to pull back on each end.

I checked the swr on the ground, and it was 2½:1 from about 14.200 MHz to 14.350 MHz, except that it dropped to 2:1 in the area of 14.250 MHz. I figured that this would improve when it was up in the air, and it did. At the height of 43 feet, it dropped to 1.5:1 at 14.250 MHz and 2:1 at 14.350 and 14.200 MHz.

I have no rotator yet, so I wanted to face the beam SW. It needed to be attached to a mast to raise it about 5 feet above the 38-foot tower. I had 8 feet of 1½-inch heavy wall aluminum tubing, and I inserted a similar length of 1¼-inch steel tubing inside to make a stiff mast. I drilled a hole and inserted a metal screw to hold the tubing together.

I had planned that we drill the mast for the T-fixture when it was up in the air, but my friend, Bill Burns WA8IEJ, who was going to raise it for me, wanted to drill it on the ground. I think he regretted it when he carried it to the tower. I had told him the beam weight was about 12 pounds, I thought. I had easily carried it on the ground.

While he was carrying it up in one arm and climbing with the other, he stopped to rest a couple of times, and he said it was more like 25 pounds with the attached masting. I recommend that you wait until it is on the tower and drill it before lifting the mast up to the desired height. I let it stick out 5 feet above the tower, which gives me enough inside the tower to attach a rotator.

I later wished I had done one more thing. I should have slipped the wire through a short piece of Teflon™ or nylon tubing as it comes out of the end of the fiberglass arm. This would help prevent the chafing of the wire by the sharp edge of the tubing and might keep the wire from breaking. It probably will last at least a couple of years, though. There is not much pull on the wire, since I did not draw it up very tight, so perhaps it will last longer.

It makes a lot neater arrangement than a 20 meter quad, and up in the air it looks nice.

I used a quarter wavelength of RG-59/U as a matching section from the driven element to the RG-8/U coax lead-in. I guessed that the beam impedance would be about 20 Ohms, and this would raise it to 40 Ohms. This would give an swr of 1.25:1, so the 1.5:1 final measurement was not far off.

When I got a chance to test it, I first called CQ and a California station came back and said that I had a "really strong signal" in his location. Next, I went in a pileup and got a reply, after only two calls, from P29JS in Papua, New Guinea. He said I was 5 x 9. It was a new country for me. The band was going out, so I went to bed.

The next night I tried to talk to a friend, Dale WD8VTD in Jamestown, Ohio, about 19 miles away, but he was off the side of my beam and we were really weak. While I was listening for him, Hans SM6CVX called me and wanted to know my Ohio county. When I told him Fayette, he wanted a QSL card. He gave me 5 x 7 and he was 5 x 8 here. I guess that my front-to-back is probably about 12-15 dB, so it seems I can work Europe off the back OK.

I usually work 40 meters from about 0600 to 0900 GMT, so I don't get on 20 until late. Thus I work mostly Pacific stations.

Last night I called Harry VK3XI and he came back on the first call. He said the band was going out and my beam must be pretty good, as he would not otherwise have been able to work me. He was 5 x 7 here.

I am running just about 800 Watts PEP, so I am very pleased with the results. I think I could have done well with just a 15 meter quad alone and a 1½-inch boom, but I used what I had. My 15 meter quad boom was only 1½ inches x 5 feet long, so I wanted a longer boom. There is no reason why you can't make your own beam from scratch with bamboo or even 1 x 2 wood and a plywood spider. The fact that there is a support for the arms, and the shortened length, bring up many possibilities for a light, cheap beam or even a dipole.

The director is not connected to the boom. The boom is 8 feet long and 2 inches in diameter—a very husky beam.

After seeing my 20 meter compact beam, Kenny Long WB8NGX wanted a 15 meter like it, and I had four arms left, so I decided to build one for him. I used lightweight spiders and a boom from a Kirk 15 meter quad, and of course, I didn't need such a long wire. I only used about 22 feet of wire for a 15 meter beam, so I decided to thread the wire just to the ends of the arms and bend them back an inch, both to hold them taut and to allow for corona prevention. I then had only about 1 foot, 5 inches left in the center.

I pulled this out along another short fiberglass arm, about 18 inches long. See Fig. 5. Then I fastened the wire to the binding posts on a short fiberglass strip. I bolted this to the arm and then added another strip for a spreader. This kept the wire from touching the metal of the spider arm. This was for the driven element.

For the director, I had only about 5 inches left on each side. I used a short piece of PVC tubing bolted to the arm to hold this piece. This wire was not broken, nor was it grounded to the boom. The boom is 6 feet long.

The beam is a very light, neat, and rugged affair. I guessed that it weighed about 7 pounds. I carried it over to Kenny Long's house on the top of a car, not even tied down. We held it down by hand, sticking our arms out the windows. ■

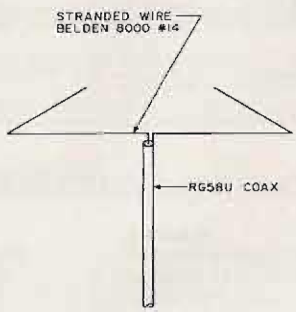

Fig. 2. Schematic of one element.

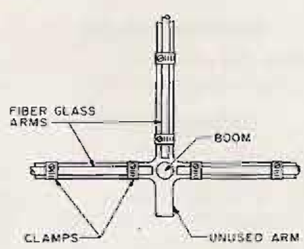

Fig. 3. Closeup of spider.

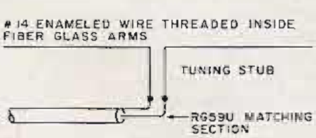

Fig. 4. Schematic of 15 meter driven element.

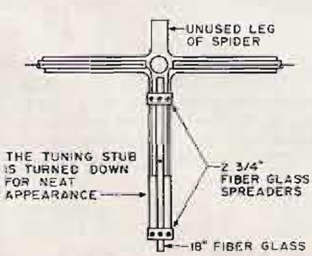

Fig. 5. Closeup of spider.

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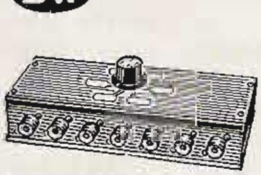

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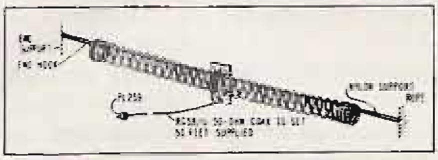

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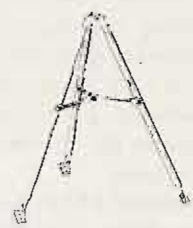

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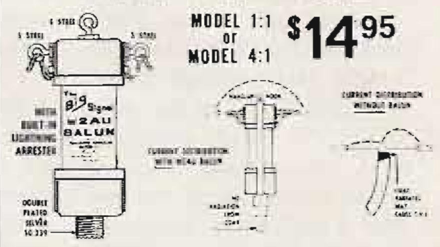

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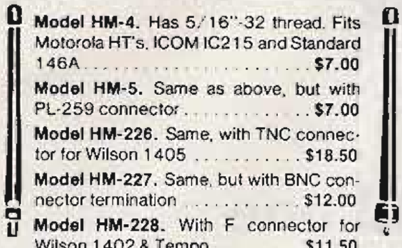

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Art Pightling WA6OYS
240 Louisiana Place
Oxnard CA 93030

There are two things which I look for in a vertical antenna: simplicity (no traps or hats) and availability of parts. A quarter-wave vertical for forty meters fits both of these criteria, but it is often overlooked when antenna construction is contemplated.

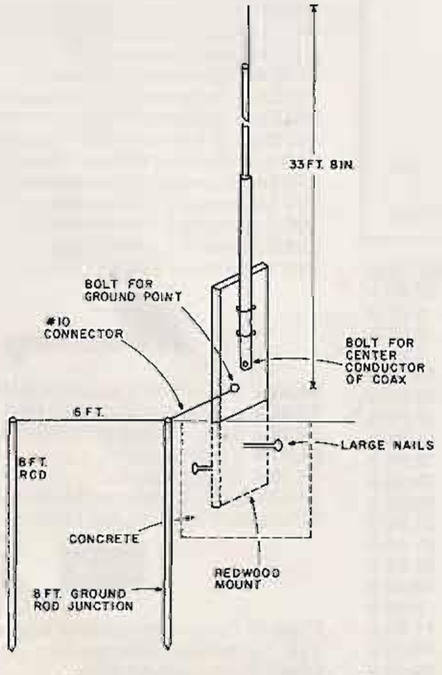

Fig. 1. Forty meter vertical.

There are also two schools of antenna construction: the oak (make it so rigid and strong that it just cannot be destroyed by wind, earthquakes, snow, ice, or whatever) and the willow (able to bend, flex, and take all of the above and spring back). Since the "oak" method never did work for me, this antenna is of the "willow" configuration. It is made of lengths of concentric tubing and ends in a whip.

To determine how much tubing we will need, we have to figure out how long a quarter wave is at forty meters. Using $\lambda/4(\text{feet}) = 246/f$ (MHz) and then converting the fraction of a foot which remains to inches, we get $\lambda/4 = 33'10''$ for a center frequency of 7.265 MHz. Any center frequency can be chosen by placing that frequency in place of f in the formula.

Construction

Now let's get down to business. The aluminum tubing is available locally in most areas in concentric sizes from 2" to 3/8". I had a 3'×1-1/2"-o.d. piece of tubing on hand, so this was the logical place to start. Now, all we need is 30'10" more. Five 8' sections of tubing were used: 1-1/4", 1", 3/4", 1/2", and 3/8" o.d. After slotting the ends with a hacksaw and clamping the ends with hose clamps, I had 30' of tubing in 6' sections with approximately 2' of each inside the lower tube. An 18" whip was clamped to the top, and the already-on-hand 3'× 1-1/2" tube was attached to

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the bottom. Now we have either a very long trout rod or a slightly-oversize quarter-wave antenna for forty meters.

Ground is an important part of a quarter-wave antenna, so ground mounting was chosen. A piece of redwood 3′×4″×1/2″ was found and painted to match my fence. Holes were drilled in appropriate place for U-bolts to hold the vertical to the redwood, and a test fitting showed that the antenna could be securely fastened to the redwood. A couple of large nails were driven into the bottom part of the redwood mount to give the concrete more to grab on to. A 24″-deep hole was dug in an inconspicuous corner of my yard and filled with a 60-pound bag of concrete. The prepared hunk of redwood was then placed in the wet concrete and propped up so that it would be straight when the concrete set. A bolt was put into the bottom of the antenna so that the center conductor of the coax feed could be connected. Another bolt was placed in the redwood mount to serve as a junction point for the ground system. (This bolt must be insulated from the radiating element.)

The Ground System

Some of us have a good ground (swamp or salt marsh) and others don't (rock or sand). My worst-case ground was 120 #18 wire radials, each a little more than a quarter-wavelength long, splayed out sunburst-style around the base of the antenna. The ground system which I wound up with was three radials, six feet long, terminating at 8′ ground rods. These three radials were joined at the antenna base on another 8′ ground rod. I used #10 wire to interconnect the ground rods and the *short* run to the bolt which was previously placed for ground connection on the redwood mount. To be sure, there was a difference in vswr obtainable, but the simpler ground system was satisfactory for my area.

Adjustment

Connect one foot or less of 52-Ohm coax to the antenna, connecting the center conductor to the vertical radiator and the ground braid to the ground connection on the redwood. Connect the vswr meter and the transmitter. Take a reading at the low end of the band, one at the middle, and one at the top. This should be enough to give you an idea of whether to shorten or lengthen the element. If you have built the antenna as described, you will probably have to shorten it a bit. This is best at the top sections. Do your fine tweaking with the whip. You have to take the antenna down each time you want to adjust it, so, by all means, take notes to help you make as few adjustments as possible. When this was done, an swr of 1.2 to 1 was obtained at 7.265 MHz and the swr did not go above 1.6 to 1 in the forty meter band. This was quite acceptable to me. The swr on the top end of fifteen meters was around 2 to 1—not bad for a bonus band.

This antenna has performed well at this QTH and was used when I was net control for the infamous swap net. Using only an FT-101 "barefoot," I was quite well heard in all of southern California, Arizona, and northern California as well. The antenna is also good for DX on forty and fifteen meters because of its low angle of radiation. ■

✓ Reader Service—see page 211

Karl Schulte WA2KBZ
3711 N. Firestone Dr.
Hoffman Estates IL 60195

Marine-Band Activity

— a complete guide

Tune in to the world's top traffic.

Between 160 meters and 10 meters, we amateurs generally think in terms of the six HF amateur bands. There are, however, a great many other services operating in those large gaps between our bands. Most hams are aware of some of those other users, such as shortwave broadcasters (Voice of America and Radio Moscow are two examples), if for no other reason than the QRM they cause on the 40 meter phone band at night!

A partial list of the HF band population would include such services as land mobile (U.S. Corps of Engineers, on 5,015 kHz, for example), special industrial, on 4,637.5 kHz (mineral exploration), forestry (in the Pacific Northwest, primarily), and, of course, the military of all nations.

But there is one other major service, one of the oldest, known as the maritime service; that is the subject of this article.

Why is the maritime (or marine) service worth listening to? Because it usually provides the most interesting listening of the communications services (which excludes the broadcast service) and it is the busiest (and therefore easiest to tune in). Also, since it was the first regular user of radio, ship radio has an aura of romance and adventure.

SOS and Mayday — cries for help across the sea — are still heard today, although (thankfully) less frequently than in the past. The famous ship disasters of the last seven decades electrified the public and brought a fleeting fame to the "sparks," as ship operators were known.

Before the SOS was accepted, the most common call for help was CQD, which was made famous in 1909 by Jack Binns, radio officer of the British ship *Republic*. His heroism saved most of the passengers of his doomed ship, which had been rammed by the *S.S. Florida* one day out of New York. Working by candlelight in the January cold, he remained at his key for a continuous 36-hour shift. He delayed his escape from the sinking ship until he knew that help was at hand, risking his life to save the lives of many others.

From the first radio call for help from the British *Goodwin Sands* lightship in March, 1899, through the famous *Titanic* tragedy and the *Morro Castle*, whose smoldering hulk became a tourist attraction when it beached near Asbury Park, New Jersey, boardwalk in the mid 1930s, to the *Andrea Dorea* and the oil tanker sinkings of today's TV news, the tradition of the radio operator's staying at the key until the last possible minute (sometimes losing his life as a result) has remained constant.

I remember following the terrible events of the Texas tower which sank off New Jersey in the early 1960s, from the first Mayday signal to the last announcement that the tower had disappeared with all hands in the horrified sight of the rescue ship. There was a violent gale and there was no way of effecting a rescue. The frequencies used were 2,182 kHz and 500 kHz for phone and CW, both easily heard on an old Navy receiver. That was my introduction to marine radio.

Of course, these tragic

Frequency	Emission		Service
500.0 kHz	A1, A2	(CW)	marine/air
2,182.0	A3, A3A, A3H, A3J	(voice)	marine/air
4,134.3 (ship T) 4,428.7 (ship R)	A3J	(voice)	marine (U.S.C.G.)
6,200.0 (ship T) 6,506.4 (ship R)	A3J	(voice)	marine (U.S.C.G.)
8,241.5 (ship T) 8,765.4 (ship R)	A3J	(voice)	marine (U.S.C.G.)
156.8 MHz	F3	(voice)	VHF marine (ch. 16)
121.5 MHz	A3, A2	(voice/tone)	air/marine*
243.0 MHz	A3, A2	(voice/tone)	air/marine*

*Table 1. Emergency frequencies. *E.P.I.R.B. uses these frequencies — an automatic floating SOS beacon.*

Voice signal	Morse equivalent	Meaning
Mayday	$\overline{\text{SOS}}$ (3 times) (sent as one letter, not S O S)	*Distress*—when there is immediate danger to life or property. Has priority over all other signals. Preceded by "auto-alarm" when time permits.
Pan	$\overline{\text{XXX}}$ (3 times)	*Urgency*—when safety of life or vessel is threatened or if a less immediate danger exists (sickness, out of fuel in open water and no immediate danger, "man overboard," etc.).
Securité	TTT (3 times) (sent 3 letters not as an "O")	*Safety*—when a danger to navigation (hulk in channel, buoy missing, severe weather) exists.
(Voice) Auto-alarm (two alternating audio tones, 1 min. max.)	Auto-alarm (4 sec. on, one sec. off, dashes, one min.)	Sent before Mayday or $\overline{\text{SOS}}$ when time permits, to attract listeners.

Table 2. Priority signals for voice and Morse.

Channel	Frequency*	Channel	Frequency*
4A	4136.3 kHz	22A	22,094.5 kHz
4B	4139.5 kHz	22B	22,098.0 kHz
4C	4434.9 kHz	22C	22,101.5 kHz
6A	6210.4 kHz	22D	22,105.0 kHz
6B	6213.5 kHz	22E	22,108.5 kHz
6C	6518.6 kHz		
			2-MHz frequencies
8A	8281.2 kHz		2,182 kHz
8B	8284.4 kHz		2,638 kHz
12A	12,421.0 kHz		2,670 kHz (U.S.C.G.)
12B	12,424.5 kHz		2,738 kHz
12C	12,428.0 kHz		
16A	16,565.0 kHz		
16B	16,568.6 kHz		
16C	16,572.0 kHz		

*Table 3. HF ship-ship (plus limited coast) simplex channels. *Carrier frequencies are listed; listen on USB. The above 2-MHz frequencies are not, strictly speaking, in the same category, but are often used for similar purposes.*

events are luckily less common today, due to the availability of search planes and fast boats and the fine job done by the Coast Guard. Yet there are about two or three Mayday calls on 2,182 kHz in a week in the Gulf of Mexico alone. Most are promptly solved by the U.S. Coast Guard or nearby ships with no loss of life.

The bulk of traffic is more mundane by comparison, but still very interesting. Some typical SSB traffic, heard on almost any day, would include oil well drilling operational information, fishing fleet chatter, river tugboats, tankers and freighters talking to their home ports or arranging for supplies at their next port, and international radio telephone (phone patch) conversations. I often receive Germany and English marine operators at my Chicago home. If you wish to copy CW, telegrams, ship supply orders, news, weather, and ship arrival times can be heard if one knows where to listen.

Now that I have (hopefully) aroused your interest and curiosity, you are probably wondering where to listen, so here is a fairly complete guide to the marine bands. The information is as accurate and up to date as possible, being derived from a combination of sources, one of which is the rule book of the International Telecommunications Union — a source of many FCC regulations. To this is added my own experience in working with marine radio as HF-SSB consultant for a large Chicago-based company and as an SWL.

The maritime service is divided into several operational categories, four major frequency bands, and two

City	Primary coast transmit	Primary coast receive	Secondary coast transmit	Secondary coast receive
Boston	2506 kHz	2406 kHz	2450 kHz	2366 kHz
New York	2590 kHz	2198 kHz	2522 kHz	2126 kHz
Miami	2514 kHz	2118 kHz	2490 kHz	2031.5 kHz
New Orleans	2598 kHz	2206 kHz	2482 kHz	2382 kHz
Galveston	2530 kHz	2134 kHz	2450 kHz	2366 kHz
San Francisco	2506 kHz	2406 kHz	2450 kHz	2003 kHz
San Pedro (L.A.)	2566 kHz	2009 kHz	2466 kHz	2382 kHz
Seattle	2522 kHz	2126 kHz	2482 kHz	2430 kHz
Hawaii	2530 kHz	2134 kHz	—	—
Great Lakes	2514 kHz	2118 kHz	2550 kHz	2158 kHz
Mississippi (simplex)	2782 kHz	2782 kHz		

Table 4. 2-MHz marine operators.

Station	Code U.S. channels	Ship transmit frequency	Ship receive frequency
KMI—Oakland	401	4063.0	4357.4
	416	4109.5	4403.9
	417	4112.6	4407.0
	804	8204.3	8728.2
	809	8219.8	8743.7
	822	8260.1	8784.0
	1201	12330.0	13100.8
	1202	12333.1	13103.9
	1602	16463.1	17236.0
	2214	22040.3	22636.3
WLO—Mobile	WLO-4	4118.8	4413.2
	WLO-8	8284.9	8808.8
	WLO-13	12407.5	13178.3
	WLO-17	16584.0	17356.9
WOM—Ft. Lauderdale	403	4069.2	4363.6
	412	4097.1	4391.5
	417	4112.6	4407.0
	423	4131.2	4425.6
	802	8198.1	8722.0
	805	8207.4	8731.3
	810	8222.9	8746.8
	825	8269.4	8793.3
	831	8288.0	8811.9
	1206	12345.5	13116.3
	1208	12351.7	13122.5
	1209	12354.8	13125.6
	1215	12373.4	13144.2
	1223	12398.2	13169.0
	1601	16460.0	17232.9
	1609	16484.8	17257.7
	1610	16487.9	17260.8
	1611	16491.0	17263.9
	2215	22043.4	22639.4
	2216	22046.5	22642.5
	2222	22065.1	22661.1
WOO—New York	410	4090.9	4385.3
	416	4109.5	4403.9
	422	4128.1	4422.5
	811	8226.0	8749.9
	826	8272.5	8796.4
	1203	12336.2	13107.0
	1210	12357.9	13128.7
	1605	16472.4	17245.3
	1626	16537.5	17310.4

European channels	Channel #	U.S. Co-user
GCN—Portishead, England	410	(see WOO)
	826	(see WOO)
	1202	(see KMI)
	1611	(see WOM)
PCH—Shevenigen, Holland	802	(see WOM)
	1215	(see WOM)
	1626	(see WOO)
ROME RADIO—Rome, Italy	826	(WOO)
	1209	(WOM)
	1603	(KMI)
		(also Cyprus)
SVA—Athinai, Greece	802	(WOM)
	1232	(none)
	1609	(WOM)
	WLO-17	(WLO)
Atlantic channels		
VRT—Bermuda	410	(WOO)
Caribbean channels		
PLC—Curacao, Antilles	408	(WUQ)
	1607	(WLO-17)
8PO—Barbados	4098.0 (?)	4396.6 (?)
(in process of change)	8210.8	8744.8
Pacific channels		
KQM—Honolulu, Hawaii	418	(none)
	808	(WOO)
	1222	(none)
	1601	(WOM)
KUQ—Pago Pago, Samoa	806	(none)
	1232	(none)
UIS—Sydney, Australia	419	(WLO)
(or other Australian station)	802	(WOM)
	1203	(KMI)
	1610	(WOM)
VQJ—Honiara, Solomon Islands (in change)	8204.4 (?)	8738.4 (?)
ZLW—Wellington, New Zealand	408	(KUQ)
	813	(none)
	1209	(WOM)
P29—Papua, N.G.	805	(WOM)
9VG—Singapore	4078.8	4377.4
	824	(WLO-8)
	1641	(WLO-17)
Tokyo (JMC-?)	810	(WOM)
	1605	(WOO)

Table 5. Selected high seas marine radiotelephone stations (frequencies are shared).

fundamental station types — fixed (coast) and mobile (ship) stations.

Of primary interest to the amateur or SWL are the frequencies, of course, but a summary of the other information will prove useful, enabling the listener to find the type of station he would like to hear.

The basic operational division is that of radiotelegraph (CW) and radiotelephone (phone) operations. These two divisions are interspersed in alternating subbands throughout the 2-26 MHz portion of the spectrum, plus the VLF bands below 500 kHz (exclusively CW except for some weather broadcasts and foreign broadcasting) and the VHF-FM main band which is exclusively phone. RTTY and special data are used a great deal, but are difficult for most SWLs to decode.

An important fact to keep in mind, with regard to ship and shore stations, is that most of their frequency assignments are duplex (actually half-duplex, or two-frequency simplex, at the ship station), with the two stations transmitting and receiving on different frequencies. This is true of many marine channels, from VLF to VHF. An example, WOO 8-26 (WOO is "Ocean Gate Radio" in New York), is given below under "Reading the Tables." The reason for this duplex operation is that the shore stations usually

Station location	Station callsigns	Typical frequency***
Azores	CUG	6,393.5 kHz
Cuba	CLQ	6,435.0 kHz
Dominican Republic	HIA	8,642.0 kHz
England* (Portishead)	GKI**	12,858.0 kHz
Halifax	CFH	12,726, 8,697 kHz
Greece	SVA	12,689, 12,858 kHz
Italy	IAR	8,670.0 kHz
Japan	JOS	8,706.0 kHz
Philippines	DZR	8,568.0 kHz
U.S.A.—East	WSL, WSC**	6-, 8-, 12-MHz bands
U.S.A.—West	KFS**, WNU	6-, 8-, 12-MHz bands, 4,310 kHz
Honolulu—CG	NMO	9,050, 13,655 kHz

*Table 6. Selected CW shore stations. *Sister station of GCN (phone). **Also listen 420-500 kHz. ***Operate many frequencies. See Table 8 for band limits.*

Channel Designator	Ship Rx	Ship Tx
401	4357.4	4063.0
402	4360.5	4066.1
403	4363.6	4069.2
404	4366.7	4072.3
405	4369.8	4075.4
406	4372.9	4078.5
407	4376.0	4081.6
408	4379.1	4084.7
409	4382.2	4087.8
410	4385.3	4090.9
411	4388.4	4094.0
412	4391.5	4097.1
413	4394.6	4100.2
414	4397.7	4103.3
415	4400.8	4106.4
416	4403.9	4109.5
417	4407.0	4112.6
418	4410.1	4115.7
419	4413.2	4118.8
420	4416.3	4121.9
421	4419.4 (4C) Ship simplex	4125.0 (4A)
422	4422.5	4128.1
423	4425.6	4131.2
424	4428.7	4134.3
425	4431.8	4137.4
426	4434.9	4140.5
427	Ship simplex	4143.6 (4B)
601	6506.4	6200.0
602	6509.5	6203.1
603	6512.6	6206.2
604	6515.7	6209.3
605	6518.8	6212.4
606	6521.9 (6C)	6215.5
607	Ship simplex	6218.6 (6A)
608	Ship simplex	6221.6 (6B)
801	8718.9	8195.0
802	8722.0	8198.1
803	8725.1	8201.2
804	8728.2	8204.3
805	8731.3	8207.4
806	8734.4	8210.5
807	8737.5	8213.6
808	8740.6	8216.7
809	8743.7	8219.8
810	8746.8	8222.9
811	8749.9	8226.0
812	8753.0	8229.1
813	8756.1	8232.2
814	8759.2	8235.3
815	8762.3	8238.4
816	8765.4	8241.5
817	8768.5	8244.6
818	8771.6	8247.7
819	8774.7	8250.8
820	8777.8	8253.9
821	8780.9	8257.0
822	8784.0	8260.1
823	8787.1	8263.2
824	8790.2	8266.3
825	8793.3	8269.4
826	8796.4	8272.5
827	8799.5	8275.6
828	8802.6	8278.7
829	8805.7	8281.8
830	8808.8	8284.9
831	8811.9	8288.0
832	Ship simplex	8291.1 (8A)
833	Ship simplex	8294.2 (8B)
1201	13100.8	12330.0
1202	13103.9	12333.1
1203	13107.0	12336.2
1204	13110.1	12339.3
1205	13113.2	12342.4
1206	13116.3	12345.5
1207	13119.4	12348.6
1208	13122.5	12351.7
1209	13125.6	12354.8
1210	13128.7	12357.9
1211	13131.8	12361.0
1212	13134.9	12364.1
1213	13138.0	12367.2
1215	13144.2	12373.4
1216	13147.3	12376.5
1217	13150.4	12379.6
1218	13153.5	12382.7
1219	13156.6	12385.8
1220	13159.7	12388.9
1221	13162.8	12392.0
1222	13165.9	12395.1
1223	13169.0	12398.2
1224	13172.1	12401.3
1225	13175.2	12404.4
1226	13178.3	12407.5
1227	13181.4	12410.6
1228	13184.5	12413.7
1229	13187.6	12416.8
1230	13190.7	12419.9
1231	13193.8	12423.0
1232	13196.9	12426.1
1233	Ship simplex	12429.2 (12A)
1234	Ship simplex	12432.3 (12B)
1235	Ship simplex	12435.4 (12C)
1601	17232.9	16460.0
1602	17236.0	16463.1
1603	17239.1	16466.2
1604	17242.2	16469.3
1605	17245.3	16472.4
1606	17248.4	16475.5
1607	17251.5	16478.6
1608	17254.6	16481.7
1609	17257.7	16484.8
1610	17260.8	16487.9
1611	17263.9	16491.0
1612	17267.0	16494.1
1613	17270.1	16497.2
1614	17273.2	16500.3
1615	17276.3	16503.4
1616	17279.4	16506.5
1617	17282.5	16509.6
1618	17285.6	16512.7
1619	17288.7	16515.8
1620	17291.8	16518.9
1621	17294.9	16522.0
1622	17298.0	16525.1
1623	17301.1	16528.2
1624	17304.2	16531.3
1625	17307.3	16534.4
1626	17310.4	16537.5
1627	17313.5	16540.6
1628	17316.6	16543.7
1629	17319.7	16546.8
1630	17322.8	16549.9
1631	17325.9	16553.0
1632	17329.0	16556.1
1633	17332.1	16559.2
1634	17335.2	16562.3
1635	17338.3	16565.4
1636	17341.4	16568.5
1637	17344.5	16571.6
1638	17347.6	16574.7
1639	17350.7	16577.8
1640	17353.8	16580.9
1641	17356.9	16584.0
1642	Ship simplex	16587.1 (16A)
1643	Ship simplex	16590.2 (16B)
1644	Ship simplex	16593.3 (16C)
2201	22596.0	22000.0
2202	22599.1	22003.1
2203	22602.2	22006.2
2204	22605.3	22009.3
2205	22608.4	22012.4
2206	22611.5	22015.5
2207	22614.6	22018.6
2208	22617.7	22021.7
2209	22620.8	22024.8
2210	22623.9	22027.9
2211	22627.0	22031.0
2212	22630.1	22034.1
2213	22633.2	22037.2
2214	22636.3	22040.3
2215	22639.4	22043.4
2216	22642.5	22046.5
2217	22645.6	22049.6
2218	22648.7	22052.7
2219	22651.8	22055.8
2220	22654.9	22058.9
2221	22658.0	22062.0
2222	22661.1	22065.1
2223	22664.2	22068.2
2224	22667.3	22071.3
2225	22670.4	22074.4
2226	22673.5	22077.5
2227	22676.6	22080.6
2228	22679.7	22083.7
2229	22682.8	22086.8
2230	22685.9	22089.9
2231	22689.0	22093.0
2232	22692.1	22096.1
2233	22695.2	22099.2
2234	22698.3	22102.3
2235	22701.4	22105.4
2236	22704.5	22108.5
2237	22707.6	22111.6
2238	22710.7	22114.7
2239	22713.8	22117.8
2240	22716.9	22120.9
2241	Ship simplex	22124.0 (22A)
2242	Ship simplex	22127.1 (22B)
2243	Ship simplex	22130.2 (22C)
2244	Ship simplex	22133.3 (22D)
2245	Ship simplex	22136.4 (22E)

Table 7. ITU channels for marine HF use.

have separate receive and transmit sites to reduce interaction between on-the-air transmitters and receivers monitoring other channels, thus providing for a more efficient system. It also helps to compensate for the often inefficient ship, yacht, or boat antenna.

There are also a number of simplex channels, such as 2,182 kHz for calling and Mayday use, and 4,125 kHz for ship-to-ship or limited coast station usage.

These frequencies are spread throughout the range of 2-27 MHz, but the most useful for the average listener are between 4 and 17 MHz, providing high activity both day and night and allowing both sides of the conversation to be heard with one receiver, even far inland. Table 3 lists these simplex channels by number and frequency, while Table 4 lists the most interesting duplex channels by band, station, and frequency.

Morse operation is found on the frequencies listed in Tables 6 and 8.

Although not the main purpose of this article, in the interest of completeness I have included several tables listing all the marine bands from VLF to VHF. One last

Limits (kHz)	Assignable working frequencies for high-traffic ships b)	Limits	Calling frequencies d)	Limits (kHz)
4,172.25	4,172.5 -- 4,177.5 11 frequencies spaced 0.5	4,178	4,178.5--- 4,186.5 17 frequencies spaced 0.5	4,187
6,258.25	6,258.75-- 6,266.25 11 frequencies spaced 0.75	6,267	6,267.75- -6,279.75 17 frequencies spaced 0.75	6,280.5
8,341.75	8,342-- 8,345 -- 8,355 14 frequencies spaced 1	8,356	8,357--c)-- 8, 373 17 frequencies spaced 1	8,374
12,503.25	12,504--12,513--12,517.5 --12,532.5 20 frequencies spaced 1.5	12,534	12,535.5 ---12,559.5 17 frequencies spaced 1.5	12,561
16,660.5	16,662--16,672--16,684--16,690 --16,710 25 frequencies spaced 2	16,712	16, 714 ---16,746 17 frequencies spaced 2	16,748
22,184.5	22,187--------------------------22,221 18 frequencies spaced 2	22,222.5	22,225 ---22,265 17 frequencies spaced 2.5	22,267.5

Assignable working frequencies for low-traffic ships Group A	Group B	Limits
4,187.5 -- 4,208 84 frequencies spaced 0.5	4,208.5 -- 4,229	4,231
6,281.25-- 6,312 84 frequencies spaced 0.75	6,312.75-- 6,343.5	6,345.5
8,375 -- 8,416 84 frequencies spaced 1	8,417 -- 8,458	8,459.5
12,562.5 --12,624 84 frequencies spaced 1.5	12,625.5 --12,687	12,689
16,750 --16,832 84 frequencies spaced 2	16,834 --16,916	16,917.5
22,270 --22,320 41 frequencies spaced 2.5	22,322.5 --22,370	22,374

Limit	Calling frequencies	Limit
25,070	25,073.5 --------------- 25,081 6 frequencies spaced 1.5	25,082.5

Limit	Working frequencies	Limit
25,082.5	25,084 ---------------- 25,106.5 16 frequencies spaced 1.5	25,110

(RTTY and data)

Ship stations, wide-band telegraphy, facsimile, transmission systems:

4,142.5 - 4,162.5 kHz
6,216.5 - 6,244.5 kHz
8,288 - 8,328 kHz
12,431.5 - 12,479.5 kHz
16,576 - 16,636.5 kHz
22,112 - 22,160.5 kHz

Ship stations, oceanographic data transmission:

4,162.5 - 4,166 kHz
6,244.5 - 6,248 kHz
8,328 - 8,331.5 kHz
12,479.5 - 12,483 kHz
16,636.5 - 16,640 kHz
22,160.5 - 22,164 kHz

Ship stations, narrow-band direct-printing telegraph data transmission systems:

4,166 - 4,172.25 kHz
6,248 - 6,258.25 kHz
8,331.5 - 8,341.75 kHz
12,483 - 12,503.25 kHz
16,640 - 16,660.5 kHz
22,164 - 22,184.5 kHz

Coast stations, wide-band and manual telegraphy, facsimile, special and data transmission systems and direct-printing telegraph system:

4,231 - 4,361 kHz
6,345.5 - 6,514 kHz
8,459.5 - 8,728.5 kHz*
12,689 - 13,107.5 kHz
16,917.5 - 17,255 kHz
22,374 - 22,624.5 kHz
*plus 8078.1—U.S. Navy, Va.

Table 8. Frequencies assignable to ship radiotelegraph stations using the maritime mobile service bands between 4 and 27.5 MHz.

note on the calls you will hear is that the callsigns follow the same general assignments as amateur calls and a three-letter call is that of a shore station, while a four-letter or letter/number combination is usually that of a ship. Finally, in order to help you read the tables, the following section explains the channel designation numbering system and summarizes what information can be found in the various tables.

Reading The Tables

Many of the frequencies listed have channel designations after the frequency. These refer to the band and number of channels on a particular band. Therefore, a channel labeled "410" tells us that it is a 4-MHz channel, and refers to a particular frequency. Stating the channel as WOM 410, however, tells us that this is a 4-MHz channel of the Fort Lauderdale, Florida, high seas station and is registered as being 4090.9 kHz (ship transmit)/4385.3 kHz (ship receive). These are always half-duplex frequencies.

Channel designators		International Ship stations	Coast stations
c)	60	156.025	160.625
01		156.050	160.650
	61	156.075	160.675
02		156.100	160.700
	62	156.125	160.725
03		156.150	160.750
	63	156.175	160.775
04		156.200	160.800
	64	156.225	160.825
05		156.250	160.850
	65	156.275	160.875
06 e)		156.300	
	66	156.325	160.925
07		156.350	160.950
	67	156.375	156.375
08		156.400	
	68	156.425	156.425
09		156.450	156.450
	69	156.475	156.475
10		156.500	156.500
	70	156.525	
11		156.550	156.550
	71	156.575	156.575
12		156.600	156.600
	72	156.625	
13		156.650	156.650
	73	156.675	156.675
14		156.700	156.700
	74	156.725	156.725
15 d)		156.750	156.750
16		156.800	156.800
17 d)		156.850	156.850
	77	156.875	
18		156.900	161.500
	78	156.925	161.525
19		156.950	161.550
	79	156.975	161.575
20		157.000	161.600
	80	157.025	161.625
21		157.050	161.650
	81	157.075	161.675
22		157.100	161.700
	82	157.125	161.725
23		157.150	161.750
	83	157.175	161.775
24		157.200	161.800
	84	157.225	161.825
25		157.250	161.850
	85	157.275	161.875
26		157.300	161.900
	86	157.325	161.925
27		157.350	161.950
	87	157.375	161.975
28		157.400	162.000
c)	88	157.425	162.025

U.S. channels

Channel	Frequency (MHz) Ship	Coast	Function Intership	Ship-to-shore
Distress, safety and calling (worldwide)				
16	156.800	156.800	YES	YES
Intership safety (worldwide)				
6	156.300	156.300	YES	NO
Liaison U.S. Coast Guard				
22	157.100	157.100	YES	YES
Navigational (worldwide)				
13	156.650	156.650	YES	YES
State control				
17	156.850	156.850	NO	YES
Commercial				
7	156.350	156.350	YES	YES
8	156.400	NONE	YES	NO
9	156.450	156.450	YES	YES
10	156.500	156.500	YES	YES
11	156.550	156.550	YES	YES
18	156.900	156.900	YES	YES
19	156.950	156.950	YES	YES
67	156.375	NONE	YES	NO
77	156.875	NONE	YES	NO
79	156.975	156.975	YES	YES
80	157.025	157.025	YES	YES
88	157.425	NONE	YES	NO
Noncommercial				
9	156.450	156.450	YES	YES
68	156.425	156.425	YES	YES
69	156.475	156.475	NO	YES
70	156.525	NONE	YES	NO
71	156.575	156.575	NO	YES
72	156.625	NONE	YES	NO
78	156.925	156.925		YES
Public correspondence (note: 4.6 MHz T/R)				
24	157.200	161.800	NO	YES
25	157.250	161.850	NO	YES
26	157.300	161.900	NO	YES
27	157.350	161.950	NO	YES
28	157.400	162.000	NO	YES
84	157.225	161.825	NO	YES
85	157.275	161.875	NO	YES
86	157.325	161.925	NO	YES
87	157.375	161.975	NO	YES
Port operations				
12	156.600	156.600	YES	YES
14	156.700	156.700	YES	YES
20	157.000	161.600	YES	YES
65	156.275	156.275	YES	YES
66	156.325	156.325	YES	YES
73	156.675	156.675	YES	YES
74	156.725	156.725	YES	YES

Weather

Channel	Frequency	Usage
WX1	162.550	NOAA primary weather channel
WX2	162.400	NOAA secondary weather channel
WX3	161.650	Canadian weather channel (ITU channel 21)

Table 9. VHF.

Band (kHz)	Comments
14-160	VLF, Morse, shared with radio navigation and direction finding
255-285	VLF, Morse, shared with radio navigation and direction finding
410 ±5	Reserved for direction finding
415-525	MF-low, Morse—most common ship frequency band in early days—still used for medium range today
500	"SOS" and calling
1605-2850	Morse and voice—primarily old "ship-to-shore" band in "AM" days; mostly being replaced for short range by VHF
3155-3400	Voice, Morse—less common in U.S.
3400-3800	In some parts of world, shared with amateur service
4060-4440	CW, Morse, RTTY—propagation like 75m
6200-6524	Mostly CW with a few ship-to-ship and duplex SSB channels. Propagation like 40m
8194-8815	Voice, CW, many high seas overseas stations at night—propagation like 40m
12330-13200	Voice, CW, many high seas overseas stations during day—propagation like 20m
16460-17360	Voice, CW, many high seas overseas stations during day—propagation like 20m
22000-22720	Voice, CW, RTTY—propagation like 15m
25060-25110	Mostly CW—very long daytime range
156.0-162.6 MHz	VHF-FM, voice, weather. 156.8 MHz for emergency calling—40-mile range

Table 10. Summary of marine bands.

NMO—Honolulu	All use AMVERS frequencies plus following: 4955, 8150, 8682, 13380, 16445, 12730 for CW
NMC—Pt. Reyes CA	
NMN—Portsmouth VA	
NAM—Portsmouth VA	
NGR—Athens, Greece	
NPN—Guam	
NDT, NPO—Slave stations (for weather)	

Table 11. High seas Navy and Coast Guard stations.

For another example, WOO 811 is one of the 8-MHz channels for New York's (actually located in New Jersey, near Atlantic City) Ocean Gate Radio (8226.0T/8749.9R). Table 4 provides a listing of many of the major world high seas stations and their frequencies. There are two other types of channel numbers: for HF ship-to-ship (a number and letter combination), and for VHF-FM (a simple channel number). These are to be found in Tables 3 and 9, respectively.

In order to find the emergency frequencies quickly, they are listed separately in Table 1, followed by the types of emergency or priority signals heard on them in Table 2.

For those who have transceivers or receivers with spare bands, the various bands, channel breakdown schemes, and voice as well as Morse operation are to be found in the remaining tables.

That's it. Pick out where and what you want to hear, tune it in, and enjoy the excitement and fascination of the marine bands. ■

Reader Service—see page 211

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✓ Reader Service—see page 211

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✓ Reader Service—see page 211

W2NSD/1 NEVER SAY DIE

editorial by Wayne Green

from page 6

the blame, so I can understand the need to try to revise the one lone vote against the project into an even split. It was an ambitious project which might have managed to die on its own accord without the jugular being cut by Tenney . . . but that we'll not know for sure, and so, should amateur radio lose frequencies at WARC this fall, we certainly know where to point the finger. My own evaluation is that the project to interest African countries in the benefits of amateur radio to their people would have worked, just as it did in Jordan, and could have made a decisive difference at Geneva . . . perhaps getting some backing for the US proposal for even more amateur bands.

Future historians interested in getting facts on these ARMA meetings should contact me for copies of the tapes. It's all there for anyone with the constitution to listen through.

FM STARTED IT

The Japanese had no serious foothold in the US with ham gear until the advent of FM and repeaters. I would like to point out that when I started pushing FM in *73 Magazine* back in 1969, I made sure that every US manufacturer of ham equipment knew what I was doing and the impact that I expected it to have. They ignored my predictions, feeling that FM never would be a significant factor in the ham market.

This reminded me of my similar failure to interest the major firms in getting into sideband back in 1955 when I saw that one coming. I talked with Hallicrafters, Hammarlund, National, etc., about it and none of them had any interest at the time. It took Central Electronics to get things moving and the big firms came along when there was no other choice.

By leaving the FM field open to imports, the US industry made it possible for them to set up importing and marketing in this country on a large scale . . . laying the foundation for the 70% penetration we see today. If US manufacturers will be adventurous and try to lead the market instead of follow it, they can sell everything they can make.

CANADIAN HIJINKS

Having received some sanctimonious letters from Canada in response to my criticisms of the ARRL pulling what appears to be a con job on the Canadians, I had someone look into the state of affairs of the supposed incorporation of a Canadian League . . . and nothing could be found filed with the Canadian government. This would lead a naive person like me to suspect that all those promises of untying the apron strings are the usual baloney.

In looking over the list of officers for Canada, I see W2HD listed as their vice president. I dunno why Canadians put so much stock in carpetbaggers and prefer to be run from the US instead of from Canada. Perhaps they are still too weak to stand on their own? Yet, which way is the money flowing? Is it going to Canada or from it . . . and I'm kidding there, because I know as well as you which way the money goes . . . into the bottomless pit down in Connecticut.

MEMBERSHIP DISASTER

The League officials were wearing very worried looks at Dayton. It was difficult to even get them to come forth with a wan smile. It seems that the $18 fee has brought renewals almost to a halt. Now hams are taking a gimlet-eyed look at what they are buying. They see a magazine with few interesting articles . . . they see a lot of back-patting news which is stale before they even get the magazine . . . and ads.

The directors have been trying to get the magazine beefed up, but as the editor complained at Dayton, hardly anyone will write for *QST* anymore. They just don't have the articles—except those from the few staffers who have not yet left the magazine.

SUNSPOT MADNESS

It has not been with a little smugness that we've been watching the sunspot cycle to see how well it would correspond with the model predicted by our resident expert, John Nelson . . . particularly as compared with the predictions for this cycle by the many other experts in the field.

Probably one of the real sleepers in the radio publishing field has been John's book, *The Propagation Wizard's Handbook* ($6.95 from Radio Bookshop, Peterborough NH 03458). John was virtually the only "expert" in the field to have accurately predicted this cycle as it has evolved—and his prediction was way out in left field. He predicted a very low sunspot number for this cycle, with the appearance of a very few large spots instead of the myriad of small spots which have made up the past cycles . . . and he has been absolutely right!

The Nelson book is now being ordered in larger numbers by the scientists at NASA and at Boulder, where the National Bureau of Standards runs a propagation laboratory. Nelson's predictions have been right on the nose, while the government predictions have been noticeably short on accuracy.

There is nothing really new about the Nelson system. He's been using it for about 30 years and has described it in many articles down through the years. When I first ran into his concept of the planets having an influence on sunspots, some 25 years ago, it made a lot of sense to me. I met John when he was giving a talk on his system at a Long Island ham club. I was impressed by his cautious approach and penchant for rigorous attention to details. I noted that only his predictions seemed to stand up, while those of the Bureau of Standards and George Jacobs (VOA) would be frequently in serious error. When John said conditions were going to stink, that was the time to take a vacation. When he said they would be hot, you made sure your antenna was working right.

Oh, what value are these long-range predictions? John wrote an article for *73* quite some time ago telling us what we could expect from the eleven meter CB frequencies during this cycle . . . and his predictions have been most accurate. Since this cycle is unlike any other in history and was predicted by John this way, the effects on both the CB frequencies and the ham bands have been remarkably different from past cycles. Knowing about this ahead of time is valuable in making rules and planning activities. Is it worthwhile to put a lot of development time and money into ten meter repeaters? That depends on propagation.

TURKEY CLUB

One club and one club only refused to cooperate with the ham clubs in the greater St. Louis area on their recent ARCH MARCH hamfest. Their excuse was that as an ARRL club they refused to support any amateur activity where Wayne Green was going to talk.

When I heard about this, I wrote to the club and offered to come to St. Louis a day early and go to a special club meeting where the members could have an opportunity to face me with their beefs and have an opportunity to find out the truth of things they believed on trust from the ARRL. The club flatly refused to face me. Failing in that, I tried to get a meeting with the head of the club and this was agreed upon.

Came the time for the meeting, the only time this chap could make it, at 10:00 pm the night before the hamfest, and the chap didn't show up. I sat and waited for almost an hour, but no message and no club president. I was worn out after a full day of television appearances, meeting the mayor of St. Louis, and other meetings. When the chap didn't show, I went to bed to get rested up for the busy hamfest on the day to come. I had to be up very early to set up our booth, get set for my two major talks that day, etc.

Suddenly, the phone rang . . . our friend had finally gotten to the hotel. He got angry when I said I wouldn't get dressed again and come down to argue with him for an hour or so. I had gone to a lot of trouble to make the time available for him—which was wasted—and I was not about to stay up a good part of the night and thus make my talks the next day less entertaining just because he was unable to keep an appointment.

Phooey.

MARCH WINNER

"The NCX-Match" was a close winner over K6IQL's "The 10-GHz Cookbook" in our March Reader Service card balloting, so Rick Ferranti WA6NCX/1 (Newton Centre MA) will be receiving our $100 bonus check for being the author of that issue's most popular article.

Ham Help

I would appreciate it if anyone could help me connect a Heathkit HG-10B vfo to my Swan 500CX to be used as an outboard vfo.

Ancel W. Norris WB4AUB
4357 Mountaindale Road
Birmingham AL 35213

RTTY Loop

from page 14

Certain characters, not represented in Baudot, have an $FF stored at their location. This directs the program to use the special table (SPLTBL), located from $80 to $A6. The table is organized as a three-byte, fixed-format table. The first byte is the ASCII character, and the next two are the Baudot codes for the two-letter symbol for each ASCII code.

The main program starts at $0100 by setting up the stack and initializing the PIA, addressed to port 7, as an output. A character is input through the monitor's input routine and used as the index for the table. If the retrieved character is $FF, the ASCII code needs a special character representation, and a branch to SPLCHR is executed. A retrieved null, $00, initiates a branch back to input, with no output produced. One more test and we're ready to fly. If the retrieved character is a space ($90 in Baudot), a check is made on the running total characters in the line. If it is greater than sixty, forget the space and send a carriage-return, line-feed sequence. If it is not a space, hooray—we put it out.

First things first, the MSB is shifted into the carry bit, where it can be used to set or reset the software flip-flop used to monitor case. This was well diagrammed last month and will not be detailed here. Each of the five data bits is then shifted out and sent sequentially, after a character START bit is sent, and a STOP bit, 33 milliseconds of pure MARK, is plastered on at the end.

Now things are going to get a bit tacky. Each data bit must be sent for exactly 22 ms. The timing is set in a software delay loop, called MSEC10, set for approximately an eleven ms delay. Since this delay is produced by loading a number into the index register and decrementing it, the speed of the computer's clock can make a significant difference in the delay.

For the "original" SWTPC 6800, with the MP-A CPU board, the clock speed is roughly 902.255 kHz, and a delay constant of $0480 is used. If you have the MP-A2 CPU board, your clock speed may be anything from about 900 kHz to 1.5 MHz. To find the constant that is right for your system, enter Program 2 into your computer and type "G". Time, exactly, the interval, in seconds, between the "B" and "E". Use the formula shown in Fig. 1 to calculate your delay constant. Remember, this is hexadecimal arithmetic. Work through the example to be sure you've got it right.

One more thing to do before we can use the program on the

Program 1 (continued).

```
009B 5C                FCB    $5C,$CC,$D0   \=BS
009E 5D                FCB    $5D,$24,$24   ]=))
00A1 5E                FCB    $5E,$F0,$B4   ↑=UP
00A4 5F                FCB    $5F,$F0,$A4   ←=UL
00A7 0000      TEMP01  FDB    0000
00A9 00        SHIFT   FCB    0
00AA 00        CHRCNT  FCB    0
00AB 0D        CRLFST  FCB    $D,$A,$15,0,0,4
               * MAIN PROGRAM STARTS HERE
               *
0100                   ORG    $0100
0100 8E A070   START   LDS    #$A070
0103 4F                CLR A
0104 B7 801D           STA A  PIACA
0107 4A                DEC A
0108 B7 801C           STA A  PIADA
010B 86 04             LDA A  #$4
010D B7 801D           STA A  PIACA
0110 86 01             LDA A  #$01
0112 B7 801C           STA A  PIADA
0115 BD E1AC   INCHR   JSR    INEEE
0118 B7 011F           STA A  INDEX+1
011B CE 0020           LDX    #TABLE
011E A6 00     INDEX   LDA A  X
0120 81 FF             CMP A  #$FF
0122 27 3C             BEQ    SPLCHR
0124 4D                TST A
0125 27 EE             BEQ    INCHR
0127 81 90             CMP A  #$90
0129 26 08             BNE    AROUND
012B C6 3C             LDA B  #60
012D D1 AA             CMP B  CHRCNT
012F 2D 02             BLT    AROUND
0131 20 5A             BRA    CRLFOT
0133 8D 05     AROUND  BSR    OUTPUT
0135 7C 00AA           INC    CHRCNT
0138 20 DB             BRA    INCHR
013A 48        OUTPUT  ASL A
013B 25 11             BCS    CKLTRS
013D 7D 00A9   CKFIGS  TST    SHIFT
0140 27 1B             BEQ    OUTCHR
0142 36                PSH A
0143 86 D8             LDA A  #$D8
0145 BD 01AD           JSR    OUTBDT
0148 32                PUL A
0149 7F 00A9           CLR    SHIFT
014C 20 0F             BRA    OUTCHR
014E 7D 00A9   CKLTRS  TST    SHIFT
0151 26 0A             BNE    OUTCHR
0153 36                PSH A
0154 86 FF             LDA A  #$FF
0156 BD 01AD           JSR    OUTBDT
0159 32                PUL A
015A 7C 00A9           INC    SHIFT
015D 8D 4E     OUTCHR  BSR    OUTBDT
015F 39                RTS
0160 B6 011F   SPLCHR  LDA A  INDEX+1
0163 81 0D             CMP A  #$0D
0165 27 26             BEQ    CRLFOT
0167 CE 0080           LDX    #SPTABL
016A A1 00     SPLOOP  CMP A  X
016C 27 05             BEQ    FOUND
016E 08                INX
016F 08                INX
0170 08                INX
0171 20 F7             BRA    SPLOOP
0173 08        FOUND   INX
0174 86 1C             LDA A  #$1C
0176 8D C2             BSR    OUTPUT
0178 A6 00             LDA A  X
017A 8D BE             BSR    OUTPUT
017C 08                INX
017D A6 00             LDA A  X
017F 8D B9             BSR    OUTPUT
0181 86 1C             LDA A  #$1C
0183 8D B5             BSR    OUTPUT
0185 C6 04             LDA B  #$4
0187 DB AA             ADD B  CHRCNT
0189 D7 AA             STA B  CHRCNT
018B 20 88             BRA    INCHR
018D CE 00AB   CRLFOT  LDX    #CRLFST
0190 BD E07E           JSR    PDATA
0193 86 88             LDA A  #$88
0195 8D A3             BSR    OUTPUT
0197 86 88             LDA A  #$88
0199 8D 9F             BSR    OUTPUT
019B 86 A0             LDA A  #$A0
019D 8D 9B             BSR    OUTPUT
019F 86 FF             LDA A  #$FF
01A1 8D 97             BSR    OUTPUT
01A3 86 FF             LDA A  #$FF
01A5 8D 93             BSR    OUTPUT
01A7 7F 00AA           CLR    CHRCNT
01AA 7E 0115           JMP    INCHR
               *
01AD C6 05     OUTBDT  LDA B  #$05
01AF 8D 16             BSR    SNDSPC
01B1 48        SFTLFT  ASL A
01B2 25 04             BCS    MRKOUT
01B4 8D 11             BSR    SNDSPC
01B6 20 02             BRA    NXTELE
01B8 8D 08     MRKOUT  BSR    SNDMRK
01BA 5A        NXTELE  DEC B
01BB 26 F4             BNE    SFTLFT
01BD 8D 03     SNDSTP  BSR    SNDMRK
01BF 8D 01             BSR    SNDMRK
01C1 39                RTS
               *
01C2 36        SNDMRK  PSH A
01C3 86 01             LDA A  #$01
01C5 20 03             BRA    OUTDAT
01C7 36        SNDSPC  PSH A
01C8 86 00             LDA A  #$00
01CA DF A7     OUTDAT  STX    TEMP01
01CC B7 801C           STA A  PIADA
01CF 8D 04             BSR    MSEC20
01D1 32                PUL A
01D2 DE A7             LDX    TEMP01
01D4 39                RTS
               *
01D5 8D 01     MSEC20  BSR    MSEC10
01D7 01                NOP
01D8 CE 0480   MSEC10  LDX    #$480
01DB 09        MSLOOP  DEX
01DC 26 FD             BNE    MSLOOP
01DE 39                RTS
               *
A048                   ORG    PGCTR
A048 0100              FDB    START
               *
                       END
```

Program 2.

```
                       NAM    CLKSPEED
                       OPT    0

               *
               * PROGRAM TO DETERMINE
               * DELAY CONSTANT BY
               * ESTIMATING CLOCK
               * SPEED OF THE SWTPC
               * 6800 COMPUTER
               *
               * MARC I. LEAVEY, M.D.
               *
               ***************************
               * EXTERNAL REFERENCES
               *
     E1D1      OUTEE  EQU    $E1D1
     E0E3      SWTBUG EQU    $E0E3
     A048      PGCTR  EQU    $A048
0100                  ORG    $0100
0100 86 42     START  LDA A  #'B      PUT OUT A "B"
0102 BD E1D1          JSR    OUTEE    IN THE BEGINNING
0105 8D 10            BSR    ONEMIN   :    N O W
0107 8D 0E            BSR    ONEMIN   :    W A I T
0109 8D 0C            BSR    ONEMIN   :     F O R
010B 8D 0A            BSR    ONEMIN   :    F I V E
010D 8D 08            BSR    ONEMIN   :M I N U T E S
010F 86 45            LDA A  #'E      PUT OUT AN "E"
0111 BD E1D1          JSR    OUTEE    AT THE END
0114 7E E0E3          JMP    SWTBUG   AND GO TO MONITOR
               *
0117 86 07     ONEMIN LDA A  #$07     RING THE BELL
0119 BD E1D1          JSR    OUTEE    EACH MINUTE
011C C6 3B            LDA B  #$3B     :
011E CE F800   LOOP1  LDX    #$F800   : THIS LOOP
0121 09        LOOP2  DEX             : IS TIMED
0122 09               DEX             : TO RUN
0123 08               INX             : ONE MINUTE
0124 26 FB            BNE    LOOP2    : WITH A
0126 5A               DEC B           : CLOCK OF
0127 26 F5            BNE    LOOP1    : ONE MHZ
0129 39               RTS             :
               *
A048                  ORG    PGCTR    SET UP PROGRAM COUNTER
A048 0100             FDB    START    WITH STARTING ADDRESS
               *
                      END
```

The Scanning Memorizers

FT-127RA
(220 MHz)

FT-227RB
(144 MHz)

FT-627RA
(50 MHz)

The FT-127RA, FT-227RB and FT-627RA, FM transceivers, allow scanning and expanded memory coverage for the demanding VHF FM operator. All feature up/down scanning capability with control from the microphone; the scanner will also search for a busy or clear channel. Four memory channels are available — two for simplex, three for repeater channels, one for a split of up to 4 MHz. Other performance features are similar to those of the renowned FT-227R.

OPTIONAL EQUIPMENT

Keyboard Microphone: YM-22 for FT-127RA and FT-627RA; YM-23 for FT-227RB (YM-22 standard feature with FT-227RB) • Squelch Unit • FP-4 AC Power Supply

CPU-2500R/K 2M FM Transceiver
with Central Processing Unit

The age of computers has entered the amateur scene with the announcement of the CPU-2500R/K 2-meter FM transceiver. Controlled by a 4-bit central processing unit (CPU), the CPU-2500R/K contains a scanner, 4 memory channels, manual or automatic tone burst, an optional sub-audible tone squelch, and 25 watts output.

The keyboard microphone allows two-tone input for autopatch or control purposes, as well as remote programming of dial or memory frequencies.

Automatic ±600 kHz repeater split, or program a split up to 4 MHz using the memory. Keyboard microphone allows remote programming of odd splits.

CPU scanner will search for a busy or clear channel, upon your command.

Four memory channels for simplex or repeater use, plus another memory channel for a split of up to 4 MHz.

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Reader Service—see page 211

air: Interface it. The data is coming out of bit 0 (the LSB) of the A side of a PIA interface on port 7. This TTL level signal represents MARK with a high and SPACE with a low. If you have an ST-6 or equivalent, interfacing may be accomplished easily, adding only one diode, as described several months ago for the test generator. Other interfacing schemes could include an opto-isolator or reed relay. Remember, though, *don't* allow the loop voltages access to the computer or you will have a smoking pile of expensive "junque."

If all goes well, when you load the program, adjust the delay constant, and accomplish interfacing, any character struck on the keyboard should come out in Baudot on the other end.

General Formula:
"Constant Delay" × "Constant Time" = "New Delay" × "New Time"

Constants for MP-A System:
Constant Delay = \$480 (1152 Decimal)
Constant Time = 332 Seconds

Practical Formula:

$$\frac{1152 \times 332}{\text{New Time}} = \text{New Delay}$$

An Example:
MP-A2 System Time = 234 Seconds

$$\frac{1152 \times 332}{234} = 1634 = \$666 \text{ New Delay}$$

Fig. 1.

Now, one last hooker: If you are using an MP-C "control interface" (the one that was supplied with the computer if it had an MP-A CPU board) and you type in a character while one is sending, you will get garbage. This is an unfortunate result of the software UART written into the MIKBUG™ or SWTBUG™ monitor to handle serial data through a PIA interface on port 1. Yes, I know we are doing essentially the same thing on port 7, but that is the problem. While the system will support one delay loop, it will not support two running at the same time. The solution is to take one of the I/O structures out of a *software* UART and into a *hardware* UART, or ACIA. The easiest way to do that is to use a serial MP-S interface for control on port 1. Now, characters input during an output are simply ignored. Not an ideal solution, but adequate for this simple program.

Next month, we'll . . . no, I'm not going to tell you! There are few surprises in life; let one of them be next month's RTTY Loop.

Contests

from page 19

Phone—3920, 7260, 14300, 21360, 28600, 50.3, 145.1.

Use of FM simplex is encouraged but no repeater contacts are allowed.

AWARDS:

A plaque to the top RI and non-RI scorer, plus certificates will be awarded to the top scoring station in each RI county, state, province, DX country, the top scoring Novice and Technician station in each RI county and state, and the ARC in each state, province, and DX country that submits the highest aggregate score with a minimum of 3 logs per club.

ENTRIES:

Logs must show date/time in GMT, call, exchange, band, and mode. On a separate sheet show name, call, mailing address, club affiliation if any, total QSO points, multiplier claimed, and final score. Entries must be postmarked no later than August 31. Send logs and summary to: East Bay Amateur Wireless Association, PO Box 392, Warren RI 02885. Include an SASE for results.

NEW JERSEY QSO PARTY
Contest Periods:
2000 GMT Saturday, July 28 to 0700 GMT Sunday, July 29
1300 GMT Sunday, July 29 to 0200 GMT Monday, July 30

Sponsored by the Englewood Amateur Radio Association, the contest is open to all amateurs worldwide for the 20th year. Phone and CW are considered the same contest. A station may be contacted once on each band. Phone and CW are considered separate bands, but CW contacts may not be made in the phone segments. NJ stations may work other NJ stations. General call is "CQ NJ." NJ stations are requested to identify themselves by signing "DE NJ."

EXCHANGE:

QSO number, RS(T), and QTH (ARRL section or country/NJ county).

FREQUENCIES:

1810, 3535, 3900, 7035, 7135, 7235, 14035, 14280, 21100, 21355, 28100, 28600, 50-50.5, and 144-146.

Suggest phone activity on the even hours, 15 meters on the odd hours 1500 to 2100 GMT, 160 meters at 0500 GMT.

SCORING:

Out-of-state stations multiply number of complete contacts with NJ stations times the number of NJ counties worked (21 maximum). NJ stations score 1 point per W-K-VE-VO QSOs, 3 points per DX QSO. Multiply total number of points times the number of ARRL sections (including NNJ and SNJ—75 max.). KP4, KH6, KL7, KZ5, etc., count as 3-point DX contacts and as section multipliers.

AWARDS:

Certificates will be awarded to the first-place station in each NJ county, ARRL section, and country. In addition, a second-place certificate will be awarded when four or more logs are received. Novice and Technician certificates will also be awarded.

ENTRIES:

Logs must show GMT date/time, band, and emission, and be received not later than August 25. The contact for each claimed multiplier must be indicated and numbered and a checklist of contacts and multipliers should be included. Multi-operator stations should be noted and calls of participating operators listed. Logs and comments should be sent to: Englewood Amateur Radio Assoc., PO Box 528, Englewood NJ 07631.

A size #10 SASE should be included for results. Stations planning active participation in NJ are requested to advise the EARA by July 7 of your intentions so that they can plan for full coverage from all counties. Portable and mobile operation is encouraged.

ENDEAVOUR AWARD

The Royal Naval Amateur Radio Society already sponsors two awards, the Mercury Award for contacting members of the Society, and the Hampshire County Award for contacting amateurs in the English county of Hampshire. The Society now has great pleasure in announcing a third award, called the Endeavour Award, for contacting Society members residing in Australia. The title of the award links the Royal Navy with Australia and the award is open to all radio amateurs.

Applicants must establish two-way amateur communications with RNARS members residing in Australia. Points will be awarded on the basis of one point per VK RNARS member worked per band, after the commencement date of January 1, 1979. To qualify, the following is required: for amateurs residing inside Australia—15 points; for amateurs residing inside Oceania—10 points; for amateurs residing outside Oceania—5 points.

In addition, for amateurs residing outside Oceania, contacts with VK RNARS members on the 3.5 MHz band will count double points. For the purposes of this award, any RNARS maritime-mobile member when located inside Australian waters may be counted as a VK member.

The award will be endorsed only on the request of the applicant and the following endorsements are available: all CW, all SSB, all 3.5 MHz, all 28 MHz, all Novice, and five-by-five, the last endorsement being for gaining at least five points on each of the five high frequency bands.

To claim the award, no QSLs are required. However, full log details showing the VK member (or /MM + QTH) worked, their RNARS number, date, time, frequency, mode, plus an application fee of \$1.50 Aust or 7 IRCs are to be sent to the Endeavour Award Custodian: R. Baty VK5MD, 43, HMAS Australia Road, Henley Beach South, SA 5022 Australia. Please ensure all checks are in Australian currency and made payable to "R. Baty." Clearly state what endorsements are claimed. Certificates to successful applicants will be forwarded by airmail as soon as possible after the claim has been checked.

TESLA COMMEMORATIVE AWARD

A very attractive award is being offered by YU2EAB, the Gospic Amateur Radio Club, to commemorate the birth of Nikola Tesla. To obtain this award you must work the special station YU0NT for 5 points plus any other Gospic station for one point. Six points are needed for the award. No band or mode restrictions exist. YU0NT will operate from July 7 through July 17 from the house where Nikola Tesla was born. Some of the other stations to look for in Gospic include YU2CET, YU2CGE, YU2CGG, YU2CPJ, YU2CTK, YU2CUD, YU2EAB, YU2RWI, YU2RWY, and YU2VE.

No QSLs are necessary to obtain the award; send only the usual log data along with 5 IRCs or \$2.00 to: YU2EAB, Box 55, 48000 Gospic, Yugoslavia.

Looking West

from page 12

more fitting than this contact. Fate had been very kind indeed.

The station operates under the callsign W6RO—W6 "Rolling Ocean"—as a tribute to one of the founding members of the club sponsoring the overall *Queen Mary* wireless operation. Amateurs wishing to operate from the *Queen Mary* can do so in one of two ways. Those living in the area and wishing to serve as scheduled volunteer operators can contact the Associated Radio Amateurs of Long Beach and make their intentions and availability known. However, if you are planning a trip to Los Angeles and would like to operate the station, you can take the *Queen Mary* tour and, when it gets to the wireless room, locate the operator in charge and explain your desires. You will have to present your original amateur license and some additional identification before you will be permitted to operate. Guest operating periods will be approximately 15 minutes in duration.

Currently, two motion pictures are in production which in part are being done aboard the *Queen*. One is the epic film "Titanic," scheduled for release late next year. The other hits much closer to home. In early September or thereabouts, the ARRL will be releasing its new film, "The World of Amateur Radio," produced by Emmy-award-winning filmmaker Dave Bell W6AQ. Thanks to Nate and his organization, Dave was able to film the narration sequences (which feature NBC News correspondent Roy Neal W6DUE) aboard the *Queen Mary*.

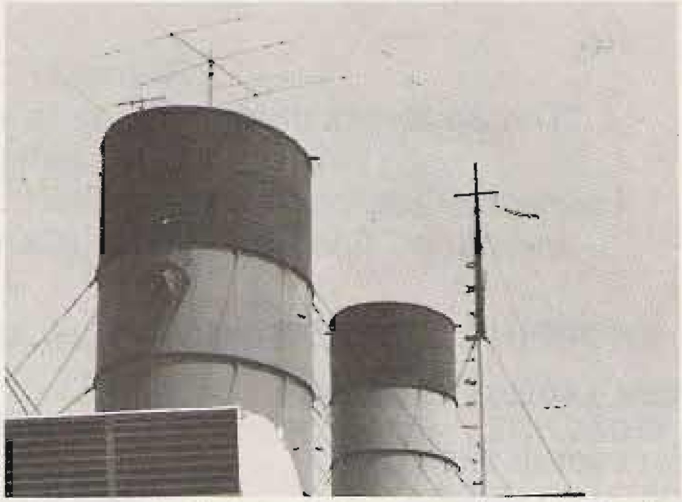
Dave has made one request of the amateur community now that the news of the new film has been made public. It will be several months before the film is ready for distribution. Please do not call either Dave or the ARRL requesting the film until its availability has been announced. The initial prints are destined for showing at the World Administrative Radio Conference in Geneva in order to underline the attributes of the worldwide amateur service. Eventually, there will be enough prints for all of us to see, so it is suggested that you monitor *QST*, *HR Report*, The Westlink Amateur Radio News, and this column to find out the availability date. Your cooperation in this regard is deeply appreciated.

THE "THEY-WON'T-LET-220-DIE" DEPARTMENT

The 220-SMA of southern California has gone on record as being willing to take any action necessary to ensure that the 220-to-225-MHz amateur band never falls into the hands of maritime interests. To show that they really mean business, what is called a "WARC Action Committee" was formed at their April 22 meeting, with Ray Von Neumann K6PUW as its chairman.

At present, a number of directions are being considered, although two tend to offer the most promise of at least marginal success. The 220-SMA may well have hired a Washington-based attorney by the time this reaches print. His job will be to go into federal court and either file a direct appeal on the matter or request an injunction barring the use by our WARC delegation of the portion of the US WARC proposal dealing with the 216-to-225-MHz spectrum. It is the 220-SMA's contention that both the FCC and the maritime services may have violated the Federal Administrative Procedures Act in regard to the preparation of that portion of the document. One lawyer explained to me that if the 220-SMA were successful in obtaining such an order, then our delegation would be barred from discussing or voting on issues brought before WARC dealing with that spectrum. This could place the US in a rather awkward position at the conference later this year, but the same legal expert did say that he did not feel the 220-SMA could obtain such an order. I thus suspect that any legal action will come in the form of an appeal. Only time will tell where the 220-SMA will go if they choose this route at all.

Another direct offensive action they are considering—one I expect to see initiated quickly—is filing a formal Petition for Rulemaking with the FCC requesting the immediate transfer of currently unused maritime VHF spectrum to the amateur service. The feeling is that the



A new triband addition to the Queen Mary. *(Photo by KH6IAF)*

Joe Rudi WA6PVA, baseball player with the California Angels, makes the first official QSO from W6RO. Looking on is Nate Brightman K6OSC, of the Associated Radio Amateurs of Long Beach, the club which installed the gear. (Photo by W6VGQ)

TV actor/comedian Stu Gilliam WD6FBU operates W6RO, the new amateur station aboard the Queen Mary. *(Photo by W6VGQ)*

New MFJ 3 & 1.5 KW Versa Tuners

Run up to 3 KW or 1.5 KW PEP and match everything from 1.8 thru 30 MHz: coax, balanced line, random wire. Built-in balun.

3 KW VERSA TUNER IV's — **1.5 KW VERSA TUNER III's**

NEW MFJ KW VERSA TUNERS HAVE THESE FEATURES IN COMMON

These 6 new MFJ KW Versa Tuners let you run up to 3 KW or 1.5 KW PEP (depending on the model) and match any feedline continuously from 1.8 to 30 MHz: coax, balanced line or random wire. Gives maximum power transfer. Harmonic attenuation reduces TVI, out of band emissions.

All metal, low profile cabinet gives RFI protection, rigid construction, sleek styling. Black. Rich anodized aluminum front panel. 5x14x14 inches. Flip down stand tilts tuner for easy viewing.

Efficient, encapsulated 4:1 ferrite balun. 250 pf, 6000 volt capacitors. 18 position dual inductor, 17 amp, 3000 V ceramic rotary switch (3 KW version). 12 position inductor, ceramic rotary switch (1.5 KW version). 2% meters. SO-239 coax connectors, ceramic feedthru for random wire and balanced line. One year limited warranty. Made in U.S.A.

3 KW VERSA TUNER IV's

[1] MFJ-984 3 KW VERSA TUNER IV

$299.95

***EXCLUSIVE RF AMMETER** insures maximum power to antenna at minimum SWR. Built-in dummy load.*

This is MFJ's best 3 KW Versa Tuner IV. The MFJ-984 Deluxe 3 KW Versa Tuner IV gives you a combination of quality, performance, and features that others can't touch at this price.

An exclusive 10 amp RF ammeter insures maximum power to antenna at minimum SWR. A separate meter gives SWR, forward, reflected power in 2 ranges (2000 and 200 watts).

Versatile antenna switch lets you select 2 coax lines thru tuner and 1 thru or direct, or random wire, balanced line or dummy load.

A 200 watt 50 ohm dummy load lets you tune your exciter off air for peak performance. Efficient, encapsulated 4:1 ferrite balun.

[2] MFJ-981 3 KW VERSA TUNER IV

$199.95

Accurate meter gives SWR, forward and reflected power in 2 ranges: 2000 and 200 watts. 4:1 ferrite balun.

The MFJ-981 3 KW Versa Tuner IV is one of MFJ's most popular Versa Tuners. An accurate meter gives you SWR, forward and reflected power in 2 ranges: 2000 and 200 watts. Encapsulated 4:1 ferrite balun.

[3] MFJ-982 3 KW VERSA TUNER IV

$199.95

Antenna switch lets you select 1 coax thru tuner and 2 coax thru tuner or direct, or random wire and balanced line.

The MFJ-982 3 KW Versa Tuner IV gives you a versatile 7 position antenna switch that lets you select 1 coax thru tuner and 2 coax thru tuner or direct, or random wire and balanced line. Encapsulated 4:1 balun.

If you already have a SWR/wattmeter, the MFJ-982 is for you.

[4] MFJ-980 3 KW VERSA TUNER IV

$169.95

Heavy duty encapsulated 4:1 ferrite balun for balanced lines.

The MFJ-980 is MFJ's lowest priced 3 KW Versa Tuner IV but has the same matching capabilities as the other 3 KW Versa Tuner IV's.

Features an efficient, encapsulated 4:1 ferrite balun for balanced lines.

1.5 KW VERSA TUNER III's

[5] MFJ-962 1.5 KW VERSA TUNER III

$169.95

SWR, dual range forward and reflected power meter, 6 position antenna switch, encapsulated 4:1 ferrite balun.

The MFJ-962 1.5 KW Versa Tuner III is an exceptional value.

An accurate meter gives SWR, forward and reflected power in 2 ranges (2000 and 200 watts).

A versatile six position antenna switch lets you select 2 coax lines thru tuner or direct, or random wire and balanced line. Encapsulated 4:1 balun.

Black front panel has reverse lettering.

[6] MFJ-961 1.5 KW Versa Tuner III

$149.95

6 position antenna switch lets you select 2 coax lines thru tuner or direct, or random wire and balanced line.

The MFJ-961 1.5 KW Versa Tuner III gives you a versatile six position antenna switch. It lets you select 2 coax lines thru tuner or direct, or random wire and balanced line. Encapsulated 4:1 ferrite balun.

If you already have a SWR/wattmeter, the MFJ-961 is for you.

Black front panel has reverse lettering.

FOR YOUR NEAREST DEALER OR FOR ORDERS

CALL TOLL-FREE 800-647-1800

Why not visit your dealer today? Compare these 3 KW and 1.5 KW Versa Tuners to other tuners. You'll be convinced that its value, quality and features make it a truly outstanding value. If no dealer is available, order direct from MFJ and try it. If not delighted, return it within 30 days for a prompt refund (less shipping). Charge VISA, MC. Or mail check, money order plus $10 shipping/handling.

For technical information, order/repair status, in Mississippi, outside continental USA, call 601-323-5869.

Order By Mail or Call TOLL FREE 800-647-1800 and Charge It On VISA master charge

MFJ ENTERPRISES, INC.

P. O. BOX 494 M52
MISSISSIPPI STATE, MISSISSIPPI 39762

Reader Service—see page 211

need for this can be easily documented by showing the overall inactivity in current VHF maritime operations and the current growth patterns in VHF amateur activity. Basically, the 220-SMA feels that it is time to stop being on the defensive and become outward and aggressive in fighting to save our spectrum. They hope to rally support not only from 220-MHz spectrum users, but also from the overall amateur community.

Already, some words of support have been voiced, such as the following statement issued by the Jet Propulsion Laboratory's Amateur Radio Club: "The Jet Propulsion Laboratory's Amateur Radio Club supports the 220-SMA of southern California in its efforts to keep the 220-to-225-MHz band an amateur one. To this end we have pledged our support." The JPL ARC did more than just add a bit of encouragement. They also provided the facilities and hosted the meeting.

THE "NAVY-TO-THE-RESCUE—MAYBE" DEPARTMENT

The 220-SMA sent copies of its since-denied Petition for Reconsideration to several government agencies in addition to the FCC. Among those who received copies were the nation's military branches. Just prior to the April 22 meeting at JPL, the 220-SMA dropped what might best be described as a bombshell. It had been contacted by the Chief of Naval Operations and had been told that neither the Chief's office nor the Naval Telecommunications Frequency Management Group had ever been informed of any proposed reallocation of the 216-to-225-MHz spectrum. As it turns out, the Navy has a rather vested interest in this spectrum. It operates what is known as the Space Surveillance Systems Group, a nationwide communications network that keeps track of all space debris resulting from US space operations. In fact, the Space Surveillance Systems Group utilizes frequencies from 216 through 233 MHz, according to an SMA-220 spokesman, and is what is termed a "long-term, high-monetary-investment naval operation."

Needless to say, the Navy is more than just a bit upset over finding out that it may be evicted along with the amateur service from spectrum in which it has a definite interest. Apparently, it is upset enough to have ordered the Telecommunications Frequency Management Group to start a detailed investigation of the matter and report their findings back to the Chief's office. What seems to have irritated them the most were the official statements contained in the WARC position paper itself, rhetoric that said this proposed transition had been cleared with the military prior to its inclusion. If this is true, then I wonder whose military the FCC and maritime services cleared it with. According to the Navy, it wasn't ours.

THE "I-NEED-A-FOREIGN-CORRESPONDENT" DEPARTMENT

Is there an amateur in Geneva, Switzerland, who happens to read Looking West? If so, I need your help. I need a volunteer to act as a Looking West correspondent during the World Administrative Radio Conference later this year. His or her job would be to sniff out any news of what's happening at the conference in relation to VHF/UHF spectrum matters, write same into a monthly synopsis, and forward it to me for inclusion in this column. If you have both the time and interest, drop me a line at the address given at the column's top and we can go from there.

THE "BIG-CHANGE-AT-WESTLINK" DEPARTMENT

Actually, there has been more than one change, but the one that affects most Westlink service users is the discontinuance of their "Cassette Exchange Program." Effective immediately, the cassette program has been replaced by an automated telephone system that permits those wishing to obtain the weekly newscasts to simply dial a telephone number in order to obtain the information.

There were two reasons for Network Director Jim Hendershot to make this decision. First, the Westlink News Service has grown far larger than he ever expected. This is a free, nonprofit service, but he found himself spending virtually every free moment duplicating tapes. He could have gone to a high-speed duplication house to have this work done, but it would have meant going away from the free aspect of the operation and possibly charging upwards of $100 or more annually for the service. This he did not want to do.

Second, there have been ongoing postal problems. Not a week had gone by when a subscriber didn't call to complain that his tape had not arrived or that it had arrived too late to air that week. Consequently, Jim has dropped the cassette exchange system.

There has been a second big change at Westlink. Alan Kaul W6RCL, Bill Orenstein KH6IAF/6, and I recently produced a 20-minute documentary entitled "The Peril to 220" which covered the many aspects of the current situation in that spectrum. The response to that special was so positive that Jim asked us to continue producing such programs on a monthly basis. We have accepted the assignment. In fact, currently in production are programs dealing with the OSCAR satellites, DXing from DX lists, and handling malicious interference.

To accomplish this, a second Westlink studio is being assembled at Bill's office in Hollywood; by midsummer, we should be in full production. Distribution will also be via a dial-in telephone number. We will also be setting up another telephone number so that amateurs can leave input for either the weekly newscast or the monthly "magazine of the air." Those interested in obtaining either or both of these services should contact Jim at the Westlink Radio Network, 8331 Joan Lane, Canoga Park CA 91402. Jim no longer must limit the service to repeaters and bulletin stations, so the service is available to just about anyone.

DX

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The following information has been provided by OK3BG on OK3TAB/D2A. OK3TAB is Laci Toth who arrived in Angola in March. He went to Luanda on a long business trip and was able to get on the air almost immediately. Laci is using a home-brew transceiver running 200 Watts to a triband quad. Look for him after 1700Z around 21360 kHz or 14250 kHz. He seldom strays far from these frequencies. QSLs have already been printed and you can QSL via OK3ALE or through the OK bureau.

Alex Kasevich W1CDC passes along the word that he is planning an extended stay on Montserrat beginning in August when he will be signing VP2MM. Look for him on CW only in the lower 25 kHz listening up 5. QSL to his home call with an SASE, of course.

The 1978 annual report of the Hong Kong Amateur Radio Transmitting Society lists 56 full members, 31 associate members, and six overseas members. With VS6FE as president, the group has an active 2-meter repeater and conducts the nightly Cantonese Net on 14130 kHz. VS6GW runs the QSL bureau at Box 541, Hong Kong.

The Gilbert Islands become independent on July 10 with the present KH1/VR1 prefixes being replaced by one new prefix. Prefix hunters must be going crazy these days trying to keep up.

14240 kHz and 14275/280 kHz are good areas to monitor for various list-type operations, generally after 2300Z.

Joe Ely 7P8BI reports that anyone needing a card for his 3D6BL operation from September, 1977, to August, 1978, or his present stint in Lesotho can QSL to his new manager, Gary Yarus WB0MSZ, 921 N. Clay Avenue, St. Louis MO 63122.

The Mad River Radio Club managed over 4,000 contacts during the ARRL CW DX Contest from FG7AR/FS7 for a score of some 3.4 million points. All contacts from March 14 to March 20 should be QSLed to K8OCR. Neither FG7AR nor his managers have records for contacts during this period.

The Sorel-Tracy Amateur Radio Club, VE2CBS—Province of Quebec, will sponsor a DXpedition to Zone 2 this month to aid those needing this rare zone to fill out their WAZ Award.

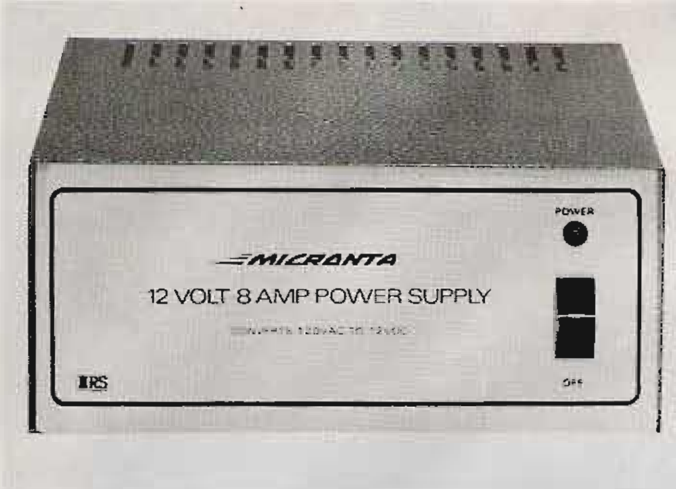
The operation will take place the week of July 21—July 28. They plan to operate all amateur frequencies using both CW and SSB.

As club Public Relations Director Marcel Lapolice VE2EML, would say, "Au plaisir de vous recontrer sur les ondes durant cette semaine de DX-pedition dans le nord de la province de Quebec." Right on, Marcel.

That station on during the WPX contest signing HD1A was a multi-multi operation by K7CA, WA4UAZ, K4ERO, and KA6CNS. HD1 is a special Ecuador prefix and you can obtain a QSL by dropping an SASE to WA4QMQ.

That about covers it for this month. We hope some of the preceding information will help you pick up a few new ones. In the meantime, we are always looking for DX information and photos. Photos can be either black and white or color. We in particular need information pertaining to CW, SSTV, OSCAR, VHF/UHF, and 160 meters. Thanks as usual to the *West Coast DX Bulletin*, LIDXA *DX Bulletin*, and *Worldradio News* for much of the preceding information.

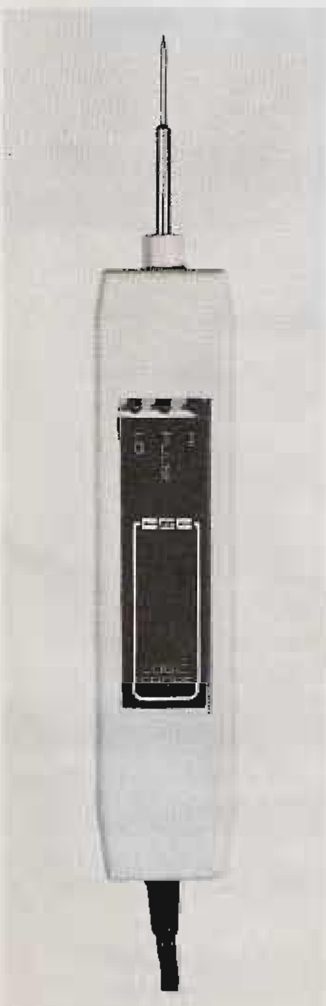
New Products



Micronta 12-volt 8-Amp power supply from Radio Shack.

from page 24

Radio Shack stores and dealers. *Radio Shack, 1300 One Tandy Center, Fort Worth TX 76102; phone (817)-390-3272.*



LPK logic probe from CSC.

CSC LOGIC PROBE KIT OFFERS KIT-BUILDERS MULTIPLE BENEFITS

For Continental Specialties Corporation, already well known as a manufacturer of professional digital trouble-shooting instruments, their first kit-style test instrument logically emulates their line of logic probes. Both as a kit and as a probe, the CSC Model LPK Logic Probe Kit represents an excellent value.

The kit instructions are exceptionally well-written, offering step-by-step assembly procedures. Solder, wire, and all miscellaneous hardware are included in the kit—along with the printed circuit board, case, and all components, of course—leaving no extras to buy. Even beginning-level kit-builders can assemble the LPK quickly.

Once assembled, the LPK offers respectable performance as a logic probe. It is circuit powered through attached clip leads. HI, PULSE, and LO LEDs display logic states and transitions. The high logic state is defined as 70% or more of the supply voltage, the low state as 30% or less, making the probe compatible with most digital logic technologies or families. With its high (300,000-Ohm) input impedance, circuit loading is minimized.

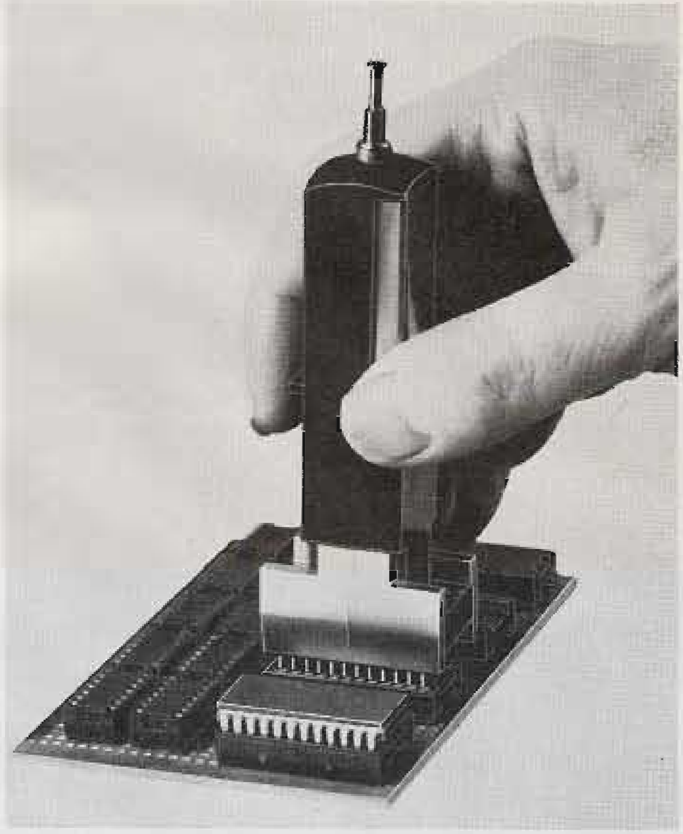
With the LPK, even very narrow pulses can be detected. Internal circuitry stretches pulses as short as 300 nanoseconds into 1/10 second flashes of the PULSE LED; pulse trains at repetition rates up to 1.5 MHz keep the PULSE LED flashing.

The LPK includes self-protecting circuitry which permits the power leads to be connected in reverse or to as much as 25 V dc without permanent damage; the probe tip, similarly, can contact ±50 V continuously or 110 V ac for up to 15 seconds without permanent damage to the probe.

As a troubleshooting tool, the LPK holds its own against any logic probe in all but very high speed applications. As an educational venture for the kit-builder, it should be noted that the LPK, while a digital tool, is based on analog circuitry, offering a unique opportunity to see how the two disciplines merge.

The LPK Logic Probe Kit is available through selected local distributors both in the US and around the world.

For more information, or for the name of your nearest CSC stocking distributor, call *Continental Specialties Corporation, 70 Fulton Terrace, New Haven CT 06509; phone (203)-624-3103, TWX (710)-465-1227.* Reader Service number C9.



IC Insertion Tool from OK Machine and Tool.

IC INSERTION TOOL

The new Model MOS-2428 DIP Inserter handles all MOS, CMOS, and regular 24- and 28-pin ICs. This unique new insertion tool also aligns bent-out pins. Simply rock the IC on the straightening saddle to align the pins. Press the tool over the IC to pick it up, then simply place the tool onto the socket and depress the plunger for instant and accurate insertion. The tool features heavy chrome plating throughout for reliable static dissipation. It includes a terminal lug for attachment of a ground strap. The MOS-2428 IC Insertion Tool is available from your local electronics distributor or directly from *OK Machine and Tool Corporation, 3455 Conner Street, Bronx NY 10475.* Reader Service number O5.

FREQUENCY COUNTER PREAMP

This general-purpose counter preamp has up to 25 dB gain from 10 MHz to 1 GHz. Designed to front-end a frequency counter's 50-Ohm VHF/UHF input, the AP-8015 preamplifier can be used with an antenna or pickup loop as well as be direct-coupled to allow low-level signal sources to be counted. The AP-8015 includes a 115 V wall plug transformer for ac operation as well as a dual 9-volt battery harness for portable operation. The preamp is enclosed in a heavy-duty anodized aluminum case. Size: 4-1/8" L x 2-1/4" W x 1-1/4" D. Weight: 6 ounces. For orders or information, contact *Optoelectronics, Inc., 5821 N.E. 14th Avenue, Ft. Lauderdale FL 33334; phone (305)-771-2050/1.* Reader Service number O3.

FSK-1000 DEMODULATOR FROM IRL

"This is not a sedan or a truck. This is a sports car."

That's how the engineers at iRL describe their new FSK-1000 demodulator.

The FSK-1000 is a new, sophisticated, two-tone limiterless demodulator which offers selectivity as narrow as 55 Hz in each of its matched, selectable-bandwidth, active-filter tone channels. Although it includes such "extras" as continuously adjustable shift, dual-mode autostart, and a keyboard-activated switch, the designers insist, "We don't want a family sedan dressed up with mud flaps and raccoon tails. We want to give the serious HF or VHF operator a TU with the best raw performance available anywhere."

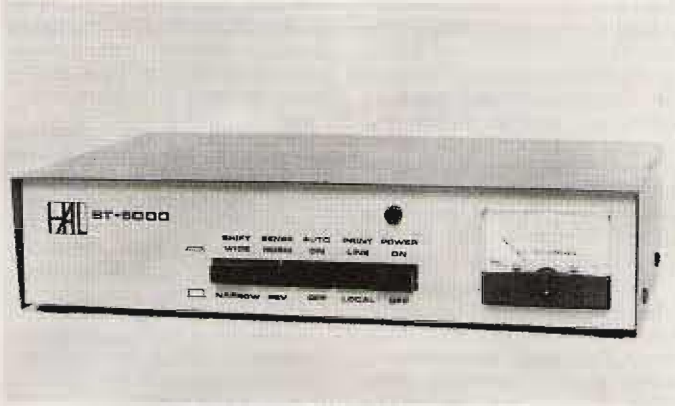
The FSK-1000 has both high-voltage current loop and low-voltage (RS-232 compatible) outputs to interface readily with mechanical teleprinters, computers, or both.

Receiver tuning requires a careful touch with the narrow filters switched in, but this gives the serious operator the selectivity he needs when the QRM gets really bad.

The FSK-1000 circuitry utilizes 48 operational amplifiers (twenty FET types) and a host of other devices. Complete details are available from iRL dealers or by writing *iRL, 700 Taylor Road, Columbus OH 43230.* Reader Service number 127.

NEW RTTY TERMINAL FROM HAL

HAL Communications is proud to announce a new compact and low-cost RTTY terminal—the DS2000 KSR. The new terminal features operation with Baudot, ASCII, and Morse codes (Morse receive optional) and incorporates many of the features of more expensive terminals. A new 72-character line by 24-line display format, two 32-character programmable "Here Is" messages, and CW identification at the touch of a key simplify operation. A terminal-status line keeps the operator aware of data rate, data code, and other terminal conditions. Text is transmitted one word at a time and editing is possible anywhere in the line being composed. All terminal functions are controlled by a combination of a control key and a key from the top row of the keyboard. Other deluxe features such as unshift-on-space, synchronous idle, keyboard-operated switch, and both QBF and RY test messages are available at the stroke of a key. Connect the DS2000 KSR to a standard 18-120 mA, 200 V dc (maximum) current loop for Baudot and ASCII operation. Morse output is accomplished via a transistor switch to



DS2000 RTTY terminal from HAL.

ground for keying either "grid-block" or "cathode" circuits. An optional Morse receive board (MR2000) is available for reception of Morse code at rates from 1-175 wpm and is customer installable allowing purchase at any time. An optional 9-inch diagonal measure video monitor is also available. The terminal weighs 6 lbs. (2.75 kg) net (10 lbs/4.55 kg shipping) and comes in an attractive blue and beige cabinet. Contact *HAL Communications Corp., PO Box 365, Urbana IL 61801,* for further information.

ROHN NO. 25 FOLD-OVER TOWER

When an amateur thinks of towers, chances are that he thinks of Rohn. And for good reason. Rohn has been building towers for a long time, providing amateurs with a variety of top-quality models at a reasonable price.

Recently, when I needed a new tower, my thoughts turned naturally enough to Rohn. Getting out their catalog, I thumbed through it to see just what they had to meet my particular requirements. After a few minutes of browsing, I decided that the 48-foot No. 25 Fold-Over was just what I was looking for.

Among the considerations I had in mind while choosing a new tower was that it get my beams clear of adjacent buildings and trees but not be so tall as to stand out prominently from its surroundings. As a result, I concluded that it should be approximately 50 feet high. And, since I prefer to keep my feet firmly on the ground, it should fold over so that work on the beams and rotor could be done from the ground or, at most, while standing on a short stepladder.

I also felt it highly desirable that the tower be easily assembled and disassembled by two people. And the likelihood that I would want to relocate it within the foreseeable future meant that it should be readily transportable, preferably in a small pickup or van. In addition, it should be rugged, durable, and easy and inexpensive to maintain. And, of course, it should be affordable.

The more I studied the Rohn catalog, the more I became convinced that the No. 25 Fold-Over was the answer. While I had never owned a Rohn tower, I was quite familiar with those used by friends and had been very favorably impressed by what I had seen. I liked the way they stood up to everything from hurricane winds in my native Florida to severe New England ice storms.

No. 25 towers utilize heavy-duty 1¼-inch-diameter #16-gauge steel tubing for side rails in a 12½-inch equilateral triangular design with solid-steel zig-zag cross pieces, entirely electrically-welded and fabricated by precision machines. There are 8 zig-zag steps per 10-foot tower section. Design and construction enables No. 25 towers to be installed at guyed heights up to 200 feet.

The tower's hot-dipped zinc galvanizing provides protection from rust and corrosion. A minimum molten zinc coating of 2 ounces for every square foot of surface fuses permanently to the metal, becoming an actual part of the steel so that it cannot be separated. Also, the tubular steel used in the towers is coated both inside and out to provide protection against deterioration from condensation and moisture. If a galvanized surface becomes scratched or chipped, the surrounding zinc actually "heals the wound" and continues to seal out corrosive elements.

Double-bolted joints are used to join tower sections for sturdiness and dependability. The No. 25's strength allows it to be self-supporting, provided a house bracket is used; it can go 35 feet above the bracket under normal conditions. A 200-foot No. 25 tower will withstand a 30-lb.-per-square-foot wind load—equivalent to 86.6 mph true wind velocity—when guyed and installed according to the manufacturer's specifications. This includes an antenna with an area of 6 square feet as well as 2 transmission lines. Those figures made me confident that a 48-footer with the sort of antennas I planned to use should be almost indestructible under typical New England weather conditions.

One of the things I like best about the No. 25 Fold-Over is the variety of mounting options that are available, covering virtually any situation you're ever likely to face. In addition to the more or less standard short base section for concrete, there is a hinged version for mounting in concrete, hinged and non-hinged base plates for use with concrete, plus mounts for flat and peaked roofs. And, also available and especially handy for Field Day, are a single drive-in base and a base plate for use with drive rods. If you can't guy, or you simply prefer not to, there are several sizes and types of house- and eave-brackets available. In my own case, I decided to install the tower at the rear of the barn using a house bracket for support.

In choosing a location for the tower, care should be taken to ensure that it will be well clear of trees, wires, buildings, and other objects, to permit a free swing of the hinged portion of the tower and antenna. If guys are to be used, the location should be suitable for placing four guy anchors at the appropriate distances.

The work begins with the digging of a hole 30 inches square by approximately 36 inches deep. After spreading a couple of inches of gravel in the bottom of the hole, attach the base section to the first 10-foot section and set the assembly on the gravel. Then spread another 3 inches of gravel around the legs of the base. This allows the tower base legs to extend the required amount below the base of the concrete, thus allowing for drainage of moisture into the gravel.

Before pouring the concrete, coat the base section over an area about 3 inches above and 3 inches below the space where the top of the concrete base will be, using a water-proof asphalt-type material. If the tower is situated near a building, be sure that the base is set so that two of the tower legs lie in a plane perpendicular to the wall of the building. This will cause the hinge axis to also be at right angles to the wall, and the tower will fold clear of the building. With the base set, pour the concrete around it and check its plumb with a carpenter's level on one or more of the legs of the tower. The top of the concrete should be slightly crowned to prevent water accumulation.

It's a good idea to allow at least three days for the concrete to harden before continuing to erect the tower. An erection fixture or gin pole will make the process easier and faster, especially if you decide to add one or two additional 10-foot sections, bringing the total height to 58 or 68 feet.

If you're doing a 48-footer like mine, you place the hinged section atop the second 10-foot section, making sure the shipping-tab bolt is closed and that the hinge is positioned on the correct side of the tower. Guy wires (if used) are then installed on the guying tabs near the hinge point. The next step is to align and bolt together the two pieces of the boom (lever) section. The boom is then attached to the hinged section. Be sure the hinge bolts are loosened before you attempt to fold the tower over. If practical, a house- or eave-bracket may be used at the hinge point in place of guy wires. The bracket must be placed within 2 feet of the hinge point.

The remaining sections are lifted into place and installed in the usual manner. Next, the winch and cable mechanism is bolted to the leg of the lower tower section, just below the clevis on the boom. If an additional 10-foot tower section has been placed below the hinge section, an extra pulley must be installed just below the clevis on the boom. Finally, the cable must be secured with clamps and a wire rope thimble to the boom clevis and to the winch.

That's all there is to putting up a Rohn No. 25 Fold-Over tower. The installation instructions are quite simple and straightforward. Follow them and you'll get your tower up quickly, easily, and, most important of all, safely!

Once the hole is dug and the base assembly is installed, two people can complete the job in a morning or afternoon, including mounting a rotor and beam. Then you can sit back and enjoy operating, secure in the knowledge that if you pull routine preventative maintenance a couple of times a year and take prompt care of anything that crops up between times, you'll have a setup that should provide many years of reliable service.

While the 48-foot No. 25 Fold-Over tower proved just right for me, it may not be what you need. In that case, you should check out the other versions of the No. 25, as well as the many other models available from Rohn. For more information, write *Unarco-Rohn, a Division of Unarco Industries, Inc., 6718 West Plank Road, PO Box 2000, Peoria IL 61656.* Reader Service number U2.

Morgan W. Godwin W4WFL
Brattleboro VT

LETTERS

from page 10

windows at the higher elevations to Midland, El Paso, and Carlsbad. For the NBVM QSOs, we are carrying a GE Microcassette recorder.

All radio systems will be powered directly, without the use of a battery, from a 72-cell solar array which weighs four pounds. Limited night operations from dark to bedtime will be powered by a palm-sized nicad battery. Antennas will be half-wave slopers or quarter-wave radiators against quarter-wave counterpoises, as most of that area offers a very poor rf ground.

On-the-air operations will occur according to the following schedule, beginning as early as midday Sunday; listen for CQ NBVM from K5SBU on NBVM, SSB, and CW.

0600 CDT/1100 UT	14,235 kHz
0700 CDT/1200 UT	7,195 kHz
0900 CDT/1400 UT	14,235 kHz
1000 CDT/1500 UT	28,85 kHz
1100 CDT/1600 UT	21,385 kHz
1230 CDT/1730 UT	7,195 kHz
1500 CDT/2000 UT	21,385 kHz
1700 CDT/2200 UT	14,260 kHz
1900 CDT/0000 UT	14,385 kHz
2000 CDT/0100 UT	21,385 kHz
2100 CDT/0200 UT	14,260 kHz

The first Texas NBVM station, Bob W5GEL (W5BT), will be on frequency to coordinate, as his time allows. We would be pleased to QSO with any mode and will listen carefully for other QRP stations and DX stations. All NBVM stations should be prepared to tape-record QSOs; send the tape with your QSL. If we can find our tape of the QSO, it will be recorded on the blank side of your tape and returned.

The signal from K5SBU will be very weak, so tune slowly. Ten minutes after the schedule time, if we do not have a QSO, we may QSY to the QRP CW calling frequency for that band (60 kHz up from the bottom of each band). QSL to address below.

C. Richard Hoffman K5SBU
Box 1600
Corpus Christi TX 78403

WAYNE GREEN'S LAIR

I found this editorial, *Wayne Green's Lair* (*VHFER*, Vol. 1, No. 5, September, 1963, Comaire Electronics, Ellsworth MI), written some time ago by Doug DeMaw (Senior Technical Editor, ARRL) and thought you might be interested.

Wayne Green's Lair

The trip would not be complete without a visit to "73 Acres" in Peterborough, N.H. Never before have we been greeted with such hospitality and friendliness. No one should sojourn through N.H. without meeting this dedicated man, his wife, and his staff, who have completely thrown themselves into the cause for improved amateur radio conditions. We enjoyed our overnight stay at W2NSD. A personally prepared waffle breakfast, by the "Ed." himself, with New Hampshire pure maple syrup and all the trimmings and garnished with a vigorous discussion related to the controversial matters of the day (which are destined to affect all ham radio operators) was very invigorating.

For many months I have tried to understand this man Green's motives and his attacks on other publishers and organizations, but until I met this guy face to face, I could not properly evaluate his thoughts. I am convinced through seeing the results of his publishing house efforts, listening to his explanation of his convictions, and hearing him relate his hopes for the ham fraternity and its future, that he is neither vindictive nor radical. He believes in what he is doing, and is willing to fight for those who share his beliefs.

Wayne's empire includes a mountaintop location a few miles distant from his main facility, which is composed of numerous sky wires, a farm house and a magnificent 125' tower supporting 96 elements on 2 meters. Along with all this, a mountain of radio gear reposes in the "shack" and is presently being assembled into operating positions of one kW denomination for all bands.

All in all, we were mighty glad to meet Wayne, his charming XYL, and staff. They are truly a wonderful group. Don't miss stopping at Peterborough when you are in that area.

I have been reading your magazine since its beginning, and I even went on the *73* trip to Europe. I still think you are one of the good guys.

Wm. Edwards K8DNV
Bellaire MI

GUATEMALA '76

One of my favorite pastimes is handling traffic from the nets as fast as I am able. Although the messages that are handled are of the health and welfare type, there is a certain amount of satisfaction which one gains in being able to deliver the message in the least amount of time. Until recently, the practice did not appear too important, but after several proddings by my fellow hams on various nets, I agreed to jot down the details of the contact that took place during the Guatemala earthquake in 1976.

Without any doubt, a major part of the credit for saving lives and organizing the rescue effort during the disaster is due to that very fine group of amateurs that carried the greatest load in and around Guatemala City. Our efforts at the time were devoted to assisting wherever we could and fitting into any circumstance where help was needed. For a time, the traffic was picked up from the Interstate Net on seventy-five in the evening and relayed to the Guatemala City stations the first thing the following morning. Many nets were utilized to ensure the most expeditious handling of the traffic.

During this time, not very many minutes passed when there was a lack of traffic. On February 14, 1976, an amateur station in Peru, OA4CYC, called. It seems that Maria OA4CYC had tried for several days to secure information on two sisters in Guatemala City and had probably monitored the traffic being passed on to the Guatemala City station, TG9DF, which she was unable to hear. After gaining our attention and the verification of callsigns, Maria asked for our help.

After trying for the previous three days by telephone and wire services, Maria wanted to know if it would be possible to secure health and welfare information on the two sisters who were in Guatemala City. On securing the details from Maria in Peru, the information was relayed immediately to Don TG9DF. He recognized the location where the two sisters were, or would be, in the city and indicated that he would try to reach that point via the local telephone system. In less than five minutes, Don had the answer for Maria: "The two sisters were not injured, were feeling fine, and were working hard."

That message was relayed to Dayton OH and then to OA4CYC in Peru within eleven minutes of the moment the message was received. This was amateur radio in action, and a small example of the real-life drama that can occur.

This short experience of mine would not even have been in print had it not been for my friends and fellow amateurs who pointed out that the benefits afforded by amateur radio would be far greater if the story was put in print.

Paul Weigert, Jr. W8TH
Centerville OH

NEEDED LESSON?

I had no complaints about Bill Pasternak's Looking West column until now, but since he went over to the Int'l HFers Headquarters and was baptized, it seems to me that he may be needed more in their Fox Tango Newsletter than in *73*. These people haven't changed a bit—they still espouse and promote illegal, scofflaw bootlegging outside of the CB band. But I guess even Pasternak is no exception—California is a veritable hotbed of illegal activity—must go along with the kook philosophies prevalent out there in the Land of the Cults.

CB neighbors of mine are in receipt of several letters from various printing callbooks (phoney calls and first names only, of course) and operating QSL card bureaus out of PO boxes. For anywhere from two to ten dollars, you can get a 2 Echo, 19 Whiskey, TCN66, or whatever happens to be in vogue at the moment, plus your QSL cards forwarded to your QTH monthly! Neat.

What I can't understand is how some of them can "guarantee" that the FCC will leave them alone "if they use their Echo call and only operate on certain frequencies." Another club claims that they have "advance notice" when the FCC is going to appear in a given area! Is the FCC really cooperating with these bandits?

Another thing I fail to understand is why the FCC can't seem to find these people, even though the same ones are on the air every day, day in and day out, and talk for hours! Even an idiot could drive up to their door with a simple receiver with no S-meter!

At least (so far) most of the nitwits have had the good sense (or are afraid) to stay out of the 10-meter ham band. But I'd like to see the FCC legalize 27.4 to 28.0—*then* "superior" ones would surely move into ten. There is a certain type of CBer who just *has* to operate illegally, even if there's no reason to. This type will eventually take over and ruin what's left of ham radio.

Frankly, I'm hoping that WARC '79 will give all our ham bands to the minority countries. It might teach the whole damned bunch of us a much-needed lesson!

William L. Harris KN9FOV
Lafayette IN

ASHAMED

This isn't really a letter to the editor, but I thought you should know that Stan Jopek K2JQT passed away on April 13, 1979. Stan was 40 years old and in excellent health, but he had a sudden fatal heart attack. He leaves his wife, Joan, and four teenage children. Stan was very active on six meters in the past, and was more active recently on 2 FM as the owner/operator of the .07/.67 repeater in Fredonia NY.

As tragic as Stan's sudden death was, subsequent events were repulsive, and they were the reason for this letter. One day after his death, while the family and friends were at the funeral home, someone broke into the .07/.67 repeater site and stole the entire machine and backup systems. The total value of the loss was over $3800.

What I find most repulsive in this is that the theft had to have been done by hams. The .07/.67 repeater was located in a remote area, and very few people even in amateur circles knew its exact location. It was located in a building along with several other commercial repeaters and transmitters which were much more valuable, less traceable, and much more portable. These units were not touched. The thieves were thorough. They even searched out the manuals for the 2-meter gear and took them also; they pig-tailed off the power leads, took the input tags for identification, and even taped up the leads to the standby batteries.

A four-wheel-drive vehicle was used, and at least two people carried the 6' high 19" rack over the muddy ground to the vehicle. The theft is being investigated by the Chautauqua County Sheriff's Department, and any information should be forwarded to them at (716)-672-5151. The Spectrum 1000 serial number is 0219.

I feel confident that a theft of this magnitude and perfidy will be solved. I only hope that the persons responsible are apprehended by the authorities rather than members of the repeater club. This is the first time I've ever really been ashamed of being a ham.

Ron Warren WA2LPB
Fredonia NY

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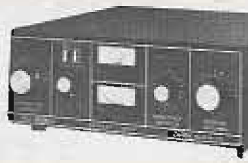

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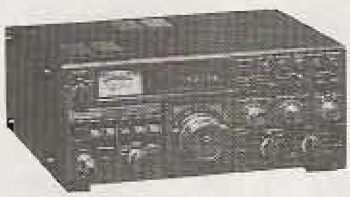

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Ham Help

If anyone has a Heathkit HW-20 Pawnee (2m AM tunable xcvr) that is physically complete but not necessarily operating, I am interested in purchasing it. Please state whether or not the manual would be included. I will be happy to pay shipping via UPS.

Wm. C. Aycock WB5YEE
257 Belair Dr.
Pearl MI 39708

Our radio club has been given an old US Coast Guard receiver, model R-649/UR, made by Hallicrafters. Can anyone help me find a schematic for it? Thanks.

Thomas Dick WA9QDZ
2851 Wayside Dr.
Evansville IN 47711

I desperately need the schematic for a Hy-Gain UHF 4-channel pocket scanner. Any help would be most appreciated.

Dennis Lemonds WB4QCD
PO Box 194
Estill Springs TN 37330

I have a 0-500-MHz frequency counter made by Northeastern Engineering, Inc., Model 14-20C. The counter is a large unit, about 75 lbs. and two feet square with tube-type design using nixie tubes for the frequency readout. I've been trying to find a manual for this gear with no success thus far. Fair Radio Sales can offer a schematic but no manual. Can anyone out there help me? Any effort would be greatly appreciated. Thank you.

R. W. Bowyer KA4DTP
7335 Sunnybrook Dr.
Roanoke VA 24019

I bought a Kenwood TS-520S and have never felt like I have the tune adjustment right for best resonance of the final 6146Bs. The book furnished isn't too clear. Could anyone help me by explaining the proper procedure for adjusting this rig?

A. E. Farrell KA5DFV
4324 S.E. 16
Del City OK 73115

I would like to know what the boom length and element spacings are on a TA-33 Jr. Mosley triband: The moving company lost my boom.

Hubert J. Harlow KA5COS
1812 Arnold Palmer
El Paso TX 79935

I need a relay coil for a Central Electronics 20-A SSB exciter. Please give price.

Odell Gatlin W4MEM
R#1, Box 279
Killen AL 35645

I need the schematic for an old Hallicrafters receiver, model number SX77A or S-77A. Can anyone help?

P. B. Bjorklund
1075 Los Altos Ave.
Los Altos CA 94022

I need a Tempo One external vfo.

Keith H. Gilbertson WB0LXM
Rt. #4, Box 29A
Detroit Lakes MN 56501

I would like to arrange a CW 15 meter QSO with a Vermont ham in order to complete my WAS.

Bob Cent WB7UNM
US PHS
Rocky Mtn. Lab
Hamilton MT 59840

Social Events

from page 130

hope to arrange special licenses for visiting hams who may wish to operate from XE1-land during their stay. There will be a flea market and demonstrations at the convention hall. For more information, contact the Radio Club Leon, PO Box 12A, Leon, Guanajuato, Mexico.

ESSEX MT
JUL 21-22

The International Glacier-Waterton Hamfest will be held on July 21-22, 1979, at the Three Forks Campground, ten miles east of Essex, Montana, on US Highway 2. Registration is at 9:00 am. Talk-in on .52 and .34/.94. For more information, write Glacier-Waterton Hamfest, PO Box 2225, Missoula MT 59806.

EUGENE OR
JUL 21-22

The 4th annual Lane County Ham Fair will be held on July 21-22, 1979, at the Oregon National Guard Armory, 2515 Centennial Blvd., Eugene, Oregon. Registration is $3.00, and an extra drawing ticket is given with advance registration. There will be displays, lectures, contests, swapshop, transmitter hunt, and entertainment. The facilities provide plenty of free parking for motor homes and trailers.

For information and advance reservations, phone or write Wanda or Earl Hemenway, 2366 Madison, Eugene OR 97405 at (503)-485-5575.

PITTSFIELD MA
JUL 21-22

The NoBARC Hamfest will be held on July 21-22, 1979, at Cummington Fairgrounds, Pittsfield, Massachusetts. There will be tech talks, demonstrations, and dealers. Flea market admission is $1.00. Advance registration is $3.00 single and $5.00 with spouse, and $4.00/$6.00 at the gate. Gates open at 5:00 pm on Friday for free camping. Talk-in on 146.31/.91. For reservations, contact Tom Hamilton WA1VPX, 206 California Ave., Pittsfield MA 01201.

GOLDEN CO
JUL 22

The Rocky Mountain Radio League, Inc., will hold its Field Demonstration Day and Swapfest on July 22, 1979, at the home of Karl Ramstetter WA0HJZ, which is located on Highway 93, Golden Gate Canyon Road. This is accessible by going one mile north of the city limits of Golden, turning westward off Highway 93 onto Golden Gate Canyon Road, proceeding for approximately 7½ miles, and making a right turn across the cattle guards. Signs will be posted for further directions. There will be demonstrations, including slow-scan TV and computers, door prizes, and a potluck lunch, with soft drinks and ice supplied by the League. It would be appreciated if everyone would make his contribution to the potluck lunch by bringing his favorite dish and helping out the League with any spare blankets and chairs. There will be camping facilities available for campers, trailers, mobile homes, etc., on Saturday afternoon before the Fest. No dogs, guns, or motorbikes, please.

MARSHALL MO
JUL 22

The Indian Foothills Amateur Radio Club will hold its 4th annual hamfest on July 22, 1979, at the Saline County Fairgrounds, Marshall, Missouri. Tickets are $2.00 each or 3 for $5.00 in advance; $2.50 at the door. Registration is at 8:00 am, with lunch at 11:30 pm (all you can eat) and the drawing at 2:30 pm. Prizes include a Tempo S1, a DenTron Jr. Monitor™ tuner, and many more. There will be flea markets for the OM and XYL. There is no charge for flea market tables this year, but reservations are requested. There will also be old and new equipment displays, a 10-X booth, and other activities for the XYLs. Talk-in on .52, .28/.88, and 147.84/.24. For information and tickets, write Norman Gibbins WB0SZI, 692 North Ted, Marshall MO 65340.

SHEBOYGAN WI
JUL 22

The annual Lakeshore Swapfest and Bratwurst Fry will be held on Sunday, July 22, 1979. Events include prizes, a flea market, an auction, and manufacturers' displays. Admission is $1.00. Talk-in on .66/.06. For further information, contact WB9NRM at (414)-457-3203.

BELVIDERE IL
JUL 22

The Big Thunder Amateur Club will hold its annual hamfest on Sunday, July 22, 1979, at the Boone County Fairgrounds. The fairgrounds are located one mile north of Belvidere on IL-76. Talk-in on .52 simplex. Donations are $2.00 at the door. Advance tickets are $1.50. For information and tickets, contact Michael Santucci WD9JGH, 862 Ivy Oaks Rd., Caledonia IL 61011.

MACKS INN ID
JUL 27-29

WIMU (Wyoming, Idaho, Montana, and Utah) will hold its 47th annual hamfest on July 27-29, 1979, at Macks Inn, Idaho. Festivities include 2-meter hunts, OSCAR demonstrations, ladies' crafts, and a repeater display. The pre-registration prize will be a Wilson Mark II handie-talkie complete with touchtone™, battery pack, and charger. The grand prize is your choice of an Icom IC-211 or a Kenwood TS-520. Saturday night special events include kids' movies and an adult dance. For further information, contact Dave Hunting WB7FGV, Box 662, Kemmerer WY 83101, or call (307)-877-9440.

MOOSE JAW SASKATCHEWAN CAN
JUL 27-29

The Moose Jaw Amateur Radio Club will hold its 1979 Hamfest (Particifest 79) on July 27-29, 1979, at the Saskatchewan Technical Institute, 600 Saskatchewan St. W., Moose Jaw, Saskatchewan, Canada. Registration will be held on Friday evening with a full day of activities on Saturday culminating in a banquet and dance. Most of the meetings and workshops will be held on Sunday. There will also be a busy schedule for the XYLs.

OKLAHOMA CITY OK
JUL 27-29

The Central Oklahoma Radio Amateurs will sponsor the Oklahoma State ARRL Convention and "Ham Holiday" on July 27-29, 1979, at Lincoln Plaza, 4445 Lincoln Blvd., Oklahoma City, Oklahoma. The program will include an ARRL forum and technical talks on 1-GHz techniques, fast-scan TV for radio amateurs, NBVM, and other subjects of current interest. In addition, a full program is scheduled for the ladies. Pre-registration will be $4.00 if received before July 20. After that date, it will be $5.00. A synthesized 800-channel VHF transceiver will be awarded to encourage pre-registration. The main award will be a TS-120V with power supply. Adequate rooms are available for commercial exhibitors and swappers. Mail your registration to CORA, PO Box 14424, Oklahoma City OK 73113.

Unlimited parking space is also available.

OLIVER BC CAN
JUL 28-29

The Okanagan International Hamfest will be held on July 28-29, 1979, at Gallagher Lake KOA Kampsite, 8 miles north of Oliver, B.C., Canada. Registration starts at 9:00 am Saturday. Activities start at 1:00 pm Saturday and continue until 2:00 pm Sunday. Ladies may bring their hobbies and items for a white-elephant sale. Featured will be prizes, a flea market, bunny hunts, entertainment, a home-brew contest, and more. A potluck lunch will be served Sunday at noon. Call-in on 3800, .34/.94, and .76 simplex. For information, write John Juul-Andersen VE7DTX, 8802 Lakeview Dr., Vernon, B.C., Canada V1B 1W3, or Lota Harvey VE7DKL, 584 Heather Rd., Penticton, B.C., Canada V2A 1W8.

BOWLING GREEN OH
JUL 29

The Wood County Amateur Radio Club will hold its 15th annual Wood County Ham-a-Rama on July 29, 1979, at the Bowling Green Fairgrounds, Bowling Green, Ohio. Gates will open at 10:00 am, with free admission and parking. Dealer tables and space are available. Trunk sale space and food will also be available. Tickets are $1.50 in advance and $2.00 at the door. Prizes will be awarded. Talk-in on .52 K8TIH. For information, write Wood County ARC, c/o Eric Willman, 14118 Bishop Road, Bowling Green OH 43402.

NASHVILLE TN
JUL 29

The Radio Amateur Transmitting Society (R.A.T.S.) of Nashville, Tennessee, will sponsor the Nashville Hamfest on Sunday, July 29, 1979, at the National Guard Armory on Sidco Drive, in Nashville, Tennessee. Tables, bargains, and refreshments are available, as well as prizes. Admission is $3.00. Talk-in on .90/.30. For more information, contact Richard Wagner K4MZE, 1015 Haber Drive, Brentwood TN 37027, or phone (615)-794-5356.

BALTIMORE MD
JUL 29

The Baltimore Radio Amateur Television Society (BRATS) will be holding the annual BRATS Maryland Hamfest on Sunday, July 29, 1979, at the Howard County Fairgrounds, Rtes. 32 and I-70, 15 miles west of Baltimore, Maryland. The event, beginning at 8:00 am rain or shine, includes a giant flea market, indoor and outdoor exhibit areas, top prizes, and plenty of good food and refreshments. Tickets are $2.00, tailgating is $2.00, and tables are $4.00 in advance, $5.00 at the

Continued on page 204

QUESTION: Who has Advanced Electronics, Alpha, AMECO, Amphenol, Antenna Specialists, Astatic, Atlas, Bencher, Bird, Bomar, B&W, CDE, CES, CSC, Cushcraft, Daiwa, Datong, DGM, Drake, ETO, F9FT, Finco, Ham Key, Henry Hustler, Hygain, JMR, KLM, Kenwood, Larsen, MFJ, Microwave Filter, Morgain, Mosley, Newtronics, NPC, Nye Viking, Regency, Robot, Rohn, Sharp, SST, TPL, YAESU, more? ANSWER: TUFTS RADIO ELECTRONICS. Send for our fabulous radio catalog today.

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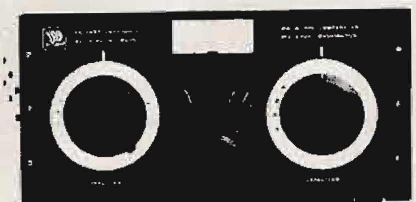
- New device opens up the world of VLF radio.
- Converts VLF to 80 meters. For use with any shortwave receiver covering 3.5-4 MHz.
- Advanced design for simple operation, high performance.
- Gives reception of the 1750 meter band.
- Also covers navigation radiobeacons, WWVB, ship-to-shore, and LF broadcast band.

LOOP ANTENNA
Loop Amplifier $67.50
Plug-in loops $47.50 ea.

- Plug-in loops available for:
  1600-5000 KHz (160/80 meter amateur bands)
  550-1600 KHz (Broadcast Band)
  150-550 KHz (VLF, 1750 meter band)
  40-150 KHz (WWVB, Loran)
  10-40 KHz (Omega)
- Nulls out interference

ALL BANDS PREAMPLIFIER
$89.50

- Tunes 1.8 to 54 MHz. Covers ALL amateur bands 160 to 6 meters. ALL shortwave broadcast bands.
- For receivers AND transceivers.
- Up to 20 db gain.
- Peps up that tired receiver.
- Reduces image and spurious response.



Nye Viking

Model MB II $295
(with Balun) $325

MB II provides:
*Constant SWR monitoring. *Precision tuning of final amp. *Harmonic suppression. *Receiver input impedance-matching. *Maximum power transfer to antenna *Continuous frequency coverage 1.6 to 30 MHz *Precision tuning of any wire ¼ wavelength or longer, with SWR of 1:1.

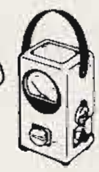
MB II features:
*Finest quality, made-in-USA components. *Large, precision, easy-to-read dials with 360 readout. *Optional 3000 watt Balun for twin lead antennas.

BIRD Electronic Corporation

$94 **VHF model 4362** (140-180 MHz)
$94 **HF model 4360** (18- 30 MHz)

The 4360, 4362 HAM-MATE Directional Wattmeters are insertion type instruments for measuring forward or reflected power in 50-ohm coaxial transmission lines. They are direct descendants of the model 43 THRULINE* Wattmeter — the professional standard of the industry — and will accurately measure RF power flow under any load condition. Each wattmeter is made up of a precisely matched section of 50-ohm line, a rotatable sensing element and meter calibrated in watts, all mounted in a high-impact plastic housing. It is this type of solid construction and the directional THRULINE coupling circuit, **without toroids**, that account for the superiority of the HAM-MATE Wattmeters.

the indispensable BIRD 43 THRULINE WATTMETER



Power Range	Frequency Bands (MHz) 2-30	25-60	100-250	200-500	400-1000
5 watts		5A	5C	5D	5E
10 watts		10A	10C	10D	10E
25 watts		25A	25C	25D	25E
50 watts	50H	50A	50C	50D	50E
100 watts	100H	100A	100C	100D	100E
250 watts	250H	250A	250C	250D	250E
500 watts	500H	500A	500C	500D	500E
1000 watts	1000H	1000A	1000C	1000D	1000E
2500 watts	2500H				
5000 watts	5000H				

MODEL 43	$125.00
Elements (Table 1) 2-30 MHz	45.00
Elements (Table 1) 25-1000 MHz	38.00
Carrying case for Model 43 & 6 elements	27.50
Carrying case for 12 elements	17.00

READ RF WATTS DIRECTLY! (Specify Type N or SO239 connectors) 0.45 – 2300 MHz, 1-10,000 Watts ±5%, low insertion VSWR – 1.05. Unequalled economy and flexibility. Buy only the element(s) covering your present frequency and power needs, add extra ranges later if your requirements expand.

B&W Barker & Williamson

5 —BAND TRAP DIPOLE
(80 thru 10 Meters)

Power rated 2k WPEP, approx. 110 ft. span

Complete with: wire, traps, end insulators, 50 ft. RG-8/U, PL-259 connector, heavy-duty cast aluminum and steatite center connector. 4-Band (40 thru 10M) 55 ft.

Pre-assembled:
Model 370-11
— $59.95

Kit (illustrated):
Model 370-12 — $49.95

BOMAR Crystal Company

TWO METERS
CRYSTALS IN STOCK

Motorola HT 220 Crystals
In Stock!

Standard ● Icom ● Heathkit ● Ken ● Clegg ● Regency ● Wilson ● VHF Eng. ● Drake ● And Others! **Lifetime Guarantee! Now only $9/pair.**

Hy-Gain REEL TAPE PORTABLE DIPOLE for 10 thru 80 Meters Model 18TD

The most portable high performance dipole ever...

The Model 18TD is unquestionably the most foolproof high performance portable doublet antenna system ever developed. It has proven invaluable in providing reliable communications in vital military and commercial-applications throughout the world. Two stainless steel tapes, calibrated in meters, extend from either side of the main housing up to a total distance of 132 feet for 3.5 mc operation 25 ft. lengths of polypropylene rope attached to each tape permits installation to poles, trees, buildings... whatever is available for forming a doublet antenna system Integrated in the high impact housing is a frequency to length conversion chart calibrated to meter measurements on the tapes... makes installation foolproof. Feeds with 52 ohm coax. Delivers outstanding performance as a portable or permanent installation Measures 10x3½x2 inches retracted Wt., 4.1 lbs.
Order No. 228 Price: $94.95

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Also available for
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NEW! NEW! NEW!

KDK

FM2016A

All Solid State-CMOS PL digital synthesized - No Crystals to Buy! 5KHz steps - 144-149 MHz-HUGE ⅜" LED digital readout PLUS MARS-CAP and MULTIPLE OFFSET BUILT IN. ● 5 MHz Band Coverage - 1000 Channels (instead of the usual 2 MHz to 4 MHz-400 to 800 Channels) ● 4 CHANNEL RAM IC MEMORY WITH SCANNING AND AUTO TRANSMIT ● MULTIPLE FREQUENCY OFFSETS ● ELECTRONIC AUTO TUNING - TRANSMIT AND RECEIVE ● INTERNAL MULTIPURPOSE TONE OSCILLATOR ● RIT ● RF ATT ● DISCRIMINATOR METER - 16 Watts Output-Superior Receiver Sensitivity and Selectivity - 15 POLE FILTER, MONOLITHIC CRYSTAL FILTER AND AUTOMATIC TUNED RECEIVER FRONT END, COMPARE! ● Superb Engineering and Superior Commercial Avionics Grade Quality and Construction Second to None at ANY PRICE.

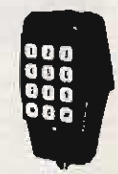
INTRODUCTORY PRICE

$369.00

ALSO - **NEW** FM 6016A FOR 6 METERS

Regulated AC/PS Model FMPS-4R . . . $39.95

SHOWN WITH OPTIONAL µP-800 MICRO-PROGRAMMER* **$99.00**



FMMC-1* Microphone with Built-in Touch Tone Pad

WHY BUY LESS? THE FMMC-1 HAS IT *ALL!*

- New! Auto key up
- Snap-Action Keyboard
- Adj. level and tone balance
- Use with any transceiver
- Only 3¼" x 2" $39.95

- **FREQUENCY RANGE**: Receive and Transmit: 144.00 to 148.995 MHz, 5 Khz steps (1000 channels) + MARS-CAP and MULTIPLE OFFSET BUILT IN.
- **HUGE ⅜" LED DIGITAL READOUT.**
- **4 CHANNEL RAM SCANNER WITH IC MEMORY AND AUTO TRANSMIT**: Program any 4 frequencies and reprogram at any time using the front panel controls—search for occupied (closed) channel or vacant (open) channels. Internal Ni-Cad included to retain memory (no diode matrix to wire or change).
- **MULTIPLE FREQUENCY OFFSETS: NO CRYSTALS TO BUY - EVER** - Any offset any split! "Odd Ball" splits accomplished by digital programming. Never any need for crystals!
- **INTERNAL MULTIPURPOSE TONE OSCILLATOR BUILT IN**: Sine Wave 1750 Hz tone burst for "whistle on operation" and sub-audible tone operation. Internal 2 position switch for automatic and manual operation, tone burst or sub audible tone. PL - adjustable 60-203 Hz (100 Hz Pre-Set).
- **AIRCRAFT TYPE FREQUENCY SELECTOR**: Large and small coaxially mounted knobs select 100KHz and 10KHz steps respectively. Switches click-stopped with a home position facilitate frequency changing without need to view LED's while driving and provides the sightless amateur with full Frequency Selection as standard equipment.
- **FULL AUTOMATIC TUNING OF RECEIVER FRONT END AND TRANSMITTER CIRCUITS**: DC output of PLL fed to varactor diodes in all front end RF tuned circuits provides full sensitivity and optimum intermodulation rejection over the entire band. APC (AUTO POWER CONTROL) - Keeps RF output constant from band edge to band edge. NO OTHER AMATEUR UNIT AT ANY PRICE has these features which are found in only the most sophisticated the expensive aircraft and commercial transceivers.
- **TRUE FM**: Not phase modulation - for superb emphasized hi-fi audio quality second to none.
- **RIT CONTROL**: Used to improve clarity when contacting stations with off frequency carrier.
- **MONITOR LAMPS**: 2 LED's on front panel indicate (1) incoming signal-channel busy, and (2) Transmit.
- **FULLY REGULATED INTEGRAL POWER SUPPLY**: Operating voltage for all 9v circuits independently regulated. Massive Commercial Hash Filter.
- **MODULAR COMMERCIAL GRADE CONSTRUCTION**: 3 Unitized modules eliminate stray coupling and facilitate ease of maintenance.
- **ACCESSORY SOCKET**: Fully wired for touch tone, phone patch, and other accessories. Internal switch connects receiver output to internal speaker when connector is not in use.
- **MULTI-PURPOSE METER**: Triple Function Meter Provides Discriminator Meter, "S" Reading on receive and Power Out on Transmit.
- **RECEIVE**: Better than .25uv sensitivity, 15 POLE FILTER as well as monolithic crystal filter and AUTOMATIC TUNED LC circuits provide superior skirt selectivity - COMPARE!
- **HIGH/LOW POWER OUTPUT**: 16 watts and 1 watt, switch selected. Low power may be adjusted anywhere between 1 and 16 watts. Fully protected - short or open SWR.
- **RF ATT**: Live right next to King Kong Repeater and can't operate? With the 2016A You Can - Just flick the RF ATT switch. Only the 2016A has this feature.
- **OTHER FEATURES**: Dynamic Microphone, built in speaker, mobile mounting bracket, external 5 pin accessory jack, speaker jack, and much, much more. Size 2½ x 7 x 7½. All cords, plugs, fuses, microphone hanger, etc. included. Weight 5 lbs.

Manufactured by one of the world's most distinguished Avionics manufacturers, Kyokuto Denshi Kaisha, Ltd. First in the world with an all solid state 2 meter FM transceiver.

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A21

FREQUENCY COUNTER KIT

Outstanding Performance

CT-50

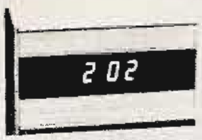
Incredible Price $89.95

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm, 20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. **Order your today!**

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadir	15.95

CAR CLOCK



The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock, which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock

12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDS, high accuracy (1 min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
DM-1 dimmer adapter	2.50

PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens, typically 20 mv at 150 mHz. Specify ÷ 10 or ÷ 100 ratio.

PS-1B, 600 mHz prescaler	$59.95
PS-1BK, 600 mHz prescaler kit	49.95

OP-AMP SPECIAL

741 mini dip	12/$2.00
B1-FET mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all. 6- 5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches.
Complete kit, less case (not available)
DC-9 $34.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 kit	$12.95
FM-3 wired and tested	16.95

CLOCK KITS

our Best Seller
your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).

Clock kit, 12/24 hour, DC-5	$22.95
Clock with 10 min. ID timer, 12/24 hour DC-10	27.95
Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

Hard to find PARTS

LINEAR ICs		**REGULATORS**	
301	$ .35	78MG	$1.25
324	1.50	723	.50
380	1.25	309K	.85
380-8	.75	7805	.85
555	.45	78L05	.25
556	.85	7905	1.25
566	1.15	7812	.85
567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	**TTL ICs**	
CMOS ICs		74S00	.35
4011	.20	7447	.65
4013	.35	7475	.50
4046	1.85	7490	.50
4049	.40	74196TI	1.35
4518	1.25	**SPECIAL ICs**	
5369	1.75	11C90	13.50
TRANSISTORS		10116	1.25
2N3904 type	10/1.00	4511	2.00
2N3906 type	10/1.00	5314	2.95
NPN 30W Pwr	3/1.00	5375AB	2.95
PNP 30W Pwr	3/1.00	7001	6.50
2N3055	.60	4059-N	9.00
UJT 2N2646 type	3/2.00	7208	17.95
FET MPF102 type	3/2.00	**LEDs**	
UHF 2N5179 type	3/2.00	Jumbo red	8/1.00
MRF-238 RF	11.95	Jumbo green	6/1.00
SOCKETS		Jumbo yellow	6/1.00
8 pin	10/2.00	Mini red	8/1.00
14 pin	10/2.00	Micro red	8/1.00
16 pin	10/2.00	BiPolar	.75
24 pin	4/2.00	**FERRITE BEADS**	
28 pin	4/2.00	With info. specs	15/1.00
40 pin	3/2.00	6 hole balun	5/1.00

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 kit **$2.95** FM-2 kit **$4.95**

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.
Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 $2.95

VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!
Complete kit, VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 $5.95

WHISPER LIGHT KIT

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
Complete kit, WL-1 $6.95

SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
Complete kit, BN-9 $5.95

POWER SUPPLY KIT

Complete triple regulated power supply provides variable ±6 to 18 volts at 200 ma and +5V at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.
Complete kit, PS-3LT $6.95

SIREN KIT

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 $2.95

ramsey electronics

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TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order, $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

R8

NATIONAL SEMICONDUCTOR **NEW!**

CAR CLOCK MODULE - #MA6008

$6.99 each

SPECIAL OFFER: Two for $13

Originally used by HYGAIN to indicate time and channel on an expensive C.B. Mini size, self contained module. Not a Kit. Four digits plus flashing indicator for seconds. Includes MM5369 and 3.58 MHZ crystal for super accurate time base. With hookup data.

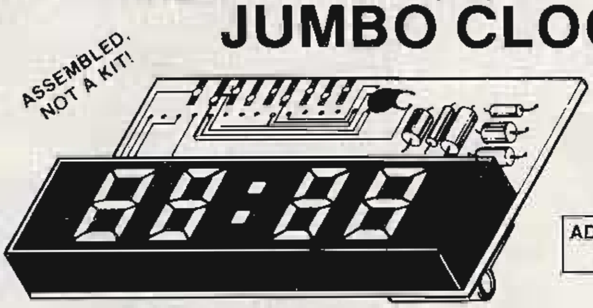
INCLUDES CRYSTAL TIMEBASE!
WORKS ON 12 VDC!

MFGR's CLOSEOUT
LIMITED QTY.

NATIONAL SEMICONDUCTOR

MILITARY TIME FORMAT! **MA1008D BRAND NEW!**

JUMBO CLOCK MODULE



$4.95
REG. $9.95

ADD $1.95 FOR AC XFMR

FEATURES:
- ★ FOUR JUMBO ½ INCH LED DISPLAYS
- ★ 24 HR REAL TIME FORMAT
- ★ 24 HR ALARM SIGNAL OUTPUT
- ★ 50 OR 60 Hz OPERATION
- ★ LED BRIGHTNESS CONTROL
- ★ POWER FAILURE INDICATOR
- ★ SLEEP & SNOOZE TIMERS
- ★ DIRECT LED DRIVE (LOW RFI)
- ★ COMES WITH FULL DATA

ZULU
50% OFF SALE!

PERFECT FOR USE WITH A TIMEBASE.

COMPARE AT UP TO TWICE OUR PRICE!

MANUFACTURER'S CLOSEOUT!

NATIONAL SEMICONDUCTOR
SIX DIGIT ALARM CLOCK CHIP

National's second generation clock chip. 24 Pin Dip. Super easy to use.

FEATURES:
- 12 HOUR DISPLAY ★ 24 HOUR ALARM
- 4 OR 6 DIGITS ★ ALARM TONE OUTPUT
- SNOOZE ALARM ★ EASY LED INTERFACE
- POWER FAIL IND. ★ BRIGHTNESS CONTROL
- AM/PM INDICATION ★ SINGLE POWER SUPPLY
- FAST AND SLOW SET ★ LOW POWER

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WE SUPPLY FULL DATA, SPECS.
MM5375AA

$2.49 each
3 FOR $5.95

HUGE SPECIAL PURCHASE!

MICRO-MINI TOGGLE SWITCH

SPDT. By RAYTHEON. MADE IN USA! WITH HDWR.

99¢ EACH **6 FOR $5**

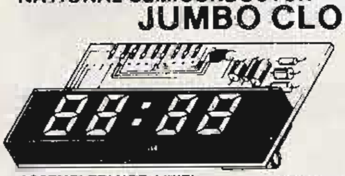
60 Hz CRYSTAL TIME BASE
$4.95 (Complete Kit)
Uses MM5369 CMOS divider IC with high accuracy 3.579545 MHZ Crystal. Use with all MOS Clock Chips or Modules. Draws only 1.5 MA. All parts, data and PC Board included.

FET SALE
2N4304. Brand New N Channel, Junction Fet. BVGD0-30V IDSS-15 MA Typ. 1500 uMHOS. TO-18 Plastic Case. Mfg. by Teledyne.
6 FOR $1

FAIRCHILD PNP "SUPER TRANSISTOR"
2N4402. TO-92 Plastic. Silicon PNP Driver. High Current. VCEO-40 HFE-50 to 150 at 150 MA. FT-150 MHZ. A super "BEEFED-UP" Version of the 2N3906.
8 FOR $1

JUMBO IC ASSORTMENT
All new not rejects. BIG computer mfg. Surplus. Some standard marked, many house numbered. TTL, DTL, LINEAR. All prime. 1st line.
50 for $1.59 **500 for $12.95**

NATIONAL SEMICONDUCTOR
JUMBO CLOCK MODULE
MA1008A BRAND NEW!



$6.95 (2 FOR $13)
(AC XFMR $1.95)

FEATURES
- FOUR JUMBO ½ INCH LED DISPLAYS
- 12 HR REAL TIME FORMAT
- 24 HR ALARM SIGNAL OUTPUT
- 50 OR 60 Hz OPERATION
- LED BRIGHTNESS CONTROL
- POWER FAILURE INDICATOR
- SLEEP & SNOOZE TIMERS
- DIRECT LED DRIVE (LOW RFI)
- COMES WITH FULL DATA

ASSEMBLED! NOT A KIT!
MANUFACTURER'S CLOSEOUT!
PERFECT FOR USE WITH A TIMEBASE.
COMPARE AT UP TO TWICE OUR PRICE!

MORE CLOCK CHIPS!

MM5316 - 4 Digit W/Alarm. An old reliable, work horse chip — **$1.99**

MK50380 - 4 Digit - Direct Drive on Readouts. Like FCM 7010 — **$1.99**

MK50250 - 6 Digits with Alarm. For multiplexed Led R.O. — **$2.95**

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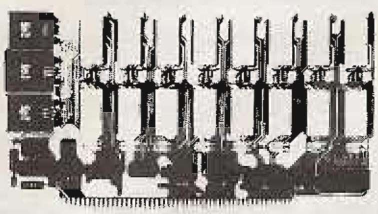
16K EPROM CARD-S 100 BUSS



$59.95 KIT

OUR BEST SELLING KIT!

USES 2708's!

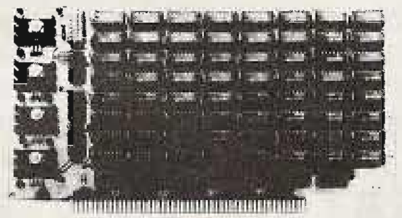
Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. All parts (except 2708's) are included. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT

ASSEMBLED AND FULLY TESTED ADD $25

8K LOW POWER RAM KIT-S 100 BUSS

250 NS SALE!



ADD $5 FOR 250NS!

$129 KIT

(450 NS RAMS!)

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use.

KIT FEATURES:

1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

Blank PC Board w/Documentation **$29.95**
Low Profile Socket Set...**13.50**
Support IC's (TTL & Regulators) **$9.75**
Bypass CAP's (Disc & Tantalums) **$4.50**

ASSEMBLED AND FULLY BURNED IN ADD $30

16K STATIC RAM KIT-S 100 BUSS

$295 KIT

FULLY STATIC, AT DYNAMIC PRICES

WHY THE 2114 RAM CHIP?

We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

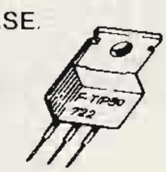
KIT FEATURES

1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 2 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA—**$33**
LOW PROFILE SOCKET SET—**$12**
SUPPORT IC'S & CAPS—**$19.95**
ASSEMBLED & TESTED—**ADD $30**
2114 RAM'S—**8 FOR $69.95**

COMPLEMENTARY POWER TRANSISTORS

SILICON NPN AND PNP. TO-220 CASE.
VCEO - 40V PD - 30 WATTS
FOR AUDIO POWER AMPS, ETC



TIP29 - NPN
TIP30 - PNP

YOUR CHOICE 3 FOR $1

16K DYNAMIC RAM CHIP

16K X 1 Bits. 16 Pin Package. Same as Mostek 4116-4. 250 NS access. 410 NS cycle time. Our best price yet for this state of the art RAM. 32K and 64K RAM boards using this chip are readily available. These are new, fully guaranteed devices by a major mfg. **VERY LIMITED STOCK!**

8 FOR $89:95

NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE SUPPLIERS OF CPM SOFTWARE.

2708 EPROMS

450 NS!

Now full speed! Prime new units from a major U.S. Mfg. 450 N.S. Access time. 1K x 8. Equiv. to 4-1702 A's in one package.

~~$15.75 ea.~~ **$9.95** ~~4 FOR $50.00~~

PRICE CUT

NATIONAL SEMICONDUCTOR ***NEW!***

CAR CLOCK MODULE - #MA6008

$6.99 each

Originally used by HYGAIN to indicate time and channel on an expensive C.B. Mini size, self contained module. Not a Kit. Four digits plus flashing indicator for seconds. Includes MM5369 and 3.58 MHZ crystal for super accurate time base. With hookup data.

INCLUDES CRYSTAL TIMEBASE! WORKS ON 12 VDC!

MFGR's CLOSEOUT LIMITED QTY.

EXPERIMENTER'S HEATING PLATE

Large Manufacturers Surplus. 5¼x10½ in. Made of 3/8 in. tempered glass with heating element laminated on back. Works off 120 VAC. Protected by thermostat and two thermal fuses. Rated 120 Watts. Use for any heating applications. Perfect for heating ferric chloride to increase PC Board etching efficiency. Units are brand new, non-submersible.

WHILE THEY LAST—$2.99 each

MALLORY COMPUTER GRADE CAPACITOR

30,000 MFD 15 WVDC
Small: 3 x 2 Inches
$1.99 ea. 3 For $4.99

New! REAL TIME Computer Clock Chip

N.S. MM5313. Features BOTH 7 segment and BCD outputs. 28 Pin DIP. **$4.95 with Data**

Z-80 PROGRAMMING MANUAL

By MOSTEK, or ZILOG. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 158 Z-80 instructions. A MUST reference manual for any user of the Z-80. 300 pages. Just off the press. **$12.95**

GENERAL INSTRUMENT

FULL WAVE BRIDGE
4 AMP 600 PIV

LOOK!

3/4 IN. SQUARE - WITH LUGS

75¢ ea. 3 FOR $2 #LM-1

"THE COLOSSUS"

FAIRCHILD SUPER JUMBO LED READOUT

A full .80 inch character. The biggest readout we have ever sold! Super efficient. Compare at up to $2.95 each from others!

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FND 843 Common Anode
FND 850 Common Cathode
$1.49 ea (6 for $6.95)

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RF POWER transistors . . .

2NRF-1 2 GHz RF power transistor. Pd. max. (@ 25 degrees C) 3.5W, Pout min. @ 2 GHz 1.0W, Pin 310 mW, efficiency @ 2 GHz 30%, round shape, similar to RCA 2N5470. **$4.95**

2NRF-2 2 GHz RF power transistor. Pd. 8.7W, Pout 2.5W, Pin 300 mW, efficiency 33%, cross shape, similar to RCA TA8407. **$5.95**

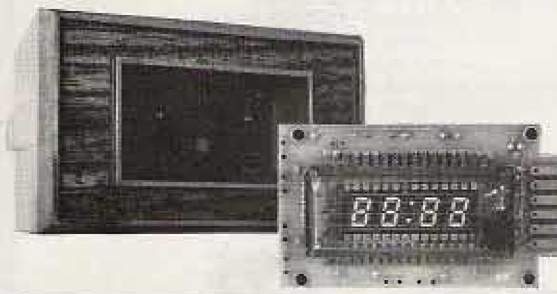
2NRF-3 2 GHz RF power transistor. Pd. 21W, Pout 5.5W, Pin 1.25W, efficiency 33%, cross shape. Similar to RCA 2N6269. **$6.95**

2NRF-4 2 GHz RF power transistor. Pd. 29W, Pout 7.5W, Pin 1.5W, efficiency 33%, cross shape. Factory selected, prime 2N6269. **$7.95**

★★MEMORY★★ ★★★★CHIP★★★★ SPECIAL !!

It has never been less expensive to play with memory . . . you can now buy 10 2102-L1 memory ICs for only $9.90. These are low power units, suitable for use with any 2 MHz computer system; they are fully static, and are new, prime, high quality parts.

MA1003 CLOCK/CASE COMBINATION $19.95



Easy to build — just add 12V DC and time setting switches. Since the MA1003 is car battery compatible and includes a built-in, precision crystal timebase, it's the easiest clock we've seen to get up and running in mobile applications. Unlike LED displays, the 4 blue/green fluorescent digits won't wash out in sunlight . . . and for something like a van clock, they look really beautiful. The matching case includes an optical filter that brings out the best of the readouts, as well as mounting hardware. Why pay the high prices of built-in car or van clocks? Do it yourself, and save lots of bucks.

The MA1003 clock module is available separately for $16.50, while the case is available separately for $5.95 . . . but we recommend the $19.95 combination price for maximum savings.

NEW FROM MULLEN COMPUTER PRODUCTS: H8 EXTENDER BOARD KIT

Mullen Computer Products has come up with another winner to go along with their **S-100 Extender Board Kit** (which is also available from us, and also costs $39). The **H8 Extender Board Kit** really takes the trouble out of testing or repairing H8 boards; it includes, among other things, jumper links in the power supply lines for insertion of fuses, Ammeters, current limiters, and the like, and a heavy-duty board that stands up to constant usage.

$39

12V, 8A POWER SUPPLY KIT $44.50

This is our longest-running kit, and the specs tell you why. Handles 8 Amps continuous, or 12A with a 50% duty cycle. Includes foldback current limiting, crowbar overvoltage protection, RF suppression, adjustable output 11-14V, more. Ideal for powering mobile transceivers, tape equipment, or TVs at home; also powers disc drives and makes a great lab bench supply. Easy to assemble — except for transformer, diodes, and filter caps, all parts mount on heavy-duty circuit board. Does not include case.

REGULATOR ICs

+ 5V, 1A, TO-220 (340/ 5T)	**$1.25**
+ 6V, 1A, TO-220 (340/ 6T)	**$1.25**
+ 8V, 1A, TO-220 (340/ 8T)	**$1.25**
+12V, 1A, TO-220 (340/12T)	**$1.25**
+15V, 1A, TO-220 (340/15T)	**$1.25**
+18V, 1A, TO-220 (340/18T)	**$1.25**
+24V, 1A, TO-220 (340/24T)	**$1.25**
− 5V, 1A, TO-220 (320/ 5T)	**$1.35**
− 6V, 1A, TO-220 (320/ 6T)	**$1.35**
− 8V, 1A, TO-220 (320/ 8T)	**$1.35**
−12V, 1A, TO-220 (320/12T)	**$1.35**
−15V, 1A, TO-220 (320/15T)	**$1.35**
−18V, 1A, TO-220 (320/18T)	**$1.35**
−24V, 1A, TO-220 (320/24T)	**$1.35**

16K MEMORY EXPANSION CHIP SET $109 (3/$320)

For **Radio Shack-80, Exidy Sorcerer,** and **Apple** machines. Compare our features with similar chip sets: 250 ns access time, low power parts used exclusively, DIP shunts included, 1 year limited warranty, and easy-to-follow instructions that make memory expansion a snap — even for beginners!

BIPOLAR, REGULATED, VIRTUALLY BLOW-OUT PROOF, 1/4 AMP PER SIDE POWER SUPPLY KIT: ONLY $15!

These power supplies are great for fixed voltage applications. Available in ±5V, ±6V, ±8V, ±9V, ±12V, and ±15V — specify project #13-XX, where the XX stands for the desired output voltage. Compact, simple assembly; does not include case.

TERMS: Add $1 handling to orders under $15. Allow up to 5% shipping, more for power supplies (excess refunded). Give street address for UPS delivery. Prices good through cover month of magazine. VISA®/Mastercharge® call our 24 hour order desk at **(415) 562-0636**. CODs OK with street address. Cal. res. add sales tax. **Thanks for your business!**

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FREE FLYER: Our new catalogue is something you need if you're into electronics. Parts, kits, computers, electronic music, specials . . . it's really packed, and it's free. Just send us your name and address, we'll take care of the rest. If you want 1st class delivery, please enclose 41¢ in stamps.

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SN7438N	25	SN74125N	49	SN74195N	69
SN7439N	25	SN74126N	49	SN74196N	89
SN7440N	20	SN74132N	75	SN74197N	89
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CD4025	23	CD4068	39	CD4518	1.29
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74C00

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74C04	39	74C85	2.49	74C173	2.60
74C08	49	74C90	1.95	74C192	2.49
74C10	39	74C93	1.95	74C193	2.49
74C14	1.95	74C95	1.95	74C195	2.49
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74C30	39	74C151	2.90	74C923	6.25
74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
74C73	89	74C160	2.49	80C95	1.50
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LM309K	1.25	LM340T-24	1.25	LM1458CN/H	59
LM310CN	1.15	LM358N	1.00	LM1488N	1.39
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LM320T-18	1.25	NE556N	39	75453CN	39
LM320T-24	1.25	NE560B	5.00	75454CN	39
LM323K-5	5.95	NE561B	5.00	75491CN	79
LM324N	1.80	NE562B	5.00	75492CN	89
LM339N	99	NE565N/H	1.25	75493N	89
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LM340K-15	1.35	LM709N/H	29	RC4195	4.49

74LS00TTL

74LS00	29			74LS138	89
74LS01	29			74LS139	89
74LS02	29	74LS47	89	74LS151	89
74LS03	29	74LS51	29	74LS155	89
74LS04	35	74LS54	29	74LS157	89
74LS05	35	74LS55	29	74LS160	1.15
74LS08	29	74LS73	45	74LS161	1.15
74LS09	35	74LS74	45	74LS162	1.15
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74LS22	35	74LS92	75	74LS193	1.15
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74LS27	35	74LS95	99	74LS195	1.15
74LS28	35	74LS96	1.15	74LS253	99
74LS30	29	74LS107	45	74LS257	89
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74LS37	45	74LS112	45	74LS260	69
74LS40	35	74LS123	1.25	74LS279	75
74LS42	89	74LS125	89	74LS367	75
		74LS132	99	74LS368	75
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EXCITING NEW KITS

NEW JE600 HEXADECIMAL ENCODER KIT

FEATURES:

- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... $59.95

Digital Thermometer Kit

NEW

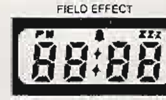
- Dual sensors—switching control for in-door/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... $39.95

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	.190" dia.		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
INFRA-RED LED 1/4"x1/4"x1/16" flat		5/$1	XC111Y	yellow	4/$1
			XC111C	clear	4/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
CLASS II
FIELD EFFECT



4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6730	Common Anode-red ± 1	.560	99
MAN 2	5 x 7 Dot Matrix-red	300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	99
MAN 3	Common Cathode-red	125	25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	99
MAN 7Y	Common Anode-yellow	300	99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	99
MAN 82	Common Anode-yellow	300	99	DL728	Common Cathode-red	500	1.49
MAN 84	Common Cathode-yellow	300	99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	300	99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	300	99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	300	99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	300	99	DL750	Common Cathode-red	600	1.49
MAN 4640	Common Cathode-orange	400	99	DL338	Common Cathode-red	.110	35
MAN 4710	Common Anode-red	400	99	FND70	Common Cathode	250	69
MAN 4730	Common Anode-red ± 1	400	99	FND358	Common Cathode ± 1	.357	99
MAN 4740	Common Cathode-red	400	99	FND359	Common Cathode	.357	75
MAN 4810	Common Anode-yellow	400	99	FND503	Common Cathode(FND500)	.500	99
MAN 4840	Common Cathode-yellow	400	99	FND507	Common Anode (FND510)	.500	99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	85	CA3401N	49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	75
DM8889	75
9374 7 seg C.A. LED driver	1.50

CLOCK CHIPS

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MOTOROLA

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IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	16	15	22 pin LP	$ .37	.36	.35
14 pin LP	20	19	18	24 pin LP	38	37	36
16 pin LP	22	21	20	28 pin LP	.45	44	.43
18 pin LP	.29	28	27	36 pin LP	.60	59	.58
20 pin LP	34	32	.30	40 pin LP	.63	62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	25	.24	28 pin ST	$ .99	90	.81
16 pin ST	.30	27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	38	31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	41	37	24 pin WW	1.05	.95	.85
14 pin WW	.39	38	37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	42	41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	68	62	40 pin WW	1.75	1.55	1.40

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ASST. 3	5 ea	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

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XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
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XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

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C36D	15A @ 400V	SCR(2N1849)	$1.95
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MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
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C106B1	50			2N3904	4/1.00
MPSA05	30	2N3055	89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
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MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

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22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

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.01mf	.12	.10	.07	.22mf	.33	.27	.22

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.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
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3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
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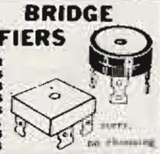

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2380	1N4004	400	10 for	1.19	20 for	1.20
2381	1N4005	600	10 for	1.39	20 for	1.40
2382	1N4006	800	10 for	1.49	20 for	1.50
2383	1N4007	1000	10 for	1.59	20 for	1.60

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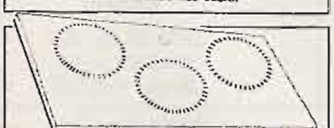

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■ PHOTO FLASH ELECTRO. CAP, 600 MF @ 360V(#3897)	1.29	2 for 1.30
■ 4 MICRO SWITCH, plunger style. N.O. contacts, SPDT, solder tabs,(#5785)	1.29	8 for 1.30
■ 10 TRANSISTOR/LED SOCKETS, 1/4" high, 3-pc leads, plastic base,(#5745)	1.29	20for 1.30
■ 5-SLIDE VOLUME CONTROLS, asst of popular values, for HIFI(#2318)	1.29	10 for 1.30
■ 10-D33021 TRANSISTORS, low power, silicon, hfe-60, TO-92(#5627)	1.29	20 for 1.30
■ 50 1/4 WATTERS, asst value carbon resistors, some 5%ers,(#5797)	1.29	100 for 1.30
■ 60-CERAMIC CAPS, incl. NPO's, neg. coef. N750's asst values(#590)	1.29	120 for 1.30
■ 10-TV/FM SPLICERS, for 300 ohm shielded twin lead. Bakelite.(#5547)	1.29	20 for 1.30
■ 30'#30 WIRE-WRAP WIRE, fits all tools and machines, continuous length,(#3803)	1.29	60 for 1.30
■ 10-G.E. POWER TAB TRANSISTORS, D40N1,N2, some N5, TO-220(#5629)	1.29	20 for 1.30
■ 2-¼" BLOCK TRIM POTS, 200K, 15-TURN PC. leads.(#2535)	1.29	4 for 1.30
■ 1-12VDC 5MIL REED RELAY, spst, N.O. 2200 ohms, 7/8" x 5/16" x 5/16"(#5515)	1.29	2 for 1.30
■ 50-TEMP. COEFFICIENT VOLTAGE REF. DIODES, asst volt,+50%(#5647)	1.29	100 for 1.30
■ 6 -SKINNY TRIM POTS, PRECISION, 50% yield(#3389)	1.29	12 for 1.30
■ 60-pc-PRECUT, PRETINNED WIRE, various lengths and colors(#1971)	1.29	120 for 1.30
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■ 4 CALCULATOR KEYBOARDS, 17 keys and up, multi-function,(#5777)	1.29	8 for 1.30
■ 10-5K POTS, audio taper, plastic snap-in mounting(#5124)	1.29	20 for 1.30
■ 10-1&2 MEG DUAL POTS, audio taper, snap-in mounting(#5125)	1.29	20 for 1.30
■ 50-1 AMP ZENERS, wide asst of values, untested(#1964)	1.29	100 for 1.30
■ 12-SCR'S & TRIACS, 10 AMP, asst values, untested(#2087)	1.29	24 for 1.30
■ 3-QUADRACS, 10 AMP, 100% prime, 50-100-200V, TO-220(#5048)	1.29	6 for 1.30
■ 20-MINI RECTIFIERS, 1½ AMPS, 25V, epoxy, axial(#5374)	1.29	40 for 1.30
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■ 20-1N4148 SWITCHING DIODES, 4 nsec. axial(#3000)	1.29	40 for 1.30
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50	25	.19	Axial	.20
50	100	.21	Axial	.22
100	15	.23	Axial	.24
100	25	.25	P.C.	.26
100	50	.35	Axial	.36
100	100	.39	Axial	.40
150	15	.23	Axial	.24
200	15	.24	P.C.	.25
220	25	.32	P.C.	.33
250	16	.29	Axial	.30
250	25	.32	Axial	.33
250	50	.45	Axial	.46
300	15	.31	Axial	.32
300	25	.33	P.C.	.34
500	15	.33	P.C.	.34
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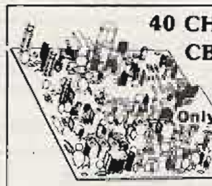

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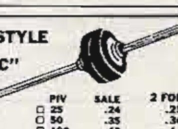

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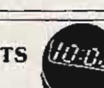

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2N3926	7.0W	175 MHz TO60	6.30
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2N5590	10W	175 MHz MT72	7.80
2N5591	25W	175 MHz MT72	10.25
2N5913	1.75W	175 MHz TO39	1.70
2N6080	4.0W	175 MHz MT72	5.40
2N6081	15W	175 MHz MT72	8.45
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2N6083	30W	175 MHz MT72	12.30
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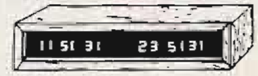

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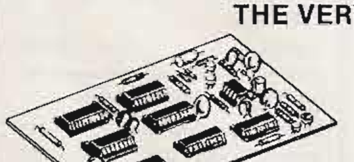

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	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zenner	.25
	1N4749	24v	1W	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25
	1N5349	12v	3W	.25

SOCKETS/BRIDGES

QTY.	Part				Price
	8-pin	pcb	.16	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.25	ww	.45
	18-pin	pcb	.30	ww	.95
	20-pin	pcb	.35	ww	1.05
	22-pin	pcb	.40	ww	1.15
	24-pin	pcb	.45	ww	1.25
	28-pin	pcb	.50	ww	1.35
	40-pin	pcb	.55	ww	1.45
	Molex pins		.01	To-3 Sockets	.35
	2 Amp Bridge			100-prv	.95
	25 Amp Bridge			200-prv	1.50

TRANSISTORS, LEDS, etc.

QTY.	Part	Description	Price
	2N2222M	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic)	.19
	2N3904	NPN (Plastic)	.19
	2N3054	NPN	.55
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.19
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

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QTY.	Part	Price	QTY.	Part	Price
	9301	.85		9322	.65
	9309	.50		9601	.30
				9602	.45

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QTY.	Part	Price
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	8T23	2.50
	8T24	3.00
	8T97	1.75
	74S188	3.00
	1488	1.25
	1489	1.25
	1702A	4.50
	AM 9050	4.00
	ICM 7207	6.95
	ICM 7208	13.95
	MPS 6520	10.00
	MM 5314	4.00
	MM 5316	4.50
	MM 5387	3.50
	MM 5369	2.95
	TR 1602B	3.95
	UPD 414	4.95
	Z 80 A	22.50
	Z 80	17.50
	Z 80 P10	10.50
	2102	1.45
	2102L	1.75
	2107B-4	4.95
	2114	9.50
	2513	6.25
	2708	11.50
	2716 D.S.	34.00
	2716 (5v)	69.00
	2758 (5v)	26.95
	3242	10.50
	4116	11.50
	6800	13.95
	6850	7.95
	8080	7.50
	8085	22.50
	8212	2.75
	8214	4.95
	8216	3.50
	8224	4.25
	8228	6.00
	8251	7.50
	8253	18.50
	8255	8.50
	TMS 4044	9.95

– T T L –

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	7400	.20		7492	.45		74H20	.25		74LS76	.70
	7401	.20		7493	.35		74H21	.25		74LS86	.95
	7402	.20		7494	.75		74H22	.40		74LS90	.85
	7403	.20		7495	.60		74H30	.30		74LS93	.85
	7404	.20		7496	.80		74H40	.35		74LS96	2.00
	7405	.35		74100	1.15		74H50	.30		74LS107	.90
	7406	.25		74107	.35		74H51	.30		74LS109	1.50
	7407	.55		74121	.35		74H52	.20		74LS123	1.95
	7408	.20		74122	.55		74H53	.25		74LS138	2.00
	7409	.25		74123	.55		74H55	.25		74LS151	.95
	7410	.20		74125	.45		74H72	.35		74LS153	1.15
	7411	.25		74126	.45		74H74	.35		74LS157	1.15
	7412	.25		74132	.75		74H101	.95		74LS160	1.15
	7413	.45		74141	.90		74H103	.55		74LS164	2.90
	7414	.75		74150	.85		74H106	1.15		74LS193	2.00
	7416	.25		74151	.95		74L00	.30		74LS195	1.15
	7417	.40		74153	.95		74L02	.30		74LS244	2.90
	7420	.25		74154	1.15		74L03	.35		74LS259	1.50
	7426	.25		74156	.70		74L04	.40		74LS298	1.50
	7427	.25		74157	.65		74L10	.30		74LS367	1.95
	7430	.20		74161/9316	.75		74L20	.45		74LS368	1.25
	7432	.30		74163	.85		74L30	.55		74LS373	2.50
	7437	.20		74164	.75		74L47	1.95		74S00	.45
	7438	.30		74165	1.10		74L51	.65		74S02	.45
	7440	.20		74166	1.75		74L55	.85		74S03	.35
	7441	1.15		74175	.90		74L72	.65		74S04	.35
	7442	.55		74176	.95		74L73	.70		74S05	.45
	7443	.45		74177	1.10		74L74	.75		74S08	.45
	7444	.45		74180	.95		74L75	1.05		74S10	.45
	7445	.75		74181	2.25		74L85	2.00		74S11	.45
	7446	.70		74182	.75		74L93	.75		74S20	.35
	7447	.70		74190	1.25		74L123	1.95		74S22	.55
	7448	.50		74191	1.25		74LS00	.40		74S40	.30
	7450	.25		74192	.75		74LS01	.40		74S50	.30
	7451	.25		74193	.85		74LS02	.45		74S51	.35
	7453	.20		74194	.95		74LS03	.45		74S64	.15
	7454	.25		74195	.95		74LS04	.45		74S74	.70
	7460	.40		74196	.95		74LS05	.45		74S112	.60
	7470	.45		74197	.95		74LS08	.45		74S114	.85
	7472	.40		74198	1.45		74LS09	.45		74S133	.85
	7473	.25		74221	1.50		74LS10	.45		74S140	.75
	7474	.30		74298	1.50		74LS11	.45		74S151	.95
	7475	.35		74367	1.35		74LS20	.45		74S153	.95
	7476	.40		75491	.65		74LS21	.45		74S157	.98
	7480	.75		75492	.65		74LS22	.45		74S158	.80
	7481	.85		74H00	.20		74LS32	.50		74S194	1.50
	7482	.95		74H01	.30		74LS37	.45		74S196	2.00
	7483	.95		74H04	.30		74LS38	.65		74S257 (8123)	2.50
	7485	.75		74H05	.25		74LS40	.70		8131	2.75
	7486	.55		74H08	.35		74LS42	.95			
	7489	1.05		74H10	.35		74LS51	.75			
	7490	.55		74H11	.25		74LS74	.95			
	7491	.70		74H15	.45		74LS75	1.20			

C MOS

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	4000	.15		4017	.75		4034	2.45		4069/74C04	.45
	4001	.20		4018	.75		4035	.75		4071	.25
	4002	.25		4019	.35		4037	1.80		4081	.30
	4004	3.95		4020	.85		4040	.75		4082	.30
	4006	.95		4021	.75		4041	.69		4507	.95
	4007	.25		4022	.75		4042	.65		4511	.95
	4008	.75		4023	.25		4043	.50		4512	1.50
	4009	.35		4024	.75		4044	.65		4515	2.95
	4010	.35		4025	.25		4046	1.25		4519	.85
	4011	.30		4026	1.95		4047	2.50		4522	1.10
	4012	.25		4027	.35		4048	1.25		4526	.95
	4013	.40		4028	.75		4049	.65		4528	1.10
	4014	.75		4029	1.15		4050	.45		4529	.95
	4015	.75		4030	.30		4052	.75		MC14409	14.50
	4016	.35		4033	1.50		4053	.95		MC14419	4.85
							4066	.75		74C151	2.50

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QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	MCT2	.95		LM320K24	1.65		LM373	3.95
	8038	3.95		LM320T5	1.65		LM377	3.95
	LM201	.75		LM320T12	1.65		78L05	.75
	LM301	.45		LM320T15	1.65		78L12	.75
	LM308	.65		LM323K	5.95		78L15	.75
	LM309H	.85		LM324	1.25		78M05	.75
	LM309 (340K-5)	1.50		LM339	.75		LM380 (8-14 Pin)	1.19
	LM310	.85		7805 (340T5)	1.15		LM709 (8-14 Pin)	.45
	LM311 (8-14 Pin)	.75		LM340T12	.95		LM711	.45
	LM318	1.50		LM340T15	.95		LM723	.40
	LM320H6	.79		LM340T18	.95		LM725	2.50
	LM320H15	.79		LM340T24	.95		LM739	1.50
	LM320H24	.79		LM340K12	1.25		LM741 (8-14)	.45
	7905 (LM320K5)	1.65		LM340K15	1.25		LM747	1.10
	LM320K12	1.65		LM340K18	1.25		LM1307	1.75
	LM320K15	1.65		LM340K24	1.25		LM1458	.65
							LM3900	.95
							LM75451	.65
							NE555	.45
							NE556	.85
							NE565	1.15
							NE566	1.25
							NE567	.95
							TA7205	6.95
							76477	2.95
							95H90	9.95

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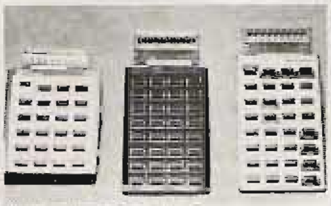
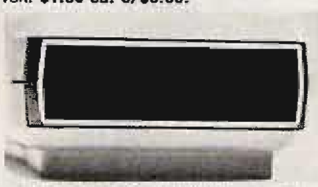
MOTOROLA 4 MHZ XTAL OSCILLATOR 14 pin dip pkg., 5 VDC in, 4 MHz out. TTL compatible. **$5.95 ea.**

NATIONAL SEMICONDUCTOR - 6 DIGIT CLOCK MODULE A 12-hr. clock featuring alarm and snooze alarm function. Comes complete with everything. All you add is a power cord and switches. Each module utilizes discreet components and is ready for you to mount in your enclosure. Display is 6 each seven segments, .33 inches high, clockchip is MM5375. Can easily be mounted in either of our instrument clock case kits. **$14.95.**



CALCULATOR GUTS
Experimenter's delight. Each keyboard includes a monolithic calculator chip and display. These are rejects. It might be something simple to repair or it could be very nasty. At this price, who cares! 9 volt. **$1.50 ea. 3/$3.00.**



INSTRUMENT CLOCK CASE KIT
A real jewel for those small projects. Hinged top door allows you to hide your control area. O.D. 4½" x 4" x 1¾". **$1.99 each.**

DB-25 FEMALE CONNECTOR
A unique assembly originally adapting the RS232 Type Connector to flat cable. **$1.50 each or 2/$2.50.**

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Perfect for your opto projects. Solid aluminum construction with real walnut sides. O.D. 5-3/8" by 5-3/8" by 2". **$6.95 ea.**

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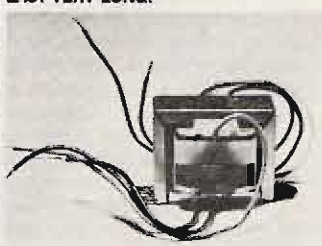
Cinch Jones 10/20 Pins. .156 Spacing PC Mount. .85 Burndy 22/44 Pins, .156 spacing PC Mount, **$1.40 each.**

DEFECTIVE CALCULATORS
Well, some are and some are not. We can't afford the time to test them. **$2.50 ea.** Batteries not included. **2/$4.00.**

LINE PRINTER HAMMER DRIVER BOARD Each board contains approx. 130 each #MJE800 (Silicon Darlington NPN hfe 750, 1.5A). About $130.00 worth, over 100 1N4001 diodes, plus support chips. The whole package is yours for only **$14.95.**

HURRY, WE DON'T EXPECT THESE TO LAST VERY LONG!



TRANSFORMER Pri. 110 VAC Sec. 11.2 and 5 VCT @ .1 amp. **$.95 ea.**

MINIATURE D.P.D.T. [PUSH BUTTON] momentary, rated 6A/125 VAC, microswitch part #8N2021. **Only $1.54.**

CLOCK DISPLAY
National Semi. 6 Digit Multiplexed Display; .33" Characters (Common Cathode). **A REAL BUY AT JUST $1.00.**

EDGE METER 100-0-100 ua 1/2" by 11/16". Compare with other meters costing $6.00. **Only $2.00 ea.** Why pay more?

DIODE SALE 1N4148
100/$1.95 TAPE/REEL
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TYPE	VOLTS	WATTS	PRICE
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1N4002	100	1A	15/$1.00
1N4003	200	1A	12/$1.00
1N4004	400	1A	12/$1.00
1N4005	600	1A	10/$1.00
1N4006	800	1A	10/$1.00
1N4007	1000	1A	6/$1.00
1N5400	50	3A	5/$1.00
1N5401	100	3A	5/$1.00
1N5402	200	3A	5/$1.25
1N5403	300	3A	4/$1.25
1N5404	400	3A	4/$1.25
1N5405	500	3A	4/$1.49
1N5406	600	3A	4/$1.49
1N5407	800	3A	3/$1.49
1N5408	1000	3A	2/$ .99
1N4148	75	10M	20/$1.00

SOLID DIPPED TANTALUM CAPACITORS

		1-99	100 PLUS
.1 X 35 VOLT		.23	.19
.15	35	.23	.19
.22	35	.23	.19
.33	35	.23	.19
.47	35	.23	.19
.68	35	.23	.19
1.0	35	.25	.20
1.5	35	.29	.23
2.2	35	.31	.25
3.3	35	.36	.29
4.7	35	.38	.30
6.8	35	.50	.40
10.0	35	.60	.48
15.0	35	.79	.63
22.0	35	1.39	1.12
33.0	35	2.08	1.66
47.0	35	2.65	2.12

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NYLON TIE WRAPS

3"	65000	10/$ .30
4"	65002	10/ .50
5.3"	65003	10/ .59
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10.8"	65005	10/ 1.59
13.0"	65006	10/ 2.69
14.4"	65055	10/ 2.96
SCREW MOUNT		
13.6"	65054	10/ 4.29
7.4"	65052	10/ .98
5.8"	65051	10/ .89
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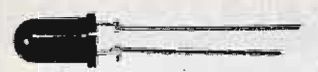

GALLIUM PHOSPHIDE L.E.D.'s
Provide greater light out-put, brighter colors, greater uniformity and less current drain than regular L.E.D.'s

.110 DIAMETER		
P/N 724H	Red Diffused	4/$1.00
724G	Green Diffused	4/ 1.19
724Y	Yellow Diffused	4/ 1.49
7240	Orange Diffused	4/ 1.49
.220 DIAMETER		
714H	Red Diffused	5/$1.19
714G	Green Diffused	4/ 1.49
714Y	Yellow Diffused	4/ 1.59
7140	Orange Diffused	4/ 1.59
.220 DIAMETER (low dome)		
704R	Red Diffused	4/$1.59
704G	Green Diffused	4/ 1.65
704Y	Yellow Diffused	4/ 1.84
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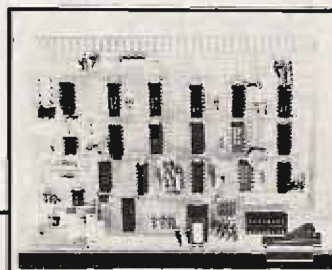
101R-g	Dual (Red and Green) $2.85	2/5.00
MOUNTING HARDWARE		
.220 Diameter #7aMH		12/$1.44

¼ WATT 5% DEPOSITED CARBON FILM RESISTOR ASSORTMENTS

ASST. A	10 ea 1 OHM 1.5 OHM 2 OHM 2.7 OHM 3 OHM 3.6 OHM 4.7 OHM 5.6 OHM 6.8 OHM 8.2 OHM	100 pcs $2.40
ASST. B	10 ea 10 OHM 12 OHM 15 OHM 18 OHM 22 OHM 27 OHM 33 OHM 39 OHM 47 OHM 56 OHM	100 pcs $2.40
ASST. C	10 ea 68 OHM 82 OHM 100 OHM 120 OHM 150 OHM 180 OHM 220 OHM 270 OHM 330 OHM 390 OHM	100 pcs $2.40
ASST. D	10 ea 470 OHM 560 OHM 680 OHM 820 OHM 1K 1.2K 1.5K 1.8K 2.2K 2.7K	100 pcs $2.40
ASST. E	10 ea 3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	100 pcs $2.40
ASST. F	10 ea 22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	100 pcs $2.40
ASST. G	10 ea 150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	100 pcs $2.40
ASST. H	10 ea 1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	100 pcs $2.40
ASST. A-H	INCLUDES ALL RESISTOR ASSORTMENTS (800 pcs)	$14.95 ea



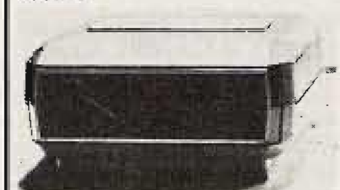
PARTS BOARDS A great way to buy parts on a budget. We guarantee your money's worth. **ONLY $1.00 ea.**

ROTRON WHISPER FAN #WR2H1
3 Blade 4" Diameter 75CFM 115VAC. NET $17.00 **YOUR PRICE $9.95** Wait now, these are not pull-outs or something like that, these are new!

CLAIREX PHOTO CELLS
These have a real USEFUL range to them. Any project involving control from ambient light levels will utilize this photo cell. Light resistance 1K. Fast response. .156 Diameter. **$.75 each or 2/$1.00.**

NOVUS CALCULATOR #824R
Rechargeable Ni-Cad calculator WITH MEMORY, EX, CS AND % KEY. **$4.95 ea.** (owners manual and charger are not included)

PLASTIC PARTS BOX A nice little hinged-top box for storing all your small parts. O.d. 6¾" by 3¾" by 2". **$.75 ea. 10/$5.00.**



REPEAT OF A SELL-OUT A complete 12 hour digital clock. Some are manufacture line rejects, some are returns, and some are just scratched. Features: hours, minutes, alarm, snooze alarm. Parts value alone would equal $20.00, you pay **only $6.00 ea.**

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75493N (quad seg. driver)	.55
SN7428N	.25
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2000uf 25VDC AXIAL	.50
18 ga. LINE CORD 6'	.25
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2N3054	.75
2N3055 (TO-3)	.99
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SIEMENS MAGNETIC SENSOR	1.99
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With min. purchase of **$50.00**, you will receive free, a 5 function National Semiconductor L.C.D. mens watch. With min. purchase of **$100.00** you will receive free, our L.C.D. car clock. (watch and clock advertised in Dec. issue of 73 Mag.)

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Social Events

from page 182

door. Talk-in on .16/.76, .63/.03, .52/.52, and 52.525. For information, contact BRATS, PO Box 5915, Baltimore MD 21208.

IRVING TX
AUG 3-5

Encounter '79, the Texas VHF-FM Society's 1979 Summer Convention, will be held August 3-5, 1979, at the Villa Inn, Irving, Texas. Activities include a transmitter hunt, flea market, FCC exams, manufacturers' exhibits, hospitality room, and several programs and forums. Talk-in on 146.52 and repeaters in the area. Pre-registration is $5.00 until July 1. Registration at the door is $6.00. For information, write Encounter '79, PO Box 3608, Arlington TX 76010.

FLAGSTAFF AZ
AUG 3-5

The Amateur Radio Council of Arizona will hold its annual Ft. Tuthill Hamfest on August 3-5, 1979, at Flagstaff, Arizona. Prizes include TS-520 transceivers, a microwave oven, a Wilson Mark II HT, a Wilson System III triband antenna, and more. Featured will be a western barbecue, tech sessions, and exhibits. Camping facilities are also available. For further details or information, write Ft. Tuthill Hamfest, c/o 8520 E. Edwards Ave., Scottsdale AZ 85253.

LITTLE ROCK AR
AUG 4-5

The Central Arkansas Radio Emergency Net (CAREN) Amateur Radio Club will hold its second annual Ham-a-Rama on Saturday and Sunday, August 4-5, 1979, at the Arkansas State Fairgrounds, Little Rock, Arkansas. There will be two main prizes given, as well as door prizes. Featured will be forums, dealers' exhibits, a Saturday night party, and a large flea market. Talk-in on 146.34/.94. For details, send an SASE to Morris Middleton AD5M, 19 Elmherst Drive, Little Rock AR 72209.

REND LAKE IL
AUG 5

The Shawnee Amateur Radio Association Hamfest will be held on August 5, 1979, at Rend Lake in southern Illinois. Complete camping and recreational facilities will be available, so plan to spend the weekend at the lake and attend the hamfest on Sunday. Family activities are planned. Hourly door prizes will be awarded. There will be no charge to vendors. For information, contact WB9ELP or WB9SWG.

PITTSBURGH PA
AUG 5

The South Hills Brass Pounders and Modulators will hold its 42nd annual Pittsburgh Hamfest on August 5, 1979, from noon until dusk at the Allegheny County Community College south campus on Rte. 885, 2 miles south of the Allegheny County Airport and approximately 15 miles southeast of Pittsburgh, Pennsylvania. Advance registration is $1.50; $2.00 at the door. There will be a large indoor air-conditioned area for vendors and the flea market, and a large paved surface for the outdoor flea market. There will also be prizes and food. Talk-in on 146.13/.73 and .52/.52. For information and preregistration, write Bruce Banister, 5954 Leprechaun Dr., Bethel Park PA 15102.

MT SINAI LI NY
AUG 5

The Radio Central Amateur Radio Club will hold its "Ham-Central" on Sunday, August 5, 1979 (rain date is August 12, 1979), at the Mt. Sinai Elementary School, Rte. 25A, Mt. Sinai, Long Island, New York. Admission for sellers is $3.00 per tailgate space and $1.50 for buyers, with XYL and children under 12 free. Monies are to be used for Radio Central and the St. Charles Hospital Repeater. Doors will open at 7:00 am for sellers and 9:00 for others. They will close at 4:00 pm. Featured will be antenna advice with Art and Madeline Greenberg, a Novice table, great food, a CW contest, an ARRL table, a special event of a fly-in by the Suffolk County Police Dept. helicopter, and a Radio Central Club table. Talk-in on 146.52 WA2UEC and 144.71/145.31 K2VL. For information, call Joan Longtin at (516)-924-8438 or Robin Goodman at (516)-744-6260, or write Radio Central, "Ham-Central," PO Box 680, Miller Place NY 11764.

JACKSONVILLE FL
AUG 4-5

The Jacksonville Hamfest Association is pleased to announce the 1979 Jacksonville Hamfest and ARRL North Florida Section Convention to be held on August 4-5, 1979, at the Jacksonville Beach Municipal Auditorium, Jacksonville, Florida. The location is just one block from the beach, where U.S. 90 meets the sea.

Advanced registrations are available at $3.00 per person from R. J. Cutting W2KGI/4, 303 10th St., Atlantic Beach, Florida 32233. Price at the door will be $3.50.

A large indoor swap area will be featured, with advance table reservations available for $5.00 per table per day from Robbie Roberts KH6FMD/W4, 10557 Atlantic Blvd., #31, Jacksonville, Florida 32211. Information on exhibitors' booths and space are available from the same address.

Other features and programs include statewide organization meetings on such topics as traffic nets and MARS, a microprocessor seminar, a solar power demonstration, a DX "pileup" contest, a hidden transmitter hunt, an OSCAR forum, ARRL forums, emergency preparedness programs, DX and contest presentations, antenna and technical seminars, and much more.

More general information may be obtained from JHA, 911 Rio St. Johns Dr., Jacksonville FL 32211.

SALEM OH
AUG 5

The second annual Salem Area Hamfest will be held on August 5, 1979, from 9:00 am to 3:00 pm at the Kent State Salem campus, Salem, Ohio. Tickets are $1.50 in advance and $2.00 at the door. Inside tables are $5.00 with space for your own table at $2.00. Flea market space is $1.00. There will be air-conditioning, a wheelchair ramp, free parking, refreshments, and prizes, consisting of an Atlas RX-110, TX-110, and a PS-110. Talk-in on 146.52. For details, write Harry Milhoan WA8FBS, 1128 West State, Salem OH 44460.

AMARILLO TX
AUG 10-12

The Panhandle Amateur Radio Club will hold its sixth annual Golden Spread Hamfest and Convention on Friday, Saturday, and Sunday, August 10-12, 1979, at The Inn of Amarillo, 601 Amarillo Blvd. West, Amarillo, Texas. The format consists of two full days of exhibits and trading, six technical sessions, programs for the ladies, valuable door prizes, Army and Navy MARS meetings, ARES meeting, an ARRL forum, and plenty of free parking. Displays may be set up any time after 1:00 pm on Friday, August 10th, at a fee of $20.00 per table. For information, write Hamfest, PO Box 10221, Amarillo TX 79106, or phone Jay Ledbetter WB5UBM at (806)-376-6042 (nights and weekends) or Chuck Passmore WB5BRC at (806)-372-1631.

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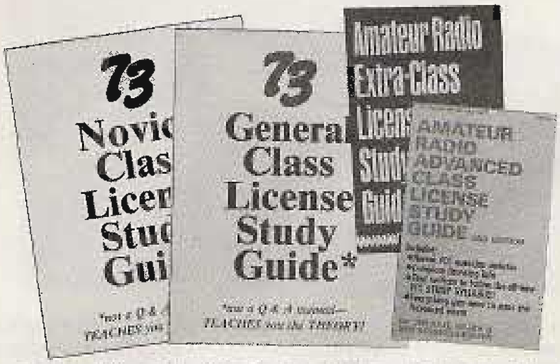

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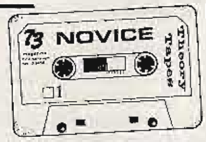

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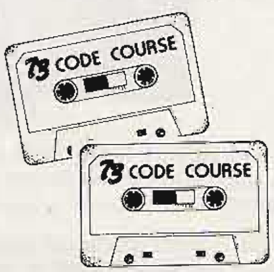

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6+ WPM—CT7306—This is the practice tape for the Novice and Technician licenses. It is made up of one solid hour of code, sent at the official FCC standard (no other tape we've heard uses these standards, so many people flunk the code when they are suddenly—under pressure—faced with characters sent at 13 wpm and spaced for 5 wpm). This tape is not memorizable, unlike the zany 5 wpm tape, since the code groups are entirely random characters sent in groups of five.

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10+ WPM—CT7310—73 hasn't forgotten the Canadian hams—our 10 WPM tape prepares you to breeze through your country's licensing exams. Like the other code groups, the tape is not memorizable and, once mastered, provides a margin of safety in the actual text situation.

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13+ WPM—CT7313—Code groups again, at a brisk 13 per so you will be at ease when you sit down in front of the steely-eyed government inspector and he starts sending you plain language at only 13 per. You need this extra margin to overcome the panic which is universal in the test situations. When you've spent your money and time to take the test, you'll thank heavens you had this back-breaking tape.

"COURAGEOUS"

20+ WPM—CT7320—Code is what gets you when you go for the Extra class license. It is so embarrassing to panic out just because you didn't prepare yourself with this tape. Though this is only one word faster, the code groups are so difficult that you'll almost fall asleep copying the FCC stuff by comparison. Users report that they can't believe how easy 20 per really is with this fantastic one hour tape.

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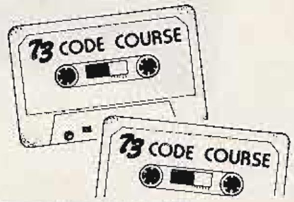
25+ WPM—CT7325—This is the tape for that small group of overachieving hams who wouldn't be content to simply satisfy the code requirements of the Extra Class license. It's the toughest tape we've got and we keep a permanent file of hams who have mastered it. Let us know when you're up to speed and we'll inscribe your name in 73's CW "Hall of Fame."



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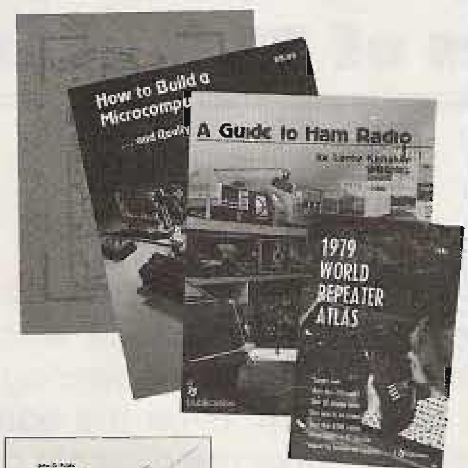

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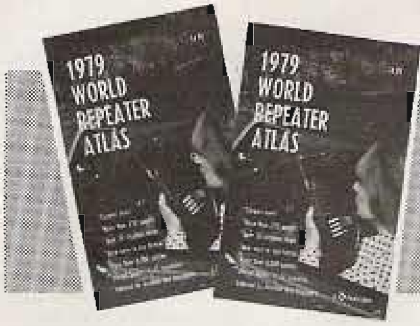

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by
J. H. Nelson

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ALASKA	14	14	14	14	7	7	7	14	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	21	21	21	21	21
AUSTRALIA	21	14	14	7A	7	7	7	7	7	7	14	21
CANAL ZONE	21	14	7A	7	7	7	7A	14	14	21	21	21A
ENGLAND	14	14	7A	7	7	7	14	14	21	21	21	14
HAWAII	21	21	14	7A	7	7	7	14	14	14	21	21
INDIA	14	14	14B	7B	7B	7B	14	14	14	14A	14	14
JAPAN	14A	14	7A	7	7B	7B	7B	14	14	14	14	14A
MEXICO	21	14A	14	7	7	7	7	14	14	14	21	21
PHILIPPINES	14A	14A	14	7B	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14	14	7	7	7	7	7A	14	14	14	14	14
SOUTH AFRICA	7B	7	7	7	7B	14	21	21	21A	21	14	14B
U. S. S. R.	14	14	7A	7	7	7	14	14	14A	14A	14	14
WEST COAST	21	21	14	7	7	7	7	14	14	14	14A	14A

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CANAL ZONE	21	14A	14	7	7	7	14	14	21	21	21	21A
ENGLAND	14	14	7A	7	7	7	7	14	14	21	21	14
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MEXICO	14	14	7A	7	7	7	7	7A	14	14	14	14
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PUERTO RICO	21	14	14	7	7	7	14	14	14	21	21	21
SOUTH AFRICA	7B	7	7	7	7B	7B	14	14	21	21	14	14B
U. S. S. R.	14	14	7A	7	7	7	7	14	14	14	14	14

WESTERN UNITED STATES TO:

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ARGENTINA	21	21	14	14	7	7	7	14	21	21	21	21
AUSTRALIA	21	21A	21A	21	14	7A	7	7	7	7	14	21
CANAL ZONE	21A	21	14	7	7	7	7	14	14	21	21	21
ENGLAND	14	14	7	7	7	7	7	14	14	14A	14A	14
HAWAII	21	21A	21A	21	14	14	7	7	14	21	21	21
INDIA	14	14	14	14B	7B	7B	7B	7A	14	14	14	14
JAPAN	21	21	21	14	7A	7	7	7A	14	14	14	14
MEXICO	21	14	14	7	7	7	7	14	14	14	21	21
PHILIPPINES	14	14A	14A	14	7A	7B	7B	14	14	14	14	14
PUERTO RICO	21	14A	14	7	7	7	7	14	14	21	21	21
SOUTH AFRICA	7B	7B	7	7	7B	7B	7B	14	14A	14A	14	14B
U. S. S. R.	14	14	7A	7	7	7	7	14	14	14	14	14
EAST COAST	21	21	14	7	7	7	7	14	14	14	14A	14A

A = Next higher frequency may also be useful
B = Difficult circuit this period
F = Fair
G = Good
P = Poor
SF = Chance of solar flares

july

sun	mon	tue	wed	thu	fri	sat
1 G	**2** G	**3** F	**4** F	**5** G	**6** G	**7** G
8 G	**9** G	**10** G	**11** F/SF	**12** F/SF	**13** F/SF	**14** P/SF
15 P/SF	**16** F	**17** F	**18** F	**19** G	**20** G	**21** G
22 G	**23** G	**24** F	**25** F	**26** F	**27** G	**28** G
29 G	**30** G	**31** G				

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