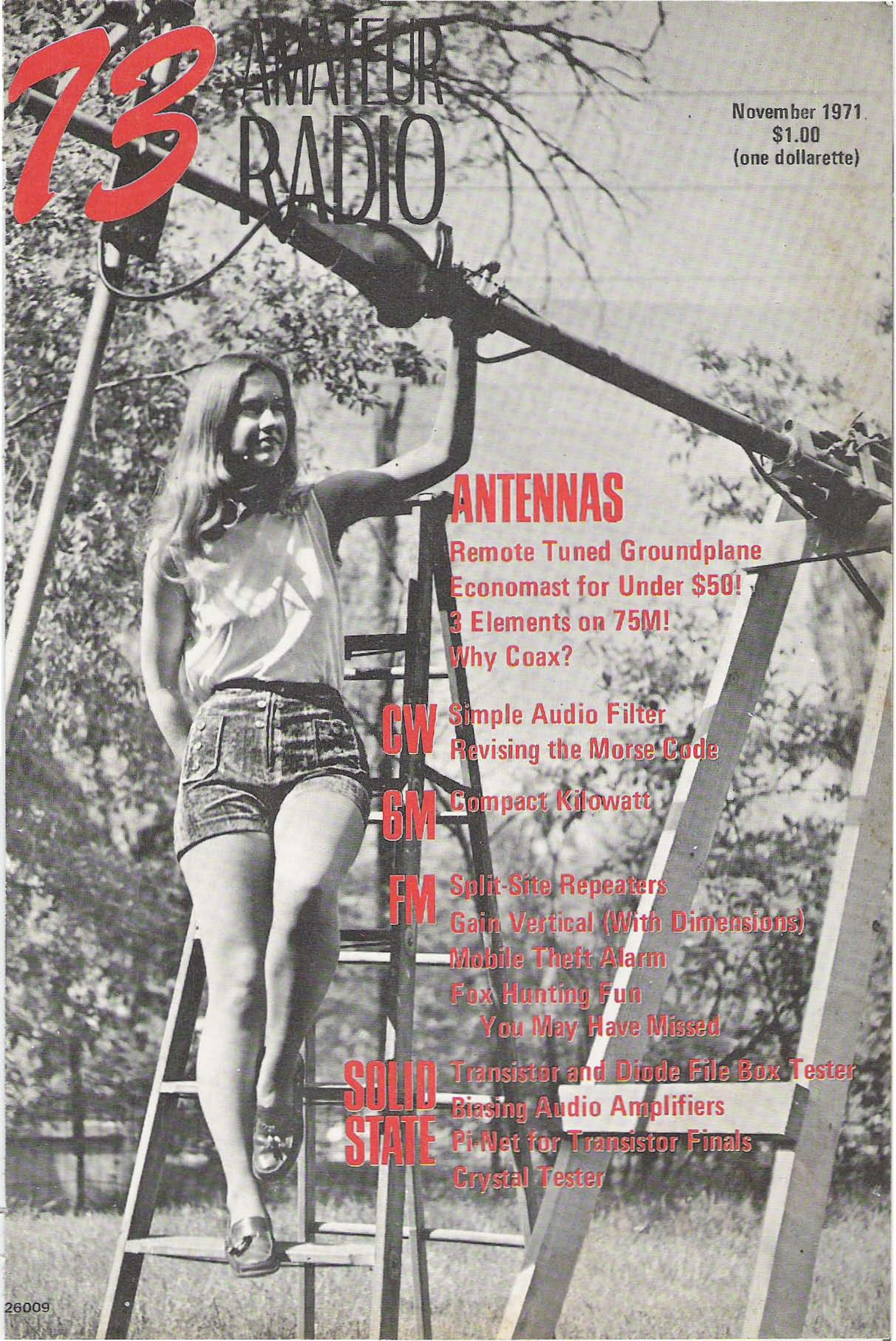

73 AMATEUR RADIO

November 1971
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73 MAGAZINE

#134 NOVEMBER 1971

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STAFF

Cover: "Chuck" Webb KØBWR gets the credit for this month's cover shot of Debby Hebert.

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Amateur Radio

NOVEMBER MCMLXXI **Monthly Ham**

BLAST ROCKS

On Sunday evening, July 25, 1971, fear suddenly became a major part of the emotions of a large sector of Birmingham area people. What had been a warm, quiet and peaceful time became alive with fear as an enormous blast shook houses over some 20 square miles or more. People ran from their homes and businesses to try to see what had happened. Moments later a second and much more powerful explosion took place, sending glass fragments from windows across rooms over a wide area, with enough force to embed them in opposite walls. Walls were cleared of wallboard, and garage doors were blown out. Power was off in a large area of eastern Birmingham and surrounding communities

A routine day's activity on the 2 meter repeater of the Birmingham Amateur Radio Emergency Service was suddenly transformed into a terse emergency net. Several stations were in the shock area, both fixed and mobile. The BARES alerting system activated when W4AXL received several calls. He notified W4WLF, whose family then called the rest of the list and the Red Cross Disaster Service. (The BARES is the emergency wing of BARC, the Birmingham Amateur Radio Club. The Red Cross is our host for meetings and provides space in the communications center for the Club Station W4CUE.) On the way to the Club Station, mobile units of the BARES were directed to proceed to Civil Defense, Red Cross, the disaster area, and other key points. Some stations were on as soon as the blast occurred, and by 2130, only 15 minutes after the first blast, a sizable group of stations was on and in position.

Within a few minutes reports started to come in by police radio that either a plane had crashed or a train had blown up at the rail yards. K4REL, still somewhat shaken by the blasts, reported he could see the fire. By taking side roads he was in the major damage area by the time most of us could get to our cars. He reported many homes in the Observatory Hill area suffered major damage. WB4JOY was on fixed, and he logged all stations as to their location so the data could be transferred to the club station disaster charts as soon as it could be manned. W4DFE and K4DSO were requested to report to W4CUE to assist there. By 2150 W4CUE was in contact with the Red Cross field units moving into the area, with Civil Defense, the Birmingham Police and Fire Departments, as well as many other agencies. The Jefferson County Sheriff's Department had charge of the overall operation since it involved several communities. They also were in the C.D. Net. Only a few minutes after the first blast K4TQR reached the explosion area and reported that the source of the disaster was an ammonium nitrate plant near the Norris Rail Yard (shades of Texas City . . . and who can forget that disaster?). W4DGY, also mobile in the area, reported that large traffic jams were already blocking many roads. Police roadblocks increased the confusion. K4TQR W4RTI and W4FKG assisted officers as requested, including manning roadblocks.

By this time mass evacuation of the area, including a heavily populated section to the north, was ordered by officials. They felt that due to the number of fires burning in the area and the belief – later confirmed – that more explosives remained, this was the only safe action to take. K4TQR and K4REL assisted in manning roadblocks and in a house-to-house search for injured. They also gave many residents the information to leave.

W4AYK reported to the main medical complex for duty. When it became clear they were not receiving large numbers of casualities, if indeed any, he reported on the air and left for the Birmingham Police Department control site. There he stood by for communications duty and rendered first aid to those needing it. Red Cross mobile units and canteens served coffee to workers and established a field command post where ambulances reported for standby duty.

K4OZQ, Director of Emergency Communications for BARC and head of BARES, reported to W4CUE and was in overall charge of the BARES.

Eddy Shell W5ZBC, a commercial photographer, snapped this picture of Rick Jordan racing at Shreveport. We wish Rick well. Have any other readers run across the number 73 anywhere interesting?

In the confusion at City Hall much-needed BARES operators were turned away and sent to the East Lake precinct to stand by. A later check with Civil Defense revealed that they did need help, so WB4MKU and Dr. William Hammack, a member of the club's Novice class were dispatched. One BARES unit stood by at a major shopping center until police could take charge to prevent looting. Almost every window in the center was blown out.

It has been reported that K4TQR did willfully violate his Southern upbringing when he assisted Revenooers (Alcohol, Tobaccŏ, and Firearms Division Agents of the Treasury Department) to find the blast site.

So far only a few calls have been mentioned. There were many units on, and many others available if needed. Only a few stations were placed in the disaster area, due to the possibility of another explosion. Those that were there, were able to do the required job.

News Pages

BIRMINGHAM

This operation was an impressive operation on the part of the amateurs of the area. The many drills and operations to back community events showed its impact in the way the team reacted to the emergency. It was a well-organized effort and resulted in many comments from officials. The Red Cross Disaster Chairman had only praise for the work of the amateurs.

Except for one or two stations on 75, who relayed data from 2, all work was done on 2 FM through WB4QEX. This station is located on Shades Mountain, and is the BARES repeater on 34–94.

The caution of holding the units clear was proved to be justified, as not one job was assigned to our group that was not promptly handled . . . and two large magazines of explosives were found undetonated as cleanup crews started work at the plant site.

Damage to homes and businesses in the area is estimated to exceed $500,000. Fifteen people were injured and treated at hospitals, while numerous others received lesser cuts and bruises. None treated at hospitals were seriously injured. The force of the explosion left a crater 35 ft deep and 65 ft across . . . a stern reminder of what 20 tons of explosive can do.

Calls of stations known to have participated: K4YDI K4REL, K4TQR, W4RMB, WB4FGV, WB4JOY, W4YYH, WB4MKU, W4AYK W4RTI, WA4OBQ, WA4AWS, WA4OSB, W4HMV W4HMV W4AXL, W4WLF, K4OZQ, K4TWJ, W4FKG, WA4VUG, K4HAL, K4ZCY, W4WJX, WB4QES (Repeater), K4VRQ, W4DFE, K4DSO, K4AQZ, W4DGY, K4UMD, WB4JFG, W4CUE, and W4BJG. We hope we did not leave anyone out.

IN PACIFIC NORTHWEST

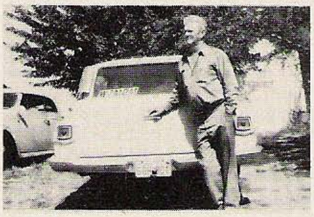
NAMSERVICE GOES BIG

(Special to 73 Magazine)

Out in the Pacific Northwest the new NAMService (Northwest Amateur Monitoring Service) on 3970 kHz has – in less than two months' operation – firmly established itself and already has demonstrated its emergency-rescue value.

In one of these K7EHN was up in rugged mountain area out of Vancouver, Washington, on a fishing trip. Backing his trailer to park it, one of the brake cylinders of his 1967 4-wheel drive International pick-up gave out. All four wheel brakes were then inoperative; he was "grounded" instantly.

Vic (K7EHN) got on 3970 kHz and was almost immediately talking (via phone patch) to his wife. She followed directions: drove to a Portland, Oregon, parts store for a replacement cylinder; got Vic's tools together and sent all this up to Vic with their nephew that same day. Next morning Vic (who is a master mechanic) removed a wheel, made repairs, replaced the wheel and was ready to "roll" again.



"Without NAMS I would have had to hitch-hike down the mountain and find a telephone somewhere, or even go clear back home," he said. "And with things as they are, some thief might have plundered my trailer and pick-up truck while I was gone."

K7EHN (he gets around, being retired from the merchant marine) on another occasion was hailed by a vacationing couple from California when he was at Lewis & Clark State Park – and they were in distress. Their car heated up, boiled over stalled, etc. Vic found dirty breaker

(continued on page 4)

GEOALERT
Now in English

GEOALERT, the world-wide solar and geophysical warning and information system designed to aid solar-geophysical researchers, as well as technological activities such as radio communication and long-line electric power transmission, has been modified so that its radio broadcasts are now in English-language voice rather than Morse code.

GEOALERT provides reports and forecasts of solar and terrestrial conditions and activity. This information permits observers and experimenters to coordinate and interpret their own observations with greater certainty and to calibrate their apparatus to better observe the phenomena which interest them. Technological activities monitor the GEOALERT broadcasts to help regulate and coordinate their work.

Current geophysical information and alerts are broadcast by WWV, Fort Collins, Colorado, and WWVH, Kauai, Hawaii, during the 18th minute of each hour from WWV and during the 45th minute of each hour from WWVH. The messages are updated daily at 0400Z with provisions to modify at any time to provide immediate alerts of outstanding occurring events. These are followed by summary information on selected solar and geophysical events during the past day and corresponding forecasts for the current day, all of which are prepared by the Space Environment Services Center.

The summary information includes two solar terrestrial factors of the past 24 hours, the solar flux (amount of energy radiated from the sun at a frequency of 2800 MHz) and the A-Index (an approximate measure of geomagentic storm activity.) Other solar terrestrial conditions reported when they occur are the degree of solar activity, the condition of the geomagnetic field, the coordinates and time of major solar and proton flares,

(continued on page 4)

(cont. from page 3, col. 2)

NAMSERVICE

points needing replacement; he cleaned them and got the car running. But he also broke into NAMService and (via phone patch) reached the couple's relatives in Yakima. They promptly motored down to make sure all would go well.

"Those people were due to catch a plane at Seattle in a short time," Vic explained, "and if it hadn't been for NAMS they would have missed it."

Alerting the state patrols for wrecks on freeways is more or less regular in NAMS operation. One afternoon a camper body fell off a pick-up truck north of Tacoma, Washington, on Interstate 5. WA7GYP/mobile 7 saw it happen; he was monitoring NAMS and immediately reported it to monitor control (WA7BKR at that time). W7UU, likewise "guarding" 3970 kHz while at work, heard the exchange and broke in; then telephoned the Washington State Patrol. Within minutes a state patrol car was on the scene. WA7GYP doubled back as soon as he could; when he arrived back at the scene the state patrol car was there.

A similar incident occurred when WA7VPW/mobile 7 chanced to be crossing the Interstate 5 bridge over the Columbia River at Vancouver, Washington when, ahead of him, a car and a Greyhound freight truck tangled. Ken (WA7VPW) broke into NAMS and a state patrol car was on the scene within minutes.

That same day W6MRA/mobile 7 on Interstate 5 near Eugene, Oregon, came upon a car on fire in the median strip of Interstate 5. Calling NAMService immediately, he reported the accident and the Oregon State Patrol was alerted and got to the scene quickly.

Sometimes it's just a matter of helping someone – as when K7MHL/mobile 7 was crossing White Pass near Yakima, Washington, and saw two pretty girls with a disabled Volkswagen. Stopping, he ascertained it had run out of oil; its engine was ruined. Via 3970 kHz and W7UU in Seattle, Bruce (K7MHL) gave all the details to the Seattle office of AAA and a tow truck was on its way.

NAMS is a completely voluntary "unorganization" and perhaps that is why it has caught on so quickly and well. It has no officers, no membership list, no roll call, no dues.

"It's all Indians and no chiefs," explained Curly Milner (W7MDM), of Sara, Washington (near Vancouver), who started it out on 15 July 1971. "We want to keep it that way. Hams know how to operate NAMS the minute they hear it. Regimentation and coercion are what we don't need."

NAMS serves Oregon, Washington, Idaho and British Columbia (Canada) – and sometimes farther, when conditions permit. It runs from 9 a.m. until 5:45 p.m. daily, and seldom is there lack of a monitor control station – someone to speak up every half-minute or so and provide a "hitching post." If 3970 kHz is silent for a few moments, someone is sure to notice it and start calling for a monitor control.

And so you hear, more than anything else in the Pacific Northwest these days, the statement "This is ——, monitor control for NAMS, standing by on 3970 for breaks."

Photo: Courtesy Daily Courier News, Elgin, Illinois.

ANTIQUE RADIO COLLECTION

Dr. Ralph W. Muchow of Elgin, Illinois has one of the largest collections of old radios in the world. These are all built from 1900–1927, when batteries were replaced by ac supplies, and all of these old sets are in good working order! If you are interested in old radios you might get in touch with Bruce Kelley W2ICE, the Secretary of the Antique Wireless Association, Holcomb, NY 14469 and ask about membership and a subscription to their very interesting and well done magazine. If you are visiting in the vicinity of Holcomb you might want to see the club museum which has over 600 old radios!

(cont. from page 3, col. 3)

GEOALERT

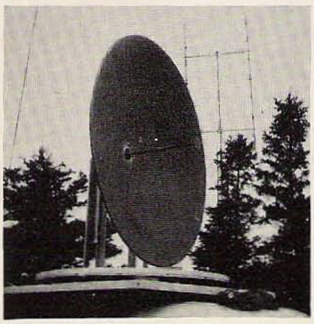
the occurrence of flare-related proton events observed on satellites and polar cap absorption events.

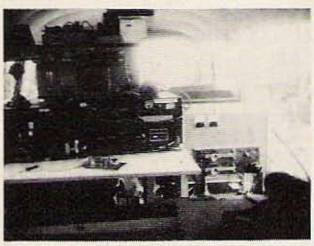
The forecast for the next 24 hours includes the degree of solar activity, the condition of the geomagnetic field, the time of an expected geomagnetic storm, and the coordinates for an expected proton flare. A stratwarn alert, provided by the National Weather Service, reports expected stratospheric warnings in the high latitude regions of the winter hemisphere of the earth.

ARRL BULLETIN

WWV transmits time signals by voice every minute on 2.5, 5, 10, 15, 20 and 25 MHz. WWVH in Hawaii uses 5, 10 and 15 MHz and may be identified by the use of female voice announcements. Every 5 minutes propagation notices applying to paths over the North Atlantic are sent by WWV in code, using a letter and number. North Pacific forecasts occur from WWVH. The letter N indicates normal, U unsettled and W disturbed. The numerical scale is the forecast for the following six hours and ranges from number one, or useless, to number nine, excellent. CHU, the Canadian time signal station, transmits on 3333, 7335, and 14,670 kHz with voice announcements each minute in both English and French. The ARRL Handbook carries full information on these services. The publication detailing Standard Frequencies and Time Services is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

SEPT. VHF CONTEST





Yup, that's a six foot dish on top of that VW bus. This was a summer project by Bruce WA1LXU and was the heart of the 1296–3300 MHz effort of the Honeywell 1200 Radio Club W1DC operating in the September VHF contest from the top of the Pack in Peterborough. Inside the bus Hank W1OOP had his usual line of gear for 220, 432, and up. The extra multipliers on 1296 and 3300 MHz made W1DC a tough customer to beat in these contests in spite of a location that is a bit out of the way.

Bill K1DRB has the front hood of his VW open again, as on the September cover picture. This time he's off to operate elsewhere during the contest. Bob K9AQP/1 looks on from the left.

WITH THE FCC

Things have been relatively quiet on the FCC front, with the notices being strictly routine . . . at least routine for most of us. The few amateurs mentioned in the FCC releases were involved with citations, fines, and the like. For instance K7ABV paid a $50 fine, WB4DXX has had his license revoked, WA6GMR is threatened with revocation, as are the licenses of K2WSP and WN4RGR.

PETITIONS AWAITING FCC ACTION

Thanks to Bob Chapman W1QV for this interesting list of petitions on file with the FCC. Copies of the actual petitions may be had at a nominal charge from Cooper-Trent, 1130 19th Street NW Washington DC 20036. Watch out, though, for some of these petitions can be very, very long and thusly a lot more expensive than you might expect. Ask first.

RM No.	Date Filed	By	Substance
968	3/66	San Diego County	Use of other than 220 MHz to remotely controlled RACES Stations.
(1016?)	8/66	?	Tech operate on Novice HF band with CW.
1116	3/67	California CD	RACES Rules, control of non-ham licensees.
1346	8/68	K3MGO/K3MNI	Senior Citizens License.
1363	10/68	K2ZRO	"Advanced" Tech License.
1429	3/69	WA8DCE	Permit F-4 at 144 MHz.
1454	5/69	K1KTB	Allow Techs to use CW 80 through 10.
1455	5/69	W2NSD	Counterpart call signs.
1456	5/69	W2NSD	Permit Techs same CW priv. as Novices.
1478	4/69	W6PQH	Permit 40F2 emission by RACES on 2 & 1¼.
1516	10/69	WA6FNR	Tech privileges 21 MHZ Novice band.
1528	9/69	W3KMV	CW & phone segs, 6m Advanced band.
1521	10/69	K1RKL	Tech CW privileges.
1526	10/69	W3BWU	Tech CW privileges, 10m.
1535	11/69	ARRL	Tech priv., 29.5–29.7 & 144–148 MHz; dual holding, Novice & Tech.
1536	11/69	ARRL	Counterpart call signs.
1542	12/69	K6MVH	New repeater rules.
1568	2/70	W8WEF	Novice priv. for Techs.
1572	2/70	?	New license "Tech First Class."
1597	4/70	ARRL	1 x 3 call signs for new Extras.
1602	4/70	WB4OBZ	Novice priv. for Techs.
1604	4/70	WB6UTC/WB4NQA	Change ID rules for short QSOs.
1615	3/70	W5JJ	Cond. Class limited to 1 yr; no new Tech; create Intermediate & Communicator licenses.
1629	5/70	W7ELN	Create military examining point in Germany for FCC amateur exams.
1633	5/70	W2NSD/1	Create Hobby Class lic. 220.5–224.5 MHz.
1646	4/70	WA3JHB	In part: 1 x 3 calls for Extra Class lic.
1655	3/70	W3BQN	Substitute holding of commercial lic. for part of 25 yr stint for 2-letter calls.
1656	6/70	W6ODX	Set minimum age for ham license; move CB to 220 MHz ham band.
1658	7/70	Williams, Paul	Move Extra Class Grandfather clause up to 12/1941.
1677	8/70	WA2GGX	Provide 1 x 3 calls for new Extra Class; see RM-1597.
1703	10/70	K3UEJ	Call letters of SK to a family member.
1711	11/70	W1FK/W1KVP	No d.s.b. below 32 MHz.
1724	12/70	WA2LRO	Reduce General code to 10 wpm; give Techs Novice CW privs; restore Novice A-3 in 145 MHz.
1725	12/70	K6MVH/1	Drop licensee control & monitor for repeater with auto. turn-off & coded access.
1747	2/71	EIA	CB on 220–222 MHz.
1748	2/71	WA6GLD	Expand voice bands.
1761	2/71	K4ETZ	Hobby/Personal Radio service on 220 MHz.
1771	3/71	W3EWI	Require certificate of performance, etc. on equipment commercially produced or imported for the ham service.
1776	5/71	WB2EZG	Establish a new ham license above Extra Class.
1787	5/71	Bracy, E.L.	Move Extra "Grandfather" clause to 1/1/40.
1793	5/71	W2GHK & W3ASK	Establish VHF radiotelephone license in ham service.
1804	5/71	K2UTC	25 KHz standard AM 80–15m, 250 w. max. (No SSB in these segments.)
1805	5/71	W7NVY	2 new code-only licenses.
1811	6/71	W8WZ	Grandfather clause for Extra – 50 years.
1830	6/71	K8QEW	Change name of Amateur license to Radioman.
1841	7/71	United CB's	Turn 27 MHz over to "hobbiest," all personal and business CB work on 220 MHz.
1843	7/71	W8JJL	Automatic Extra Class lic. after 25 yrs service (general or higher).

EDITORIAL BY WAYNE GREEN

Staff Openings

We have openings in the advertising, editorial and circulation departments for qualified amateurs who might be interested in combining their hobby with their work.

In advertising we need someone to help contact prospective advertisers and convince them that 73 is the best possible medium for bringing their gear to the attention of the active amateurs. We feel that whenever we are unable to convince an advertiser to use 73 that we have failed not only ourselves, but the advertiser. When we see his ads in other magazines we feel that we have let him waste his precious ad money and we feel miserable that we have let him make this terrible mistake. Sure, we realize that not all readers of Brand X are mentally underprivileged, even though the magazine seems to be written primarily for this audience, nor are all the readers of Brand Y the "build-don't-buy" fanatics that the magazine seems to cater to, but we wonder if exceptions are enough for us not to feel guilty when, through our ineptitude, an advertiser virtually throws away his ad budget by supporting these magazines.

Some background in selling or advertising would be most helpful for this position, since we have to act as advertising agency to roughly half of our advertisers. It is difficult to lay out an ad for a client, write the copy and even arrange for photographs and artwork without some experience in this field.

In the editorial department we need an experienced amateur to help test new equipment and write it up. We need help with preparing the newspages, with the editing and preparing articles. Writing experience would be valuable for this position, as would background on the air working DX, RTTY, contests, VHF, FM, and other facets of the hobby. Solid state know-how will be invaluable too.

In circulation we need a knowledgeable amateur to help us reach potential subscribers and convince them to get 73. This means letters to newly licensed amateurs, to radio clubs, booths at conventions, etc. It is an interesting and fascinating job and it calls for a dedicated amateur with some experience in direct mail work, writing, and a lot of drive.

73 is an interesting and unusual place to work. It is utterly informal, from the offices strung out through an old New England mansion to the croquet games at lunch and after work. In the winter we take time off for skiing, when the snow is right. The area is fantastic for anyone who digs hiking, easy mountain climbing, trail biking, lakes, scenery, clean air and water, camping, skiing, snowmobiling, peace and quiet, the country life far away from the hassle of the city, the most beautiful fall coloring in the world, and a climate that doesn't get too hot in the summer or too cold in the winter. Many of our employees live in seclusion at the end of long dirt roads, surrounded by woods.

Permanence? Nothing in life is permanent except change, but things certainly look bright for us. In a field where virtually every publisher is awash in red ink, with one cutting ad prices to anything he can get just to keep his pages filled, we are comfortably in the black and working on expansion rather than drying up and blowing away.

If you think you can handle one of these jobs, send along a resume and let's see what happens. The pay? Enough, but not a lot . . . probably less than you're getting now. But pay isn't everything, right? If money is all that important to you, you'd do well to stay out of amateur radio entirely as a business and particularly out of amateur radio publishing.

Technician Proposal

There has been a proposal filed with the FCC for several years now asking that Techs be permitted to use the entire 144–148 MHz two meter band. I am 97% in favor of this and would like to see it come about. One of the possible hangups is that this would open the 144.0–144.1 CW band to Techs. I see nothing much wrong with this . . . I know several Techs who are a lot better at CW than I am . . . and a little CW practice won't hurt the rest of them . . . but this may be a block from the FCC's viewpoint. Perhaps someone would be so nice as to send a petition to the FCC requesting that the Tech band be expanded to 148 MHz, but leave the 144–145 segment for higher class licenses. Perhaps this compromise would get some action. With repeaters filling up the 146–147 segment of the band it is getting late in the game to plan the next step . . . will it be repeater expansion into the 145.5–146.0 part of the band or on up above 147?

Relay Repeaters

Clubs with repeaters that are looking for some additional action might think in terms of setting up a relay repeater. Though the FCC has threatened to prohibit this, they haven't as yet, and the more that we have going successfully the better argument we have to keep them going. If we don't set them up now before they are prohibited we may never get the chance.

For instance, a 91 or 97 input repeater in New York City or Northern New Jersey, or even Eastern Pennsylvania, could repeat New England and Eastern New York repeaters down to Philadelphia. An output on one of the lesser used repeater channels down there would complete the trip. A 91–16 machine would relay WA1KFZ (soon to become K1FFK on Mt. Greylock) down to WA3BKO in Philadelphia, tying almost all of Massachusetts, half of Connecticut and most of Southern Vermont and New Hampshire into the Eastern Pennsylvania and Southern New Jersey regions.

Why the 30 kHz Spacing Between FM Channels?

Even with fairly slective receivers, 30 kHz is all too thin a line. For example, at the WA1KGO site on Pack Monadnock in Southern New Hampshire we are using a G.E. Prog line receiver. We find that stations that are a bit off the 34 channel, perhaps 10 kHz, sneak through on our 37 input on our receiver. This is frustrating, and it illustrates all too clearly that there is no way to sandwich any channels between the present 30 kHz accepted standard. As you narrow down the bandwidth of an FM signal you begin to lose the noise-rejecting benefits of the mode, so substantially narrower receivers do not seem practical.

Some work can be done on improving skirt selectivity of i-f strips in amateur receivers and I think we will have an article or two before long on a simple and inexpensive filter which will greatly help most receivers. I notice the difference between receivers when I operate from mountain tops. With broad receivers the signal from WA1KFZ 70 miles away on 91 comes smashing through on both 88 and 94 channels. The more selective receivers ignore the KFZ signal on adjacent channels.

Why 600 kHz Repeater Spacing

About 75% of the repeaters in the country are now set up on what has become the standard spacing between the input and output of 600 kHz – for instance take the most used pair of frequencies of 146.34 in and 146.94 MHz out.

The 600 kHz split was chosen because it was wide enough, just, to permit a repeater receiver to operate with its receiving antenna on the same tower as its transmitting antenna. Much less of a split and the problems of keeping the transmitter from triggering the receiver become formidable . . . and expensive.

Okay, so 600 is a minimum, but what difference does it make if the spread is more than that? There will be that much less trouble setting up the repeater if 800 kHz spread is used, so why isn't this even better?

It would be better if there were no other considerations. There *are* some other considerations that enter into the picture. One is that most FM operators want to be able to work simplex as well as through the repeater. Most of the amateur FM transceivers are delivered today with crystals in place for 34/94 and 94/94 as starters. It is asking a lot of a transmitter to expect it to be reasonably in tune for both 146.34 and 146.94 with only the switching of the crystal taking place. If the input were moved to 800 kHz, or down to about 146.13, the output at 146.94 would definitely be down on many of the rigs.

This is a problem, but not really compelling enough to make anyone adamant about 600 kHz spacing. There is one more good argument that you, as a repeater owner or user, should mull over in your conscience and that is this. If your repeater is split more than 600 kHz, this means that the complimentary channels which would normally be used for 600 kHz are going to be split less than 600, and their use would be limited to repeaters with split sites where the spacing between the receiving and transmitting antenna can be made great enough to overcome the narrower split. Is this really fair? Few repeaters are in locations where the receiving site can be split from the transmitting so, in most cases, your use of more than 600 kHz renders another pair of frequencies unusable.

In areas where there are only a few repeaters this is not yet a problem. But in a growing number of areas virtually all channels between 146 and 147 are fully occupied and new repeaters either have to set up outside of the band or else trod upon toes of earlier repeaters, with subsequent wars.

Fellows, please do give serious thought to setting up new repeaters on 600 kHz spacing and to moving present repeaters to that standard. The move will reduce QRM a lot.

If any crystal manufacturer, equipment manufacturer, club or individual would be interested in setting up a crystal bank, I can guarantee that I will do whatever I can to make the project a success. I would like to see some group or company offer to buy used crystals for a reasonable price in order to make it reasonable for repeater users to change channels. At $5 to $10 a throw for crystals, it is difficult to get a lot of FMers go agree to change repeater channels. But if they knew that they could change crystals for a buck or two apiece, it might be a different story. Any takers? It wouldn't be a big deal to set up in business . . . about 1000 crystals would get it going.

RTTY Repeaters

Dunno if many of you remember, but the very first two meter repeaters were set up for RTTY. Back in 1948 John Williams W2BFD set up a repeater on top of the Municipal Building in New York which repeated the AFSK RTTY signals on 146.96 MHz, enabling all of the TT fellows in Greater New York to get in touch with each other. Most of us were using SCR-522s in those days and they were fine for the job with their wide 12 MHz i-f.

Today there are a growing number of repeaters being set up for RTTY. Most of them have been established on the 10–70 channels and it seems reasonable to me for us all to think in terms of holding out that pair for RTTY across the country.

Repeater groups might give serious consideration to setting up an RTTY repeater in addition to their FM unit. Once an installation has been made it isn't all that difficult to add a second repeater. If all goes well at the WA1KGO repeater here in Peterborough, we'll add one of the Dycomm Echo II repeaters for 10–70.

TTers can plug their AFSK oscillators into their two meter FM rigs and operate through the local 10–70 repeater. There's nothing much to it.

Gregory Electronics

The ham sales of FM gear are secondary to the turnover of equipment for the commercial users, I was told as I toured the impressive warehouse full of surplus FM equipment at the Gregory Electronics plant in Saddle Brook, New Jersey. They have mountains of both mobile and base units there, low and high band, plus a staff to check them out and make sure that they are in good shape before shipment.

Dave Pearlstone, president of Gregory, welcomes us to the plant.

If you are interested in FM it will be worth your while to visit Gregory and pick out an extra rig or two. They are just about 15 minutes from New York City, right on Route 46.

Just a small part of the piles upon piles of FM rigs. Incredible!

Repeater Updating

In order to make our repeater listings valuable we do need to know what repeaters are on what channels where. Please assume when you find an error in our past listings that no one has corrected us and take it upon yourself to drop a card with the info. We would like to publish charts of the repeaters in use for each major population center, so would you take the time to make a list of the repeaters within range and send it in? Please give the repeater call, its location (town, mountain, or whatever will locate it in one word), and its frequencies.

Our Man-in-Washington

Washington lobbyists have their hands full these days. They must keep in touch with all three branches of the government: legislative, executive and civil service. They have to be available to provide information wherever it is needed and this is not a simple job. First of all they have to know the answers to questions or at least how to get them quickly. Then they have to know who might need the information and be sure that it is there at the right time.

Perhaps the most important function of the representative is to find out what is happening on all three levels of government and make sure

(continued on page 9)

LETTERS

PEN PALS?

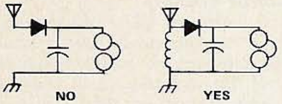
I hope you will forgive me for writing to you. I'm a Soviet ham of seventeen years of age. I've been looking for a ham in a foreign country with whom I may correspond, and you can't imagine how happy I should be if you would enable me to realize my cherished dream.

Well, I am going to tell you a little about myself. My name is Victor. I have finished Secondary school this year. My hobbies are ham radio, pop music, and so on. I want to correspond with any boy, from any State. I have a friend who is also a ham and also wants a pen pal from the USA.

I'm afraid you can't read my English easily because I'm not very good at it. But I hope you can understand it, anyway.

Victor Taran
Post Box II/I
Kiev – 139
252139
U.S.S.R.

CORRECTION



NO YES

By now I suppose your office has been inundated with protests by hundreds of disgruntled Novices. I am referring, of course, to Part X of the General Class License Study Guide in the July issue. The "simplest radio receiver" shown in Figure 1 cannot possibly work – since a diode must have a dc return path in order to rectify ac. I suggest you add an rf choke from the antenna to ground.

75 years since Marconi, and some people still get it wrong! Tsk! Tsk!

Donald Kochen K3SVC
Dundalk MD

NON-RENEWER PENITENT

I was working very nicely toward DXCC with 82 countries worked. I also had 45 States confirmed for WAS. Not bad for a Novice, right? My first hint of trouble was the 15 meter band going to the dogs. Then I ran into all kinds of trouble getting a 40 meter vertical up in my yard. Finally, the very night I had a sked with DL4BW to check out the 40 meter vertical, my receiver died. Please, please, renew my subscription before the gods become angrier.

James J. Lord WN2OSI

Okay, but watch it next time.

GAP?

Thought you might like to know that there is no generation gap in ham radio. Just a communication gap between the ARRL and the amateurs themselves. Keep up the good work but please, a little less FM and more Bob Manning (K1YSD) – enjoy his madness – and more YL candid shots.

Bob Damrau WA1LOT
Clinton CT

JANEL 432CA CONVERTER

After searching around for the ultimate 432 converter for the past three years and using the leading 432 transistor converters, I decided that my own home brew style nuvistor converter with a transistorized preamp was indisputably the best. To make a long story short, I soon discovered that my home brew converter wasn't the best and my egotistical nature decreased to minus 80 dB. The Janel converter did an excellent job with plenty of gain and low noise level, which gives it a big plus for the serious 432 enthusiast.

The circuit uses 5 NPN bipolar silicon transistors, one MOSFET, one zener diode for local oscillator voltage regulation, and two diodes in a full-wave built-in ac power supply. The rf amplifier uses a 40235 in a common emitter configuration, with a broadband input circuit to tune out input reactance, insuring a low noise figure, and two silver plated strip-line output circuits for maximum selectivity and image rejection. The local oscillator chain begins with a crystal in the 100 MHz region, thus reducing the number of multipliers and spurious responses. A 40235 oscillator excites two 40235 doublers to obtain oscillator injection frequency which is mutually coupled into the base of the 40235 grounded emitter mixer. The output of the mixer is capacitively coupled to the 3N140 dual gate MOSFET stagger-tuned i-f amplifier providing 0–27 dB of i-f gain with the adjustment on the front panel.

All American components are used, which are mounted on an epoxy PC board and housed in a metallic green two-piece die-cast aluminum cabinet. Each converter is tuned to order and individually built and tested. Other features of this converter include a jack for 12V dc input and its relatively small size (6 3/4"L, 5 1/2"D, 2 1/4"H). Other specifications are as follows:

Frequency input: Any 4 MHz segment between 420–470 MHz; Stocked fre-

(continued on page 10)

DX FOOTNOTES

ZL4OL/A Campbell Island on around 0930z 14026, and 0300z on SSB on low end of band. QSL ZL2GX. ZL3OL/C Chatham Island on at odd hours on CW on 3510, 7010, 14030, 21030 and SSB 3690, 3790, 7090, 14190, 14625 (Pacnet), 21300. QSL to ZL2AFZ.

SPRATLY ISLAND

DU1DB, who was hoping to make the Spratly DXpedition from VS6 and W, did not get his boat in shape in time to have the expedition completed by the time the typhoon season began, so the DXpedition has been put off indefinitely. Anyhow, the islands are now the focal point of a political dispute. BV-Land has occupied one of the Spratly group and DU-Land has lodged a protest. Meanwhile the BY boys have constructed a military base on the nearby Paracel Islands. Both of these island groups are also claimed by both halves of XV-Land. So the chances of there ever being a DXpedition to these areas is remote indeed, unless a member of the Chinese Signal Corps decides to try ham radio. *(Info tnx to Gus.)*

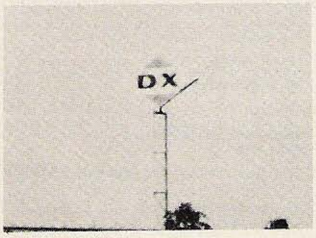
BHUTAN. AC5PN continued to show up rather regularly in the last part of August, the West Coast getting in there frequently and often Yonten being worked in other parts of the country. One report says he was on every morning from 1300kc between 14034–14036kc. ITU told him that Bhutan can officially request an ITU prefix and then make their own internal assignements for amateur, commercial, government and military calls. Yonten is still using the call AC5PN but may change it to AC5PY . . . or he may wait for the ITU action. There is a report that a beam antenna is being offered. Possible that no QSLs will be printed until call sign clarified. Pre-prepared QSLs may be successful.

SIKKIM AC3PT showed up recently around 14300kc from 1300z. No set frequency but this is the area . . . sometimes higher, sometimes earlier. Has also appeared on SEANET. One day UA1CK was emceeing the action.

CAMBODIA 9M2IR visited in Cambodia and obtained operating permit – VE7IR/XU. Plans are to demonstrate amateur radio to XU-officials and then push for lifting of ban.

BURMA 9M2IR also visiting in Burma. Telecoms Director there says 12 XZ-licenses still in effect but higher authorities banning transmitting. Apparently no foreigner will be allowed any XZ-operations and a Burma citizen probably will be the first back on the air . . . when things are eased. *(Thanks to West Coast DX Bulletin)*

Look for W7UXP/KM6 Midway around 21–24 Oct., and /Kure Island from the 25th of Oct. QSL to KH5HCM, 5952 Gannet, Eva Beach HI 96706.



Leave it to dedicated DX chaser W4NJF to spot this one and snap it from the car window between Jackson and Nashville.

Some DXers from Two Land

If you have any reasonably good photographs of well-known DXers, send 'em on in. The following were snapped during a DX get together in New Jersey. If the band is open at all you will hear at least one of these chaps coming through.


W2FZY


K2NUR


W2GHK


W2LAX


WA2ELS


W2BXA


W2ONV


W2DXX

DX MAILBAG

On November 3rd Wayne Warden, Jr. (W9IGW) and myself (W2BBK) plan to arrive at St. Maarten. We will be operating for a couple of days from the French side of the island as FGØGD/FS7. Thereafter we will go to Anguilla for a few days, operating as VP2EF (Wayne) and VP2ES (myself), in company with PJ7VL (Vince LaBega). After the Anguilla stint, I will be returning to Dutch St. Maarten for a few days to operate as PJ8AA. We plan to cover all bands that are open from 10 through 80, both phone and CW. We will generally be 30 kHz inside the low edge of each American CW and phone band.

QSL's from FGØGD/FS7 and FP2EF should go to W9IGW.

QSL's for VP2ES and PJ8AA should go to W2BBK.

"Doc" Evans W2BBK
Englewood, NJ

LOOKING AT SOME WELL KNOWN DX'ERS

W1OOP Hank, one of the vanguard on 220, 432 and up. You'll hear him operating from W2DC during contests if you ever want to contact New Hampshire on one of the UHF bands.

W2NSD/1 *cont. from page 7*

that the amateurs are aware of anything of importance to them. This means keeping close track of adminis trative programs legislative proposals and actions, and agency regulations. There is a virtual army of GS-10 employees in government agencies who work through the years, no matter what party is in power or which legislator is elected, and most of the things that seriously affect amateur radio happens on this obscure level – a level that only a professional lobbyist can really know.

The mere presence of such an individual is enough in many cases to insure that amateur radio will get a better deal. Actions on fairly low levels in the State Department, Army, Navy, Air Force, and many other government agencies can have long-range effects on us. Would the Voice of America have quite so many of their incredibly loud transmitters in our ham bands if we had any clout? It is just a small thing, to be sure, and of little import to FM'ers, but a lot of 40m ops may stop and think a bit about it. VHF operators might wish that there had been a loud voice asking questions when the Air Force decided to take first priority on all UHF bands a few years back, permitting amateurs to continue to use the bands as long as there was no interference to the AF. Hmmm? Those are just a couple of small examples.

. . .Wayne

AL	WA4AHX	Albertville	34–94
AL	WA4AHX	Albertville	20–76
AZ	WA7HUH	Globe (CD)	145.68–146.85
AZ	WA7AJU	Mingus Mt	34–94
AZ	WA7AJU	Mingus Mt	16–76
AK	?	Ft. Smith	34–94
AK	W5ZF	Hot Springs	28–88
CA	WB6DGJ	Eureka	34–94
CA	WA6URI	Inland Empire	16–88
CA	WA6URI	Inland Empire	145.48–146.88AM
CA	K6APE	Kern County	145.25–146.75
CA	K6MYK	Los Angeles	146.98–145.22AM
CA	K6ROC	Los Angeles	147.24–145.22AM
CA	WA6UPB	Los Angeles	145.175–147.66AM
CA	WA6ZOC	Los Angeles	224.82–221.74
CA	WA6ZOC	Los Angeles	224.82–146.40
CA	K6SYU	Orange County	52–19
CA	K6SYU	Orange County	145.62–146.19AM
CO	WAØVVC	Denver	444.35–449.35
CO	KØOVQ	Denver (1800T)	146.82–147.30
CO	WAØBAG	San Luis Valley	16–76
CT	WA1KHK (was WA1INO)	Avon	28–88
CT	WA1KGB (was W1BNF)	Meriden	37–97
CT	K1IGF	New London	19–79
IA	K9ITW	Now defunct	
IL	WA9ORC	Chicago	16–76
IL	WA9ORC	Chicago	34–76
IL	WA9ADW (was W9BYZ/9)	Genoa	34–76
IN	WA9WVC	Anderson	22–82
IN	W9INX	Ft. Wayne	28–88
IN	W9INX	Ft. Wayne	52.64–52.88
MA	K1OAI	Oxford	22–82
MA	K1FFK (was WA1KFZ)	Greylock	04–91
ME	W1EFF	Gray	34–94
MI	K8WNJ	Muskegon	22–82
MI	Simplex	Muskegon monitored	94–94
MI	? (creating fury in Chicago)	Benton Harbor	34–94
MI	? (Murderous situation?)	Benton Harbor	94–76
NJ	WA2PRI	W. Orange	04–85
NJ	WA2UWP	Bergen	28–79
NJ	WA2ZVQ	Toms River	31–91
NJ	WA2UWO	(Woodbridge (PL)	22–82
NJ	.	Sayerville	16–76
NJ	WA2UWC	Greenbrook	34–94
NY	W2CVT	Mt. Beacon	37–97
OK	WA5SJE (was WA5KWH)	Tulsa	22–82
PA	WA3BKO	Philadelphia	16–76
PA	W3TKQ	Philadelphia	29.640–29.493
RI	W1HQV	Providence	22–82
WA	VE7APU delete from list		
WA	VE7MQ delete from list		

Thanks to WA2ROJ, WA8GVK, W2LAL, W1UPB, WA9CWE, W2AWX, W1WAS, and K9LSB.

LETTERS

(continued from page 8)

quency output: 26–30, 28–32, 50–54 MHz; Gain (front panel adjustable): 0 to 35 dB; Noise figure: 4.3–5.5 maximum dB; I-f rejection at 28 MHz i-f: 75 dB; Image rejection at 28 MHz i-f: 40 dB; Maximum input signal level: 10 mW; Power supply: 117V ac or 12V dc @ 40 mA; Price class: $65.00.

The manufacturer also has plans for producing an antenna mounted 432 MHz preamplifier with built-in antenna relay and power supply. The Janel model 432CA converter and further information are available direct from *Janel Laboratories, P.O. Box 112, Succasunna, N.J. 07836.*

Lyle T. Dysinger WA2VJC
Clifton NJ 07011

About a month ago I had the good fortune and pleasure to take a motor trip through Canada, and on my return visit I detoured through New Hampshire just so I could visit you and 73 Magazine. I am sorry that you were not there at the time but I enjoyed the visit anyhow. Your whole staff, including your charming wife and daughter, just dropped their chores for the moment and treated me like a long lost brother It almost made me envious to see the famous Southern Hospitality being outdone by all those Yam Dankees. In fact, everywhere I went in both New Hampshire and Vermont, people were so doggoned nice to me it just made me even prouder to be an American.

After I reluctantly left 73, I decided to drop by the ARRL headquarters, but they didn't seem to be quite as glad to see me. My reception wasn't cool, but it definitely lacked the sparkle of my visit in Peterborough. For facilities they have you beat hands down, having a well-stocked museum, operating building, spacious, richly appointed offices, well-equipped laboratories, plenty of technicians to work on construction projects, et cetera, but facilities alone cannot make up for other deficiencies. I wanted to meet some of the personalities whose names regularly appear in QST magazine, but they were too busy to see visitors. The best I could do was to subscribe to QST – maybe on my next trip (if ever the opportunity strikes again) they might be a little less stuffy about their own importance.

I think that you and your staff issue an outstanding magazine from every respect and am proud to be a life subscriber, but if it would help you to become a director of the ARRL I would not mind your selling out to someone who could and would maintain the top quality everyone has come to expect in every issue of 73. If I had the money it would be me – I like the country, I would eat up the challenge, and the general subject matter is of great interest to me. Right now, the best I can do is to recommend 73 to all my friends and non-friends alike.

If you are ever in Jackson, look me up – I am not famous nor do I publish magazines, but my steaks and hospitality are known far and wide. "Y'all come!"

John Salter
Jackson MS

Make mine thick and very, very rare . . . okay?

In your "New Books" column in your last issue, you had a small picture of a bookshelf and on it were books with humorous titles such as *Cold Solder Joints I Have Known*, and *Coax Cable Braid Weaving*. How could you forget such best sellers as *First Aid for Bleeder Resistors*, and *A.M. and AM Not*??? Don't forget the sizzler from SM land, *My Study on the Skin Effect*. I feel your library is lacking without these books.

Karl G. Smrekar Jr. WN3PJB
Houston PA 15342

VHF Construction Lines!

This bit about "VHF home construction to be stopped?" in August 73 referring to the certification of radio receivers for use above 30 MHz sent me to my copy of Part 15. According to it, "no radio receiver . . . that operates in the range 30 to 890 Mc . . . shall be operated without a station license unless it has been certified . . . "

In Part 15 there is no reference to converters, so presumably it is not necessary to certify these, as they are certainly not receivers. In addition, receivers tuning below 30 MHz do not require certification. Put the two together, and what do you get? Obviously not a receiver, but a receiving system. Part 15 has nothing to say about receiving systems. The moral is – don't build VHF receivers. Keep converters and i-f systems in separate boxes and be content with receiving systems.

In the event that the legal experts construe "receiver" to include "receiving system," there is another way to legally avoid problems of certification of equipment. Part 15 states that "no radio receiver . . . shall be operated without a station license . . . " – so why not operate the receiver with the station license? If a converter is used and if the i-f frequency is chosen so that the converter oscillator frequency falls within the band, the "receiver" is legal, as long as appropriate signal identification is made. Solutions to automatic signal identification can be found in the literature pertaining to repeater operation. Straight C.W. keying of the local oscillator signal at 500 WPM is recommended. Undoubtedly other methods of unnoticeable detectable station identification of receivers could be developed.

Think of the fun of "receiver" to "receiver" contacts and QRP without a "transmitter!" Think of the new terminology-T/R ratio (ratio between transmitter power output and receiver power output), FS (frequency spacing between transmitter frequency and receiver frequency), etc. "VHF home construction to be stopped?" Not by a long shot!

John J. Duda W2ELV
Geneseo NY 14454

NATIONAL HRO 500 for sale new condition less than fifty hours, $1195.00. Dennis Dressler, Rt 7, Topeka, Kansas, fone 913-478-4751.

HALLICRAFTER HT 46 Xmitter and SX 146 Receiver, with relay and books, will ship, $175.00, perfect condx. 2 - TA 33 beams @ $50.00. 1 - TA 33 Jr beam $25.00. 1 - 40 ft. crank-up tower, $75.00. W. Abrahams, Southview Ave., Middlebury, Conn. 06762.

2 METER AM Clegg 22'er transceiver like new $75.00. J. A. Smith, Box 2065, Newburgh N.Y. 12550. Tel. 914-562-4300.

"1971 TESTS–ANSWERS" for FCC First and Second Class License – plus – "Self-Study Ability Test." Proven! $9.95. Satisfaction guaranteed. Command, Box 26348-S, San Francisco 94126.

2-METER FM IC-20, solid state, state of the art, fully Xtaled, w/mike, m-mount, & other accessories. $220. Bob Brunkow, 15112 S.E. 44th., Bellevue, WA 98004.

A TRANSFORMER for linear builders. Tapped 115 v. pri. Sec 1050 v at 1 amp. C.T. Can be used in bridge circuit for sweep tube or in a doubler circuit would furnish over 2900 volts at 500 ma. for zero bias triodes. Sealed case. $14.95 plus shipping. Wt. 47 lb. Can be shipped via U.P.S. A.R.C. Sales, 181 E. Wilson Bridge Rd., Worthington, Ohio 43085.

SAROC SEVENTH ANNIVERSARY January 6–9, 1972. Advance Registration $9.00 per person entitles registrant to SAROC Special room rate $12.00 per night plus room tax, single or double occupancy, effective January 4 through 12, 1972; tickets for admission to technical seminars, HAM RADIO MAGAZINE and SAROC Happy Hour Thursday, SWAN ELECTRONICS and SAROC Social Hour Friday, HY-GAIN/GALAXY ELECTRONICS and SAROC Champagne Party Saturday, Buffet Hunt Breakfast, Sunday. Ladies who register will receive transportation for shopping tour, luncheon and Crazy Hat program at the New Union Plaza Hotel downtown Las Vegas, Saturday. Advance Registration, with Flamingo Hotel mid-night show two drinks, $14.50. Advance Registration, with Flamingo Hotel Dinner Show (entrees Brisket of Beef or Turkey) no drinks, $17.50. Tax and Gratuity included except for room. Frontier Airlines SAROC group flight package planned from Chicago, St. Louis, Omaha, Denver, send for details. Fifth National FM Conference, ARRL, WCARS-7255, WPSS-3952, MARS, meetings and technical sessions scheduled. Accommodations request to Flamingo Hotel, Las Vegas, Nevada before 15th December. Advance Registration to SAROC, Southern Nevada ARC, Inc., Box 73, Boulder City, Nevada 89005, before 31st December.

TELETYPE PICTURES for sale. Vol 1 $1.00. Vol 2 $2.00. Vol 3 $1.50. All for $4.00. Perforated tapes available. 200 different pictures. W9DGV-C, 2210-30th Street, Rock Island Illinois, 61201.

SALE. HEATH: HW-100 (includes CW filter), ac P/S, desk mike, spkr. Excellent! Firm $300. M. Saltzberg, 9318 Edmonston Rd., Greenbelt, Md. 20770. 301-345-8412.

R-388 RECEIVER S/W mint condx. Trade toward TR-4, KWM-2A or best offer. NEED maint. manuals: GERTSCH FM-3 FREQ. METER W/DM-1 MONITOR and CMC 200B COUNTER. Have manuals for 535A, 545A and 511AD scopes and FR-67 counter. SASE for more items for sale. J. Jones, 118 Ohio Circle, Jacksonville, AR. 72076.

2 METER MOTOROLA HT-220 – 6 watt, 2 freq, with nickel-cadmium battery, like new in original carton. First $289.00 money order takes. R. J. Morse, Box 5003, Columbia, S.C. 29205.

TECH MANUALS—$6.50 each: R-274/FRR, TS-34A/AP, LM-21, BC-779B, BC-639A, TS-186D/UP, ARR-7, BC-348JNQ, SP-600JX, URM-25D, OS-8C/U, CV-591A/URR, TS-323/UR. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

SELL: Limited quantity of 12FR8 tubes, $8.50. 20A exciter and VFO, $95. Cressman, 327 N. Prospect St., Washington, New Jersey, 07882.

FOR SALE: Lampkin 105 B with all manuals, used very little, $150.00, will ship. W9PPP 1305 Jefferson Street, Racine, Wisc. 53404.

FOR SALE: Heath HW-100, HP-23a SB-600, Turner 350-C Mike, $270. Bert O'Connor, 16 Smithshire Andover, Mass. 01810.

PROFESSIONAL SERVICE – for your quality ham gear. Moseley Antennas distributor. For information or shipping instructions send card to South Shore Radio Phone, Inc., Municipal Airport, Marshfield, Mass. 02050 or call (617) 834-6900 and ask for Dave W1AAI. A very complete facility with plenty of experience to help you.

GALAXY FM-210 w/Power Supply, Mobile Bracket, Three Sets Xtals. Unit has all engineering changes, will not drift. $165.00. P.O. Box J, Lincoln, RI 02865.

FM-210 used for editorial writeup in 73 available complete with ac power supply and crystals for 34/94 and 94/94. $300 value goes to the first check for $145 received. Box A, 73 Magazine, Peterborough NH 03458. FM-210 crystals $2.50 each, Transmit 22, 28, 46, 37, and receive 82, 88, 73. While they last. Box B, 73 Magazine, Peterborough NH 03458. 1000 kHz crystals $2.00. Box C, 73 Magazine, Peterborough NH 03458.

SOLID FIBER OPTIC: 35 ft., 1/16 in. dia., PVC jacket – 75¢. 500uf–50WVDC electrolytics – 5/ $2.00, 10/$3.50. Postage plse. Electronic Systems, PO Box 206, New Egypt NJ 08533.

WANTED #195154 GEARSHIFT FOR MODEL 28 ASR. Also M28 LPR-9 Reperf. For Sale: Model 28 TD LBXD Excellent. 60 WPM with cover, $90.00 F.O.B. Larry Kleber, K9LKA/W9CPD, Belvidere, Illinois 61008.

STUDY for your first phone license at your own pace using the highly-successful Bell & Howell (DeVRY) courses. Contact Bill Welsh (W6DDB), 234 S. Orchard, Burbank, Calif. 91506.

WEST COAST HAMS buy their gear from Amrad Supply Inc. Send for flyer. 1025 Harrison St., Oakland, CA. 94607, 451-7755, area code 415.

2M FM, standard 826M, Hustler BBLT-144 ant., extra crystals for 19/73, 22/76 repeat., all 2 months old. $290.00. J. Solomon, 24 Brookfield Lane, Centereach, N.Y. 11720.

ALMOST FREE. Taped code lessons. Beginners to 5 wpm. Refundable deposit on tapes, $1.00 for postage. Tomlinson College Radio Club, 3637 West Grandview, Tacoma, Wash. 98466.

COLLINS crystal pack $150.00. Linear Systems 500–12 mobile power supply $80.00. Hi power linear xformer 2500v @ 3 amp. $40.00. All items like new! WA5ZWO, P.O. Box 35128, Dallas TX 75235.

HOT GEAR

Stolen from locked car in driveway at home, night of August 17, 1971: REGENCY 2 (incl mic), Serial: 04-03505. *T. Jeff Coffey, Jr. WA5BNM, 3102 Mindoro, San Antonio TX 78217.*

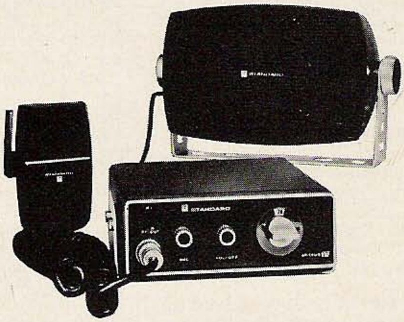
One Sonar FM-3601 2M FM Xceiver., ser. #1003, with 94/94 and 31/91 xtals. Stolen 8/28/71. *George Ritscher WB2ARM, 195 Colvin Ave. Buffalo NY 14216.*

2 METER FM HEADQUARTERS

Rigs for every use . . .
for every pocketbook!

NEW! HIGH POWER

STANDARD 851SH



25 Watt output
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All solid state
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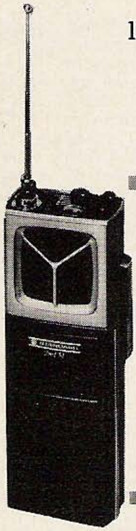

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A BIG THREE ELEMENT BEAM

(OR THE BIGGEST GAMMA ROD IN THE WORLD)

Three elements, 0.15-wavelength spacing, vertically polarized mechanically rotatable. Big deal! So what's so great about a three-element yagi? Well, really not much except this article is about such an antenna, designed, built full-sized, and operated during a DX contest for the 75m phone band!

During the contest season, I got the itch to do something different. How I decided on operating single-band on 75 phone is beyond me. I suspect a streak of masochism. I had the sick fantasy that it would be a lot of fun, especially if I could come up with a mind-blowing antenna that would rattle the boys in the northeastern U.S. loose from their monopoly of signals into Europe on 75m. Sick, sick, sick.

After several months spent experimenting with wire beams, 8JK's, Lazy H's, "bobtail" arrays and other mickey-mouse arrangements, I knew I was falling far short of my goal. In short, the W1s and W2s were eating me alive. Something a little further out was obviously needed if I was going to even partially make up for the handicap of operating from Florida.

While playing with vertical arrays, I got around to feeding my 125 ft tower. After quite a bit of fiddling, I found I could match it to coax with a huge gamma section, and it would actually radiate. This was not too difficult after I realized that the tower, plus the top loading of my six-element 20m beam, appeared to be $5/8\lambda$ long on 3800 kHz. Without going into a long discourse on verticals, I will just say that I put out six $\frac{1}{4}\lambda$ radials in very good earth at the grounded base of the tower and gamma matched the tower to 50Ω coax, using a gamma rod 3 in. in diameter and 38 ft long. Who knows whether the tower or gamma rod was radiating more? It worked fairly well, with a low angle of radiation, was rather narrowbanded – but was still only a vertical and had no gain.

While lying flat on my back in the yard one Saturday afternoon, properly fortified with a suitable quantity of cool 807s, and contemplating the tower (while there are

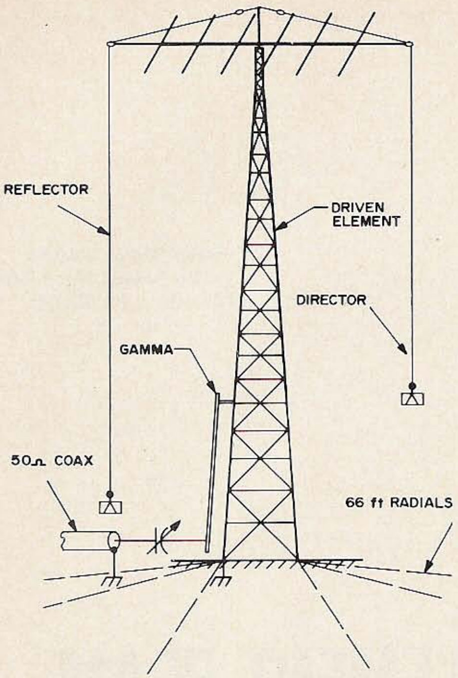


Fig. 1. The beam is a tower with a quickly and easily assembled wire contrivance to make the elements.

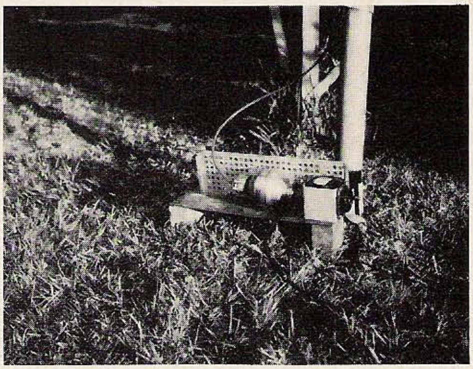
those who smoke pot and contemplate their navels, I guzzle beer and contemplate towers) I had a vision (hallucination?). Why not mount two more verticals, reflector and director, in line with the tower and make it a fixed array favoring Europe? In fact, why not hang the director and reflector from the boom ends of the 20m beam, enabling me to rotate them around the driven element (the tower) and I would have a full-sized, three-element 75m rotary beam.

Without going into too many details of neighbors burning crosses in my yard and chanting, "Fall, fall fall" every time I got on the tower, swinging elements nearly decapitating small children and FAA requesting I file a flight plan every time I rotated it, here is how W4AXE built and operated one of the most gawdawful looking (but electronically satisfying) mechanical monstrosities since the Chinese oyster-shucking machine.

Figure 1 is a sketch of "The Thing." The tower, a self-standing 125 footer, 22 ft across at the base, tapers to a mast which makes the entire structure 136 ft high. At the 125 ft level, I had only my 20m beam mounted at the time. Its six elements on a 46 ft boom made it an excellent top-loading capacity hat that I really didn't need, as the tower would have been much easier to load if it was a half wavelength long. The reflector was calculated and cut 136 ft long, and the director length was chosen to be 112 ft long.

The parasitic elements were strung from the very top, over outriggers mounted to the boom, and down vertically, parallel to the tower and 36 ft away from it. They were number 12 copper-clad steel wire, held taut by weights consisting of two paving bricks hung on each lower end. No attempt was made to restrain the lower ends or keep them constantly spaced from each other and the tower during rotation. This "letting it all hang out" technique resulted in some startling geometry changes from centrifugal force during rotation.

Some losses were probably incurred by having to bring the upper ends of the director and reflector close together at the mast top. This was necessary to pull the gyrating element ends, with their lethally swinging bricks, high enough to clear trees, children and a neighbor who lives for the day he can have something to sue me for. (He almost had me later when his son lost a U-control model airplane to my 75m reflector. I got out of that one by getting the kid to imagine he was a Luftwaffe pilot trying to get his ME109 through the



"Das Flamenspitzer" gamma match with covers removed. Wine bottle insulator is empty, of course. CAUTION! MUCH HIGH VOLTAGE!

barrage balloons during the Battle of London.)

The matching system consisted of a 38 ft gamma rod constructed from 3 in. irrigation tubing (hope certain grove owners don't read this!) and a 25–1000 pF vacuum variable capacitor. Why a vacuum variable? Because I could develop a jillion volts across the gamma capacitor with a kilowatt. Observe the photograph of the lower section of the gamma match, affectionately called "Das Flamenspitzer" by those who have stood too close to it. Note also the dead grass.

The outriggers were constructed of 2 in. aluminum tubing with drilled Micarta insulators plugged into the ends. The wire elements were first strung through the holes drilled in the insulators and "conveniently" coiled until after the outriggers were clamped to the boom of the 20m beam. (Conveniently – Hah! Have you ever tried to handle 250 ft of copper-clad steel wire while on top of that size tower?) The upper ends of the wires were mounted through strain insulators to the top of the mast. The outriggers were fastened to the boom using – sigh! – baling wire, and the coils of wire were heaved almost over the ends of the beam to fall toward the ground. I did a lot of heaving that day. That "almost" cost four hours, at least a pint of blood and visits from two local clergymen concerning the language broadcast from the top of my tower. The name of the game was "untangle the wire – coil it – and throw it again – and again – and again.

Finally, after getting the ends hanging clear and weighted by the bricks, I gave one last look to make sure all was hanging properly and entered the shack to try her out. I rotated the whole mess to where I thought it would favor Europe. Verrry nice! the swr was approximately 678:1 and the rf on my mike did away with the need to shave one side of my face again.

Visualize, if you will, the endless trips out to the tower, up said tower to adjust the 38 ft gamma rod, down the tower to adjust the capacitor, back by the beer cooler and finally into the shack for another measurement. Sad, but inspiring!

Weighted end of reflector. (Heads Up!)

At one time that night, I had the swr adjusted down to 662:1, I think, or else the bathroom fluorescent light finally gave up and burned out. At any rate, the good fight was given up at 2 am.

Stretch your visualizer a little further and imagine the chagrin, but delight, the next morning when it was discovered by the light of day that the reflector and director had hopelessly tangled with themselves and the tower, probably during the first rotation the night before. Apparently rotation of this antenna should be done as the hippies take baths, slowly and only when absolutely necessary. Once again, I will spare the reader the details of untangling "Godzilla," and will simply say that it was ready to go by noon that day. Unfortunately, I was not. By 6 pm I had recuperated enough to try again to tune my brand new but badly wrinkled 75m beam.

As if to make up for its earlier misdemeanors, the array tuned beautifully. The gamma rod required about a 2 ft adjustment and a lot of gamma capacity was needed, but the swr could be adjusted down to 1.2:1 on 3800 kHz. A quick tuneup and call while beaming northeast rousted three Europeans and a covey of surprised W1s and W2s. Ah so! New Yorkers no longer able to brush aside obnoxious

W4 who is working their DX. Velly intelesting!

Forward gain checks were made against my inverted-vee up 120 ft, favoring Europe. The three elements acted just like any lil' ol' yagi is supposed to. It showed about 6 dB gain stateside and, heh, heh, heh – about 9 dB gain on long-haul DX. The pattern would not make Messrs. Yagi or Uda very happy – the front-to-side ratio only about 30 dB and the front-to-back ratio about 16 dB, but who's going to tune it? At any rate, you would be surprised how many requests we received concerning information on our secret weapon from amateurs all over the Eastern Seaboard who had heard our 75m QSOs and pattern checks. I say "we" – you ought to hear my nontechnical wife describing this array over long-distance telephone to some ham who has called at 1 am.

Modesty prevents too much discussion along these lines, but a quick perusal of contest results for the 75m section of Brand X's Worldwide DX Contest will attest to the fact that this antenna does work. The only guy to beat me out in this continent was W1FZJ/KP4, a bigger nut than yours truly, reputed to be running 75m cubical quads up 175 ft high. (Yes, Virginia, there is a Sam Harris, and he is hiding out in the wilds of Puerto Rico – with a lot of wire.)

The Great Happening is over. The tower is now festooned with "normal" six-element beams on the high bands and "IT" is no more. The wire resides in some trash dump after I cut the whole thing down and the resulting tangle was judged hopeless. Children, wild game, model airplanes and my wife can again run free and gay, no longer under the shadow of brick-loaded copper scythes whistling over their heads as I crank up the prop pitch voltage chasing a quick band change. But the memories (and lawsuits) linger on. I can still occasionally come on 75m, and a W2 will hesitate to see if I am still running "IT" before he jumps in with both feet and runs me back up to 20.

I've never tried 160m in a contest. Hmmmm.

. . .W4AXE■

Warren MacDowell W2AOO
11080 Transit Road
East Amherst NY

Remote Tune Your Groundplane

To achieve optimum performance (and minimum swr, of course) with a groundplane, the length, diameter of the vertical element, and position of the ground radials are critical. The groundplane cannot really be classified as a broad-band device, so for maximum efficiency it must be retuned for different segments of the particular band you are operating.

When the groundplane is in resonance at the operating frequency, the position (angle) of the ground radials will determine the impedance of the system. If the ground radials are exactly 90 degrees in respect to the vertical element, the impedance is approximately 30Ω. An additional 45 degree lowering of the radials will incease the impedance to approximately 50Ω, which is a match for conventional RG-8/U coaxial cable.

With a groundplane antenna mounted 50 ft high on a mast, it becomes quite difficult to adjust the resonant length of the vertical element. The position of the ground radials is easily changed as they usually are part of the guy-wire network. The physical length of the vertical element must be changed to achieve resonance and to present an optimum match to the transmission line. Electronic methods for increasing or decreasing resonance of the vertical element can be devised but usually a system of capacitors and loading coils introduces loss and inefficiency. To obviate this, I devised a method of remotely changing the true physical length of the vertical element conveniently from the operating position.

My groundplane was cut exclusively for operation on 20 meters. To cover the entire band with exact resonance, the vertical element had to vary in length from 16 ft 5 in. to 16 ft 8 in. This meant evolution of a device that would mechanically increase or decrease the physical length by 3 inches.

With the aid of a small reversible ac motor, it is actually quite easy and inexpensive to devise an acceptable remote tuning method. Reversible ac motors can be salvaged from discarded TV rotators. The majority of these rotor motors run on 24V ac with capacitor start.

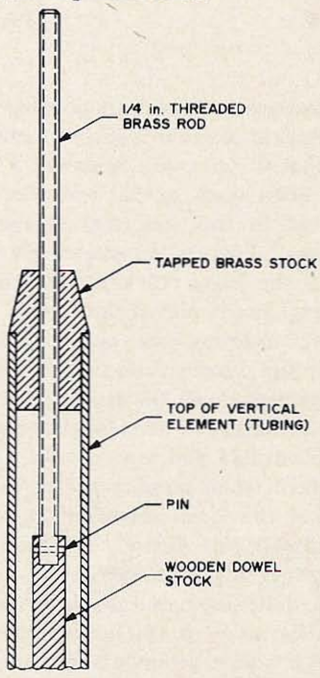


Fig. 1. Vertical top section.

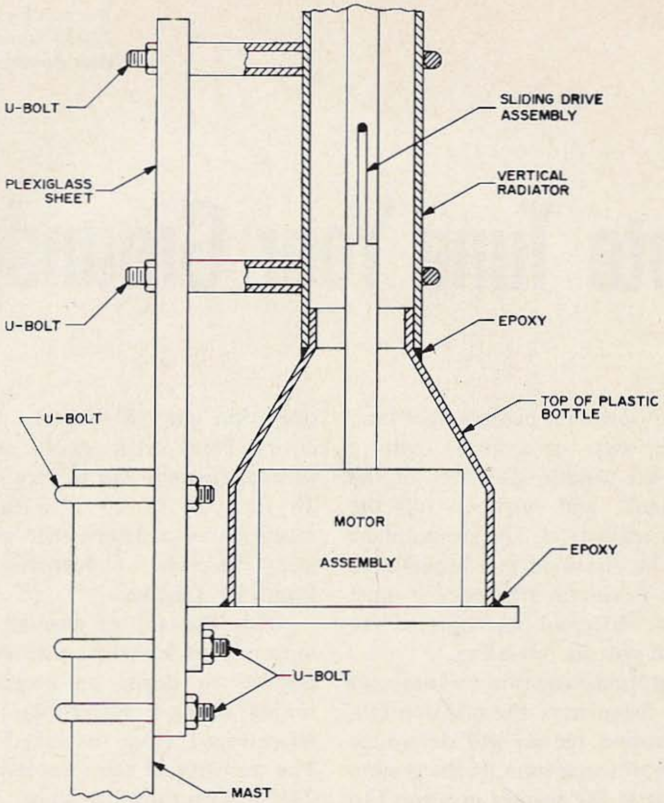


Fig. 2. Bottom drive assembly.

Most groundplanes are constructed with the vertical element made of metal tubing. All that is necessary is to cut a piece of solid brass stock so that it can be securely inserted in the end (tip) of the vertical element. Two 6/32 screws are used to retain the brass stock (after drilling and tapping) in the end of the vertical element. Before inserting the brass stock in the "whip tip" I drilled and tapped a ¼ in. hole vertically through the stock. A 10 in. piece of ¼ in. threaded brass stock is made up to fit the drilled and tapped hole. Care must be taken when tapping and threading this so that the ¼ in. threaded brass rod will turn freely but securely for good contact. In fact, it might be wise to use a matched tap and die set to do the job. Good contact must be made as voltage is highest at the tip of a ¼-wave groundplane.

Wooden dowel stock is run the entire length of the vertical element and pinned to the threaded brass rod. Dowel stock is easily obtained in almost any length from lumber yards. The weight of the dowel attached to the brass rod will assist in maintaining good contact along the threads.

If you are a real perfectionist, the entire tip assembly could be silver plated for optimum contact. Even after oxidation, silver is still a very good conductor. For protection against weathering, a plastic pill bottle was placed over the tip of the vertical. Ordinary plastic electrical tape will hold the bottle in place nicely and will establish a weatherproof seal.

The bottom portion of the vertical element is insulated from the mast with ¼ in. Plexiglas sheet stock. U-bolts hold the Plexiglas sheet to the mast and the vertical element to the Plexiglas. The reversible drive motor is also attached to the Plexiglas sheet with "L" stock fashioned from 1/8

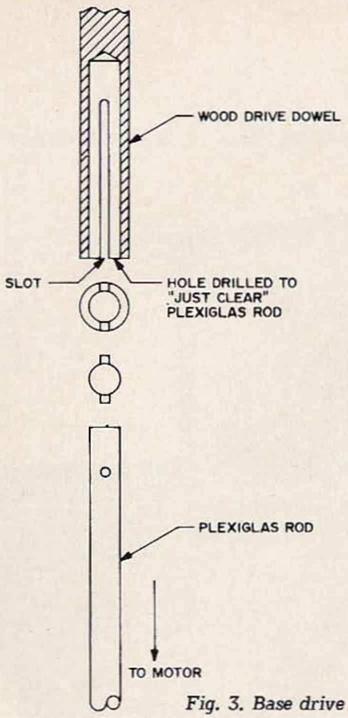


Fig. 3. Base drive details.

in. aluminum. The shaft of the reversible motor is centered exactly with the center of the vertical element. A short shaft from the motor to the wooden dowel is constructed from plastic rod. Almost any rod with good insulating properties could be used here.

Due to the screw action of the brass stock moving up or down as the groundplane is tuned, the wooden dowel must also be free to move up or down. The lower end of the dowel must be drilled so as to freely accept the plastic rod from the drive motor. A slot is then cut in the dowel to allow travel of a pin which is inserted in the top of the drive motor insulated shaft. Drive will still exist yet the dowel will be free to move up or down.

The top section of a plastic bottle was cut off and fitted into the base of the vertical radiator and over the motor assembly to shield from weathering.

TV rotor cable was run from the drive motor back to the shack and control head.

With this remote tuning, you merely watch your swr meter and tune the vertical for minimum reflected power as you move about the band. . . .W2AOO■

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When the DX bug bit me a few months ago, the spirit was willing but the antenna was weak!

My stalwart skyhook at that time was a dipole. It had faithfully delivered WAS, but when my attention turned to DX the new ones were a struggle. Feeling that my race with a declining sunspot cycle might have a sorry end, I made the decision to put up a modest beam.

Commercial towers were certainly the best bet from many points of view, but since funds were lacking, an economical interim measure had to be devised.

Since my plan was to put up a lightweight two-element 15m beam, the mast support had to be adequate to support this plus a TR-44 rotor, but not necessarily a monster called for by "big bertha" arrays. Another consideration was in making the mast fairly self-supporting. This part was easy, since the only available space was alongside the back of our house – the back yard was already criss-crossed with dipoles so that the air space there was already spoken for!

The house had been used to supply bracing points for a 15-ft mast holding my 2m VHF yagi. My question was whether or not this same approach would work in supporting a bigger array. A discussion with a local plumbing contractor who also happens to be a ham resulted in the decision to improve upon the pipe mast idea, but with heavier pipe than the 1 in. galvanized type I had been using for the VHF installation.

The resulting mast was 32 ft high – more than adequate to boost my 15m beam to an altitude that would produce a low wave angle. The mast was constructed of two sections of pipe: The bottom portion was a 20 ft length of 2 in. iron pipe, while the top section was a 15 ft length of smaller-diameter pipe.

The most important part of building a single-section mast of this kind is coming up with a technique for joining the individual pipes together to form a single, rigid sky needle. In the case of this mast, the smaller diamater top section is designed to slip inside the larger diameter bottom pipe for an overlap of three or more feet, with the two pipes then screwed together by means of a threaded reducing coupling welded to the top piece of pipe (Fig. 1).

Securing pipe for the mast can be done via the usual sources, but care should be taken to insure that the bottom pipe is threaded on one end and that these threads match those of the coupling. With a helpful welder, the pipes and coupling can be on hand and the amount of overlap determined prior to welding the coupling. During the welding, the coupling must be kept in the true vertical position, and this can be accomplished by slipping a temporary sleeve underneath. The idea here is to insure that the pipes form a single vertical section when assembled.

Equally important as the mast itself is the bracket-system used to hold the mast firmly to the side of the house (Fig. 2). I used a series of three supports placed at equal intervals, with the top one located just under the gutter about 12 ft above the ground. The supports were made of wooden standoffs that had grooved ends in which the mast rested, and a turnbuckle-and-strap combination that pulled the mast snugly into the bracket and securely in position.

The supporting brackets were made from pieces of 2x4. Semicircular cuts were made in the end of each bracket of a size slightly greater than the diameter of the pipe. The bracket length should be calculated so that when installed on the side of the house it will support the mast clear of

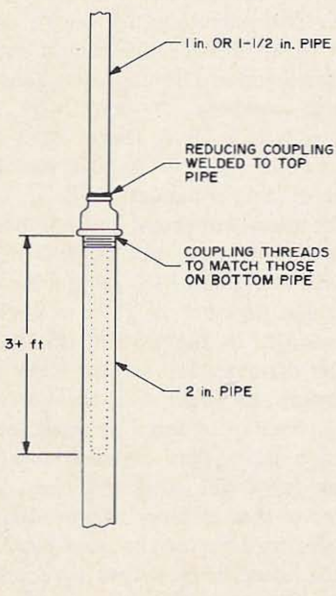

Fig. 1.

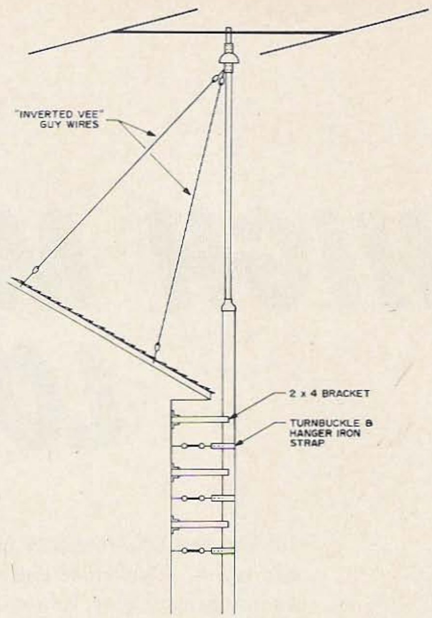

Fig. 2.

any protrusion such as gutters. I used a series of angle irons and long wood screws to attach the brackets to the house. Care should be exercised to insure that the brackets are lined up accurately so that the mast, when installed, will be perfectly vertical.

The turnbuckles holding the mast snugly in the brackets are attached to joists in the side of the house by means of long screw eyes. Strap iron is wrapped around the mast after it's installed and screwed on to the end of the turnbuckles which are then tightened sufficiently to insure stability.

Installing a mast of this type can be accomplished via any of several techniques described in the literature. I opted for a rather direct approach, since my house is a single-story structure with a gently sloping roof that allowed a member of the antenna party to operate "topside."

The first try at getting the beam airborne was to simply walk it up, but this was a near disaster and quickly abandoned. The approach that was quite successful might be dubbed the "divide and conquer" tactic. With the mast lying on terra firma and the beam-rotor assembly in place, the two pipe sections were disassembled. Then, the top mast section containing the beam was lifted to the roof with its lower end extending over the edge of the roof. Then, raising the bottom section of the mast and mating the two pieces, a pipe wrench was applied to the task of reassembly by a helping ham standing on a ladder. After the mast was together, the man on the roof (supported with a safety harness) pulled while the rest of the party pushed the mast skyward and into the brackets. The final measure was to tighten the straps and turnbuckles to lock the mast into position.

The mast withstood 60 mph winds last winter with nothing more than a gentle swaying motion. But since the rather inexpensive beam design led to strong element torque and the eventual snapping of an aluminum gamma strap, I lowered the beam this spring and beefed up the hardware considerably. One valuable improvement was the addition of a pair of guy wires which were actually a 20m inverted vee anchored to each end of the house. The resultant guyed mast is adequate to withstand most severe storms and performs very well.

Certainly the mast described here could be improved via some form of tiltover mechanism and the addition of several more guy wires, but for the money, the mast certainly does the job. . . .WB2FBF■

A GAIN VERTICAL ANTENNA for 2 METER FM

Glen E. Zook K9STH
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Richardson TX 75080

Most amateur FM activity in the United States is vertically polarized to facilitate easy contact with mobile stations. Thus, amateur base stations have tended to utilize whatever type of vertical antennas available. Generally, these antennas consist of groundplanes, obsolete commercial gain antennas, and modified mobile antennas. These antennas are quite satisfactory in many applications; however, when more signal is needed in an omnidirectional pattern, various types of antennas begin to look less desirable. The groundplane is often used as the standard 0 dB reference and thus is the first antenna to show deficiencies. The various types of commercial gain antennas are often the most desired types. Of these, the "Croppie Pole" is among the best. But these are quite expensive and hard to find. Thus, the amateur FM'er often resorts to mounting a gain mobile antenna (such as the Antenna Specialists ASPS 177) with radials, on a tower or mast. Unfortunately, these antennas are relatively expensive and present somewhat of a compromise in mounting.

In each case the antenna is almost always fed with some type of coax, most often a 50Ω low-loss type. If the run is quite short, this present no major problem. But, as line length increases (as happens when the elevation of the antenna is increased) the line loss increases considerably. Thus, the point is soon reached at which all gain realized, in either the antenna height or in the antenna itself, is absorbed by the feedline. For the disbelievers, RG-8/U has a loss of approximately 2.7 dB per 100 ft at 150 MHz (solid center conductor), and the more common RG-58C/U (stranded center conductor, noncontaminating jacket) has a loss of approximately 6.8 dB per 100 ft at 150 MHz. In contrast, 300Ω

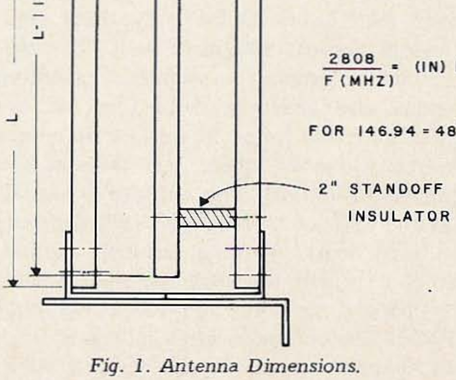
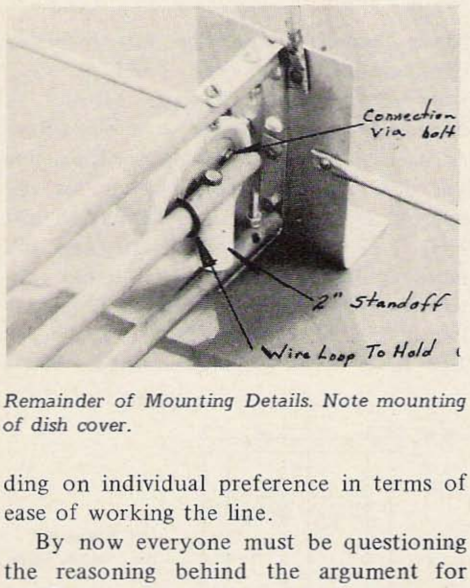


Fig. 1. Antenna Dimensions.

twinlead has losses of from 1.0 dB per 100 ft to 1.5 dB per 100 ft at 150 MHz in dry weather and from 1.0 dB per 100 ft to approximately 10.0 dB per 100 ft in wet weather.

The minimum effects of wet weather are found in the jacketed (not shielded) twinlead such as Belden 8285 and in tubular twin lead such as Belden 8275. The worst losses occur when common flat twinlead is used. Best all-weather 300Ω conditions are met with 300Ω open line. Losses range from about 0.5 dB per 100 ft at 150 MHz when dry to 1.4 dB per 100 ft when wet. However, open wire line is hard for many amateurs to work with. Thus, either the jacketed twinlead or open wire line is the most desired, depending on individual preference in terms of ease of working the line.



Remainder of Mounting Details. Note mounting of dish cover.

By now everyone must be questioning the reasoning behind the argument for 300Ω line. After all, aren't RG-8/U and 50Ω feed antennas the only thing practical in vertical antennas? Well, the commercially available antennas, excepting beams, are generally 50Ω feed, as are most antennas found in amateur reference books. However, there still remains the three-wire vertical. This antenna is basically one half of a three-wire folded dipole (600Ω feed) working against ground. Since it is only one half, the step-up ratio is changed and the impedance is only 300Ω. This antenna, when increased from its original ¼ wavelength to 5/8 wavelength, will exhibit a gain of approximately 3 dB over the usual ¼-wave groundplane. Also, the 300Ω feed allows use of one of the three desired 300Ω feed lines with decreased line losses. The 300Ω balanced line may be matched to the coax input of the FM unit by a simple balun.

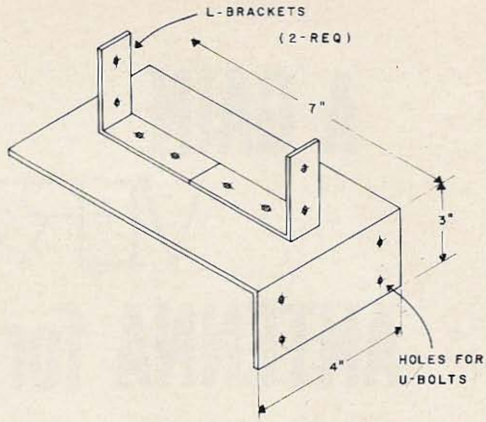


Fig. 2. Mounting Bracket Detail

The antenna may be constructed from aluminum tubing or steel conduit. Aluminum is much lighter in weight, but conduit is readily available.

Construction is straightforward. Three pieces of conduit are cut to length (per Fig. 1 or formula). At one end, two of the insulated standoffs are used to space the three sections. At the other end, only one is used to separate the center element from one of the outside elements. Next

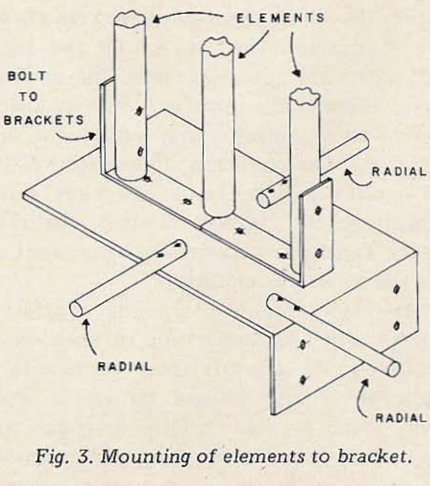


Fig. 3. Mounting of elements to bracket.

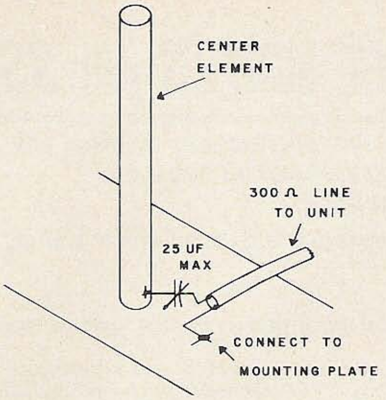


Fig. 4. Coupling capacitor installation detail.

the sheet of aluminum is bent per Fig. 2. The L-brackets are attached end-to-end as in Fig. 3 and the photographs. Next, the holes for the U-bolts are drilled in the sheet, as in Fig. 3. The conduit assembly is next attached to the L-brackets. Three or four radials 20 in. long are attached to the base by small bolts. The variable capacitor is mounted inside the plastic dish with only the shaft protruding. Attach a knob to this to insulate the shaft while tuning. The capacitor is wired per Fig. 5. The feedline may be attached directly to the capacitor or by use of a terminal strip as in the photographs. The plastic container may be mounted by attaching the cover to the center element with small bolts and then snapping the remainder of the assembly in place. The purpose of this dish is to protect the matching capacitor in wet weather.

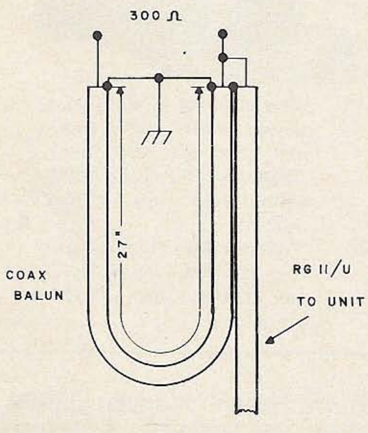
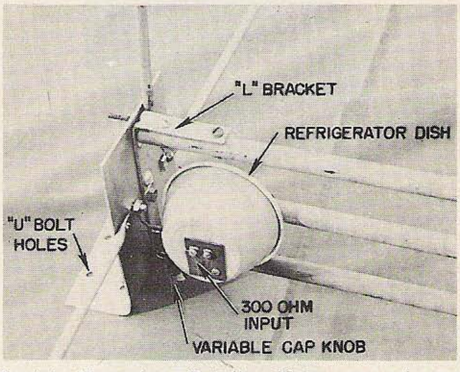


Fig. 5. Details for construction of balun.

To match the coax input of most FM units, a balun is needed. Such a balun may be made from 29 in. of coax (polyethylene, not foam) as described in Fig. 6.

Tuning of the antenna is similar to tuning a gamma match. A slider must be made and the length of the effective antenna adjusted while watching a VHF swr bridge or wattmeter. Also, the matching capacitor should be adjusted for optimum match. Since the two adjustments interact, it will be necessary to go from one to the other several times to achieve optimum settings. When the optimum



Partial Mounting Details. Note use of carpenter's "L" Brackets and Refrigerator Dish.

length has been found, the strip of aluminum is attached with sheet-metal screws to the three elements to provide a permanent short. In a pinch, the antenna may be adjusted with a received signal by watching the limiter readings.

The final step is to mount the antenna as high as possible and then run the feedline. Normal practices concerning open-wire line or twinlead should be followed.

The prototype antenna (shown in the photographs) was compared with both a groundplane and an ASPS 177 antenna. Gain over the groundplane was approximately 2.7 dB with the three-wire vertical, and 3.1 dB with the ASPS 177. These were with line lengths of less than 10 ft. This antenna can be made to work on other bands by varying the length and size of the tuning capacitor.

. . K9STH■

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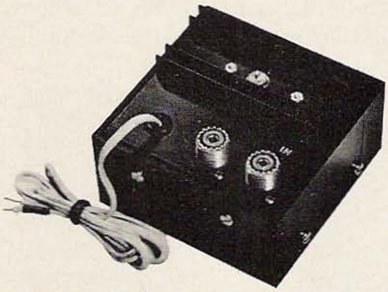

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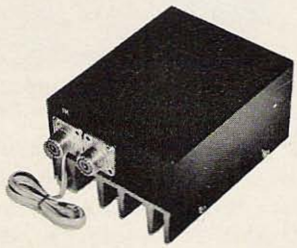

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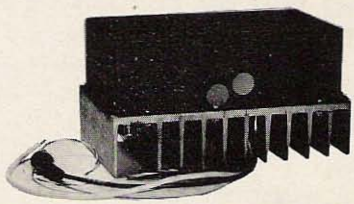

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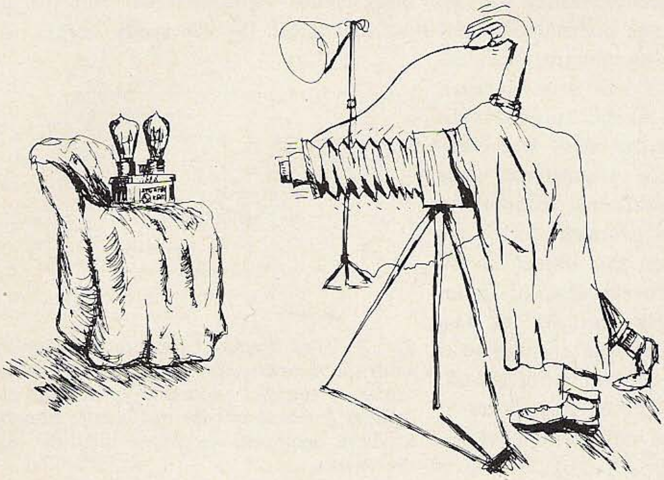
Photographing Radio Equipment



John J. Schultz W2EEY
40 Rossie St.
Mystic CT 06355

If you can't bring a piece of "home-brew" equipment to a club meeting or adequately describe it in correspondence, why not simply photograph it? This article is not intended for photo hobbyists but for radio amateurs who own simple camera equipment. It describes how such equipment can simply but adequately be used to photograph small electronic units.

Often it is desired to photograph a piece of equipment for purposes of illustrating it to someone else, preserving a record of the construction used, etc. Since equipment is constantly growing smaller in size, the type of photography necessary becomes increasingly concerned with taking closeup photos. Of course, closeup photography of radio equipment is generally similar to taking closeup photos of any object, but there are some special considerations involved. This article tries to discuss those considerations and the general subject of taking simple closeup photographs. The information is certainly not intended for the advanced photo hobbyist, but for the amateur who has an inexpensive to expensive general purpose camera and who has often desired to photograph some equipment but not known how to proceed.

Camera Types and Lenses

Perhaps the first thing that should be mentioned about any camera that is available is that one must be able to take reasonably sharp photos with the camera used under *normal* conditions. If this cannot be done, there is no sense in trying closeup equipment photography. If it can be done, it should be completely possible to make reasonably sharp closeups with some practice.

Unless one owns such a camera as a Mamiya Macro which will focus down to 2½ inches, a twin-lens reflex type with a built-in lens bellows, etc. it is necessary to place an auxiliary closeup lens on the camera used. The lens that is necessary depends upon the type of camera being used. Various makes of cameras have auxiliary closeup lens sets available that will permit focusing down to a few inches. When using such auxiliary lenses with viewfinder cameras, the distance between the camera and the equipment being photographed must be that specified for the auxiliary lens. Usually, the instruction sheet that comes along with the camera manufacturer's closeup lens set will give detailed instructions. Generally, unless an adapter is placed over the viewfinder also, the viewfinder image will not be accurate at close distances. Often, manufacturers recommend constructing a simple wire-frame, as shown in Fig. 1 , which places the object to be photographed at the correct distance from the camera lens and also "frames" it. The metal frame is just made large enough so it doesn't appear in the actual photograph. One doesn't look through the viewfinder at all but simply places the wire frame over the object to be photographed. The system is simple but quite good, once the correct frame size has been established for a particular closeup lens/camera combination.

If one has a single-lens reflex camera, the object that is photographed appears in the viewing screen as it will appear on film, since the object viewing is through the taking lens and not through an auxiliary viewing lens. This remains true when auxiliary lenses are used, so one simply focuses while viewing regardless of the auxiliary lens being used.

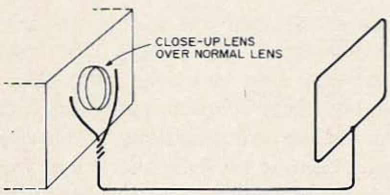


Fig. 1. Wire frame used to establish framing and proper distance from camera for object to be photographed using a closeup lens.

Again, camera manufacturers of single-lens reflex cameras provide auxiliary closeup lens sets for their cameras. However, since most cameras of this type accept standard screw-on auxiliary lenses (of a specific thread for a specific camera), one can use a wide variety of makes of auxiliary lenses. If the camera normally focuses down to about 3 feet, a simple +3 diopter lens costing a few dollars is a good start. It will permit the focus to go down to 8–12 inches, a range very useful for most small equipment or chassis section photography. If one really wants to have

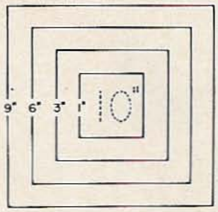


Fig. 2. "Test Pattern" used to test closeup lens. Made on brown paper or cardboard, number in center is changed according to camera distance. Squares (or rectangle for rectangular film formats) establish approximate frame size for different distances.

versatility, instead of buying various fixed diopter closeup lenses an investment in a Vari-closeup lens (about $20–$25) might be desirable. It is variable from +1 to +10 diopters, with a resultant focus range of 1–2 inches to about the camera's normal minimum focus distance. Such a variable diopter lens can also be used with simpler viewfinder cameras that accept screw-on auxiliary lenses but the focusing distance for each setting used on the variable auxiliary lens has to be established by test, as described next.

One may also have a camera which does not accept screw-on auxiliary lenses and for which the manufacturer does not provide any form of closeup lens set. Such cameras can still be used for closeups, providing they take clear, sharp images when used normally. The first problem is obtaining a closeup lens that can be held somehow over the normal camera lens. Some experimentation is necessary in this regard and the simplest procedure is to bring the camera being used to a discount camera shop that carries a variety of lenses. Choose a +3 diopter lens that covers the camera lens. Since the camera will be used with care for closeups , a rugged mounting is not necessary for the auxiliary lens, although it must fit snugly over the camera lens and not wobble. For instance, I have used lenses held by masking tape on the front of a camera without difficulty. The next step is to establish the focusing range. If the basic camera has a focusing range adjustment, set it on minimum range and shoot a test roll of film. A similar test roll can be shot with the basic camera focus adjustment set on specific values. Simple black-and-white film should be used and only negative development is necessary. The test films will quickly reveal the focus range, as long as the camera setup remains unchanged, and should be retained for reference. Once the range is established, a taking frame such as shown in Fig. 1 can be built, if desired.

Lighting and Composition

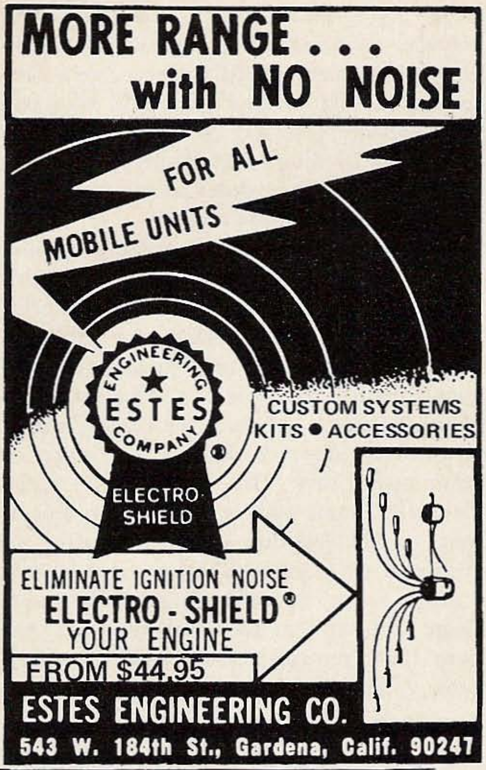
Closeup photos can be made outdoors in bright daylight if carefully done. One problem is shadows, unless the sun is almost directly overhead or unless the equipment to be photographed is propped to eliminate deep shadows. Shadows which appear minor to the eye often show up on photographs as being very deep and they obscure components details, etc. Another problem is reflection from metal cased components (transistors, transformers, etc.). The simplest solution is to spray the unit being photographed with something like Krylon dulling spray (similar sprays are available in photographic shops). The spray will not harm equipment and will also be found useful for indoor usage. Another solution to reflection and glare problems is to use a polarizing filter on the camera. Generally, the use of the dulling spray is the simplest and least expensive solution. Also, the surface on which the equipment rests should not produce glare. Simple construction paper or coarse surface brown paper make good surface materials.

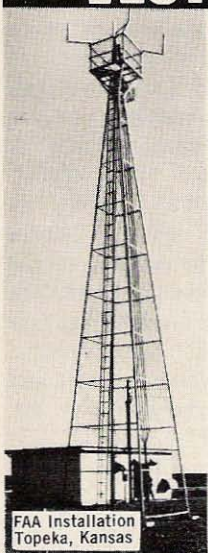
Indoors one can attempt closeup photography using flash bulbs but a number of problems can arise. When using flash bulbs at distances of less than two feet, they often produce a too intense light and the "guide" numbers normally used are no longer correct for camera settings. Quite a bit of experimenting must be done to find the correct camera settings. Most often it will be found far easier and less expensive to purchase an inexpensive photoflood lamp outfit. A basic dual 300 watt photoflood lamp fixture with bulbs can be obtained for around $5! It will provide sufficient illumination to photograph equipment at 20 inches or less with reasonably fast outdoor type film. Also, one can generally get away without using some of the special filters that are necessary when using flash bulbs in order to prevent severe glare and unusual color effects.

The composition of a photograph should be directed at showing detail and also give some perspective or depth. Using the print copying accessory available for Polaroid cameras, for instance, one has an extremely simple method available to make closeups at about 6 inches, but since the camera would be looking directly down at a piece of equipment a very "flat" photograph results. Generally, some sort of side view is best as long as the lighting can be adjusted to eliminate deep shadows. Often, it is best to remove tubes or other large components from a unit and lay them nearby rather than have them remain in place and hide many other components.

Exposures and Films

If one owns one of the "automatic" types of cameras which both set lens aperture and shutter speed there is no exposure problem. The only exception would be a case in which the photocell used in the camera were not mounted by the lens barrel, or were not a through-the-lens type, in the case of single lens reflex cameras. If the photocell is mounted far to the side of the camera it may not read the same light condition as the camera lens sees when taking closeups. A few test shots can be used to determine whether the photocell reading is usable by using manual overide to set the camera aperture at various test openings centered about that determined by the photocell light meter reading. Exactly the same testing may be necessary using "manual" cameras with a built-in light meter but where aperture and shutter speed must both be manually set. Simpler cameras may only have a "daylight/ shade" type setting. The "daylight" setting should be used when using photoflood lamps and some test shots made. When the setting between daylight and shade is of a continuously variable type instead of only click stop settings, test shots should be made





for a number of possible settings.

Until one has refined the technique necessary for taking closeups, simple black-and-white negative film should be used (ASA 100/125 speed). Inexpensive negative development only is necessary to check the results of test photographs. Later, when one is sure of the technique involved, prints—both color and black-and-white—can be ordered. Generally, if using photoflood lamps, most cameras can be operated at fast enough shutter speeds such that they can be hand held. If jitter in the photograph is apparent with hand-held operation several remedies are possible. Stronger lighting can be tried in order to increase the camera's shutter speed. Faster film can be used—up to ASA 400 as long as the slightly increased graininess over slower film is not objectionable. Or a tripod can be used to stabilize the camera. Quite adequate tripods are available even from the radio mail-order supply houses at $6-$10 which will suffice for a small camera. For maximum effectiveness a shutter release cable should also be used with the tripod so hand motion is not transmitted to the camera mount during exposure.

Summary

The taking of closeup photographs is both an interesting and very useful adjunct to radio equipment construction. The expense of a few photographs is far less than that involved in constructing a piece of equipment over again experimentally to develop a successful circuit, component layout, etc. Also, illustrating a piece of equipment to others is very much simplified and the taking of a piece of equipment out of operation, subjecting it to mishandling, etc., is avoided.

I have tried to present only the simplest basics of the closeup photography of radio equipment. For those who wish to explore the subject further, many excellent books are available (the Kodak series, for instance, which contains information applicable to a wide range of camera types). Finally, when buying auxiliary photographic equipment, one should use the same care and regard to prices as when buying amateur radio equipment.

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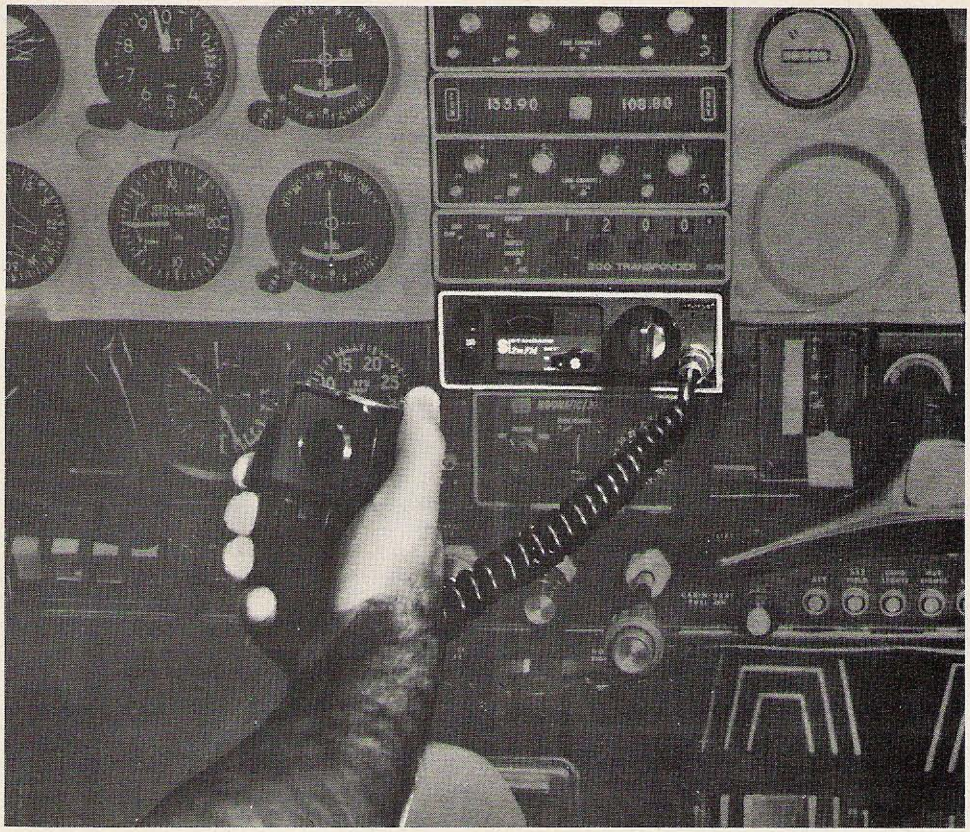

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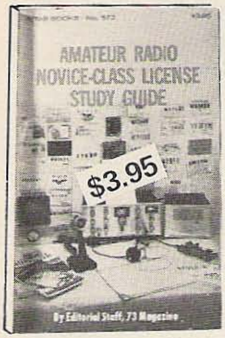

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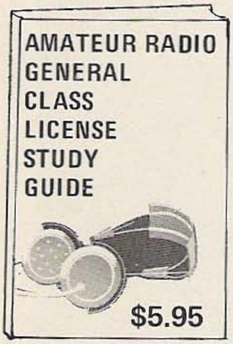

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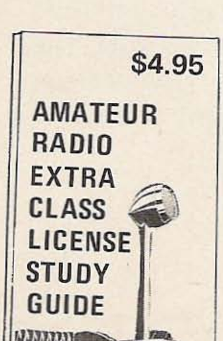

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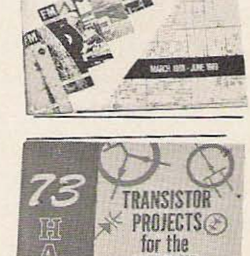
F The FM Anthology ($5.95) has reprints of all of the articles and technical data from the early issues of the FM Journal. No FM library is complete without this data, much of it just not available elsewhere.



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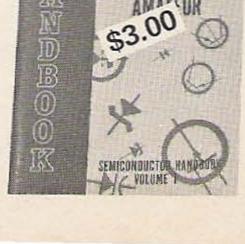

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Biasing the Transistor Audio Amplifier

When building an audio amplifier using transistors, there is a temptation to follow religiously the values of biasing resistors recommended by some "authority." This authority often is a person who has built up a circuit, identical or similar, and who has been satisfied with the results obtained. Some people have labeled this as "the cookbook procedure," noting that it places blind trust in the original builder.

The true amateur of radio technology, however, seldom makes a Chinese copy of some other person's design. Often he adapts ideas to suit his peculiar purpose or to conform with parts available from his junkbox. Such originality is highly commendable, but it can lead to undesired results when the builder leans too heavily upon published information.

Active devices, whether vacuum tubes or transistors, vary in characteristics from one sample to another. This is very much the case with transistors. Because of this lack of uniformity, even the recommendations of manufacturers are "bogey" values, those to fit the average case. That transistor you took out of your junkbox or brought off a dealer's shelf may be a far departure from the average!

What, then, do you do? Well, you use the transistor you have, but you adapt the circuit component values to fit that particular transistor! This is much easier than it sounds, for certain component values can be nailed down initially. This limits the variables to only one or two for each stage. Look at Fig. 1. It shows a single-stage amplifier using a bipolar NPN transistor in the common-emitter configuration. "Black boxes" are used to show the input source and the output load. These may vary greatly in nature, and they cannot be ignored. You must take them into consideration when you are adjusting circuit element values for optimum performance.

In this stage, the values of C1, C2, C3, R2, and R4 usually are predetermined by factors relating to the stage gain and the range of frequencies to be amplified. We'll consider them to be fixed. That leaves only R1 and R3 as the variables. Let's see what we can do with them.

Consider R3 first. It has two purposes in the circuit. One is to guard against thermal runaway, that self-regenerating (or is it self-degenerating?) propensity of a transistor to increase its collector-to-emitter current increases. To head off this "everybody loses" rat race, you put R3 in the emitter circuit to introduce direct-current degeneration. Stated another way, as the dc component of the collector-to-emitter current increases, the IR drop across R3 increases and places an additional negative bias on the transistor's base, thereby tending to reduce the collector-to-emitter current. That's one reason. The other is to make that particular circuit insensitive to variations in transistor uniformity. This permits the user to replace the original transistor with another one without having to hand pick the replacement to insure identical characteristics.

We'll assume you are building an item for keeps; you don't plan to change transistors often. Therefore, you are not particularly interested in making the circuit tolerant of individual transistor characteristics, especially as you know that you'd be doing so at the expense of diminishing the stage gain. So you'd like to put in just enough resistance to insure that the transistor will not suffer thermal runaway. That's not much, about 200Ω for a small-signal transistor and decreasing to about 0.1Ω for some power transistors. You can get some educated guesses about how much to use by noting the smallest values used in similar circuits.

That leaves you with only R1 to juggle. To set its value by any means other than "by guess," you'll need the services of an audio sine-wave generator and an oscilloscope. A variable resistor, with a maximum value of at least ten times that of R2, and an ohmmeter will make the job easier. Unless your af generator can be adjusted for a very low output voltage, you may want to put a potentiometer across its output as an additional voltage divider.

Now for the procedure. Put the variable resistor in as R1. Make very certain that the input and output loads and the collector voltage is that which you'll normally use. Then float the af signal into the input, introducing as little additional input loading as possible. Hook the oscilloscope

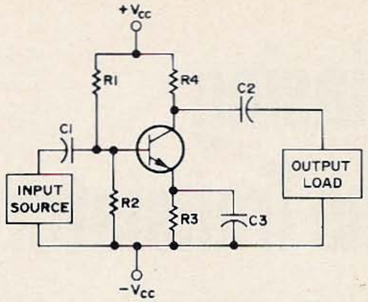

Fig. 1. In this circuit the front-end gain is "locked" onto the i-f gain and tracks with it.

across the output load and look at the waveform. If it looks horrible (after you've adjusted the scope, of course), reduce the input voltage until the waveform clears up. Shift the scope from output to input and back again to output to assure congruity of waveform.

Having obtained, initially, a good waveform, you next deliberately distort it by increasing the input voltage until the waveform shows limiting (flattening off) on one peak, either the positive-going or the negative-going. Adjust R1 to restore the waveform to sinusoidal shape. Then ruin it again by increasing the input voltage. Continue this cycle of actions until the waveform limiting occurs simultaneously on both the negative-going and the positive-going peaks. Now you can disconnect the variable resistor, measure its resistance with the ohmmeter and replace it with a fixed resistor of the same value.

Continue this procedure, stage by stage, until you've covered them all. You can leave the af generator on the input stage if it'll attenuate the signal sufficiently to prevent overloading the following stages. When you have completed the total operation, you can be assured that you have exercised proper technique in the final design engineering of an audio amplifier that'll deliver the maximum undistorted power output it can develop! And don't be shocked if you find that you've adopted values that are far, far departures from those shown in the cookbook. Yours are the correct ones for your situation.

. . .W5JJ■

THE SPLIT SITE REPEATER

K. W. Sessions, Jr. K6MVH

Desensitization, as most repeater owners are all too aware, is the biggest single problem affecting repeater coverage. The pages of 73 Magazine have carried valuable information in the past on how to reduce this problem, and a great many pages of the FM Repeater Handbook (Editors & Engineers, Ltd., Indianapolis, IN) are devoted to methods for licking the problem. But by far the most effective technique, and curiously the one most often overlooked, is physical separation of the transmitter from the receiver. When this system is employed, the machine is said to be a "split site" repeater.

Getting a split-site system going is very often a considerably simpler process than repeater owners typically suspect. Getting a mountaintop facility in the first place – the basic repeater location – may prove to be a pretty sticky problem; but once it's in the bag there is seldom much difficulty in coming up with a second site somewhere in the general vicinity of the first.

Look at your own repeater location. Chances are you have some radio "neighbors" – commercial two-way or governmental radio facilities sharing the same mountain or hill. Ever think about asking one of them to let you install your receiver in one of their buildings? Maybe they'd like to split *their* site as well, taking a similar advantage of *your* site.

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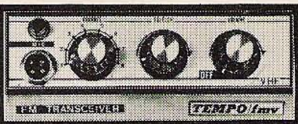
...the world's most complete line of advanced 2 meter fm equipment

TEMPO /fmv



A true value in 2 meter FM, the Tempo fmv is the father of the Tempo VHF line. This small package offers operation at 12 volts, or with the accessory power supply, at 110 volts, for 10 watts output. An unmatched design at any price, the fmv offers high quality and top performance at a reasonable cost. The Tempo fmv . . . $249.00

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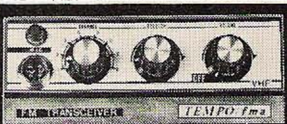

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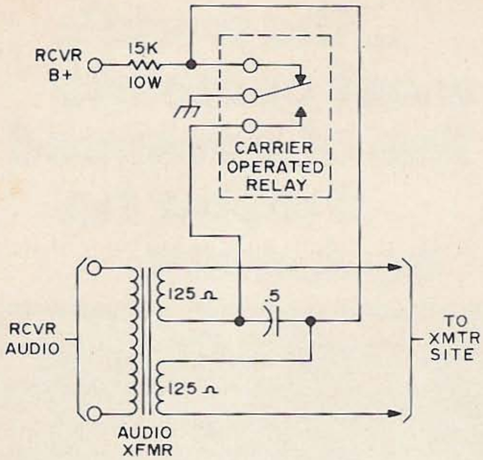

Fig. 1. At the receiver location (two-site repeater), a cathode follower feeds the receiver audio into a transformer continuously, but the receiver squelch keeps audio off the line until a carrier appears. The B+ leg of the two-wire line is held at ground potential by the normally closed COR. When a carrier appears, the ground is moved to the "return" leg and B+ is allowed to flow with the audio through the wire pair. The capacitor on the transformer secondary isolates the dc polarities without disturbing ac (audio) flow.

if you don't have to); receive capability can be enhanced by the addition of preamps without fear of rf degradation by high field strengths; input/output coverage can be matched to a fare-thee-well, making the range of the receiver equal that of the transmitter; shielding requirements are minimized or eliminated altogether, simplifying the installation.

One of the secrets of the fantastic 150-mile coverage radius of 73's WA1KGO repeater is the fact that the receiver and transmitter have been separated by a distance of one-half mile. With the receiver at the top of the mountain determining range, all that was necessary to balance up the system was to adjust the power output of the transmitter to closely match the coverage of the receiver when listening to a 10W mobile unit in a half-quieting area.

Getting the signal from one site to the other can involve secondary "link" setups – subsidiary repeaters operating on a UHF pair. Or it can involve leased telephone lines if the two sites are close enough to justify it economically. As a third alternative – and this is the approach used for the WA1KGO repeater – the two sites can be linked with an overground wire pair strung by the amateur repeater builders themselves. If the facility is on cleared and developed land, then this approach probably will be disallowed by the building owners or land leaseholders. But where the terrain between the two sites is high-foliage area, the homebrew wire-stringing might be just the right approach.

Even if you can't string wire overground, you might find no objections to undersurface wire-stringing – particularly when the landowner is made to realize that no unsafe voltages or currents are to be transferred over the line. Usually, undersurface wire is only required for esthetic reasons – which means you need bury it no deeper than the depth required to conceal the line.

A split-site repeater is no more complex than a single-site system; more often than not, as a matter of fact, it is even simpler. A standard single-contact carrier-operated relay at the receiver can do all the switching necessary to send both audio and dc control signals to the transmitter site. Figures 1 and 2 show one method for

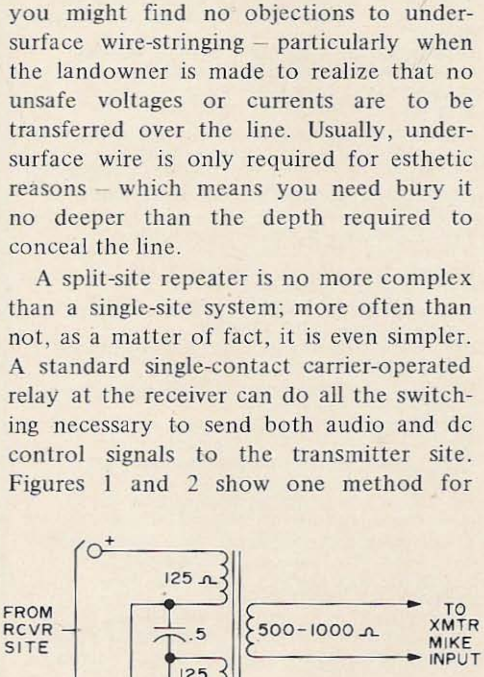

Fig. 2. Audio and dc decoupling is accomplished at the transmitter. The dc control voltage is used to trip a sensitive relay (10 mA) with a coil voltage of about 3500Ω which keys the push-to-talk circuit. The transformer, with split primary interconnected by a capacitor, passes the audio as the dc is routed at the primary.

accomplishing this dual function.

At the transmitter site, the audio and control signals are decoupled from the line by another transformer/capacitor arrangement similar to that at the receiver location, and the circuit is complete. There is nothing particularly critical about the impedances of the transformers in either the receiver or the transmitter circuits; this is particularly true where cathode followers are used, due to their wide impedance-matching range. The most important characteristic is the split windings.

Audio anomalies can be remedied by adjusting the isolation capacitor values. The values shown (0.5 μF) were selected for their ability to reject the clicks of dc relay closures. Lowering the value will improve the low-frequency response, but it will increase the likelihood of allowing annoying clicks to be transferred over the line.

Repeater owners sometimes appear reluctant to adopt a wire pair for repeater linking because of some inexplicable fear of hum and audio level problems associated with mixing audio and B+. Such problems are nonexistent, however, in most two-site links. The secret is in the use of "balanced" lines. The transformers themselves, placed at both terminal points of the line, serve to balance the dc by virtue of the choke action of the windings through which the dc must pass. The only suggestion here would be to use good transformers.

The secret of using only two wires for passing audio and carrier-operated-relay control signals lies in the use of the capacitor-transformer combination, which of course cannot pass dc. The dc is

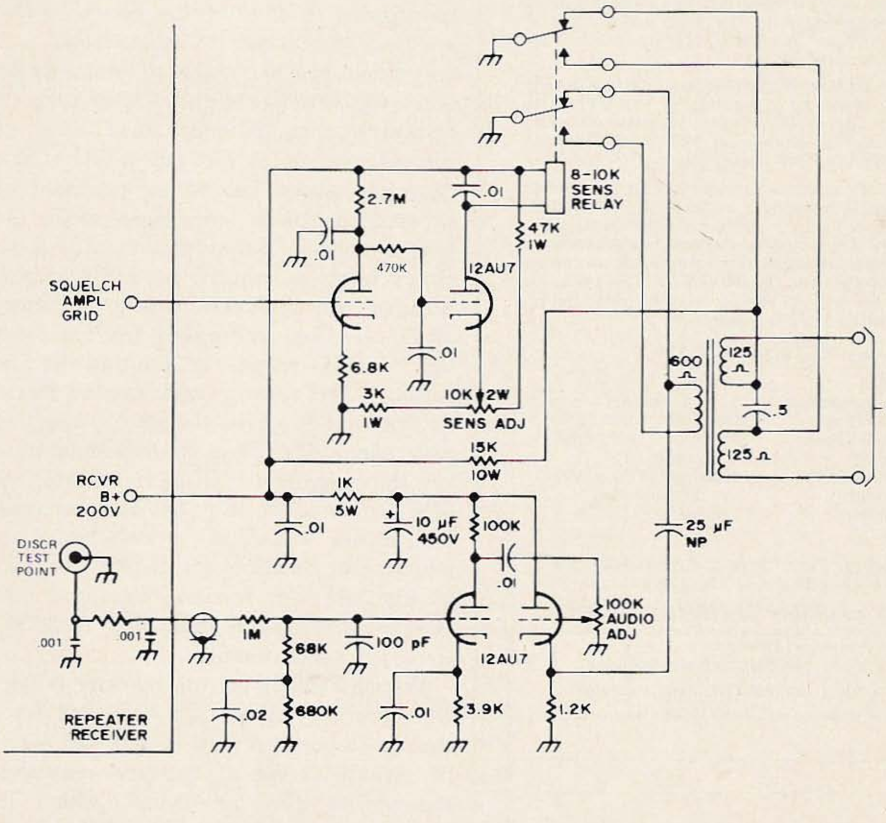

Fig. 3. Audio conditioning and carrier switching system. The audio transformer impedances are not critical, owing to the wide matching range of the cathode follower. The split secondary should match the primary of the transmitter-site transformer, however. The 100 kΩ pot in the cathode follower should be an audio type for smooth setting, though a linear taper will do the job.

imposed with the audio on the wire pair at the source. Then, at the transmitter site, the dc is directly coupled to the control relay while the ac is separated from the line by coupling it through an audio transformer.

At the receiver location, the audio signal is fed continuously into the wireline transformer (see Fig. 1), but the receiver squelch keeps audio off the line until a carrier appears. The carrier-operated relay on the receiver is used to apply B+ (dc control voltage) onto the wireline at the appearance of a signal, and to hold the line to a ground potential at all other times.

At the transmitter location, the two-wire line is connected to another audio transformer (see Fig. 2). The dc control voltage is used to key a sensitive relay (10 mA or so), which keys the push-to-talk circuit of the transmitter. This second transformer decouples the receive audio and feeds the transmitter mike circuit.

It would be a bad design to send pure B+ down the wire pair without some form of current-limiting. Without some form of current control, the wire pair would offer a dangerous shock hazard in the event of exposed insulation somewhere along the line; in addition, a short circuit could mean blown fuses or, conceivably, a fire hazard. Although the resistor shown in the circuit of Fig. 1 does accomplish another function, its key purpose to limiting the line current. The resistor value should be so chosen that it allows no more current to pass than 150% of that amount required to key the control relay at the transmitter site (Fig. 2). Once the relay has been selected, the resistor value can be determined by practical application of Ohm's Law. the transmitter. This second transformer decouples the receive audio and feeds the transmitter mike circuit.

For the benefit of the repeater builder who doesn't like to skip back and forth through a book to pick up bits and pieces of circuitry, Fig. 3 shows a complete receiver-site control scheme, which includes cathode follower audio processing, a carrier-operated relay, and a line transformer. All grounds shown are to the receiver chassis. . . .K6MVH

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The Art of T-hunting

There are many ways to have hidden transmitter hunts, but at California Polytechnic College (Cal Poly) in Pomona we have decided to remain on 6m and have minimum-time hunts. We have tried minimum-mileage hunts, but these have not gone over as well.

Most members have recently gone from using the directionality of the car's quarter-wave whip to loop antennas. Some use both modes, using the whip until they get close, then the loop for closing in.

Cal Poly has been having these hunts every other Friday since 1963 and these have been the most consistently popular events our club has. Although every area police department knows about us we have never had any real problems, just calls by neighbors or hillside dwellers who didn't know what we were doing. If the police arrive, we usually hear "Oh, you again!" And they ask us to keep it cool, quiet down, etc.

The basic system behind our T-hunts is a standard map. We all use the same map with the same borders for the eight sections. This cuts down on lost members and gray areas at the edge of a section.

The size of the area will depend on the terrain and the band used for the hunts. The maximum size should be an area slightly smaller than the effective communications range for that band under bad conditions. This makes the hunts more popular because people with poor receivers can still compete, yet it is usually a large enough area to make an interesting hunt.

To start the hunts the hidden transmitter usually goes directly to hide and does not meet at the beginning spot. The hidden transmitter should be able to be heard at the meeting point so that members can tell for sure that he is on the air. All hunters must meet at the starting point so that a car count can be taken and as the evening progresses they can tell who's left.

About an hour after the hunt begins clues should be given out. Small ones at first, leading to bigger and bigger clues until the hunt is called or all hunters are in.

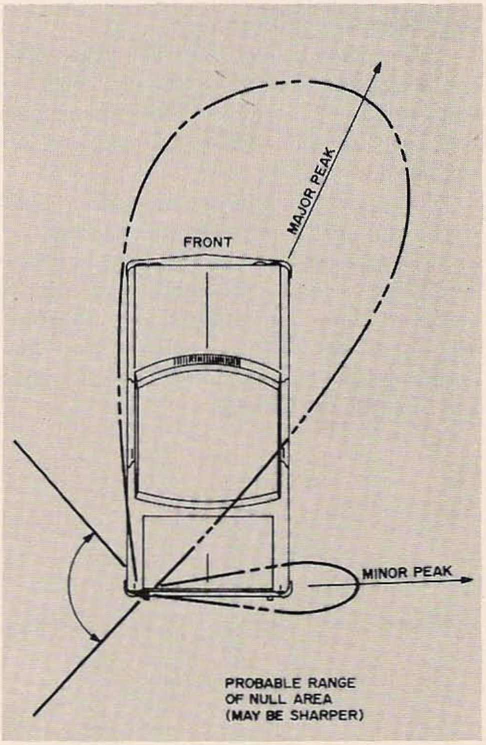

Fig. 1. Directionality of ordinary bumper mount whip.

It is a good policy to have 2m FM or some sort of guard channel to monitor during the hunt. Sometimes members will see or have accidents. Without a guard channel it could be a long time until someone gets through.

T-Hunting Techniques

If a car has an antenna mounted almost anywhere except the center of the roof it will have some sort of directional pattern. It is possible to use the car's regular radio antenna or even a gutter clamp type of antenna, but the best pattern seems to come from a bumper mount antenna.

The basic principle of this type of hunting is to box the hidden transmitter in. Start near a corner of the area where the signal is fairly readable, make a loop with the car and try to get a general direction. If no direction is apparent, just start driving; if the signal gets weaker you are going the wrong way.

Continue this pattern and keep boxing in the area where the transmitter is. Use the map if necessary to keep tabs on the directions and signal strength.

This system is good for both beginners and experienced alike. It requires only a converter and car radio for a minimum and the car's ignition noise can provide a suitable S-meter.

If the receiver you are using does not have an rf gain control it will be best to have a receiving type of signal attenuator connected between the antenna and converter or radio. As the signal gets stronger very little dip will be noticed but the attenuator will cut some of the signal out and not alter the pattern.

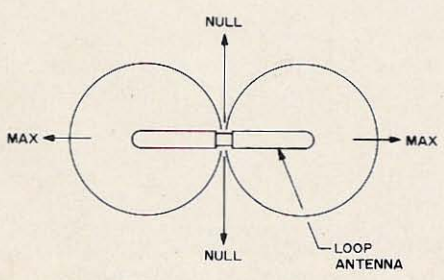

Fig. 2. Directional pattern of the coax loop.

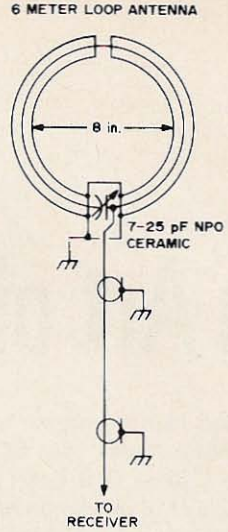

Fig. 3. Coax DF loop construction.

The shielded loop is far superior to the car body for directional characteristics, but is generally not as sensitive. Most of our shielded loops are simple RG-8/U coax loops about 8 in. in diameter. An insulated capacitor connects across the break at the support bracket, and the feed coax connects to one side of the capacitor.

The loop is tuned by holding a grid dip meter near the break in the shield at the top of the loop and adjusting the capacitor. Tune the capacitor for maximum dip at the operating frequency. If the loop will not dip within the band add or subtract capacity to lower or raise the loop's frequency.

The hunting technique is very similar to the car body hunting technique except that the rider can tell exactly what direction the signals are coming from at all times. If the loop cannot hear the hidden transmitter the hunters may have to use a car body antenna to get a strong signal, then switch to the loop antenna. Just remember that a loop nulls equally well in both directions. Don't let the hidden transmitter get behind you while you hunt for him ahead of you.

To check out either of the systems it is best to stage a dummy hunt. Use a grid dip meter, low power transmitter, or almost anything to get a weak signal on the band.

Make loops with the car, and check for

multiple dips or peaks. It depends on the car and position of the antenna where the nulls and peaks are located. Use whatever is clearest to follow as your hunting method.

For loop antennas get away from the signal so that the only signal received is through the loop and not from the wires to the loop. Check that the null is directly broadside to the loop and that it nulls equally well in both directions. If there is more metal directly on one side of the loop than the other the nulls may not be equally deep. This may be a help to establish the direction of the hidden transmitter if the hunter becomes confused. Also as the hunter approaches the hidden transmitter he will notice that the corrections to keep the signal nulled out will become sooner and sooner.

Some receivers may tend to overload as the signal strength becomes very strong. Often the only way to come in for the last quarter-mile is to pull the antenna from the radio and follow the signal strength.

Using any of the systems it is very important to have a rider along – someone to read maps, S-meters, and in general allow the driver to do what he is supposed to do: *drive*. It is not only dangerous and foolhardy to hunt alone, but less interesting.

Past Hunt Experiences

Every new hunt is an experience but in the past there have been several hunts which are classics for our group.

One of the most famous has been the quarter-mile wire hunt. On this hunt a member attached one end of a very large roll of wire to a light post and rode up a nearby hill on his trail motorcycle with the roll of wire on the back of the cycle.

His truck was then driven to the top of the hill and the wire was loaded on 6m. The antenna created many "hot spots," places where there *appears* to be a strong source of radiation. Even after people were able to find the true antenna's location the signal pattern was such that when they got directly under or near the end of the wire the signal would disappear.

Directionality is very good for confusing hidden transmitter hunters. Portable beams such as a take-apart yagi or quad work very well. If you know the receiving directional pattern of the car it is also the same for transmitting. If there are many roads leading into an area but only one way to get to the site, beam the signal away from the real entrance or rotate the antenna so that the pattern shifts constantly.

There are other ways of disguising the hidden transmitter's location. An unorthodox method is to use multiple hidden transmitters all running on the same frequency. If the transmitters have about equal signal strength they can create havoc for the most experienced of hunters. This method is suitable for large ham parties or club outings that can be prepared long in advance. The signals may even be identical if a second frequency is used to transmit the audio portion of the signal.

The more conventional way is to change vehicles or park in very obvious locations.

A change to a completely unknown vehicle and the use of an external antenna has been very successful in the past. On a recent hunt the hidden transmitter was located in a late model Lincoln Continental parked in a typical "date" type parking spot nearly overlooking the Cal Poly campus. It was a very easy hunt to get into the general area, but not after that. Most people will respect the couple in a parked car and not knock on the windows or use flashlights etc. The hidden transmitter was located by the coax leading out of a rear car door, but not until after almost twenty minutes of frantic looking.

Jack Stone (WA6BHJ) and his portable quad.

The obvious location is effective because no one would suspect anyone of parking there. A movie theatre parking lot, shopping center, residential neighborhood, almost any easily accessible place that has many other cars is excellent.

T-hunting is a great method of having fun and is as cheap or as expensive as the hunters want it to be. People have hunted successfully with as little as a Heath lunchbox and the car radio antenna, a converter to the broadcast radio and using the car antenna, or on the other extreme Swan 350s and Collins S-line with FET converters and loop antennas.

Many thanks to the members of the Cal Poly Amateur Radio Association and especially WB6AEJ, WB6HHM, WB6MYZ, WB6NUV, WB6PQV, and WB6ZJC for their contributions over the years to the club's hunting experience and their experience with T-hunting.

WB6IQS

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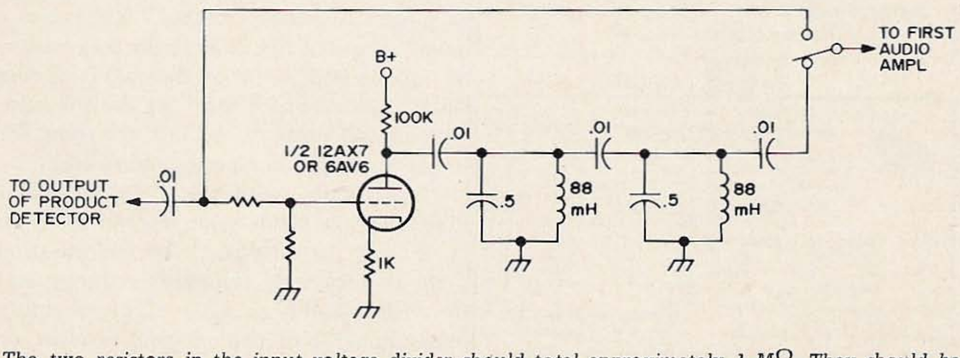
An Ultra-Simple Selective Audio Filter

There have been several articles in various amateur journals showing how to use the now commonplace (and cheap) 88 mH toroids to make highly selective audio filters, ideal for CW reception. Unfortunately, most of these articles have made a major project out of something that's really quite simple. In such a device, all that's necessary, other than the components comprising the filter itself, is a modest stage of audio amplification to equalize the gain when the filter is switched in. Most of the devices described to date have been designed to plug into the receiver's phone jack, and contain amplification to drive headphones. Besides duplicating circuitry that you already have in your receiver, this is wasteful of power, as two audio stages are required instead of one.

Besides, if you're like me, you hate to have a lot of outboard adapters and the necessary cables hanging out of your receiver. Nothing can make a station look junky and unprofessional as fast as a whole bunch of little boxes strung out over the operating table. I build everything in. If you don't want to modify your receiver, it's very easy to bend up a little L-shaped chassis which can be mounted inside a receiver on the back or side of the cabinet. Of course, if you're really cramped for space, it could be mounted outside the cabinet on the back.

This simple audio filter is highly flexible and can easily be squeezed into even the most compact receiver. If you have gain to spare, you may want to dispense with the input amplifier altogether. Most receivers will require it, and it can be built around half of a 12AX7, a 6AV6, or an audio FET without altering the circuitry shown. The



The two resistors in the input voltage divider should total approximately 1 MΩ. They should be adjusted for a balance between audio levels with the filter in and out. For a tube version, anywhere from 100 to 300V is fine. If you use an audio FET, select your voltage according to the manufacturer's recommendations.

use of a bipolar transistor is not recommended – the low impedance of a bipolar device will load the audio output of the product detector so much that the gain of the amplifier will be canceled. Whatever you use for an amplifier, power requirements are negligible.

In construction, no particular precautions need be observed except to adequately shield the audio leads. The voltage divider ahead of the input amp can be a 1 MΩ pot, but for the sake of compactness, using a couple of fixed resistors to balance the gain is preferable. The values of capacitance in the filter yield a center frequency of about 750 Hz. If you prefer a lower note, increase them (and vice versa).

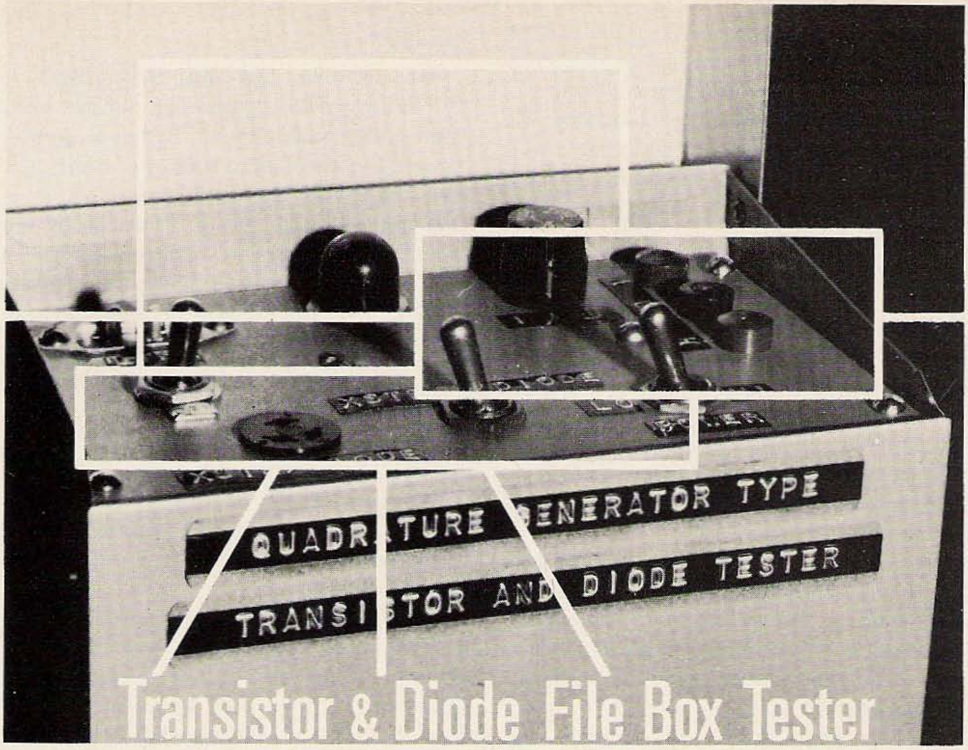
Bandwidth is about 75 Hz at –6 dB, 100 Hz at –20 dB, and 250 Hz at –40 dB. When this high selectivity is employed with some kind of i-f notch filter, you can sort out even the wildest pileups with ease. If your receiver doesn't tune pretty slow, you'll probably find it difficult to avoid passing right over signals. If this is your problem, a simple vernier adapter will solve it.

This is strictly a "no-sweat" project. Nothing is critical, it can be built in just a few minutes, and it probably won't cost more than a couple of dollars. However, the results are most gratifying, and it sure beats laying out $50 or more for a 100 Hz crystal lattice filter!

In using the filter, you'll find that white noise and static crashes are greatly reduced, but in the presence of pulse noise, this unit, like all other highly selective devices, is subject to severe "ringing." The use of a good i-f noise blanker is almost mandatory, if full benefit is to be derived from the filter. This circuit is ideal for the CW man, and should prove to be just the thing for those interested in moonbounce work.

Incidentally, with this filter in, you'll find out how stable your receiver really is. You may be surprised! By zero-beating with an accurately calibrated audio generator, it's possible to make highly accurate measurements of drift in your receiver, or on that vfo you're building, using this filter.

...W8RHR■



Transistor & Diode File Box Tester

In conjunction with an oscilloscope, this file box tester will allow you to check visually the condition of a number of diode and transistor types. The parts list is relatively small and the cost is nominal, the largest item being the 26V transformer. It is simple to build and fascinating to operate.

The circuit is based on furnishing two voltages, phased 90 degrees apart, and connected to the horizontal and vertical scope stages. The base of the transistor under test is connected to ground, the emitter and collector to the respective plates.

Referring to Fig. 1, we see the usual power line connections to the transformer primary. The 26V transformer secondary is supplied to two simple phasing circuits which, when connected to the scope vertical and horizontal amplifiers, results in a circle on the scope screen.

Note that, to exhibit a perfect circle on the scope screen, both vertical and horizontal amplifiers must be adjusted to an equal deflection on the scope and they must deflect linearly. In fact, the attempt to adjust for a perfect circle is a good test of deflection linearity. If the circle has a "flat" on the right side of the circle, the horizontal amplifier is nonlinear. If there is a flattened portion on the upper side of the

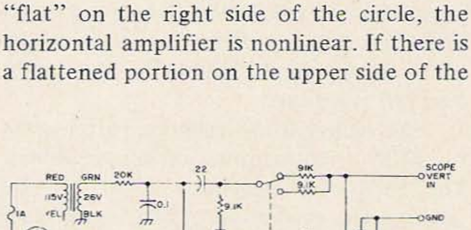


Fig. 1. File box line-quadrature generator type transistor and SCR tester.

circle, there is nonlinearity in the vertical amplifier. Fortunately, some nonlinearity will cause little test result degradation.

The term "quadrature" denotes the finding in square measure of the area of a bounded surface, as of a circle. It also has a meaning of the division of a circular area into four equal sections.

Figure 2 illustrates some of the various possible scope patterns. Note that a good PNP transistor will show a pattern of a quarter "pie" or a quadrant in the lower left portion of the scope screen. A good NPN transistor will show in the upper right quadrant of the scope screen. A good SCR will show a half circle, a unijunction an oval, and a good diode will result in a tilted half circle.

Now, if the collector and the base of a transistor are shorted, only a vertical line will result. If the short is between emitter and base, the pattern is a single horizontal line. Note that the lines radiate from the pattern center.

If the short is between emitter and collector, the single line will radiate on an angle, depending upon whether the transistor is NPN or PNP. A simultaneous short between three transistor elements will show a dot on the scope screen.

Let us suppose that the transistor is neither good nor shorted, but leaky. In this case, the pattern will look like a good transistor except that one leg will be foreshortened (base to collector, base to emitter).

The final group of patterns shows what happens when one of the elements is open. These result in a semicircle covering two of the four quadrants. Basically, what you have left is a diode.

Also included in the scope patterns are the SCRs, unijunctions, and simple diodes. The quadrature generator could also be used for the evaluation of other solid-state devices, but those given in this article should be sufficient to act as a base for additional solid-state types.

A switch allows limiting resistors of 9.1 or 91 kΩ to be inserted in the circuit. For most tests the "low power" position should be used.

Assembly

To assemble the unit, first drill four #25 holes in the bottom of the file box, positioning each 0.5 in. from a corner. Mount the four feet. Drill and mount the two angles for the panel mounting. Position them about 1/8 in. down from the front lip of the box, and at each end of the box. Fasten them with 6-32 screws. After drilling the four mounting holes in the panel, drop the panel onto the brackets and spot the four holes on the brackets. Drill and tap for a 6-32 screw.

The box is now finished except for drawing the schematic on a 3 x 5 file card and pasting on the bottom of the box. A larger 4 x 6 file card could be pasted in the inside lid to show the various patterns as illustrated in Fig. 2.

Now, finish drilling the panel holes. A word of caution: Never take hole diameters from an article. Always check your individual parts, because they sometimes differ. The TV type connector socket hole can be made with a "nibbler," or a series of holes drilled and then filed oblong. Don't forget to mount the insulated washers between the panel and the nuts of the banana jacks. Incidentally, the hole for the banana jack is the diameter of the shoulder of the shoulder washer. The two holes for the transformer depend upon the transformer used. Check these. Mount and wire the parts. You may prefer to mount the resistors and capacitors on tie lugs. Two 5-lug units will suffice. The tie lugs can be mounted through the same screws as used for the transformer. The switch marked XSTR-DIODE, as shown in the picture has been removed from the circuit as unnecessary.

The 3-hole socket is used so that several sockets can be plugged in. These could include a regular transistor socket, a diode socket, a socket for a power trasnsitor, etc. It was felt that this gave the unit a much greater utility and lessened its obsolescence possibility.

Operation is simple. Connect the unit to the house voltage. Turn the switch on. Connect banana plug leads to the scope's vertical and horizontal inputs as well as to

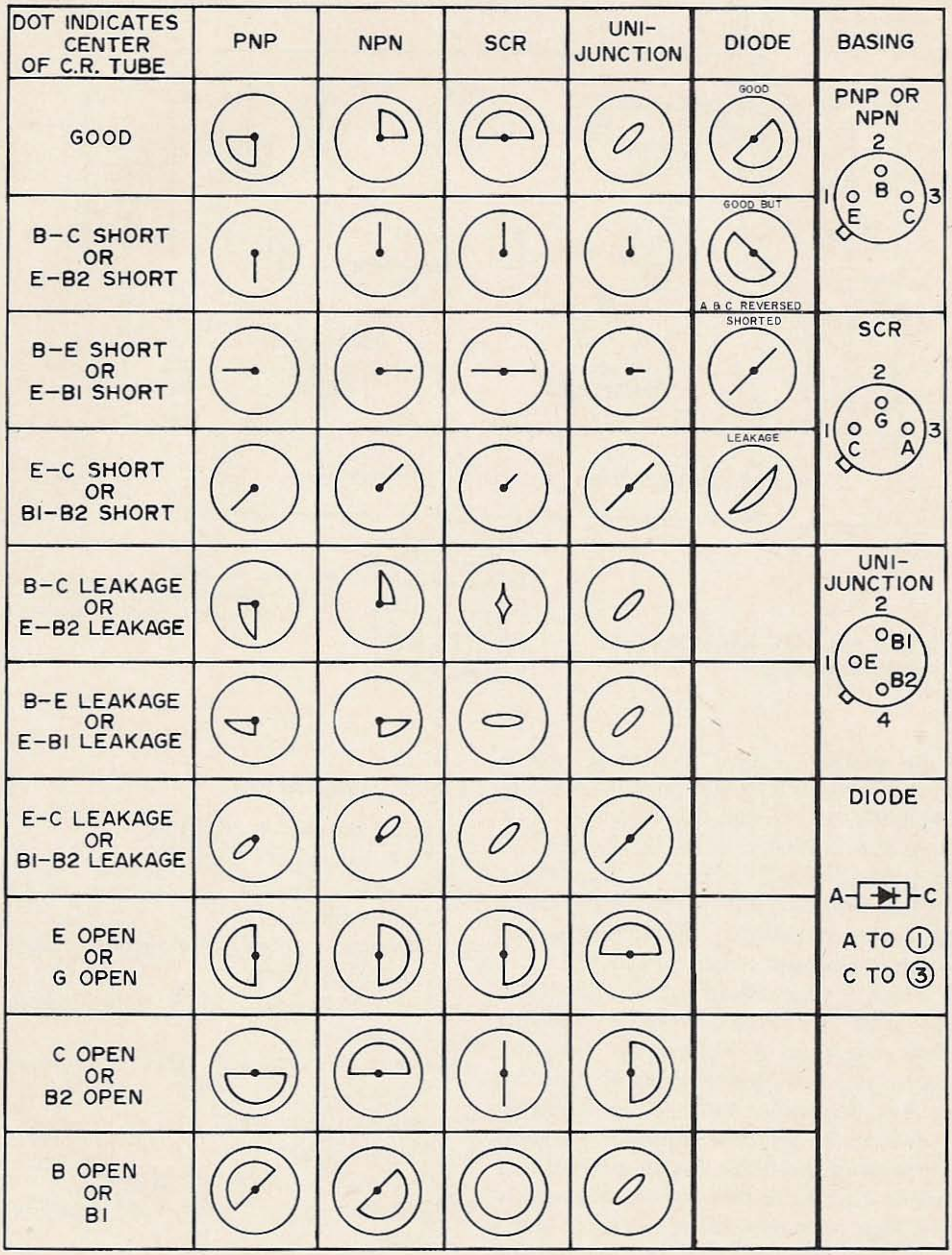
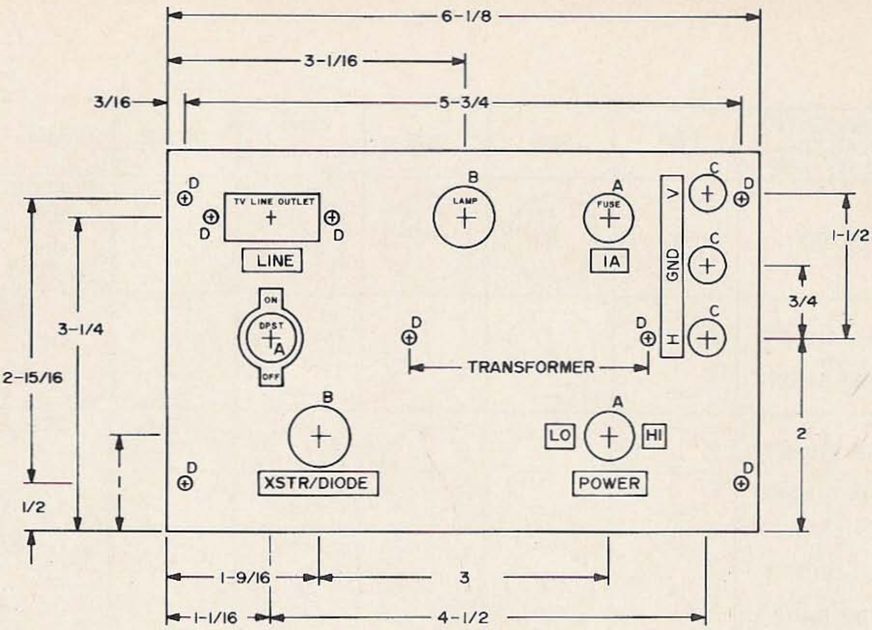


Fig. 2. Quadrature generator transistor and diode tester file box.



HOLE CHART		
LTR	SIZE	QTY
A	1/2	3
B	5/8	2
C	3/8	3
D	NO. 25	8

MATERIAL–ALUMINUM
FINISH–ZINC CHROMATE PRIMER FOLLOWED BY GREY LACQUER

Fig. 3. File box line-quadrature generator tester panel.

scope ground. Adjust the scope for a circular pattern. Plug the transistor into the XSTR/DIODE socket. Be sure that it is connected correctly. Note the pattern on the screen and refer to the various patterns for interpretation of the pattern. Except for power transistors, the LO-HI power switch can be kept in the LO position.

There is no question but that this tester will show the condition of a transistor better, because it shows, for instance, leakage as a quantitative element. You can see just how much leakage an individual transistor has. By first connecting a good transistor in the tester and then paralleling base to emitter, or base to collector, with a very high resistance resistor, then a lower value, you can see the one side of the pattern begin to foreshorten. I haven't tried it yet, but I'm going to try using the unit for testing ICs. Of course, some will not be testable, but if you take it circuit-for-circuit, you should be able to test the individual IC elements of many devices.

List of Unmarked Parts

(1) Fuseholder & 1A 3AG fuse.
(3) Jack, banana - (2 red, 1 blk.)
(1) Miniature socket (Amphenol series 78-3S) 3-hole
(1) Miniature plug (Amphenol Series 71-3SO) 3-prong
(1) Neon indicator - 115V with built-in series resistor
(1) Power transformer (UTC FT-14 or equiv.) Pri 117/Sec 26V
(1) Switch, toggle, dpdt.
(1) Switch, toggle, dpst.
(1) Socket, TV type & mating plug.
(1) File Box, metal 6 1/4 x 4 1/2 x 4 (Ohio Art).
(2) Bracket, angle aluminum - 4 x 1/2 x 1/2 in. (Reynolds Metal #2406 or equiv.)
(4) Rubber feet with 6-32 mounting screws and nuts.
(2) Tie lugs, 5-position.

. . .WB4ITN■

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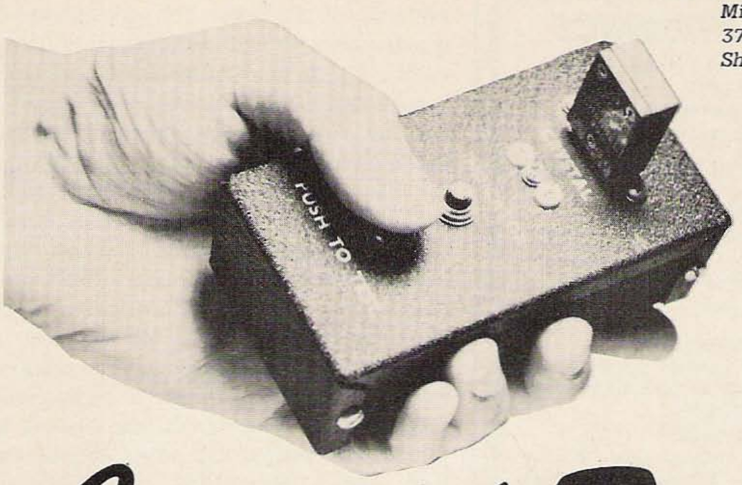
Sherman Oaks CA 91403



Crystal Tester

Here is an easy-to-build crystal tester to tell you at a glance whether or not a crystal is capable of oscillation. Battery operated and inexpensive to construct, the tester will find use in weeding out those questionable crystals that have been accumulating in the shack for years. The tester is actually small enough to carry along with you when you buy surplus crystals at the local emporium.

To use the tester, simply insert the crystal to be tested into one of the crystal sockets and press the test switch. If the indicator lamp glows, the crystal is good. If the lamp does not glow, the crystal is bad . . . what could be simpler?

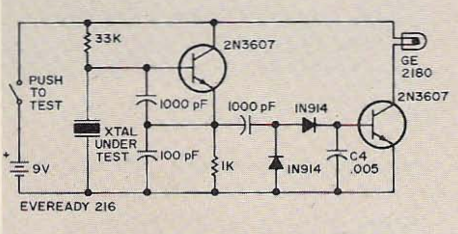


Fig. 1. Crystal Tester Schematic

The tester checks for oscillations but does not check that the crystal is oscillating at its marked frequency. Crystals that fail the test inevitably are found to be fractured, to have dirty contacts or broken leads. The tester has been used successfully to check crystals ranging from 3.5 MHz to 90 MHz.

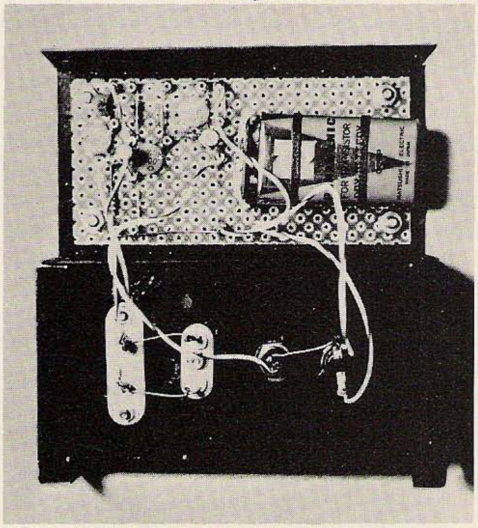
Figure 1 shows the schematic of the tester. The circuit portion at left forms an untuned Colpitts crystal oscillator which is able to oscillate over a wide range of crystal frequencies. (Of course, the absence of tuned circuits to reject harmonics means the oscillator output will not be a pure sinusoidal pattern, but this is of no concern in the present application.)

With a good crystal in the circuit and the test switch closed, the circuit will oscillate and several volts peak-to-peak will be developed across the resistor in the output of the first stage. This peak-to-peak voltage produces a dc bias at the base of the output transistor and thus causes the indicator lamp to glow.

If the crystal under test is bad (i.e. fails to oscillate) no signal will pass through the coupling capacitor and no bias will be developed at the base of the output transistor. Thus, the indicator lamp remains off, indicating a bad crystal.

The photographs show the general appearance of the tester and the method of construction. Components are mounted on a 1¾ x 3¾ in. piece of Vector board which is mounted on 1/8 in. standoffs from the bottom of a 4¼ x 2¼ x 1½ in. Minibox (BUD CU-3016A). Crystal sockets suitable for FT-243 and HC-6/U were mounted on the lid of the Minibox and wired in parallel to accommodate the most common types of crystal holders. A miniature SPST push switch (S1) and the indicator lamp were also mounted on the lid of the Minibox.

Neither circuit layout nor component values are critical. The active components should be computer switching devices, although the output transistor can be any NPN capable of collector currents in the 50–100 mA range, as determined by the indicator lamp. All components shown in Fig. 1 could be purchased new for a total cost of under $4.00, so the construction of this tester is not an expensive undertaking.



– Method of construction, Minibox opened up –

While I used a 9V transistor radio battery in the tester, any battery voltage from 6V to 15V could be used. The tester draws current only when the push switch is closed; thus, if tests are kept short, battery life will be quite long. The original crystal tester has been used to check perhaps 50 crystals over a two-year period and the original battery is still going strong!

. . .K6VCI■

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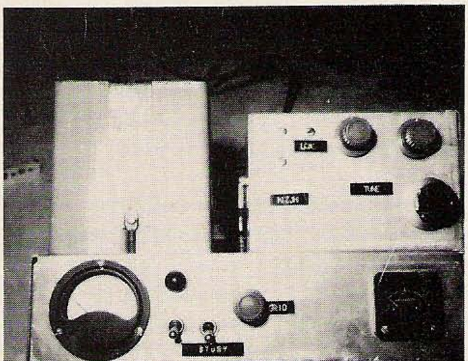
A Compact Kilowatt for Six Meters

Desiring to join the ever growing number of stations on 6m sideband, I finally built a transverter for my HF station. After a few evenings of operation, it became obvious that the 5W output from the transverter was not going to lead me down any great road to fame or glory. Not to be outdone by the average 300W signal, I decided it was time to join the elite and get at least 1 kW on the air. A quick look at my financial resources and the price of commercially available linears was enough to make me get out the drawing board and handbooks.

The linear was built as small as physically possible. Its 8 x 11 x 3 in. chassis houses the complete linear – power supply and all. One reason for the small size of this truly compact kilowatt can be attributed to the use of a 4CX250. Besides enabling the construction of such a small device, the 4CX250 has several other advantages which made it a logical choice. The tube is rugged, and it is available to amateurs at reasonable prices. The 4CX250 was designed for VHF, and it is also a zero drive tube when used in class AB1. This makes it ideally suited for use with exciters



with low power output. The only power required of the exciter is to overcome circuit losses between the exciter output and the control grid of the 4CX250. If 4CX250s are not readily available, 4CX150As (7034s) may be directly interchanged with no change in the linear's construction or operation.

The linear requires a large blower. The 4CX family of tubes is well known for the ability to handle a good amount of power. If you wonder how these tubes handle the large amount of heat dissipated in class AB1 operation, the answer lies in the circular air fin arrangement surrounding the anode. Air must be force-fed through. The more air, the cooler the tube and the longer its life. The minimum airflow permissible is 6 cfm through the fins. A 100 cfm squirrel cage may move a lot of air in free space, but when you get it feeding into a pressurized chassis, you will be lucky to get the required airflow through the plate fins. Be sure to use a chimney with the sockets. Also be sure to use a socket with a built-in screen bypass capacitor.

One of the few drawbacks of the 4CX250 is its requirement for filament voltage. Unlike most commonly used transmitting tubes which are perfectly happy with 6.3V or something thereabouts, the 4CX250 has a *maximum* filament rating of 6.0V. You may wonder what difference 0.3V can make, but it is very important. The 4CX250 is subject to cathode back bombardment and the condition worsens with frequency. The manufacturers recommend decreasing the filament voltage at UHF. The condition is minimal on 6m, so any voltage between 6.0 and 5.9V should prove satisfactory.

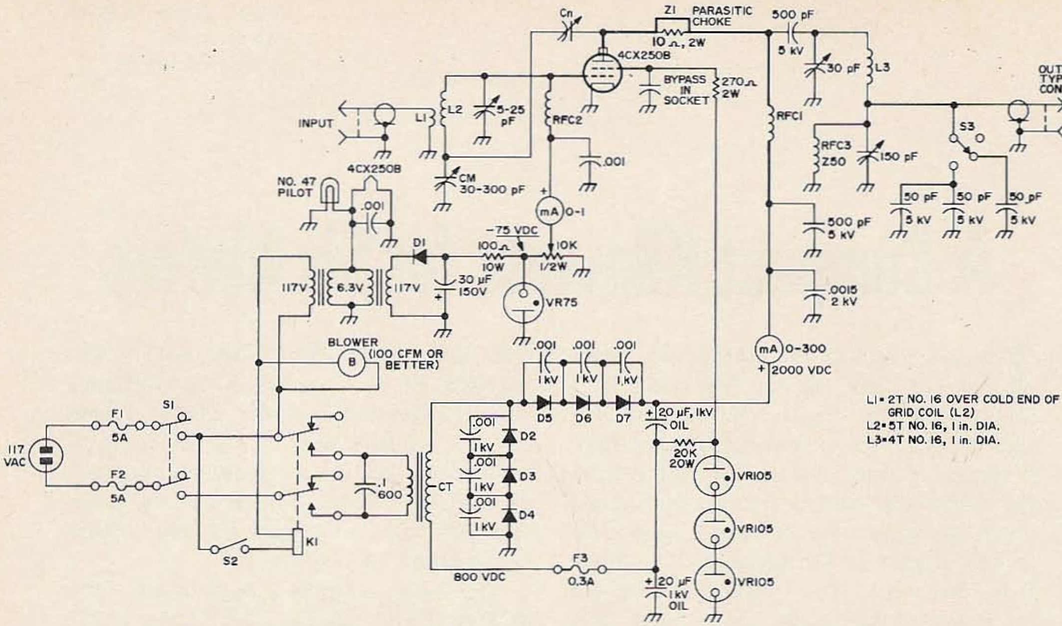


Fig. 1. Schematic of compact kilowatt. Unmarked capacitors should have 1 kV rating.

Schematic Parts List

T1 – 117V ac to 6V ac filament transformer, 2A sec.	D1 – rectifier
T2 – 117V ac to 6V ac filament transformer. 1A sec.	D2–D& – Silicons, IA at 1000 PIV
T3 – 117V ac to 800–900V ac at 300 mA or better	CM – About 30–300 pF compression mica trimmer
SW1 – 10A 2PDT switch	CN – Metal plate, see text; diagram
SW2 – 1A SPDT switch	RFC2 – 20 turns, No. 18 enamel, ¼ in. D.
RY1 – 117V ac relay 10A contacts	RFC1 – No. 24 to 20 wire wound over ½ in. d. ceramic form for 2 in. to 2¼ in. of length
	SW3 – Ceramic 3 position single pole

The rest of the power supply is for bias and plate and screen voltage. The bias transformer is a filament transformer with its 6.3V winding connected to the 6V filament supply. This produces around 110V on the other winding which is rectified by a half-wave rectifier and then regulated by a VR-75 gas regulator tube. This then goes to a variable voltage divider which supplies the bias to the 4CX250 grid. The transformer used for the plate can be obtained from an old scrapped TV set, providing it delivers around 900V across the full secondary winding. Most of the transformers used in older sets were heavy brutes and work well in linear service. The transformer feeds a full-wave voltage doubler. The screen is fed from the 2100V supply by a large dropping resistor and is regulated at a constant 300V by three VR-105s. The small resistor across each VR-105 provides equal firing potential when the supply is turned on. The screen and plate voltages in a linear should remain fairly constant; while the plate voltage can swing slightly, the screen supply is critical and should be held as stable as possible. This rules out the use of a voltage divider using resistors or, even worse, a simple dropping resistor.

The current drawn by the screen supply and the idling plate current is beneficial when used with a voltage doubler. This type of supply is characterized by a rapid rise in voltage with no load. The regulation is good; my voltage is 2100V idling; at 550W dc input it drops to around 1900V.

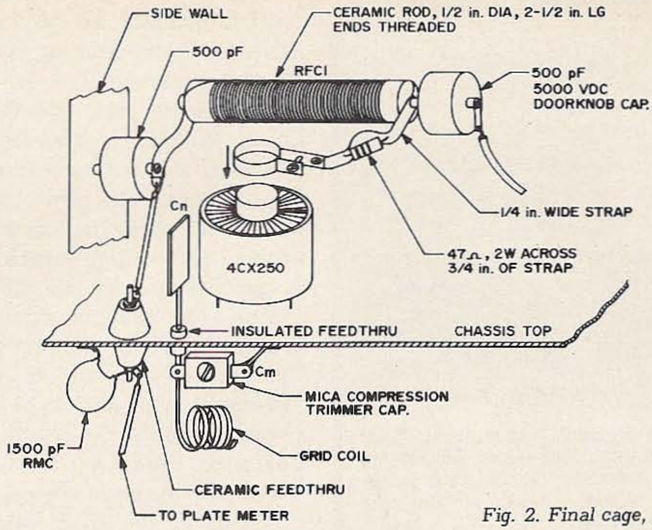
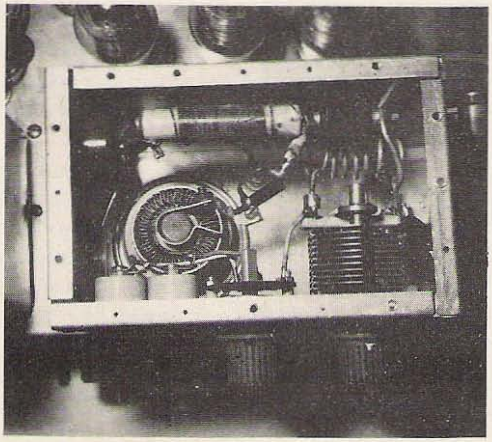


Fig. 2. Final cage, partial view.

If you stray from my power supply design and incorporate a separate supply for the screen, be sure that it is not possible to apply screen voltage without plate voltage or the tube will be damaged.

The use of a plate current meter and a control grid current meter is necessary for proper operation of the linear. It is true that in AB1 no grid current is drawn, and the reason for the grid meter is to make sure you keep operating that way. A screen current meter is recommended since you should be sure not to exceed the screen's dissipation ratings. I skimped on this since I've found the 4CX250's screen current generally stays well within bounds when run at high plate voltages. If you should



decide to install a screen meter, a zero center meter should be used, or else you will have to provide a reversing switch. It is possible for the tube to exhibit a negative screen current at times. While it is not something to worry about, it usually indicates overloading. The screen current should be kept under 20 mA.

The stability of the linear is excellent. I have always been a firm believer that neutralization is unnecessary with a properly designed and built amplifier. Most other tubes I've used responded quite nicely to screen neutralization and I almost got away with it here, but the 4CX250 proved to be my match. Neutralization was found necessary to insure stable operation. The neutralization capacitor is a 1 in. square of silver-plated copper supported on a piece of 16-gage wire. The capacitor is located directly to the side of the 4CX250 anode and is away from the plate tank. This is important. It should also be directly above its destination below chassis, and for rigidity should be supported by a ceramic feedthrough. Neutralization is achieved by the setting of Cn and Cm. Be sure to use the recommended socket. The socket has a circular screen bypass capacitor built in and also pins 2, 4, 6, and 8 are grounded, which are all cathode pins. Ground all bypass capacitors to individual soldering lugs. This will avoid common ground paths which may set up oscillation within the linear. No amount of neutralization will cure this problem.

The plate tank circuit is a pi-network type. The plate loading capacitor is capable of being shunted by several values of fixed capacitance. This gives quite a range in which to find the correct loading. The tuning and loading capacitors are mounted piggyback fashion in the final compartment. The tank is wound with 12-gage silver-plated wire. I tried using a Miniductor and the first time rf hit it I was rewarded with a blob of melted wire and burnt plastic. The conventional form of parasitic choke was tried. A 10Ω resistor with two turns of 16-gage wire lasted 10 seconds before it departed in a puff of smoke. The total amount of rf voltage across the wire in the choke was appreciable at this frequency and it quickly overheated the resistor. An inch-long copper strap across the 10Ω resistor finally worked quite well. The rf choke is wound on a ceramic form. The 24-gage wire should be given several coats of coil dope. The form is a ceramic rod about 3 in. long and ½ in. diameter. The ceramic form should have as much of the 24-gage wire wound on it as possible.

At first I was rather afraid to build such a small final compartment. Several things bothered me. Would the heat from the 4CX250 damage any of the components? Would the heat cause thermal expansion and detuning? Another thought which plagued me was what would happen with the tank coil placed close to the walls of the enclosure. I could see the Q of the coil being ruined and a few hundred watts of rf being inducted into the enclosure's walls. Luckily, none of my fears were realized and it worked like a charm.

Use of an rf-tight box for the final provides excellent isolation between the input and output. If TVI is a bad problem in your area, the use of meter shields is recommended. Also screen the blower air port and add additional power line filtering.

The clip for the 4CX250 plate is homemade. One word of caution. The parasitic choke is mechanically connected to the plate clip with a 4-40 screw and nut and a very small amount of solder. The tube may be hot enough to melt solder, so avoid "solder held" connections. I had one tube overheat and the parasitic choke fell off and shorted the B+. In a 2m linear using a plate line, a 4CX150 got hot enough to melb a blob of solder off of the plate line. It dribbled through the plate fin and hit the screen bypass ring. If you are able to silver solder, by all means do so.

At my station the linear is connected between the transverter output and the antenna relay. This eliminates the need for a changeover relay. I also leave the linear's B+ on. It does not switch to standby in the receive position. This eliminates control cables and the necessity of another clicking relay every time I transmit. If you are not going to transmit for long periods of time, switch the linear to standby.

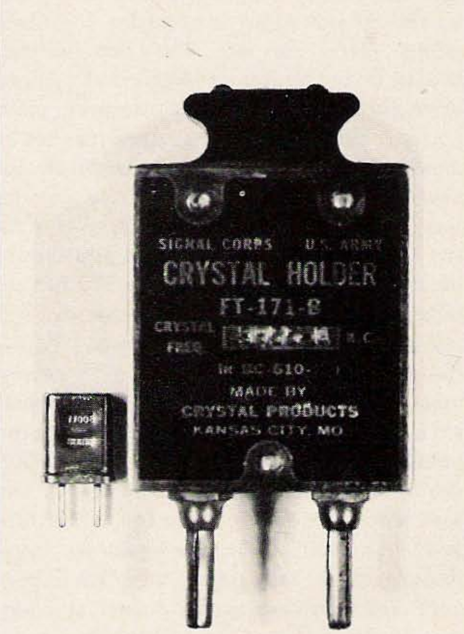
Before attempting to use the linear, it should be neutralized. There is enough information in any of the handbooks for you to do this on your own. For the smoke test, be sure the bias pot is wide open and that there is at least -60V on the grid. Turn on the B+ and adjust the bias for 78 mA of idling plate current. The bias voltage should be in the area of -40 to -50V. Apply drive and tune the grid for maximum plate current. With the loading capacitors set at maximum capacitance, dip the final. Increase the loading and alternately dip the final until you are drawing 300 mA. With the exciter in the SSB position you should be able to kick the meter up to 275 mA on voice peaks with no indication of grid current. The screen current should be 20 mA maximum. If you didn't use a screen meter, observe the VR105s. If they almost extinguish when you talk, this indicates the screen is drawing too much current. Recheck the tuning; a slight change in the load setting should correct this condition. It is important to load a linear for maximum output. This affects the plate impedance and the best match occurs at maximum loading.

I have used this linear for several months and the results have been better than I had hoped. Reports have all confirmed that the quality is good and the signal is penetrating. The linear of course can be used on CW and if the power supply will handle it, AM should be okay too.

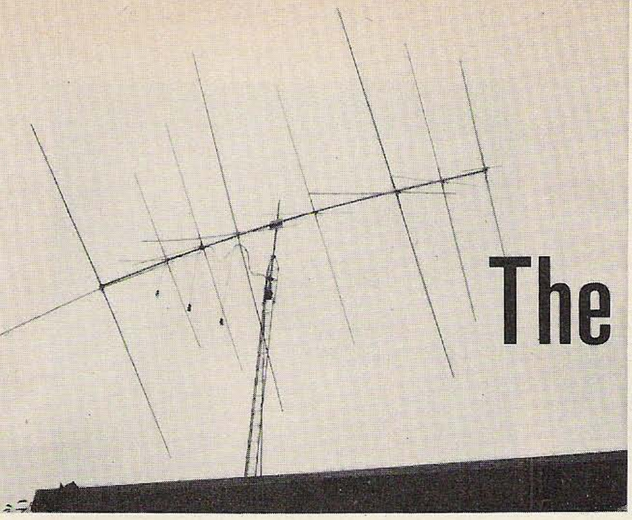
With the new interest in meteor scatter, this linear should be a helpful companion to any low-power exciter, such as the Heath HX-30. Even the larger transceivers can be used if their output is swamped down enough to prevent overexcitation. With at least 500W dc input, and a theoretical 1 kW PEP, this linear performs as well as anything available.

As an afterthought, I can see no reason why two 4CX250s couldn't be paralleled for greater power,. ALC may be needed in some cases. I found it unnecessary since the ALC in my Marauder prevented overdriving of the transverter or linear. The small resistor across the input is to keep a load present on the input. This prevents self-oscillation when there is no load connected to the output or to the input. To sum it all up, the compact kilowatt is easy to construct and run. Its size makes it ideal for any 6m station contemplating higher power.

. . .K1ZJH■



"Old timer, I get bad vibes from anyone over 30."



The 3-4-6 Quad

James M. Talens K3MNJ
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Philadelphia PA 19152

As a result of some intriguing 10 meter openings and my inability to work through the QRM with my 3 element triband yagi, I decided to construct a single-band quad, sacrificing 15 and 20 through the winter for an all out effort on 10. I chose a 6-element array with a 30 ft boom, the longest length boom I could get away with in my particular neighborhood. While forward gain peaks at .13-wavelength element spacing[1], there is negligible loss (a fraction of a dB) in going to .18 wave, but the latter provides an increased front-to-back ratio, broader gain-bandwidth product and is the figure required to equally space 6 elements on a 30 ft boom on 10 meters!

The prime forward gain determinant for a beam antenna, whether a closed loop quad or a yagi, is the boom length. In general, the longer the boom the greater the gain of the array. The feature of the quad which makes it particularly desirable is its 2 dB gain over a yagi of the same boom length. For a given required gain, a quad need only be about 0.56 as long as its yagi counterpart[2]. This point is crucial for those who live in urban centers and are afflicted with a desire for DX. It is also a point for anyone who does not have a relative in the crane rental business.

After some additional thought about not having 15 and 20 I decided to lengthen and add spreaders to restore my triband capacility. The result is the arrangement of Fig. 1. The configuration is such that there are 6 elements operating on 10 meters, 4 on 15, and 3 elements on 20. Each element is spaced .18 wavelength from its same band neighbor.The gain lost on 15 and 20 by not utilizing the entire boom through decreased spacing and additional elements is negligible considering the boom lengths used. In addition, this spacing affords economy in spreader construction, since common spreaders can be used for several of the multiband elements.

Construction

Erecting the array was not unlike constructing a suspension bridge – single handedly, with tweezers. A tilt-over tower (40 ft) next to the house facilitated matters, but did not solve them. With the tower cranked over, it was possible to mount the boom to the mast and fasten three elements on one side. The remaining five elements had to be attached with the tower vertical but retracted, using a 12 ft stepladder borrowed from the Suburban ARC on the roof of the house. I used the spreader construction method described in the ARRL antenna book[3]. The bamboo poles were coated with three layers of acrylic varnish. Once the wire mounting points were determined on the spreaders, the poles were wrapped about 6 in. either way with several layers of vinyl tape, a small nail inserted through the tape into the pole, and the wire loop mounted on the nail, with a safety wire strung around the pole. The whole area was then liberally coated with acrylic varnish.

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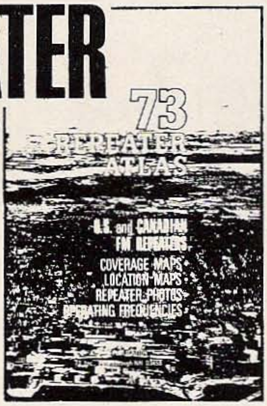

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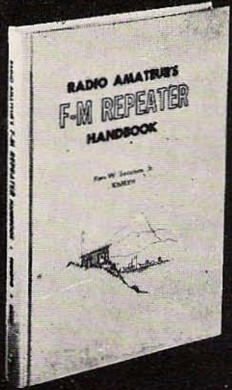

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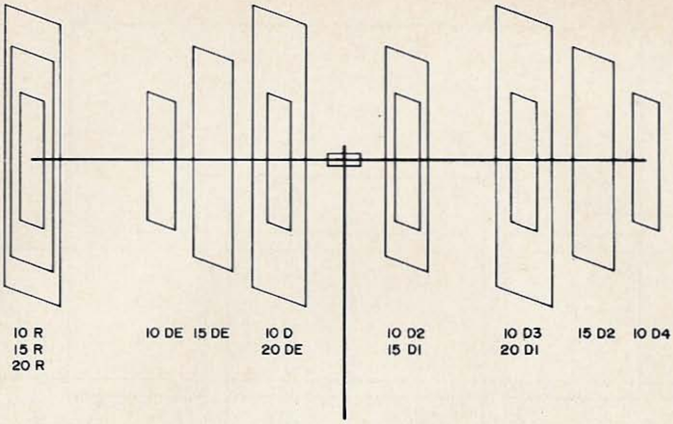


Fig. 1. The 3-4-6 Quad.

LIST OF PARTS AND PRICES:
32 bamboo pole (20 – 8 ft; 16 – 15 ft) $25
Acrylic varnish, U bolts, angle iron, hose clamps (with stainless screws), #16 wire, etc. 50
Boom: 2 in. OD 1/8 in. wall. Two 24 ft sections had to be purchased. After cutting, two 9 ft sections remained but will come in handy on Field Day. Also, 4 ft sleeve for joining at center. 55
Aluminum plates for spreader and boom mounting (from junk yard). 10
Coax, RG8/U (3 – 75 ft rolls). 25
3 baluns. 45
$210

A steel boom would have been cheaper but would put great strain on the rotor, tower and operator. At the soldered junction points and wherever water seepage could cause damage, General Electric silicone seal, a white rubber sealant, was used. It can be removed with a knife if necessary but will not wear off and is not conductive.

The loops were first constructed using dimensions from Lindsay's article in the May 1968 QST[2] but I found that a ± director–reflector tuning[1] broadened the front-to-back across 20 and 15, although the peak dropped a few dB. I used ±3% tuning on 10m (D.E. resonant at 28.5 MHz) because of my SSB preference on that band. 16-gage wire was used throughout although any soft drawn wire of at least that gage will work.

The boom droop is minimal as is wind sway. I use no boom-end to mast support but in windy areas it might be advisable. Thus far the structure has withstood 45

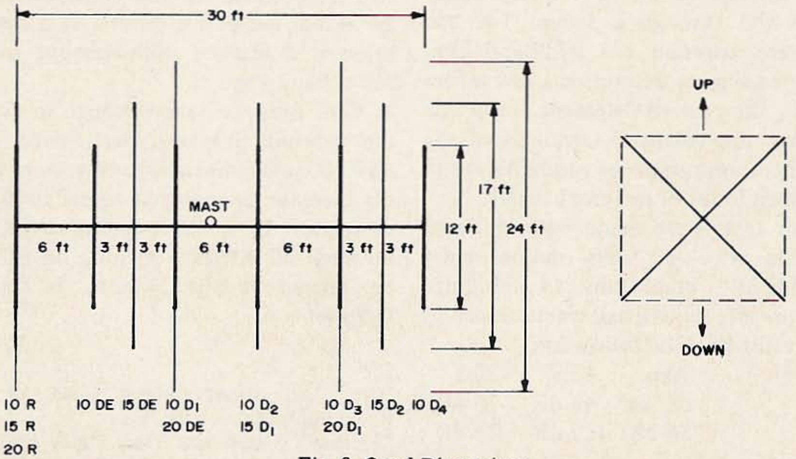


Fig. 2. Quad Dimensions.

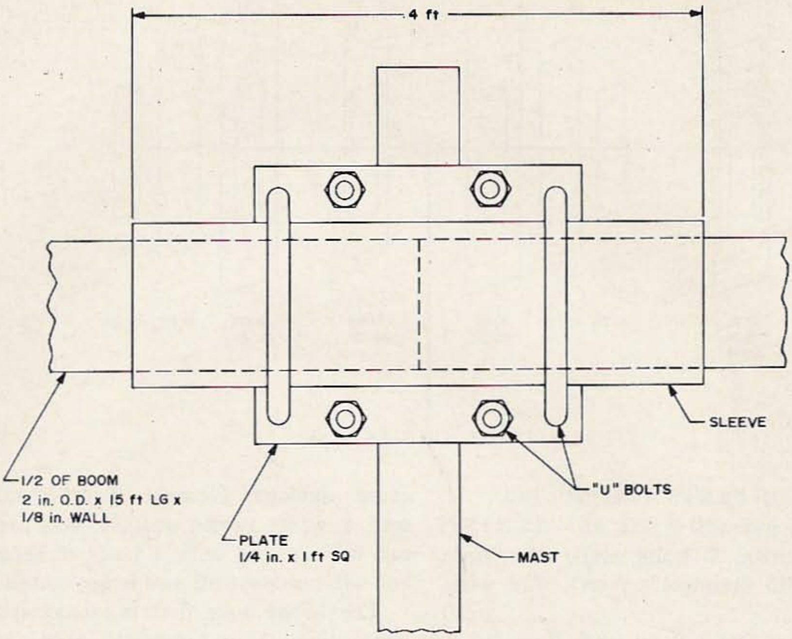


Fig. 3. Boom mounting detail.

mph gusts without damage.

Results

A first attempt at using the array produced an interesting result: on 20m, signals from the west coast peaked with the quad beaming north northwest (the rotor was calibrated correctly!). Insertion of a balun cured the problem; it appears that radiation from the coax feed line skewed or distorted the pattern.

Each driven element is fed separately with RG-8/U through a balun. The swr curves were adjusted for mid-band minimum by adding or detracting a few inches betweeen the driven element loop tie points and the balanced terminals of the balun. There appears to be negligible coupling between loops of different bands.

Pattern tests were made with six local stations in a 3–20 mile radius under "closed band" conditions to minimize backscatter effects. An arithmetic mean of all data resulted in the following:

Front to:	10m	15m	20m
side:	68 dB*	48 dB	35 dB
back:	36 dB	27 dB	25 dB

*very sharp nulls.

It was impossible to make forward gain tests, but on the air success and the above front-to-side and -back figures suggest substantial forward-gain characteristics.

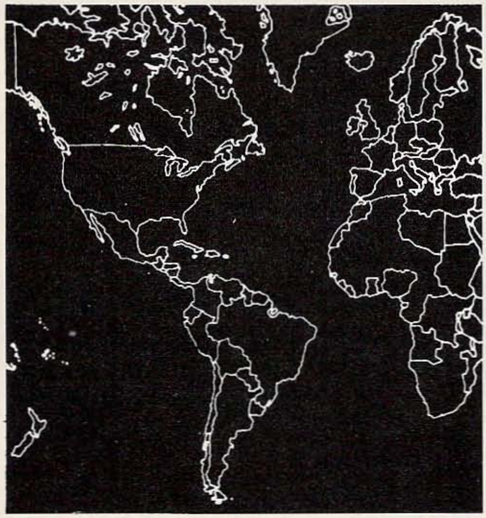
This antenna is most effective under long skip conditions, which supports the quad's purported low angle of radiation character. Often in the morning on 10 European and African stations tell me that mine is the "first Stateside signal of the day," or that K3MNJ is one of the strongest signals on the band. While these are rather subjective criteria, it is clear that there is a marked improvement over the old triband yagi.

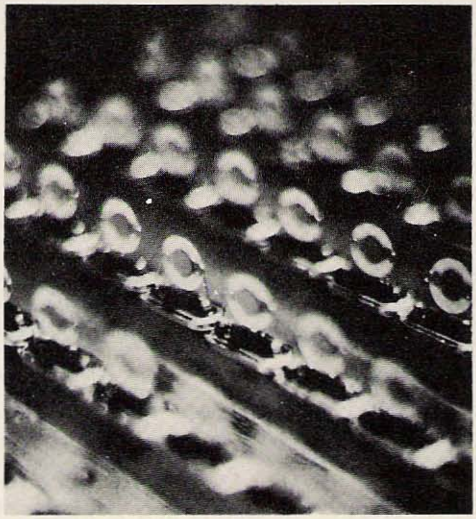
Care must be taken though in directing the antenna properly, particularly on 10 and 15, as the major lobes are sharp and 20 dB increase in reported signal strength by correction of a 22° heading error is not unusual; an African opening on 10 might be missed if the antenna is fixed on Europe!

. . .K3MNJ■

[1]Orr, "All About Cubical Quad Antennas," Radio Publications, First. Ed.
[2]Lindsay, "Quads and Yagis," May QST, 1968.
[3]ARRL Antenna Book, 11 Edition, P. 271.

People who know about quality know about Sentry





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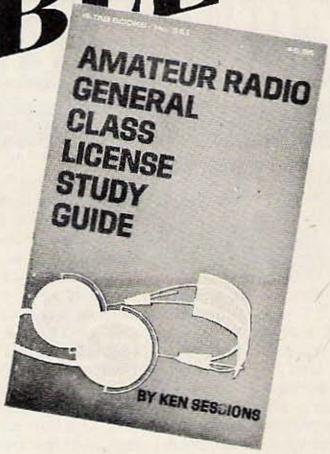

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All ham magazines make the same claim, so which can you believe? Perhaps you enjoy playing the circulation figure game, but can you really trust numbers which may be inflated by two or even three times reality, with little but the gall of the publisher to back them up? Until such a time as you can be shown audited circulation figures perhaps this isn't a good yardstick.

There is one sure proof of the selling ability of a magazine, no matter what field it is in, and it is simple, inexpensive and foolproof. Just put the magazines side by side and count the number of mail order ads. Why only mail order? Because these are the ads which are keyed for response and mail order advertisers tend to use the magazines that bring them the most sales for the least cost. If they find that a $1000 page ad brings them a better percentage of replies than a $100 ad, they will go the $1000 route.

Now sit down and count the number of mail order ads in 73 as compared with the other ham magazines . . . and start making *more* money with your ads by running them in 73.

It's funny (and sad) how many advertisers are virtually throwing away a fortune by buying ads on the basis of the length of life of the magazine, the depth to which they will cut their ad rates (how much more of a cut are others getting?), and other factors which should have nothing to do with selling the product.

Put yourself in the place of a reader for a moment and see in which of the ham magazines you would be more likely to see your ad. In the September issue of 73 there were 90 pages of articles plus 12 pages of news. Count up the articles and news in the other three magazines for a startling comparison. 73 has 77 pages of technical and construction articles . . . while one competitor has only seven such pages! As a reader, which magazine would you read all the way through, the one with 77 tech and construction article pages or the 7 pages? And which one would give you as an advertiser the best chance of getting your ad seen?

The 73 practice of spreading ads all through the magazine instead of jamming them into one solid lump in the back also gives you a tremendous advantage in having your ad seen and read. Almost half of the readers of one magazine polled said that once they came to the end of the articles they closed the magazine and seldom ever read the ads. If your ad doesn't get seen, what possible chance do you have of selling anything? And keep in mind that if an ad doesn't bring in at least ten times the cost of the ad, you are losing money . . . unless you are fortunate enough to be making more than a ten percent profit, which is unlikely these days.

73 reaches the most active amateurs of any amateur radio magazine, and the proof is in the direct mail advertising, not in promises, circulation figures, cut rates, or old age. If you have a product to sell you will sell more of it for less with ads in 73.

By the way, if you are selling through distributors, you should know that 73 is the ONLY ham magazine read at home by most of them. Over 800 distributors get 73 at home and look through it to see what products they handle are being supported by a national advertising campaign.

The ad rates are below. If you have any questions or are ready to place an ad, call Aline Coutu at 603-924-3873.

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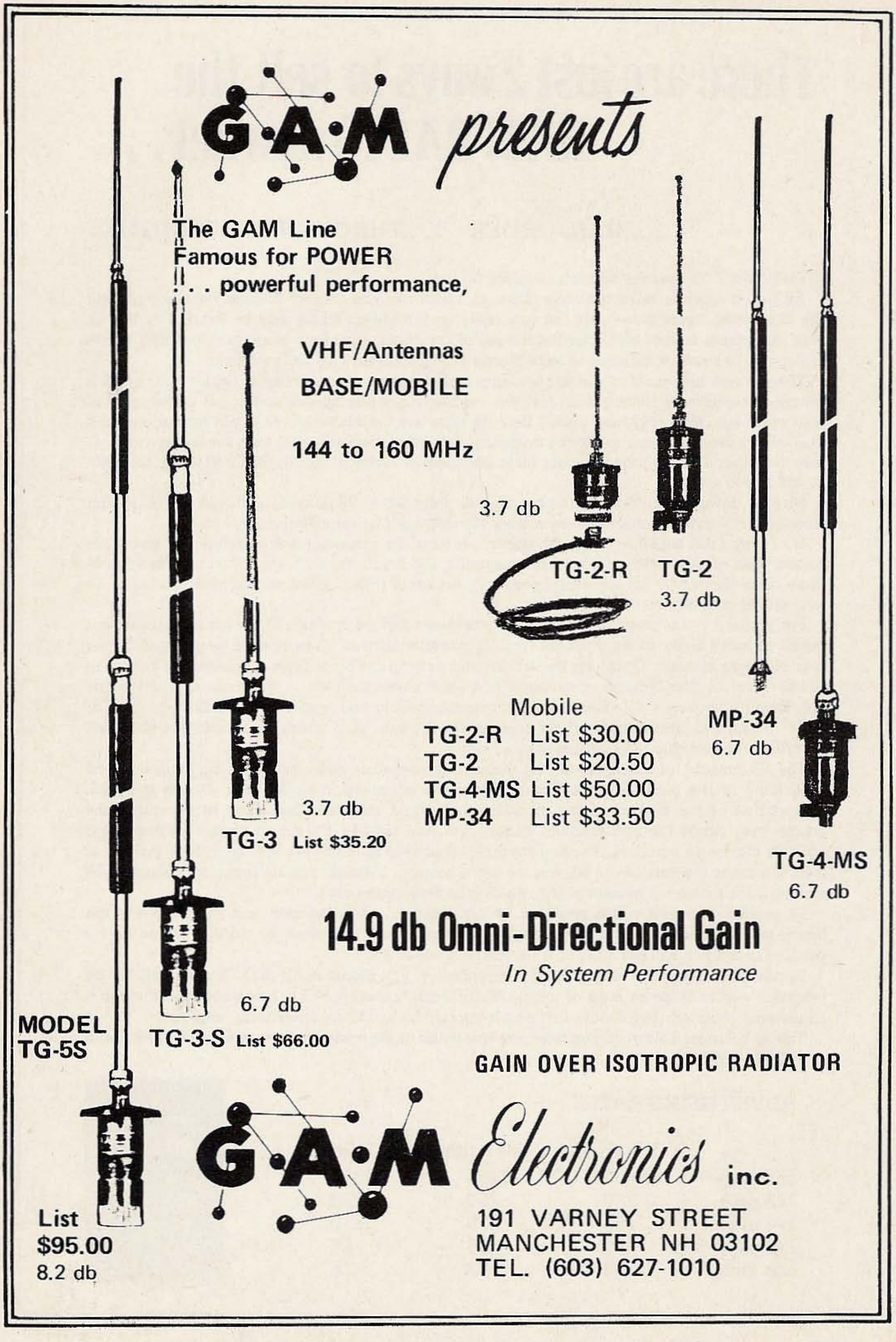
	1-5 times	6-11 times	12 times
one page	$495	$455	$395
1/2 page	270	250	220
1/4 page	135	125	110
1/8 page	70	65	55
one inch	35	32	28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(Special to 73 Amateur Radio News)

OSCAR FLY-BY SUCCESSFUL

Harold J. Wheelock W6SCW

Test flight AA2, the second airborne test of the type of equipment to be orbited on AMSAT-OSCAR-B (AO-B) early in 1972, was successfully conducted on September 25, 1971. Taking off from Van Nuys airport, northwest of Los Angeles, at 0900 PDT, the aircraft covered about 1,100 miles, flying over California's most populous areas, including about 50,000 licensed amateurs within line-of-sight of the plane. Proceeding south to the San Diego area at an altitude of 11,500 ft, it returned past Los Angeles airport at 12,500 ft, traversing the Elsinor-Corona region en route, then over Ventura, Santa Barbara, Paso Robles and Hollister, before landing at Palo Alto for refueling and lunch at 1310 PDT. The home leg of the flight began at 1545 PDT and took the plane over Sausalito, Sacramento, and down the central valley past Fresno and Bakersfield, landing at Van Nuys at 1837 PDT, some 7 flight hours after take-off.

The airplane, a Bonanza-J, was piloted and owned by Booth Hartley K6KVC. Maurice Piroumian WA6OPB served as co-pilot and flight project engineer; he maintained ground contact in a housekeeping net on 18590 kHz, reported position and other flight information to the ground net. Dick Ulrich K6KCY, the third member of the flight crew, functioned as repeater flight test engineer, kept the equipment on the air, scanned and recorded the repeater output and maintained operating logs.

Flight test AA-2 was sponsored by AMSAT and the Amateur Radio Club of the Jet Propulsion Laboratory, Pasadena, California, assisted by the Radio Club of Goddard Space Flight Center and many individual and organizational members of AMSAT.

Test AA-2 was preceded by about three months of intensive preparation including three short flights in the Los Angeles area. One was an aircraft belonging to Ted Reid W6HR and the others with the plane of Booth Hartley K6KVC. During this period the flight preparation activities were coordinated nightly on 3860 MHz, with Helmut Mecke W6ZGC as net control.

The transmitter repeater equipment was identical to that flown in Test AA-1 on May 15-16, 1971, on the East Coast. It operates on a 2-meter passband from 145.83 to 146.07 MHz. The airplane signals are translated to 10 meters for retransmission by the repeater within a segment extending from 29.38 to 29.62 MHz, being inverted in the process (upper sideband becomes lower, space becomes mark, and RTTY, and higher frequencies on the 2-meter uplink become lower in the repeater 10-meter output). A beacon signal continually transmits HI in code on 29.45 MHz as a marker for the listeners. The repeater will accept single sideband, CW, AM RTTY and slow-scan TV signals.

Although the 2-meter uplink was essentially limited to line-of-sight, the 10-meter transponded output was expected to permit communications out to 150 to 200 miles, depending upon atmospherics and the mountainous California terrain.

Uplink signals to the airplane were received on omnidirectional monopole antennas that replaced the navigational equipment on the plane. A center-loaded whip mounted parallel to the bottom of the fuselage in a longitudinal direction handled the repeater output on 10 meters. A third antenna on top of the airplane carried the ground housekeeping net, utilizing a modified monopole radiating the output of the transceiver furnished by Ted Henry W6UOU.

A ground network to provide flight status on 7225 MHz monitored the aircraft, advising listeners of its location and the progress of the test flight. Dennis Monroe WB6IOE was net control, using the station facilities of W6ZGC. The status net control was transferred to Cliff Buttschardt W6HDO when the airplane reached the San Francisco peninsula area.

A key ground station was operated as W6JPR/portable 6 on 8830 ft Mount Pinos, about 85 miles northwest of the Los Angeles City Hall. Five selected stations, two in the San Fernando Valley, one in San Diego, one at Los Altos near Palo Altos, were scheduled to attempt contact to the repeater every 15 minutes to test the range and conditions encountered in cross-channel airborne repeater operations.

The JPL Amateur Radio Club provided facilities for monitoring the test by officials of AMSAT listening on the East Coast. This phase of the operation was handled by Rex Edwards W6IIN, who manned theJPL Club's home station W6VIO, and patched the signals by telephone to AMSAT at Goddard Space Flight Center near Washington, D.C.

The AA-2 overflight and transmitter repeater tests were set up as a contest using the same rules that applied to the May 15-16 test in the East. All details of the contest will be handled through WA3NDS and QSLs should be mailed directly to P.O. Box 27, Washington, D.C. 20044.

Here is a preliminary report:

1. Flight AA-2 did not encounter the weak 10-meter output as reported during the East Coast test.
2. The repeater successfully passed AM signals, particularly if they are held below the saturation point of the repeater on modulation peak.
3. While en route to San Diego, repeater output power was reduced from 1W to 200 mW because of distortion from strong signals, causing the repeater to oscillate.
4. Almost every type of legal emission was heard through the transponder, including SSB, CW, FM, AM and some TTY.
5. No accurate count of contacts through the repeater can be made at this time, but the flight crew reported monitoring as many as 125 stations during the flight. Many others – particularly on CW – could not be logged because of simultaneous transmissions.

AA-2 crew at Van Nuys Airport, shortly before their successful flight. From left to right: Maurice W6OPB, Booth K6KVC and Dick K6KCY.

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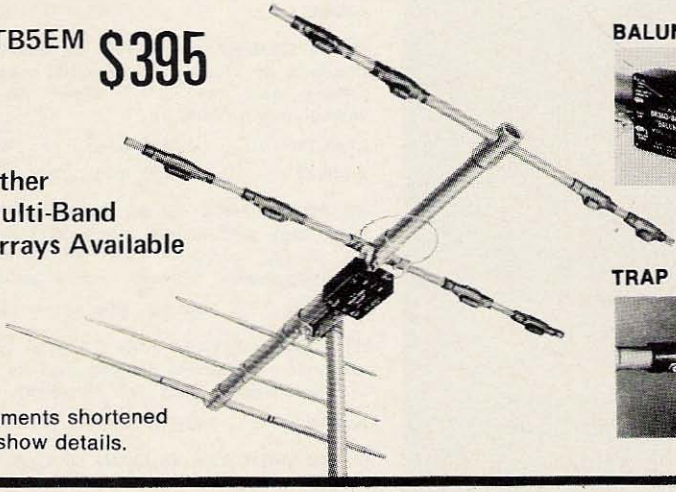

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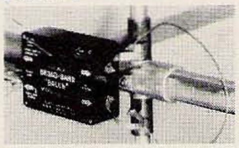
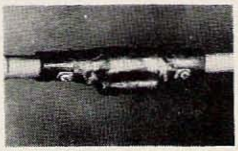


TRAP



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2M814	- "Monarch", 16 DBD, 8 El., .8 KWP, 1.375" O.D, 14' boom	\$ 59.00
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Small Boxes for Small Projects

In this age of microminiaturization it is often impossible to find suitable housings for homebrew transistor and IC projects. The smallest minibox I have been able to locate is 2¾ x 2 1/8 x 1 5/8 in. This was small in the heyday of vacuum tubes – in fact it wasn't bad in the early days of transistors. Unfortunately the utility box manufacturers have not seen fit to produce truly small boxes for truly small projects. By this I mean not only the one or two transistor or IC project but also the more elaborate type. Suppose you were to build a project on a PC board measuring 3¾ x 4¾ in., the height of the components above the board were ¾ in., and clearance below the board required another ¼ in. The ideal housing for such a project would be 4 x 5 in. times perhaps 1¼ in. A check of catalogs indicates the closest standard box to be 4 x 5 x 3, or nearly three times the volume of the required housing.

Fortunately there is available a wide variety of combinations of width and depth. The major stumbling block is height and this is the dimension which can most easily be modified. After your PC board size is chosen on the basis of the size and number of components to be used, find a standard box which most nearly approximates that size in width and depth. If the exact size is not available, consideration should be given to a slight redesign to accommodate the discrepancy. The project should then proceed as usual until the final packaging phase is reached. Carefully measure the overall height of your project, allowing a slight amount of clearance (perhaps 1/8 in.) to preclude the possibility of shorting the foil on the bottom or mashing a component on the top.

Take the chosen box apart and with a hand nibbling tool cut away those portions of the box not absolutely necessary. In this way it is possible to make a wafer-thin box if need be.

The case for a toroidal vfo presently under test at this QTH was reduced in size by over 4 cubic inches as compared to the smallest standard box. . . .WAØABI

"As soon as you can send 13 wpm, you can beat the big drum."

Let's Revise The Morse Code

Gilbert C. Ford W7OXD
1023 Ninth Avenue South
Nampa ID 83651

Probably nothing in ham radio has caused so much frustration to some and given so much pleasure to others as the Morse code. Nothing is more pleasant to the proficient CW operator than the rhythmic flow of dahs and dits being translated automatically and almost subconsciously into a message from a fellow amateur. The use of a special code, a semiprivate language, appeals to some innate, primeval instinct in us. We all know how children's imaginations are captured by speaking pig-latin or exchanging secret messages in codes or ciphers, and if we are honest, we will admit that even we adults have not completely outgrown this impulse toward the mystery of a semiprivate language. From a technical viewpoint, no one has yet proposed a simpler radio communications system than CW for getting messages through under marginal conditions.

But think of the millions of hours of pain, frustration, boredom, and who knows what else suffered through by aspiring amateurs trying to achieve the magic speeds of 5, 13, and 20 wpm. It has been estimated that 70 hours of practice are needed to attain 13 wpm. Multiplying 70 hours by 250,000 amateurs gives the staggering total of 17.5 million hours, or 2000 years, as the amount of time that U.S. amateurs have devoted to achieving the level of proficiency required for a General class license.

Why is Morse Hard to Learn?

Why does Morse code require so much effort to learn? The main reason is that it must be learned through listening and not by seeing. Anyone who has read code off visually from a moving perforated paper tape soon realizes how much faster and easier he can copy from the visual signal than from corresponding audio code signals. Granted this basic difficulty of having to introduce information into our brains through the inherently more sluggish audio channel, still Morse code as it is currently structured is more difficult to learn than it need be. Some judicious revisions of the code could dramatically reduce the amount of practice time required for achieving any given code speed.

When you begin to think of tinkering with the structure of the code, a lot of possibilities present themselves. One could, for example, change the relative lengths of the dots and dashes from their present 1:3 ratio, or introduce new basic characters in addition to the current dot and dash. But drastic changes that would leave most of the existing code characters unchanged could nonetheless make CW proficiency a lot easier to achieve.

There are two fundamental features of the present code which limit proficiency unnecessarily. First, some characters sound too much alike; second, the rate at which characters must be decoded changes by a factor as high as three or four, depending upon whether a sequence of short-length or long-length characters is being received.

Structure of Morse Code

We normally think of Morse code as made up of dots, dashes, and spaces. Although our attention is generally focused on the dots and dashes, we realize that the spaces are just as important in conveying information. The term *bit*, borrowed from the world of computers and digital devices, is convenient for describing the code. As seen in Fig. 1, one bit is equivalent to the time for making a dot, and a dash requires three bits of time. A character is some unique combination of dashes, dots, and

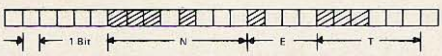


Fig. 1. Basic code character structure.

spaces representing a particular alphabetic letter, a numeral, a punctuation mark, or other signal information.The three empty bits following the last dot or dash in a character should be considered as part of the character because they must be left free or open. Two additional free open bits, or a total of five, are used as the space between words. From Fig. 1 we see that the letter N requires eight bits, the letter E is four bits long, and T is six bits long. From Fig. 2, which lists the number of bits required for each of the commonly used characters, one notices that characters vary in length from 4 to 22 bits, a ratio of greater than 1:5.

Is Morse Efficient?

From the viewpoint of encoding the letters of the alphabet into Morse with the fewest number of bits, the Morse code is fairly well designed, since the most frequently occurring letters generally require the smallest number of bits. According to Britannica, the letters of the alphabet occur with the frequencies shown in Fig. 3. The numbers listed by each letter give the average number of times that letter is found per 1000 letters in ordinary English text.

Number of Bits	Character
4	E
6	T, I
8	A, N, S
10	D, H, R, M, U
12	B, G, F, K, L, V, W, 5
14	C, O, P, Z, Z, 4, 6
16	J, Q, Y, 3
18	2, 8, question mark
20	1, 9, period
22	Ø, comma

Fig. 2. Length of characters in bits.

E	126	U	30
T	90	P	27
R	83	M	25
I	76	Y	21
N	76	G	18
O	74	W	14
A	72	V	13
S	58	B	11
D	40	X	5
L	36	K	3
C	33	Q	3
H	33	J	2
F	30	Z	1

Fig. 3. Frequency of occurance of letters in ordinary English.

Comparing the information in Figs. 2 and 3 shows that although the most frequently occurring letters usually require the fewest number of bits, there are exceptions. For example, the letter O is much higher in the frequency list than is X, but both require 14 bits. The letter K, which occurs only three times per 1000 letters, requires 12 bits while C, which occurs thirty-three times per 1000 letters, requires 14 bits, and you can easily find other such peculiarities. In all fairness it should be noted that the given frequency counts are based on the English language, and Morse is certainly used with other languages having different occurrence frequencies.

Momentary Speed Bursts

If one wanted to revise the Morse code so that an English language message could be transmitted using the fewest possible number of bits, then changes should be made strictly on the basis of how frequently the letter occurs. This type of revision would be excellent if at the receiving station the translation from Morse to English were done by a machine, but usually a human brain serves as a decoder, and the brain decodes most accurately when the rate at which code characters (not bits) being received is uniform, especially when near the upper limit of receiving ability. When we say that code is being sent at a constant speed, we usually mean at a constant bit rate. But even though the bit rate is held constant, as it will be in properly spaced code as produced by perforated paper tape or a proficient operator using an automatic key, the rate at which characters arrive for decoding will vary widely because of the marked differences in character lengths. Compare the two phrases "Your QSO could . . . " and "I see a teen net . . . ". Each phrase contains 12 characters, but the first one requires 154 bits and the second only 80 bits for transmission. If both phrases were sent at the same rate of 10 bits per second, the first would require 15.4 seconds and the other 8.0 seconds. The rate in words per minute for each could be calculated as follows:

For phrase 1

$$\frac{12 \text{ characters x } 60 \text{ sec.}}{5 \text{ characters/word x } 15.4 \text{ sec.}} = 9.35 \text{ wpm}$$

For phrase 2

$$\frac{12 \text{ characters x } 60 \text{ sec.}}{5 \text{ characters/word x } 8.0 \text{ sec.}} = 18.0 \text{ wpm}$$

If these two phrases were sent at the same constant bit rate as would normally be the case, for parts of one message or transmission, the rate in characters per minute and words yer minute would nonetheless vary by a factor of two. A detailed calculation shows that for average English copy the above rate of 10 bits per second corresponds to an average word-per-minute rate of 12.5. No wonder the poor ham's brain begins to saturate, stutter, and stumble when the rate temporarily zooms from its average value of 12.5 wpm to 18 wpm.

"If it weren't for the momentary speed burst effect, I could copy 20 smoke signals per minute easy."

The technique of copying behind can smooth out these rate variations to some extent, but most of us cannot copy far enough behind to really help the situation appreciably. The next time you are copying code at near your top speed, notice where you tend to drop out two or three letters. It will usually be in a sequence of several short-length characters where the wpm rate temporarily goes way over your top copying speed as a result of this momentary speed burst effect.

Group		
1	D B 6	— - - — - - - — - - - -
2	U V 4	- - — - - - — - - - - —
3	I S H 5	- - - - - - - - - - - - - -
4	J 1	- — — — - — — — —
5	Z 7	— — - - — — - - -

Fig. 4. Groups of Morse code characters having similar sounds at high speeds.

Characters That Sound Too Much Alike

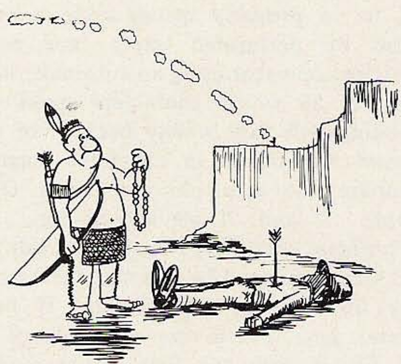
A second source of errors made when copying at near top speed results from mistaking characters that sound too much alike. It would be hard to find an operator who has not mistaken an S for an H or a V for a 4. Figure 4 lists groups of characters whose adjacent members are easily confused at high speed. By high speed, I mean any speed near the top limit of the operator, and also high enough so that he can no longer count the number of dits or dahs but is wholly dependent on the characteristic sound of the letter. My guess is that with most operators, trouble with characters having similar sounds sets in at about 12 wpm, while the momentary speed burst effect starts giving real trouble in the neighborhood of 18 wpm.

Solution for Momentary Speed Bursts

So much for the problems. Are there any solutions? Let's look first at the momentary speed-burst effect caused by sequences of low bit characters. This problem could be brought under control by modifying the letters E, T, and I. Since these letters occur so frequently and are so short, replacing their present representation by longer combinations would have a very favorable effect on smoothing out the rate at which an operator decodes Morse, but we will pay for this smoothing out of the rate, of course, by having to use more bits for a given message. However, the number of characters to be decoded in the message will not be changed, and the more uniform rate at which characters arrive will enable the operator to achieve a marked increase in his decoding rate.

Solution for Characters Which Sound Alike

What could be done about the second problem, the difficulty of distinguishing characters which sound too much alike? Consider group 1 in Fig. 4, that is, D, B, G. The adjacent letters are the ones which the operator has trouble differentiating. Hardly anyone would mistake a D for a 6, and D and B usually cause little difficulty, but B and 6 are another matter. A new distinctive sound for B would cure the difficulty with group 1. Similar problems with U, V, and 4 could be solved by using a new combination for V, and the confusions within the group S, H, and 5 would be eliminated by a



"Do you suppose the chief could've sent 'bead' not 'dead'?"

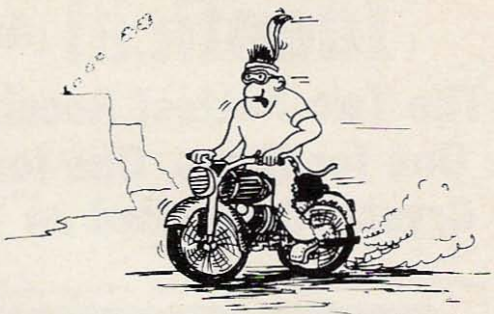
different character for H. Since the two groups J & 1 and Z & 7 do not give so much diffiuclty, and since J & Z only occur but a couple of times per 1000 letters on the average, let's not change them.

New Morse

The letters to be changed then are E, T, I, B, V, and H. What shall we change them to? Nearly all the distinctive sounds made by using two, three, or four dot-and-dash combinations have been preempted for other letters or symbols. Some which seem not to be in use are actually reserved for letters not in the English alphabet. If our new Morse is to be international, we should leave the combinations used for the foreign letters alone. There are, however, some rather distinctive sounding five-element combinations that are available. After some cogitating and playing around with a key, I am suggesting the characters shown in Fig. 5 for the *New Morse*. All other presently used characters would remain unchanged. Note that although these new characters are five-element combinations, the number of bits required is not greater than for such letters as C, O, P, X, Z, or J, Q, Y. Looking at Figs. 2 and 5, we see that in the ordinary Morse, the characters used for letters vary in length from 4 bits up to 16 bits, a ratio of 4:1, while in *New Morse* the variation is only from 8 to 16 bits, a 2:1 ratio. These numbers demonstrate that characters will arrive for decoding at a much steadier rate with *New Morse*.

	Character in New Morse	Number of Bits
E	. . — . .	14
T	— . — . .	16
I	. . — . —	16
B	. — — . .	16
V	. . . — .	14
H	. — . . —	16

Fig. 5. Characters suggested for New Morse.



"Why can't he stick to old Morse when he sends smoke signals. If there is anything I can't stand, it's Indians who don't stay with the good old ways."

Both dialects of Morse, old and new, would be compatible because no code character would have two meanings. An operator knowing both could copy either form with no ambiguity.

The number of bits required to send a given plain English message will be about 30% greater for New Morse, but don't let that number frighten you. The number of characters to be decoded will be exactly the same in both, and they will arrive at a much steadier rate. The confusion over similar sounding characters will have been eliminated, enabling the operator to copy New Morse more accurately and at a higher number of words per minute.

What Shall We Do?

Perhaps New Morse is not the best of all possible codes that could be devised, but it does point out the ways in which marked improvements could and should be made. If so, then this article has been successful. Some national or international organization should take it upon itself to make a thorough study of the best way to improve the Morse code. Experiments under carefully controlled conditions carried out by a team of professionals would lead to the development of a code far superior to the present Morse. Just as we ought to abandon our cumbersome and awkward English units of weights and measures in favor of the simpler and more efficient metric system, so we ought to modify the Morse code into a form more suitable to this last third of the twentieth century.

. . .W7OXD■

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A Pi-Net For Transistor Finals

Probably the most difficult part of a transistorized final amplifier to design is the tank circuit. The main reason for this problem is that transistors must operate into a low impedance load and therefore circuits used with tubes are not satisfactory. Also, information about good tank circuits for use with transistor amplifiers has not been available in a form useful to most amateurs.

Several approaches have been used to obtain a suitable tank circuit. One circuit used often by amateurs is the double-tapped tank in which one tap on the tank coil is connected to the transistor and the other is connected to the antenna. This works, but is difficult to adjust.

An approach used by some manufacturers is to use two π-nets with their high impedance ends connected together. The transistor is connected to the low-impedance end of one π-net and the antenna connected to the other. This circuit also works, but uses a relatively large number of components.

In addition to the circuits discussed above there are several other possible circuits. Many of these are not convenient if the operating frequency or the load impedance is variable.

The Purpose of the Final Tank Circuit

The final tank circuit should attenuate signals whose frequency is different from the desired frequency and it should provide a means for coupling the rf energy to the antenna. It is desirable that the tank coupling be adjustable to allow loading of a range of variation of antenna impedance. The resonant frequency of the tank should be variable to allow the tank to be used over a band of frequencies. In addition, the tank must present the proper load impedance to the amplifying device if maximum amplifier efficiency is to be obtained.

The π-Net

A tank circuit widely used with vacuum tubes is the *pi* network, or π-net. This circuit is very useful because it can perform all the needed and desired functions of the tank circuit using only three components: two capacitors and one inductor. The inductor is normally fixed in value and both capacitors are variable. One capacitor is used to tune the π-net to resonance and the other capacitor is used to adjust the coupling between the tank and the antenna.

In the form usually used in vacuum tube circuits, both capacitors are connected to ground. The tube is connected across one capacitor and the load across the other (Fig. 1). This circuit works very well for tube circuits where the load impedance must be fairly high, usually at least 2 kΩ. It is not satisfactory for transistor circuits, however, because most transistors must operate into a load impedance of less than 100Ω and the size of the capacitors be-

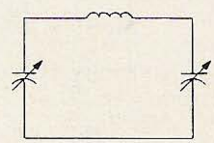

Fig. 1. Capacitor input π-net.

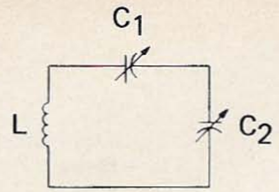

Fig. 2. Inductor input π-net.

comes very large when an input impedance of this magnitude is needed. A typical capacitor value for an 80m tank is 0.01 μF. Variable capacitors of this size are impractical.

Fortunately for builders of transistor equipment, there is a form of π-net coupling circuit that can work very well with transistors. This circuit retains all the advantages of the conventional π-net and still allows a low load impedance to be presented to the transistor. As shown in Fig. 2, the loading capacitor and the inductor are connected to ground and the tuning capacitor is "floating." This form of π-net is called an inductor input π-net and it functions essentially the same as the capacitor input circuit. The input impedance is high for both, and circuit values are similar for the same input impedance and frequency. There is one difference that makes the inductor input π-net useful for transistors, and that is a low input impedance can be obtained by coupling into the inductor with a link. The impedance level is lowered by transformer action.

There are actually several possible arrangements of the inductor input π-net. Figure 3 illustrates these.

In sketch A (Fig. 3) one side of the inductor and one side of the loading capacitor is connected to ground. The rf energy is coupled into the π-net by a link.

In B, the loading capacitor is connected to ground and the bottom of the inductor is at ground potential for rf because of the large bypass capacitor. The collector is connected to a tap on the π-net inductor and the impedance is transformed down by this autotransformer connection. The dc also flows through the inductor. This circuit requires a minimum of parts.

In C, one side of each of the capacitors is connected to ground and the inductor is floating. Rf is coupled into the π-net by a

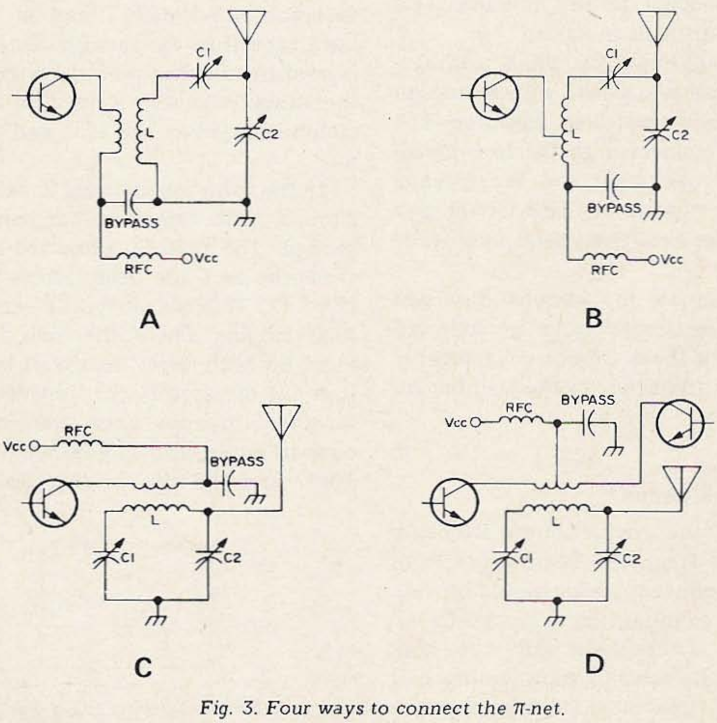

Fig. 3. Four ways to connect the π-net.

link. This arrangement eliminates the primary disadvantage of the circuits shown in the previous two figures, which is that the tuning capacitor must be isolated from ground. The inductor can float because the link isolates the inductor from the dc portion of the transistor circuit and the rf is still applied across the inductor. If a link is to be used, this is the preferred arrangement.

If push-pull operation is desired, the circuit of D may be used. The collector supply voltage is connected to the centertap of the link and the transistors are connected to each end of the link as in the conventional push-pull circuit. Push-pull operation may also be accomplished by using a centertapped link with the circuit shown in A.

It is actually easier to work with the inductor input π-net than it is to work with the capacitor input π-net. With the capacitor input π-net it is necessary to design a completely new tank circuit each time a different load impedance is needed. With the inductor input π-net all that is needed to change the load impedance is to change the number of turns on the input link. The basic π-net remains unchanged and all that is changed when a different input impedance is needed is the number of turns on the link.

The Universal π-Net

It is possible to use one basic π-net circuit for all input impedances and it is possible to design a universal π-net circuit. The universal π-net is described by giving reactance values for the inductor and the capacitors. The value of inductance and capacitance is then calculated for the desired operating frequency.

The universal π-net is designed by first choosing an input impedance across the entire inductor. The Q of the tank is designed to be at least 12 to obtain good suppression of harmonics. The value of inductive and capacitive reactance and the tuning range of the capacitors required to tune across the amateur band with the highest percent bandwidth and to load the desired variation in antenna resistance is calculated.

For those interested, the following equations are the basic design equations for the inductor input π-net.

$$X_L = \frac{R_r}{Q}$$

$$X_{c2} = R\sqrt{\frac{R_r}{R(Q^2+1) - R_r}}$$

$$X_{c1} = X_L - \frac{X_{c2}\,R^2}{R^2 + X_{c2}^2}$$

The reactance values, X_L, X_{c1}, and X_{c2} are for the inductor and the capacitors shown in Fig. 2. The input impedance across the entire inductor is defined as R_r and the antenna resistance is defined as R. The equations work if the Q of the circuit is greater than 10 and if R_r is greater than R and smaller than $R(Q^2 + 1)$. Also, the source of rf energy must not load the tank.

These basic equations were used to design the universal π-net tank circuit shown in Fig. 4. The reactance values at the center frequency of the band are shown in the figure for each of the components of the tank. The values of inductance and capacitance must be calculated at the center frequency of the band in which the π-net is to be used.

This tank circuit was designed to have 4 kΩ input impedance across the entire inductor. Its Q is 15 in the center of the band, 13.95 at the upper band edge and 16.2 at the lower band edge. It is designed to match resistive loads between 30 and 200Ω. The π-net can operate over a 15% bandwidth.

The input impedance was arbitrarily chosen to be 4 kΩ. This impedance level is higher than would ordinarily ever be needed in a transistor circuit and at this level there is not an excessive amount of interaction between the tuning and loading controls. Also, reasonable circuit values are obtained.

The Q at the center of the band was chosen to be 15 and the lowest Q in the

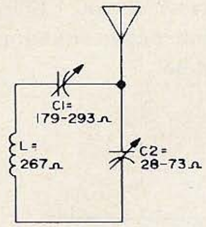

Fig. 4. Universal π-net

Table I						
Inductor and Capacitor Values						
Band	L	C_1 (pf)		C_2 (pf)		
	(μh)	Min	Max	Min	Max	
160	22.36	286	468	1155	2992	
80	11.33	145	237	585	1516	
40	5.94	75	124	307	795	
20	3.00	38	63	155	401	
15	2.00	26	42	103	268	
10	1.47	19	31	76	197	
6	0.82	10	17	42	109	

band the π-net is designed to operate over is almost 14, exceeding the minimum usable value of 12.

The π-net can match resistive loads from 30 to 200 Ω. If the load contains either capacitive or inductive reactance, the tuning range of the loading capacitor may have to be increased since its value will have to be different to balance out the reactive component of the load.

In this article, percent bandwidth is defined as bandwidth/band-center X 100. The amateur band with the highest percent bandwidth is the 80m band with 13.33% bandwidth. The band with the lowest percent bandwidth is the 15m band with 2.12% bandwidth. The π-net is designed for a 15% bandwidth and is therefore able to tune across any amateur band. For most bands there is considerably more tuning range than necessary.

The π-net shown in Fig. 4 is general in nature and can be used for any band because reactance values are given for each of the components. When using the circuit at a specific frequency it is necessary to calculate the value of inductance and capacitance based upon the reactance and frequency. Since we are interested in using the circuit only in the amateur bands it is convenient to calculate the inductance and capacitance values for each of the amateur bands in which the π-net is useful. This was done and the results are tabulated in Table I. This table shows the value of inductance and capacitance needed for each of the bands, from 160 through 6 meters. The values were calculated assuming the center frequency of the π-net is at the center of the amateur band.

By using the values shown in Table I the design of the π-net is reduced to simply choosing capacitor values and designing the inductor.

Using the Universal π-Net

The inductance and capacitance values shown in the table are actual circuit values and include stray wiring capacitance and inductance. The capacitance would usually be made up of a fixed and a variable capacitor in parallel. The sum of the fixed capacitor, the minimum capacitance of the variable capacitor and the wiring capacitance should be equal to or less than the minimum value of capacitance shown in the table. The sum of the fixed capacitance, the maximum capacitance of the variable capacitor and the wiring capacitance should be equal to or greater than the maximum value of capacitance shown in the table. Wiring capacitance must be included and it is difficult to determine its value because it is dependent upon several factors including the circuit layout and compactness. It may be as high as 20 or 30 pF and is equivalent to adding a fixed capacitor in parallel.

If the inductance is not close to the proper value, it may be necessary to adjust capacitance values a little one way or the other to obtain full tuning range across the band, especially on 80m where there is very little extra tuning range. Also, if the wiring capacitance is not close to the estimated value, the value of fixed capacitance may have to be adjusted to compensate.

The inductor must provide the inductance value and it must act as the secondary of the input transformer. It can be either an air core coil or a toroid wound on a magnetic core.

The inductor may be wound using cut

and try methods if some method is available to measure the inductance, or the size of the coil and the number of turns can be calculated.

An ARRL Type A lightning calculator is very useful for designing air core coils. With it you can design coils with a wide variety of diameters and lengths.

The number of turns needed on a toroid to obtain the desired inductance can be calculated using this equation adapted from *Electrical Engineers' Handbook*, by Pender and McIlwain:

$$N = 9.92 \sqrt{\frac{Ld}{A' + A(\mu - 1)}}$$

Where: N = number of turns
L = inductance in microhenrys
d = average diameter of core in inches
A' = area of coil at right angle to flux path in square inches
A = area of core at right angle to flux path in square inches.
μ = permeability of toroid core

If the coil is wound close to the core the equation can be simplified to the following:

$$N = 9.92 \sqrt{\frac{Ld}{\mu A}}$$

Since the inductor is the secondary of the input transformer it is undesirable for it to have a small number of turns because the lowest input impedance will be fairly high, perhaps too high for the transistor it is to be used with. For example, if the inductor had five turns on it and a one turn input link were used the input impedance would be $4000/5^2 = 4000/25$, or 160 Ω. This is based on the classical impedance transformation equation for transformers where the impedance across the secondary is 4 kΩ and the turns ratio is 5.

In the case of air core coils, the smaller the diameter of the coil the more turns that are required. Therefore, if you cannot get a low enough input impedance, use a smaller diameter coil with more turns on it. Coils with a diameter of 1-1/2 in. are about right for 160m, a diameter of 1 in. works well for 80 and 40m tanks, and for 20 through 10m tanks, a diameter of 0.5 in. is suggested. On 6m, a smaller diameter may be needed, perhaps 3/8 in. There is nothing that says these diameters must be used. They are only suggested and it may be necessary to use something different in some cases.

It is undesirable to have a small number of turns on a toroid. There is an additional problem with toroids because it is not possible to have a fraction of a turn on a toroid. Each time the wire passes through the center counts as one turn. Therefore the input impedance and the inductance changes in steps as turns are added and if the number of turns is small the steps will be large. To increase the number of turns on the toroid, use a core with a low permeability (μ). Toroid cores are commercially available with permeabilities from 7 to over 200. Cores with low permeability are best for this circuit. The physical dimensions of the toroid core also influence the number of turns needed; however, the power input to the tank will probably determine the size needed. A very good article on the use of toroids in tank circuits, written by E. L. Klein (W4BRS), appeared in 73, June 1967.

It is desirable to have an idea of the number of turns needed on the input link. The following equation is based on the classical transformer impedance transformation equation and gives an indication of the number of turns to use on the input link. The equation is:

$$N_L = \frac{N_c \sqrt{Z_{in}}}{63.3}$$

The number of turns on the link is N_L, the total number of turns on the inductor is N_c, and the desired input impedance is Z_{in}. The above equation was derived specifically for the universal π-net where the impedance across the inductor is 4 kΩ.

This equation will be close for a toroid inductor where there is tight coupling between the windings, but gives only an indication for air core coils. Coupling between the windings of air core coils is loose and the input impedance will actually be lower than indicated by the equation. Since the use of too low a load impedance may destroy the transistor due to excessive current, it is best to use more turns than indicated by the equation when using air core coils. The proper number will have to be determined experimentally by measuring the power output and power input and maximizing efficiency by varying the number of turns on the link.

If the autotransformer connection of sketch B in Fig. 3 is used, N_L in the equation is the tap point of the inductor in number of turns from the bottom. As with link coupling, the equation is accurate for toroids but only an indicator for air core coils. When using air core coils, it is best to tap higher than indicated by the equation and experimentally determine where to tap for maximum amplifier efficiency.

While either an air core coil or a toroid will work, the toroid has several advantages, among them, small size, low external field, and the toroid approaches an ideal transformer.

Since the toroid has a low external field, there is less chance of oscillation due to coupling between the final tank coil the tank coils of previous stages in the transmitter. Also, there will be little loading of the tuned circuit by nearby metal objects and the coil can be placed close to other objects, allowing a more compact circuit to be built.

The load impedance required by the transistor is needed if the previous equation is to be used to design the input link. The following equation can be used to calculate approximately the optimum load impedance.

$$Z_{in} = \frac{V_{cc}^2}{2P_o} \quad \text{(ohms)}$$

The collector supply voltage is represented by V_{cc} and the power output from the transistor is P_o.

Use As an Interstage Coupling Circuit

The π-net is also very useful for interstage coupling, such as coupling the driver transitor to the final. The π-net acts as a tuned circuit and allows the impedances to be matched between the driver and the final. Any of the basic circuits of Fig. 3 may be used. The amount of drive supplied to the final can be adjusted by varying the loading capacitor. It is much easier to turn a capacitor to adjust the drive than it is to change the number of turns on a link, as would be necessary if the final were driven from a link.

By using a loading capacitor somewhat smaller than the minimum shown in Table I, the π-net can drive loads as low as about 20Ω. This is sufficiently low for most transistors. If the input resistance of the transistor is smaller than this, the impedance across the inductor will be greater than 4 kΩ.

In applications where the operating frequency will not change greatly, small screwdriver-adjusted padder capacitors can be used when the π-net is used for interstage coupling. The circuit is tuned and then left alone unless a large change in frequency is made.

A Design Example

It is desired to build a transistorized final for 10m using a 2N2631. This transistor has a maximum collector-to-emitter rating of 80V when there is a low resistance path from the base to ground. It can operate up to about 175 MHz so will work well on 10m. It can dissipate 7W of power at a case temperature of 60°C (140°F) and therefore should be able to handle a power input of about 15W if the efficiency can be kept reasonably high.

Because the maximum rating between the collector and the emitter is 80V, the maximum usable power supply voltage is 40V. Because the highest power can be obtained at the highest possible supply voltage, a 40V collector supply voltage will be used.

Table I says the inductor should be 1.47 μH, the tuning capacitor C_1 should be variable from 19 to 31 pF, and loading capacitor C_2 will be between 76 and 197 pF.

A combination of fixed and variable capacitors must be chosen for the tuning and loading capacitors. A wiring capacitance of 15 pF will be assumed for each of these. The tuning capacitor must have a tuning range of at least 12 pF. A Hammarlund type HF-15 capacitor has a range of 2.8 to 17.5 pF or a tuning range of 14.7 pF. The sum of the minimum capacitance of the variable capacitor and the wiring capacitance (2.8 + 15) is 17.8 pF. The sum of the maximum capacitance of the variable capacitor and the wiring capacitance (17.5 + 15) is 32.5 pF. In this case, no fixed capacitor is needed because the wiring capacitance is large enough. It should be remembered however that 15 pF was estimated for the wiring capacitance and its actual value is unknown. Therefore, after the circuit is built it may be necessary to adjust the capacitance a little to be able to tune across the entire band.

The loading capacitor must have a tuning range of at least 121 pF. A Hammarlund type HF-140 has a capacitance range of 6.3 to 142 pF or a tuning range of 135.7 pF. The sum of the minimum capacitance of the variable capacitor and the wiring capacitance (6.3 + 15) is 21.3 pF. A fixed capacitor of about 55 pF will be needed to give the required minimum capacitance of 76 pF (76 − 21 = 55). A standard value is 47 pF and if this value were used, there would be about the same overlap on each extreme of the rotation of the capacitor. As in the case of the tuning capacitor, the wiring capacitance is only an estimate and it may be necessary to adjust the value of the fixed capacitor to compensate if the actual value is greatly different.

The inductor is to be a toroid. An Amidon Associates type "SF" core operates between 10 and 90 MHz and will therefore work well on 10m. The permeability (μ) of this core is 8. A core with an outside diameter of 0.5 in. should be large enough to handle the power output of this final. The inside diameter is 0.3 in. and the thickness is 0.19 in.

The coil will be wound close to the core so the simplified equation can be used. The average diameter of the core, d, is 0.4 in. (0.5 + 0.3/2). The area of the core, A, is 0.019 sq in. (0.1 X 0.19). The number of turns is then calculated:

$$N = 9.92\sqrt{\frac{1.47 \times 0.4}{8 \times 0.019}} = 19.5$$

Since a toroid must have a whole number of turns, either 19 or 20 turns could be used; however, in this example, 20 turns will be used.

The only thing remaining to be designed is the input link. The first step in designing the link is to determine the required load impedance. The supply voltage is 40V and the approximate power output is 10W. The required load impedance is then:

$$Z_{in} = \frac{40^2}{2 \times 10} = 80\Omega$$

The number of turns on the input link can now be calculated from the equation:

$$N_L = \frac{20\sqrt{80}}{63.3} = 2.83 \text{ turns}$$

The nearest whole number is 3 and the input link will use 3 turns.

Additional Notes

In the last year I have done considerable work with transistor power amplifiers using transistors designed to operate from a low supply voltage, such as 12 or 13.6V. I have discovered that many transistors of this type are unstable when the basic link-coupled inductor-input pi-net is used as the tank circuit. Fortunately, I have also discovered a simple way to prevent this instability. All that is required is the connection of a small capacitor from the collector to ground, as shown in Fig. 5.

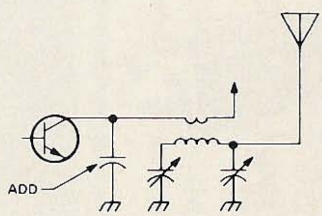

Fig. 5. Adding a small capacitor from the collector to ground will stabilize low voltage transistors.

The amount of capacitance required seems to depend upon the particular type transistor used and probably also upon the frequency of operation. All the amplifiers I have built using this capacitor to ground have operated in the high end of the 10m band. At this frequency a capacitance of 30 to 50 pF is normally enough to allow stable operation. The proper capacitor to use at lower frequencies will have to be determined experimentally and will probably have about the same capacitive reactance as the capacitor used on 10m.

Adding this capacitor does not change the basic operation of the circuit, but the value of C_1 will have to be reduced slightly to allow the π-net to resonate at the desired frequency.

The reason the capacitor improves stability is unknown but it does work and its use will allow you to successfully use the inductor-input π-net with transistors designed to operate from low power supply voltages..

...W5PAG

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CHANGING THE 75S3 into a Better CW Performer

The 75S3 is an excellent receiver with an excellent 200 Hz CW filter that comes with it as standard equipment.

However, I found the 200 Hz filter too sharp for everyday use, whereas the 2.1 kHz filter is too broad. Due to its sharpness, the signals on the 200 Hz filter tend to ring, which can make a long session quite tiresome. An intermediate filter would be needed for normal use in CW operation, retaining the possibility to switch to 2.1 kHz for SSB or CW broadband net operation, and to 200 Hz for those really bad QRM situations.

On looking at the innards of the receiver, you will see that there is room for another filter and associated capacitors, and the holes are even drilled for them already. Changing the mode switch to one of five positions would be a major operation, but these days very few operators would object to giving up the AM position on the switch and substituting it for a 500 Hz CW position (especially if they are CW operators!).

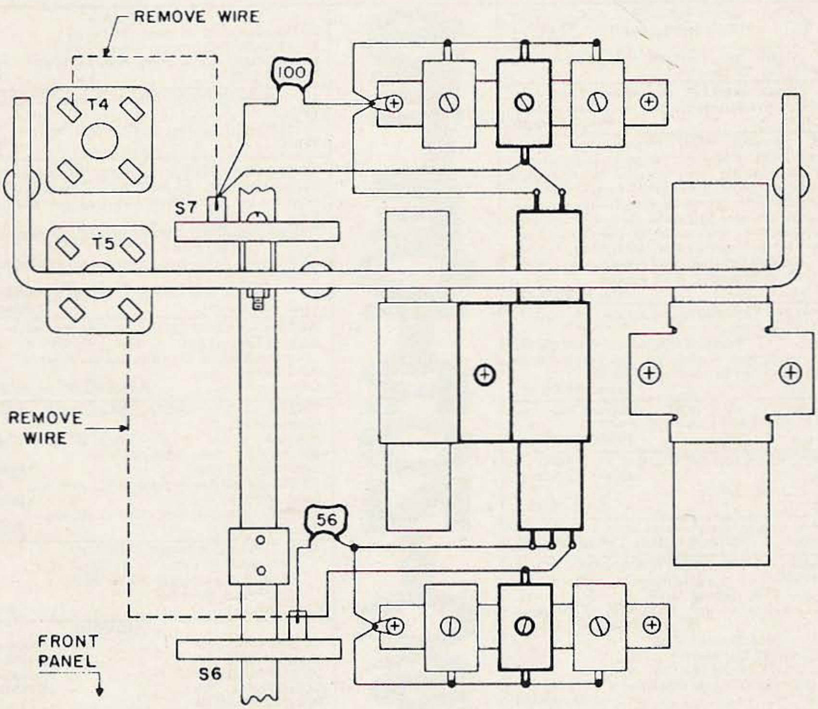


Fig. 1. Bottom view 75S3.

Collins sells a suitable mechanical filter (F455Y-05); the part number is 526.9521.001, and the price is $58. It comes complete with the little trimmers that fit into the holes in the strip on the chassis of the 75S3.

And while you are ordering from Collins, why not, for $1.50, order the hardware for mounting the filter, including two fixed capacitors, a clamp, and the wire needed for the connections. It's called an NPN installation kit.

Figure 1 shows the necessary changes in wiring needed to install the filter. What you do is simply substitute the i-f transformers T4 and T5, that are used for the wideband AM position, by the mechanical filter and associated capacitors, one of 100 and one of 56 pF, as indicated in Fig. 1, plus the two trimmers. Extra components are indicated in heavy lines.

After installation, all you have to do is provide a bfo voltage in the AM position of the switch, and connect the product detector instead of the AM diode detector to the i-f output.

Simply disconnect the lug on the wafer of the mode switch nearest the back of the receiver that is connected via a 100 kΩ resistor to pin 6 of the 6AT6, and reconnect this lug to the other three next to it (already connected together). The easiest way is to simply clip off and remove the 100 kΩ resistor that is no longer needed. You have now connected your i-f output to the product detector, and at the same time you are using the bfo in its variable position.

Align the filter by tuning the trimmers for largest signal of the internal 100 kHz oscillator on the meter, and you are in business.

The AM position of the mode switch gives you now 500 Hz selectivity without the "ringing" associated with the really very sharp 200 Hz selectivity. And when QRM really becomes bad you just flip the switch to the 200 Hz position and you will usually have a good copy again.

This investment has been one of my very best, and it has increased my pleasure in operating the 75S3 no end.

. . . OA4KF-PA0XE

WHY COAX?

E. M. Wagner G3BID
5, Ferncroft Avenue,
London, England N.W.3

Most beam antennas are based on a driven element which is half a wavelength long. Almost all beam antennas are symmetrical—that is to say, there is exactly the same length of the same diameter of element on the left of the feedpoint as there is on the right—the same amount of inductance, capacity, traps, or other devices on both sides of the feedpoint.

It has, therefore, always puzzled me why, having achieved a beautifully symmetrical structure or balanced array, one should feed it with an unbalanced feedline like coaxial cable.

I am aware, of course, of the gamma match and the balun as a means of converting the unbalanced line to operate a balanced array (and these two devices will be discussed later), but there are still quite a large number of balanced antennas, beams, dipoles and the like fed directly with coaxial cable. In many cases these connect the center conductor of the coaxial cable to one side and the braid or outer conductor to the other side of the balanced array. See **Fig. 1**.

In the case of the gamma match (**Fig. 2**), the braid is normally connected to the *center* of the driven element which is in theory grounded while the center conductor is connected (at some distance appropriate to the impedance) to one side of the center.

In this case it is assumed that the braid or outer conductor is at ground potential. If this were actually true, the first example (connecting the braid to one side of the element and the center conductor to the other) could not work since one would then connect one side of the driven element to ground at the same distance from the center as the one which is driven on the other side. Yet, examples of the gamma match, and examples of connecting the coax cable directly to the element do work.

This must surely mean that in both cases a poor compromise is being achieved. The

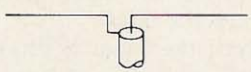


Fig. 1. Feeding a balanced antenna directly with coax.

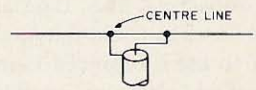


Fig. 2. The gamma match feed.

outer conductor or braid is neither genuinely grounded, nor is it genuinely hot to rf.

In the case where the coax cable is connected directly to the driven element (example 1) we must be assuming that the braid is not grounded, as we are using it to drive one side of the driven element. At this point surely it must be hot, and therefore for a considerable part of its length, the outer conductor must be carrying rf energy. Since it surrounds the inner conductor, the inner conductor cannot be radiating as it is completely shielded by the outer conductor and, therefore, it cannot balance this radiation. Thus we are producing a radiating feedline which must tend to accentuate TVI problems and, of course, upset the radiation pattern of the beam itself to some extent.

With the gamma match we assume that the outer conductor is grounded and we hope, therefore, that it is not radiating; but even in this case it seems a pity to drive a perfectly balanced array in a lopsided way on one side only and just hope that the other side will pick up the rf energy by resonance when we could, of course, feed the whole thing in balanced array by using balanced twin feedline.

But let us examine what chance we really have of grounding the outer conductor. Any conductor which is grounded at one end is no longer grounded as soon as we have traveled a quarter wavelength along this conductor away from the grounded point. In considering this quarter wavelength, we must remember that it is not only a quarter wavelength from the grounded point *at the frequency on which we intend to radiate*, but if there are harmonics present—and there very often are—then a quarter wavelength on the *frequency of the harmonic* from the grounded point and the outer cable is no longer grounded. For these reasons, it seems to me to be an illusion to imagine that the outer conductor of a coaxial cable can be regarded as effectively grounded throughout its length and, in fact if this were so, the system of connecting the coaxial cable directly to the antenna could not work.

If we were to use a balanced twin feeder instead of coaxial cable, we would not be deluding ourselves into imagining that one of the conductors was grounded. We would assume that both are hot to rf and, since they are 180 degrees out of phase, any radiation from the one conductor is balanced by the out-of-phase radiation from the other.

It may be argued that since most transmitters use pi-coupled output circuits, the transmitter is terminated by an unbalanced output and, therefore, we have difficulty in feeding a balanced feedline. Here I would advocate the use of a balun.

I am aware that there is a third method of using coaxial feeder to fit a balanced array—namely, by using a balun between the coaxial cable and the balanced array. This is, in my view, the best method of using the coaxial feedline and closely approximates the system I have just advocated of using a balun at the bottom of the feedline and feeding with a balanced twin cable.

In the case of the balun (balanced-to-unbalanced transformer), example 3, we undoubtedly have the best arrangement with this system if we *must* use coaxial line, since we are employing a device to convert the unbalanced feedline to a balanced feeder before connecting it to the balanced array.

There is still a certain disadvantage, however. Located at the top of the feedline close to the driven element, we will have a long coaxial cable for the whole of the length of the feedline and all the problems of radiation from the outer conductor still exist, but perhaps the most important disadvantage here is in feeding a lowpass filter. In the case of a lowpass filter designed for coaxial cable, the filter elements are connected in the center conductor and are so designed as materially to attenuate any harmonics which are present. If these harmonics are also present on the outer conductor (or braid) then these will pass through the metal case of the lowpass filter and, in effect, the filter is completely shorted out by the metal case.

Exactly the same applies in the case of a highpass filter connected to the input of a television set—the filter is again completely short-circuited by the case which connects the braid across the filter.

If, however, the balun is fitted close to the transmitter and the unbalanced output from the transmitter converted in a balanced feed, then a lowpass filter for twin feed with the outer case insulated from both conductors can be used. Thus, the attenuation of harmonics resulting from the use of the filter will be effectively placed in *both* transmission conductors, and the metal case, although providing screening, will not act as short circuit across the filter elements. The outer case can be grounded or left floating, whichever is found more effective. This will often depend on the length of lead necessary to ground the case effectively.

From every point of view it would seem preferable to feed balanced arrays with balanced feedline, using a balun close to the transmitter to convert the unbalanced output of the pi output circuit to a balanced feeder. Then, if necessary, inserting a lowpass filter designed for twin feed, in which both conductors are balanced and insulated from ground.

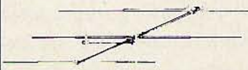
Furthermore, a balanced feedline can be a 72Ω twin feed unscreened, since the close spacing between the two conductors and the fact that the currents flowing into each are equal and opposite, any radiation will be automatically balanced.

Since in this world nothing is perfect and it may well be found that the currents in the two legs are not always exactly balanced, a screened 72Ω twin feedline can be used to eliminate radiation which might arise from the fact that the two currents are not always exactly equal and opposite. However, in almost all cases, this will not be found necessary.

There is, however, one difficulty. Most modern beams are designed for 52Ω impedance feed.

At present no 52Ω impedance twin line exists and it is unlikely that such a low impedance line will be constructed in the near future, owing to the difficulty of insulating the two conductors; they would have to be spaced too close for practical manufacture. However, there is a vast amount of 72Ω twinlead available in most ranges of current-carrying capacity, and it would seem regrettable that beams are designed for a 52Ω impedance instead of for 72Ω impedance, for which twinlead is so readily available—and inexpensive.

. . . G3BID ■



IMPROVING The HEATH TUNNEL DIPPER

Walt Pinner WB4MYL
7304 Lorenzo Lane
Louisville KY 40228

The tunnel dipper, an excellent piece of test gear at its price, can be made even better with two simple changes.

You are cautioned in the instruction book that you may expect some downward drift of the meter during warm up. This drift has been eliminated by replacing the meter amplifier transistor Q3-2N185 with an inexpensive T1XMO5 transistor.

The second change recommended corrects the extremely fast rate of adjustment of the sensitivity control which makes obtaining a center scale reading of the meter difficult.

Replace the Sensitivity pot with a Mallory U-29 control (price approximately $1) and add a 56K resistor between the black lead to the original control and the new control. Add a 27K resistor between the white lead to the original control and the new control. Reconnect the center green lead directly to the new control.

If difficulty is encountered in swinging the meter through its complete range, due to the particular transistor in the unit, adjust the fixed resistor values slightly. If either of the values are changed, alter both to keep the total series resistance approximately 100 kΩ.

Five units have been modified in accordance with the above instructions and the ease of operation and improved stability have proven well worth the effort.

. . .WB4MYL■

communications yardsticks

Reprinted from the Lenkurt Demodulator

A yardstick is a measure of a two-way system's quality, quantity and performance. The often requested discussions of logarithmic units used to measure the quality of transmission systems is reprinted here with the addition of the metric units used internationally to measure absolute quantities.

Descriptive terms used in the telecommunications industry range from the infinitesimal – 1/1,000,000,000,000 watts/cm^2 (the power rating for conversational speech) – to the enormous – 6,000,000,000 Hz (the frequency of a typical microwave radio). Such a span would be unwiedly if simplifying expressions had not been established.

Powers of Ten

The first step to simplicity is a shorthand notation that expresses numbers as powers of ten. We know that 10 x 10 = 100 can be written 10^2. Likewise, 10 x 10 x 10 = 1000, or 10^4. By definition, an exponent of three means the number 10 is used as a multiplier three times. A frequency of 6,000,000,000 Hz then becomes 6 x 10^9 hertz (6 GHz).

Note that $10^1 = 10$ and $10^0 = 1$. Numbers smaller than one can also be treated using powers of ten. By definition, 10^{-1} is the same as $1/10^1$ or 1/10. In this way, the power rating for typical conversational speech, 1/1,000,000,000,000 watts/cm^2, can be written 10^{-12} watts/cm^2.

When discussing two relative values, it is sometimes convenient to use the term *orders of magnitude*. This is another way of expressing powers of ten. That is, one order of magnitude (10^1) is 10 times as much, two orders of magnitude (10^2) is 100 times as great, etc. Simple division indicates that a supersonic plane flying 1500 miles per hour is 100 times faster than a man jogging at 15 miles per hour. So, it can be said that the plane is two orders of magnitude faster than the man. Notice that orders of magnitude are really concerned with the exponent of the number.

Logarithms

All the numbers in these examples use the same "base" number of ten. If we treat

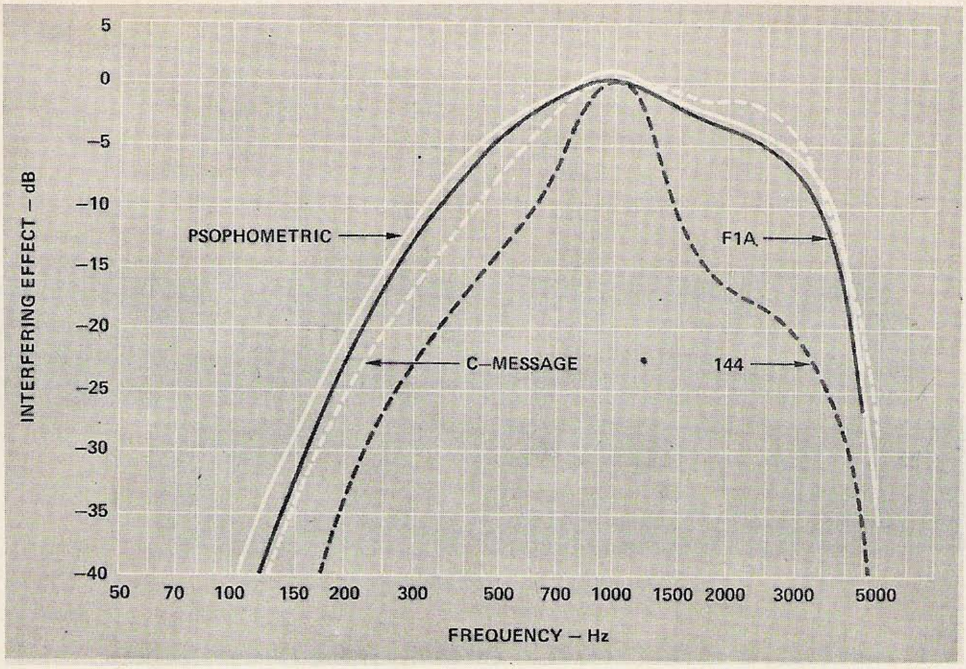


Fig. 1. Weighting curves, based on listener response shows the relative interfering effect of noise on speech.

the exponent of the base number separately, another useful shorthand is achieved, called *logarithms*. In $100 = 10^2$, the logarithm of 100 is two. That is, the common logarithm (abbreviated $\log_{10}$, or just log) is the power to which the base ten must be raised to produce the number. The written form is log 100 = 2.

The use of logarithms simplifies many forms of complicated calculations. Remember that to multiply like numbers (the number ten is used here to relate to common logs), it is only necessary to *add* their exponents ($10^2 \times 10^3 = 10^5$); to divide, subtract exponents ($10^5 \div 10^3 = 10^2$). Logarithms are used in the same way. Multiplications and divisions involving large numbers may be carried out by adding or subtracting in the corresponding logs. In fact, any series of events involving multiplication or division, if expressed logarithmically, may be handled by addition or subtraction. This is particularly valuable in two-way communications, where a variety of measurements is necessary to describe the qualities of a signal as it passes through the system. Voltages, currents, and powers are measured; noise identified; and losses assessed. These are all made easier by the use of the logarithmic yardstick.

Decibels

The basic logarithmic yardstick in communications is the decibel, derived from the less practical unit, the bel, named in honor of Alexander Graham Bell. A decibel is a tenth of a bel.

Table I. Power-Decibel Relationships

Decibels	Power Ratio
1	1.259
2	1.585
3	1.995
4	2.512
5	3.162
6	3.981
7	5.012
8	6.310
9	7.943
10	10.0
20	100.0
30	1000.0
40	10,000.0

Table II. International Standards of Measurement

Measure	SI Unit	Derived Units
Length	meter (m)	area — — (m^2) volume — — (m^3)
Time	second (s)	frequency — — hertz (H)
Mass	kilogram (kg)	
Temperature	kelvin (K)	
Electric Current	ampere (a)	

Table III. International Prefixes and Definitions

Prefix	Symbol	Multiplier
tera	T	1,000,000,000,000 = 10^{12}
giga	G	1,000,000,000 = 10^9
mega	M	1,000,000 = 10^6
kilo	k	1,000 = 10^3
hecto	h	100 = 10^2
deka	da	10 = 10^1
deci	d	0.1 = 10^{-1}
centi	c	0.01 = 10^{-2}
milli	m	0.001 = 10^{-3}
micro	μ	0.000 001 = 10^{-6}
nano	n	0.000 000 001 = 10^{-9}
pico	p	0.000 000 000 001 = 10^{-12}
femto	f	0.000 000 000 000 001 = 10^{-15}
atto	a	0.000 000 000 000 000 001 = 10^{-18}

Table IV. SI-to-U.S. Conversion Factors

American Units	SI Equivalents
inches x 25.4	= millimeters
feet x 0.3848	= meters
miles x 1.61	= kilometers
pounds x 0.454	= kilograms
inches	= millimeters x .0394
feet	= meters x 3.28
miles	= kilometers x 0.621
pounds	= kilograms x 2.21

Early experimentation proved that a listener cannot give a reliable estimate of the absolute loudness of a sound. But he can distinguish between the loudness of two different sounds. However, the ear's sensitivity to a change in sound power follows a logarithmic rather than a linear scale, and the decibel (dB) has become the unit of measure of this change. The relationship between any two power values can be calculated in decibels as:

$$dB = 10 \log \frac{P_1}{P_2}$$

If P_2 is larger than P_1 the dB value will be negative; therefore, it is convenient to designate P_1 as the larger power.

It should be emphasized that a given number of decibels is always the relationship between two powers, and not the absolute power value itself (Table I). For example, the gain in an amplifier, or the attenuation of a pad, can be expressed in decibels without knowledge of the input or output power of the device – just the change.

dBm

Frequently, however, it is convenient to represent *absolute* power with a logarithmic unit. One milliwatt (usually into a 600Ω line) is generally accepted as the standard reference for such purposes in the telephone industry, and signal powers can be written as being so many dB above or below this reference power. When this is done, the unit becomes dBm, in the expression:

$$dBm = 10 \log \frac{P_1}{P_2}$$

where P_2 is 1 mW (10^{-3} watts).

By adding a definite reference point, dBm becomes a measurement of absolute power rather than just a ratio; and can readily be converted to watts. A measurement of 10 dBm indicates a signal ten times greater than 1 mW, or 10 mW; 20 dBm is 200 times greater than 1 mW, or 100 mW. A 15 dBm signal applied to an amplifier with a 10 dB gain will result in a 25 dBm output. Or, a standard test tone (0 dBm) will be measured as -15 dBm after passing through an attenuator of 15 dB.

It is important to note at this point that most meters used in the telephone industry are calibrated for measurements of voltage appearing across a 600Ω termination (standard transmission line impedance). If the circuit to be measured is of a different impedance than that for which the meter was calibrated, the indicated power level will be wrong, and a correction factor must be taken into account. Using the relationship of $P = E^2/R$, the following correction factor is formulated:

$$dB = dB_{(indicated)} + 10 \log \frac{600\ ohms}{circuit\ impedance}.$$

For example, a +6 dB reading across a 500Ω line is calculated:

$$\begin{aligned} dB &= 6 + 10 \log \frac{600}{500} \\ &= 6 + 10 \log 1.2 \\ &= 6 + 0.792 \\ &= 6.792\ dB. \end{aligned}$$

Level Point

In most telephone systems, the toll switchboard is defined as the "zero-transmission-level point" (TLP), and the levels of both signal and noise at other parts of the system are usually referred to that point. A point in the transmission system where a signal has experienced a 16 dB attenuation relative to the toll switchboard is known as the -16 dB level point. Note that *level* used this way is purely relative and has nothing to do with actual power – a signal of any power will be down 16 dB at the -16 dB level point. When a standard test tone is transmitted over the circuit, its power in dBm at any point is numerically equal to the level in dB at that point.

dBmØ

Another term, dBmØ is used to refer measured power back to Ø TLP, and has useful significance in system planning. Measurements adjusted to dBmØ indicate what the power would have been, had it been measured at Ø TLP. For example, a tone measured at the -16 dB level point with a meter reading of +8 dBm, is equal to +24 dBmØ.

In addition to dBm, there are a number of other logarithmic units used in the telephone industry which are expressed as dB above or below some reference power. One of the most common of these is dBrnc, used in the measurement of noise.

Noise Measurement

The Bell Telephone Laboratories and the Edison Electrical Insttute did original research to determine the transmission impairment caused by noise interfering with speech. A large number of listening tests were made with different tones introduced as interference. The degree of interference was determined by comparing the power of each interfering tone with the power of a 1 kHz tone that created the same degree of interference.

A power of 10^{-12} watts) was introduced. This also necessitated a change in the units, resulting in the adoption of dBa (decibels adjusted).

dBrnc

When the new 500-type handset was put into service in the 1950s, another line weighting was introduced, called C-message weighting. Since the new equipment was an improvement over the old, an even higher reference power would have been required to express equal interfering effects with equal numbers. But this might have resulted in some unrealistic "negative" values of noise interference. So the reference power was returned to -90 dBm, and the units dBrnc, meaning decibles, reference noise C-message weighted.

Weighting curves (Fig. 1) for each handset compare interfering effects for various frequencies and are referred to as interference of 1 kHz. Noise measuring sets are frequency weighted in the same way so that meter readings obtained are meaningful in terms of what the ear detects. That is, the instrument does not measure noise intensity alone, but takes into account the frequency of the noise and how the particular frequency affects the ear.

Since there is no weighting effect on a 1 kHz tone, straightforward conversion between dBa and dBrnc is possible by comparing reference power. A 1 kHz signal having a power of Ø dBm yields 90 dBrnc. But, because wieghting networks attenuate other frequencies differently, a uniform 3 kHz band of noise (flat or white noise) will not be measured the same as a 1 kHz tone. White noise at Ø dBm will produce a noise reading of 82 dBa and 88 dBrnc. Approximate conversion is then accomplished by adding 6 dB to the dBa value:

$$dBrnc = dBa\ 3\ 6.$$

For instance, using an instrument F1A weighted, a reading of 20 dB a would be equivalent to 26 dBrnc. The conversion factor is due to the 5 dB difference in noise reference power and an approximate 1 dB difference in weighting over the voice band.

At present, dBrnc is more convenient to use than dBa.

Psophometric Weighting

Circuit noise expressed in units established by the CCITT (International Telegraph and Telephone Consultative Committee) is gaining recognition throughout the world. This international unit is linear rather than logarithmic and is in terms of picowatts (10^{-12} watts) of power, psopho metrically weighted (pWp). (Psophometric is from the Greek word psophos, meaning noise.)

The reference level, 1 pWp, is the equivalent of an 800 Hz tone with a power of -90 dBm, or a 3 kHz band of white noise with a power of approximately -88 dBm. The shape of the psophometric curve is essentially identical to the F1A curve and similar to the C-message curve. Approximate conversion may be made as follows:

$$dBrnc = 10 \log pWp.$$

Note that these terms all have absolute reference values of 10^{-12} watts, and are customarily written dBrncØ and pWpØ to relate the measurement to Ø TLP.

Signal-to-Noise

Occasionally the term signal-to-noise ratio (S/N) is encountered. The term, usually expressed in dB, indicates the number of dB the signal is above the noise. To obtain dBrncØ from S/N, it is only necessary to calculate how many dB the signal is above the reference noise power. The corrected reference (as mentioned previously for 3 kHz white noise) is -88 dBm for flat noise channels. Conversions are therefore:

$$dBrnc\emptyset = 88 - S/N$$
$$S/N = 88 - dBrnc\emptyset$$
$$S/N = 88 - 10 \log pWp\emptyset$$

When it is necessary to measure speech or program volume in a transmission system, a dB meter or voltmeter is not adequate. The complexity of the program signal, as compared to pure sine waves, will cause the meter needle to move erratically, trying to follow every fluctuation in power. This would obviously be difficult to read, and has no worthwhile meaning.

Volume Units

To provide a standardized system of indicating volume, a special instrument was created. Called a VU meter, it measures *volume units*, abbreviated VU. The VU meter is calibrated to read Ø across a 600Ω line with a signal of 1 mW (Ø dB) at 1 kHz. The scale is logarithmic and reads VU above and below this zero reference. The instrument is not frequency weighted in any way, and while not designated for the purpose, it will read single frequencies directly in dBm. Its prime function, however, is to indicate the volume of complex signals in a way corresponding to the response of the ear. The reading is not instantaneous, but a value somewhere between the average and the peak value of the complex wave due to the meter's damping characteristic.

Other units

Various other logarithmic units are used in the telephone and communications industries to conveniently compare like values. Crosstalk coupling in telephone circuits is indicated in dBx, or dB above reference coupling, and may be measured with a noise measuring set such as used to obtain dBrnc. Reference coupling is defined as the difference between 90 dB loss and the actual coupling. Two circuits having a coupling of -40 dB could be said to have a coupling of 50 dBx.

Decibels may take on many other absolute values depending on their reference. Whereas dBm is a unit of power referenced to 1 mW, dBW (referenced to 1W) is equal to 30 dBm. Similarly, dBk are decibles referenced to 1 kW.

Likewise, dBV for industrial use is defined referencing 1V. However, in writing the equation for such a measurement, it is necessary to observe the following relationship:

$$\text{dBV} = 20 \log \frac{E_1}{E_2}$$

where E_2 equals 1V. The log of the voltage ratios is multiplied by 20, rather than 10 as in the power ratios, expressing the squared relationship of voltage and power ($P = E^2/R$). It is assumed that all measurements are across the same impedance.

Another form of decibel unit related to voltage is referred to as dBV/600 and is read directly from a dBm-voltmeter calibrated at an impedance of 600Ω.

Speech energy is commonly rated in terms of the intensity level of the speaker's voice measured 1 meter from his mouth. The standard Reference Acoustical Power, Ø dBrap, is defined as 10^{-16} watts/cm^2.

Other terms come into use in broadcasting: dBμ, with 1 mV (10^{-6} volts) as the reference, and dBj, referred to 1000 mV (1(10^{-3} volts). Both are measurements of signal intensity or receiver sensitivity. Any number of logarithmic units could be devised to suit special purposes, using decibels referred to some standard unit of power – voltage or current.

As the need for different calibrations and reference points arise, new yardsticks will be defined for ease of calculation.

Absolute Quantity

The yardstick adopted by the communications industry to measure absolute quantities is really a meterstick divided into centimeters instead of inches. The metric scale is part of the SI (international standards) units used to simplify and clarify numerical communication between countires.

The basic SI units and their abbreviations are shown in Table II. The prefixes shown in Table III are added to these basic units to indicate the magnitude.

Since some English units are still prevalent and at times more familiar, conversion factors are offered to ease the transition to SI units. Table IV gives conversion factors for the two systems.

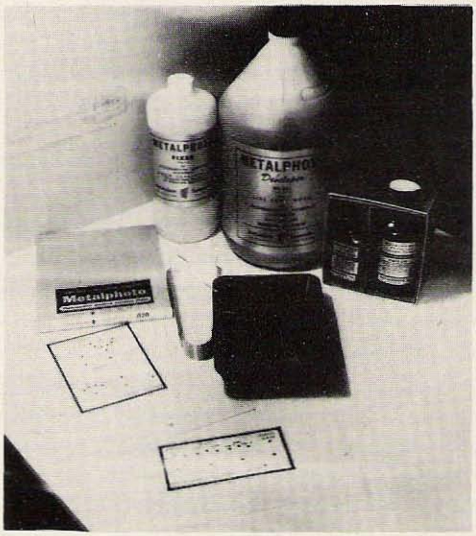
The equipment needed to provide worldwide communication is available and by adopting SI units the needed language is also provided.

Metalphoto Your Nameplate

Ed Marriner W6BLZ
528 Colima St.
La Jolla, CA

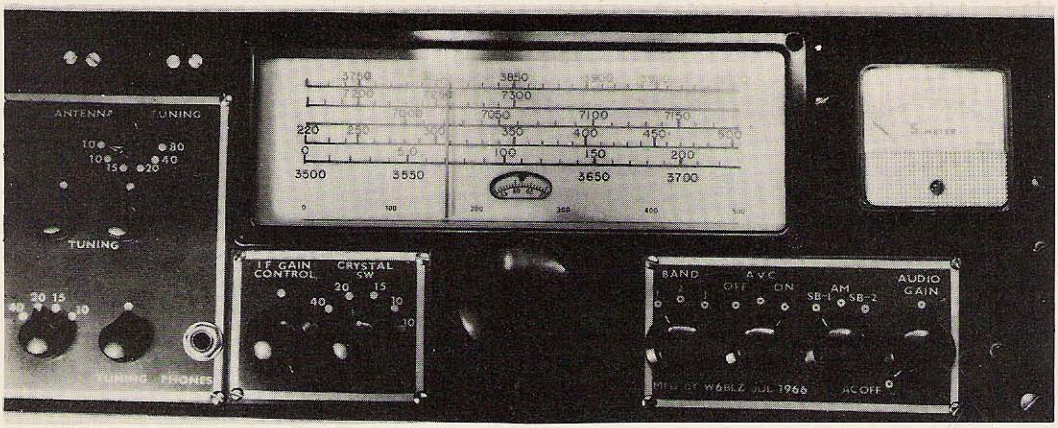
Thirty years ago you could walk into any radio parts store and buy little metal nameplates for marking home-made gear. This is no longer true. The plates have been off the market for years. Amateurs building equipment now have the choice of using decals or wax press-on letters, neither of which are very satisfactory for professional looking equipment. There is another way to label equipment, and that is by making Metalphoto nameplates. Amateurs seeing the nice results would like to make their plates but become frustrated when trying to purchase the material after hearing the store clerk quote the price. More amateurs should know about the metalphoto *trial kit* offerred by Metalphoto Corp., 18531 South Miles Road, Cleveland, Ohio 44128 which sells for $10.

What is metalphoto and what can you do with it? First, metalphoto plates are photosensitive anodized aluminum plates which can be converted into a nameplate, a dial or a schematic. To make the plate, a simple negative and standard photographic chemicals and techniques are used, and it will produce a permanent photographic reproduction. The image will be locked in a clear, glass-like, sapphire-hard, anodized layer when finished. Because of this layer, nameplates made from Metalphoto will withstand corrosive and abrasive attacks which would deface or destroy most other similar products. The whole process can be done with a few essential pieces of darkroom equipment. Actually all that is necessary is a floodlamp type P2 if a contact printer box is not available. The negative made from tracing paper is placed on top of the sensitive metal film, exposed and developed.



A negative can be very simply made on tracing paper which has been lettered with black ink, or wax art letters pressed on to the paper. Borders can be made from black printed circuit tape. This type of negative will make a nameplate having aluminum letters with a black background. For black letters on an aluminum background, a Kodalith film negative will have to be made from the tracing paper negative.

This process may seem like a lot of work, but it is fun, and how else can you obtain a decent panel? Wax letters and decals eventualy wear off, while Metalphoto will last



forever and is impervious to salt spray, organic solvents and lubricants, scratching, cracking, crazing and peeling, fading, mold, temperature extremes and repeated scourings. Are you sold? Let's get on with it.

Here is what you get in a No. 10 trial kit:

12 4 x 5 inch sensitized metal plates.
3 1 x 5 inch test plates.
1 Bottle of Chemical Image Toner (1 qt.) CT-100
1 Bottle of Developer. DM-44 (1 qt.)
1 Bottle of Fixer. FM-1 (1 qt.)

The distilled water necessary for mixing can be obtained in a grocery store.

How do you start?

First make a negative, and the best way is to draw it on K&E Transparent Sketching Pad Paper #355-11. Draw in pencil, a square the size of the nameplate. Inside this line, stick some 1/16 or 1/8 inch black tape for a border. This tape can be obtained in a radio parts store under the name ACS Tapes, Inc., and it comes in a little plastic container. At the same time buy some little black round pieces of tape used for making printed circuits. These are nice for making round corners on the borders and for making dial calibrations. Once the border is outlined, start laying in the lettering. The best way is to use wax press-on art letters which come in all shapes and sizes at any artist supply paint store. A LeRoy inking set could be used.

Once having decided on which negative to use, the next stop in the process is to lay the negative on top of the sensitized metal, and place a piece of glass over it to hold it in place. *Do this in a dark room with only a red lamp,* or the film will be exposed and ruined. When you are ready to expose the film, hold a flood lamp about 2 feet away and snap it on and off, fast as possible, for less than one second. Now place the metal film in the DM-44-4 developer for a period of 3 to 6 minutes. After a few minutes the printing should come out clear. If the plate has been over exposed the border will be sharp but the letters will be faded and dull. Very little light is necessary to expose. Remove the film from the developer and wash in clean water for one minute. The film now has to be fixed and is now placed in the FM-1-4 fixer for several minutes, taken out and washed for five minutes. Now place the metal film in the CT-100 toner solution for five minutes. After this operation the film is washed again and placed in a pan on the stove and boiled for at least five minutes to set the surface. A special solution called SA-200 can be used to give it a more glossy finished surface, but this solution does not come with the kit. After boiling, wash and dry, then polish the plate with furniture polish to give it a high gloss finish. Aluminum or chrome polish can also be used to shine the plates.

Further information and complete instructions come with each kit, and a special processing book can be obtained from the factory.

If you are building a nice piece of ham gear, it is worth the effort to make a little more investment and have it look professional by using Metalphoto nameplates.

. . . W6BLZ

Ronald Perry WA2CGA
RD 1, Glen Avenue
Fishkill, NY 12524

Amateur Radio and the Disabled

The typical amateur radio magazine contains article after article devoted to the care and feeding of the amateur operator and his hobby. Almost any able-bodied ham armed with a soldering iron, supplied by a junk box, fortified with the spirit of a true adventurer and guided by a well written article can homebrew at least something of usefulness.

But what of the physically disabled ham who cannot hold a pair of pliers, see the intricate workings of a circuit diagram or construct a beam, a boom, or a balun? To him, some of the pleasures of amateur radio are unachievable. Luckily, however, there are still many avenues open to the disabled who wish to take an active interest in amateur radio. For such people this article is mainly written.

In August of 1960, due to a freak diving accident, I became physically disabled. Medically my condition is known as "quadriplegia." In lay terms this is a semi- to complete paralysis of the arms and legs, brought about by severe injury to the spinal cord.

After a year of hospitalization and rehabilitation, I returned home. I completed my senior year of high school, graduated, and began college extension courses. Today, I get around in a battery-powered wheelchair and live a near-normal, though handicapped, life.

The amateur radio "bug" struck on Christmas of 1966. Interest in the local fire company instigated the purchase of an FM receiver. Listening to all of the activity quickly led to investigations into the world of CB. Needless to say, my hopes were soon utterly smashed. Being down, but not out, I then contacted WA2IZO and within the length of a telephone call, I was hooked.

In February of 1967 I purchased my first ham receiver and begun studying theory and code. Three months later I took my Novice tests, WA2IZO proctoring, and received my license in August. Six months and 31 states later, I received my Conditional Class license; K2TFD was the helper this time. And on April 5th, as WA2CGA running 100 watts cw, I made my first contact in New Zealand with a 5-9-9 signal report.

Since my beginnings in amateur radio, I have had much enjoyment, a great deal of satisfaction and a few problems. Most of the difficulties were easily solved, though some took a bit of ingenuity. For instance, how do you operate a bandswitch or flip an on/off control when you lack both feeling and movement of your fingers.

All controls "pegged" for ease of operation. Distance between knobs is a factor when choosing equipment which has to be "pegged."

To solve this dilemma, my dad "pegged" all inoperable controls and switches with lengths of metal knitting needles. My main tuning dial looks like an old ship's wheel, but by using the side of my hand, I can operate it "normally."

Another problem arose when it was necessary to change the crystals in the Novice rig. This was easily solved, however, by simply yelling "Mother!" whenever a new rock was needed.

Operation of the straight-key presented its little headaches, but none that ever required an aspirin. At first I literally pounded the key with my semi-closed hand. The old saw, "you have a good fist," was never more true. For General Class speed, however, this method soon proved unsatisfactory. I tried numerous types of paddles and extenders and even thought of trying a mouth-type arrangement, but nothing worked. Eventually I found that with the paddle resting in the palm of my hand, I could achieve a respectable speed. Since I could not grip the paddle, I found it was necessary to move my entire arm up and down in order to compensate or substitute for the usual wrist movements. With this somewhat awkward arrangement, I increased my speed to 14 words a minute, though 10 was more comfortable and less tiring.

Keeping the key stationary while sending presented another little obstacle. I did not want to nail the key down, so I did the next best thing. After some searching we dug up a piece of cold-rolled steel about the size of this magazine, only an inch thicker, and weighing 9 pounds. Three carbide bits later, my dad had the key mounted to the steel block. A touch of Gun-Blu and a felt bottom completed my near-permanent key. I don't recommend this type of arrangement for mobile CW work, however, for even the ablest of hams will find it cumbersome and a real toe-crusher if dropped.

With all of the minor difficulties solved, I finally began realizing many enjoyable contacts. Each new state or DX station worked was a real achievement. Not knowing when to leave well enough alone, I soon became involved in all sorts of things, many of which I knew little or nothing about.

First, I decided to buy my own Novice transmitter, despite the fact that the one I was borrowing was more than adequate. I figured why run 60 watts when 75 would get you so much further. (Believe it or not, this was a good excuse at the time.) Later, beaming at my new, shiny rig, I soon realized I had made two major goofs. First, the transmitter, which was one of the best CW rigs on the market, had no facilities for phone operations. Thus, in a few months I would have to buy another if I wanted to work in this mode. Second, the transmitter wasn't compatible with my present receiver. Facilities for side-tone monitoring, receiver muting and a new transmit/receive setup would have to be constructed all over again. Obviously another call to WA2IZO was in order.

When I purchased my General Class transmitter, I again had to face the problems of incompatibility between it and my receiver. Luckily, I had acquired a little more knowledge on the subject and a few more ham helpers, so things were a bit easier the second time. I realize all hams have to deal with this aspect of amateur radio. For many it brings much satisfaction when a workable setup is devised. To me, however, it is something I would like to avoid since I cannot do it myself and I am forced to call on others.

A word to other disabled: (1) purchase your transmitter and receiver, if at all possible, from the same manufacturer, and (2) be sure that your rig operates either AM&CW or SSB&CW. By doing so, you will then have fewer hook-up problems and you will have secondary equipment when you buy your general class equipment.

All amateur radio operators, at one time or another, regardless of license, equipment, or code speed, are confronted with the commercial broadcast interference syndrome; affectionately known as "TVI." In fact, no amateur is really an amateur until he has been officially baptized by his first irate telephone call and has encouraged the sale of a high-pass filter. Moreover, hams should be entitled, in my opinion, to commissions for their part in the sale of such filters and receive a percentage of the customer installment fees on local CATV systems.

Since my disability is fairly well known in the neighborhood, some of my TVI pains were/are somewhat different than the usual.

In one instance, where I was actually at fault, certain neighbors remained silent when they should have spoken up. I suppose they assumed I had few activities and thus didn't want to limit my new-found hobby. My ground system had deteriorated to a point where 15-meter harmonics were affecting certain TV receivers up to 300 yards away from my antenna.

In other instançes, however, when I was not at fault, the usual calls and inquiries were registered in the usual calm and diplomatic manner associated with the avid TV fan who is positive some ham is personally interfering with his reception. It seems that the mere physical presence of the tower and quad antenna, regardless of whether I was on the air or not, or even home, instigated many of the complaints; operating times in the log and cold tubes notwithstanding.

To the disabled, then, let me again state a few things: (1) see that all equipment is well grounded and filtered, and(2) be sure, above all else, that you are not interfering with your own television reception before operating on the air. Once this is done, you can be quite certain that you are not bothering the thoughtful neighbors and ηot giving "ammunition" to those who do not understand the numerous caused of non-ham-made interference. Your disability should never be an excuse for a bad signal or for improper operating procedures.

WA2CGA's complete station. All equipment easily reached without moving around. Homebrew table allows access by wheelchair.

Finally, I cannot end this article without fully endorsing amateur radio as an excellent hobby for the physically disabled. Nor can I begin to thank the many hams–WA2IZO, K2TFD, and W2VAQ to name a few, who have helped out so many times, or my dad for all his hours spent on the roof, in the shack, or at the neighbors.

I hope more physically handicapped individuals will become amateur radio devotees and that the hams who live near them will be as conscientious as those I have mentioned. To quote the FCC: "No physical infirmity is a bar to the issuance of amateur operator and station licenses, provided the applicant can qualify." And, as of June 17, 1968, the Federal Communications Commission will allow the examinations for *any* class of license to be taken by mail.

....WA2CGA

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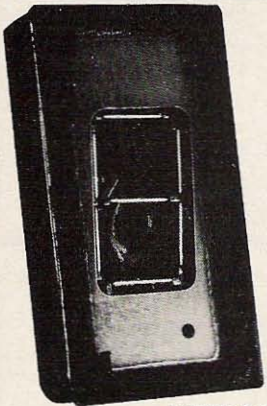

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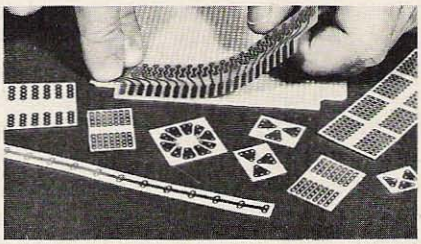

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Solid State Microwaves for Amateurs

Crystal controlled exciter-transmitter for the amateur S-Band, 2300 to 2450 MHz.

Since writing in 73 Magazine on "UHF Transistor Circuitry" in 1964–1965, a lot of water has gone under the bridge. That was not long ago by some measurements, but in solid-state technology it has made quite a difference. Transistors now oscillate at over 5000 MHz (yes, five thousand!). Good S-Band communication sets using crystal-controlled transmitters (this article describes one) and receivers are now feasible. Transistors whose collector circuits resonate and give power out at S-Band can be built on the kitchen table. Good tuneable local oscillator circuits at 4000 MHz are simple. Piezoelectric voltage controlled capacitors for remote tuning will work up to and including X-Band, and frequency multipliers using strapline made with nothing more than copper straps you can cut yourself will work well up into the ham S-Band.

So, you get some idea of the rate of progress. Now for hams, what does it mean? At the moment, let's concentrate on the 2300 to 2450 MHz ham band, leaving 1296 MHz far in the wake.

2300 MHZ

This is one of our bands so let's see what can be done with transistors on it today. Reasonable cost transistors work there. You can build this one with copper straps and nylon bolts; you can modulate it with good old Admirable Modulation; a superhet receiver is easy to make, and even little yagis work there, although this is the band where a 36 in. dish has over 20 dB gain. Dishes of almost any kind, have gain of 20 dB or more, so you only need a two footer for 2300 MHz.

You might as well use crystal control from the start, because it's the last doubler that costs the most and is the hardest to build, whereas the first stages are the easiest. It also can give you nice checks on the band edges!

My philosophy has always been for power doublers because, if you do it right you don't lose power as you double in frequency, and you can even gain power. And when you get where you want, like 2300 MHz in this case, you can modulate the doubler right away with a little $10 Lafayette amplifier. Of course nothing stops you from adding an rf amplifier and modulating that too.

Also included in this trend is the use of grounded emitter multiplier-amplifier circuits. If you ground (rf-wise, that is) the base you are setting up the correct base-collector out-of-phase condition for an oscillator! And most of the time that's just what will happen! In a multi-transistor rig there is always plenty of chance for spurious, so don't invite them in!

A list of tools required may be of interest. Scissors; small metal shears; Exacto knife; a goodly collection of small precision side-cutters, pliers, needle-nosed, thin flats, etc.; two soldering irons, one small; good set of drills and taps; bench vise; drill vise; quarter inch drill; and such meters as you may have.

48 to 50 MHz Oscillator Stage

There should be no trouble here, as plenty have been described in 73 Magazine, and we're going into real detail for a sure fire solid-state exciter, useful all the way from 50 through 144, 432 MHz, and all the way up to S-Band. Just use my patent phase-reversing circuit (the crystal does just that for you) and you can't go wrong! For the oscillator see Fig. 1A, and for test

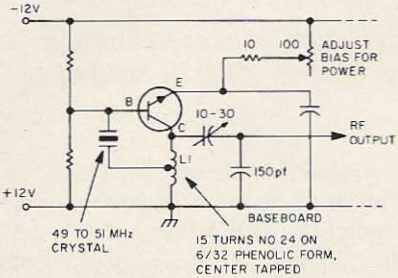


Fig. 1A. Oscillator, 50 MHz.

setup, Fig. 1B. A good trick for driving the next stage doubling circuit or amplifier is the two-capacitor impedance match to the next base input, using the smaller capacitor for tuning.

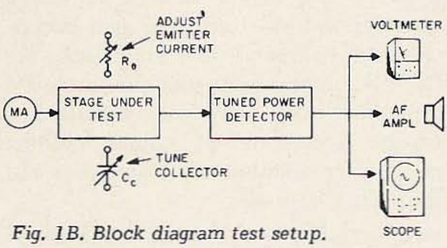


Fig. 1B. Block diagram test setup.

It tunes well, lowers the impedance to the best value, and gives dc isolation for the next base (see Fig. 2). What more could you want?

As you go up in frequency through the following stages the capacitors get smaller and smaller, but can still be managed for the three hundred MHz stage. After that you can still use capacitor tuning, but you have to make them yourself. Don't worry about them, just get in a supply of nylon nuts and bolts and away you go!

While still on the oscillator stage you might be encouraged and helped by knowing that even though my radio work goes back to 1921 and Ford coils, with my first transistor on the air in 1953, I get stuck every once in a while.

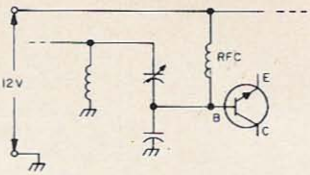


Fig. 2. Output impedance adjuster.

In my past writing, it sometimes happened (many years ago), that when a standard circuit was included in an article I felt it was quicker to *assume* it would work than to try it out. I was sticking my neck out and skating on thin ice. After getting caught this way several times I stopped assuming and now I always sit down at the bench and give it a whirl first before writing about it. Just look what happened even today! Figure 3A shows the 50 MHz oscillator stage being described. It just wouldn't work, even though I was surrounded by three older ones that did. So what to do? Just write up one of the older ones? That's sticking the neck out again. I started thinking about it around 4 am and, at the bench a little later, I disconnected the dc base bias, R1 and R2, and sure enough the emitter current was still heavy. I changed transistors but still had heavy current. When the emitter bypass capacitor was unsoldered, the current vanished.

Checking through the lists of faults (mine) here they are: 1. The use of an electrolytic capacitor for bypassing at VHF. Not needed, unless to save space for microminiaturization. 2. Playing around with both PNPs and NPNs the same day. That's how I got the polarity reversed. Remember the old rule, an NPN takes

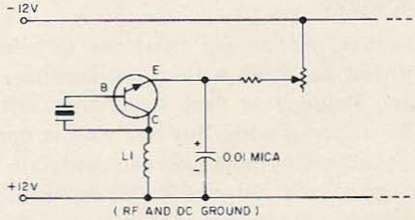


Fig. 3A. How not to do! Don't use an electrolytic capacitor.

positive voltage to attract those negative electrons; the PNP takes negative voltage to attract those positive holes. 3. The use of grounded dc collector. This was the main item, as you can see by Fig. 3A. When you are going up into the microwaves it is handy to have the collector polarity the same as the ground plane board, so that sliding shorts work out without shorting the dc as well as the rf. But this means that the emitter bypass is now *not* across the emitter resistor as usual, but is shunted across the whole battery supply, through R3 and R4. No trouble here if that electrolytic capacitor is connected right. Use molded mica anyway, it's better as you go up through VHF.

Further Oscillator Details

As long as the circuit was laid open on the bench, I checked on the possibilities of a two-terminal oscillator coil, as shown in Fig. 3B, and found that, while it can be made to work, I was better off to use the tapped coil. See Fig. 1 again.

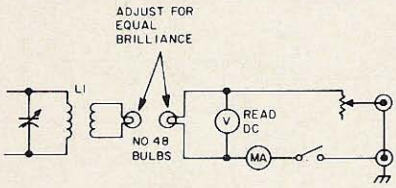


Fig. 3B. "Poor man's milliwattmeter."

Just for fun I put a pot in the battery line to see how low a voltage it would oscillate with, always a good criterion for an oscillator. The minimum was 4.6V at .3 mA, for a grand total of 1.38 mW dc input. It's a good one!

It also handles beautifully with 12V, and at 18V and 30 mA, which is over half a watt input, it puts out at least 36 mW as measured on the poor man's milliwattmeter of Fig. 3B. Running 0.8V at 45 mils dc to the number 48 bulb it shows equal brilliance. This suits me fine, because any time I've ever lit a bulb with rf, I've been able to work someone on the band. Actually of course, we don't need all of that 36 mW to drive the tripler stage coming next, but it's nice to have a little to spare. The above was using a KMC 3N2502 which is a higher frequency transistor than needed for 50 MHz. Most any good UHF device will do the trick at that frequency.

The next thing I tried was several different kinds of coils for L1 because not every ham shack has the same kind of junkbox. I always start with the air-wound half-inch units because they are more or less standard for six meters. Seven turns of 16 to the inch was the coil used for the above tests. Next tried was a coil wound with #24 wire on a 6/32 threaded phenolic core,. Another bug showed up, as the attempted two-terminal coil showed trouble at this time. If the crystal terminal designated with an arrow, as shown in Fig. 3B, is soldered directly to the collector terminal, forget it! Quick like a bunny a coil with centertap was wound up, 15 turns of #24 wire on thin-wall phenolic again, a core turned in, and bang, all kinds of good, stable power returned, with perfect handling. Of course it helps to have all these little pieces in the junkbox. The accumulation of such items should be the continuous effort of all real hams. The final circuit is in Fig. 1. Before going on to 150 MHz you might note that with a 48 MHz rock and this oscillator and the following tripler, you have a nice two meter band edge spotter. And with a slightly higher one you can talk to your two meter friends.

Tripler Stage To 150 MHz

If you have to order a crystal, you could get one on 75 MHz and double to 150 instead of tripling. Lots of hams have 50 MHz rocks around, which is why I used one. A little over won't hurt because the ham S-Band goes up to 2450 MHz, in fact, you can start a little lower if you want because a 48 MHz unit comes out on 2304 MHz with the 48 multiplication used in this exciter. 2304 MHz is a little close to the lower band edge, but no trouble should arise. There are a lot of two meter band spotting crystals around at 48 MHz and some of these low-priced microwave transistors work better at 2300 MHz than they do at 2400 MHz.

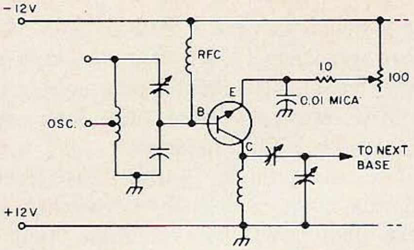


Fig. 4A. Tripler, 50–150 MHz.

Figure 4A shows the details of the tripler. Please note the simplicity. I claim it has everything you need and nothing you don't need. Anyway, it works like a charm and you should go through it and the next one like a breeze, using the test setup shown in Fig. 1B.

Avoid using too much drive. These little transistors, when used in exciters, have a nasty habit quite unlike tubes of snapping into spurious modes of operation when slightly overdriven. You can hear this while listening to the output (always a good thing anyway on general principles) or you can monitor it on a scope. It has some resemblance to superregeneration or squegging, and is *not* wanted!

Watch out also for resonance at other frequencies than 150 MHz. I always check with a tuned detector, Fig. 4B, which acts like a grid-dipper operated in the diode mode. Granted, you have to calibrate the detector first, but you must know *someone* with a signal generator. Use a coil for L1 up to around 300 MHz, and a copper strap from 300 to 1000 MHz. After that a good prayer sometimes helps!

Using the detector of Fig. 4, I found that when the dc output gets up around 5V or so, it is possible to light a No. 48 bulb if it is coupled correctly to L1 of the multiplier. This coupling must be such as not to overload the tank. Vary it to find the right amount. This stage did light the bulb, using 18V on the collector, after which I dropped it back again to 12V, which I try to standardize as being suitable for a car battery, as well as two lantern batteries.

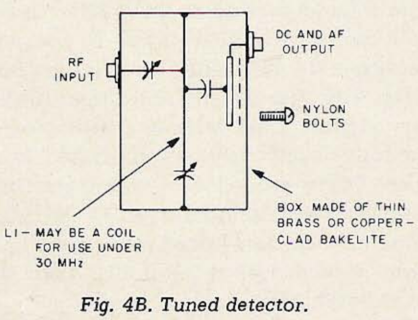


Fig. 4B. Tuned detector.

Once again, be sure that everything handles smoothly. The emitter resistor should increase the output power, but only up to the correct amount of bias for the frequency multiplication used. L1 and C1 should tune properly, and the output impedance point between C1 and C2 should match the next stage base input.

Tripler, 150 to 300 MHz

This is practically a repetition of the first multiplier. You can still use a regular coil and capacitor and get good output on 300 MHz, but you have to pay more attention to everything you use and how you do it. Figure 5 shows the details. You can use

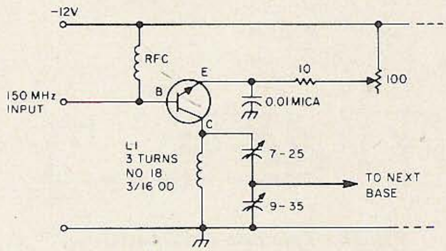


Fig. 5. Doubler, 150–300 MHz.

any good UHF transistor, like a 918, 2N3600, etc., or the UHF TV plastic jobs can be had for 39¢. Of course use a wavemeter or grid-dipper of what have you, to be sure you're on 300 MHz. Also, a tuned power detector will help find the frequency for multiplying (A). A simplified schematic is shown in Fig. 4B. A one turn link around the collector coil L1 coupled by an rf cable over to another one-turn link around the grid-dipper coil will do the trick. Once again, the midpoint of capacitor C1 and the larger capacitor C2 should be matched to the next doubler stage base input, and what better method than to use the next stage as an rf voltmeter? As the next base has no dc bias on it except that which is generated internally under the rf action of the preceding stage, the collector current will be zero until rf arrives on the base. This base drive will cause collector current to show, indicating the desired amount of input needed.

This stage can now be tuned up using the next one as an indicator of collector resonance. Don't forget that most any type of transistor can burn out the base-emitter diode of its brother type following! Figure 5 shows details. I tried a number of collector inductors just to see and there is not much difference in the results when everything is matched and running right. Just be sure and check that frequency for 300 mHz! I hit the tripling spot of 450 MHz several times while tuning up and testing various resonators. The rf chokes are not too critical – I use 30 turns of fine wire, like numbers 34 to 38, double silk covered, wound up in two sections on a small form or a tenth watt resistor of around 1 MΩ. C1 and C2 for this stage are as small as you can get in size, but are not too critical. Do *not* use lead wires at all! Use the setup shown in Fig. 1B, and use an af amplifier on the detector to listen for lf oscillations, spurious radiation, superregeneration, squeals, and other various nuisances. A scope is good too, as it will show oscillations above audible frequencies.

Doubler, 300 to 600 MHz

Cheer up, only three more to go! Really worthwhile things are not built in a day. On this one, for 600 MHz, you can go to a small cavity just for practice even if it's a square one (actually oblong). You could

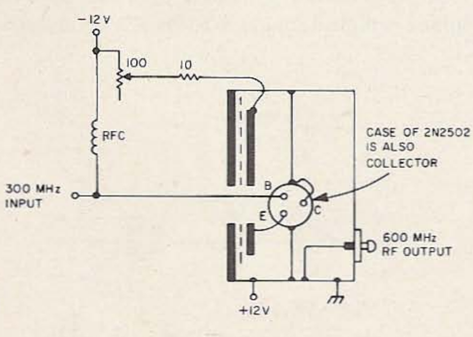


Fig. 6A. Doubler, 300–600 MHz.

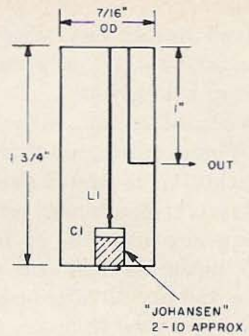


Fig. 6B. Box-cavity dimensions.

use the strapline techniques of the next two multipliers, but it doesn't hurt to try different styles once in a while. By using good UHF principles, this stage worked beautifully the first time and hit 600 MHz with good stable output. Note that you've gone right by 432 MHz which you can whip up with one hand after doing this S-Bander.

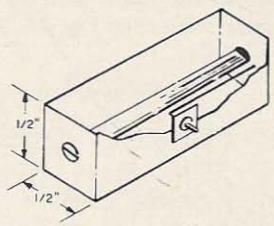


Fig. 6C. Sketch, 600 MHz cavity.

Figure 6A shows the pictorial schematic, Fig. 6B some dimensions, and Fig. 4C shows a sketch of the cavity without Ce, the emitter capacitor. Ce is formed by a thin brass strap or plate, 1¼ in. long by 7/16 in. wide, bolted to the inside of the cavity with nylon bolts and a three mil piece of fiberglass or mica sheet in between.

Cut a hole for the base lead of Q1 in both the cavity wall and the Ce plate before bolting. The emitter dc lead can be taken out of the cavity through a small hole in its wall. Re is the usual 100Ω pot with a 10Ω limiting resistor added on. I always start with a variable emitter resistor and then, when the whole rig is adjusted for good power, tuning, and proper handling, the variable pot can be removed and a fixed value substituted. The proper value for the fixed Re can vary somewhat as to the device used for Q1, and various other parameters of the circuit.

Once again of course, watch those frequencies. You're getting up there now and it's easy to hit the unwanted ones. Another thing I haven't mentioned yet is that a lower frequency like 50, or maybe 150 MHz, will sneak through and you'll find yourself on 450 or 500 MHz instead of 600 MHz, where you want to be.

Doubler, 600 to 1200 MHz

Can an ideal circuit for solid-state, easy ham construction of multipliers and amplifiers to S-Band be made? Let's try it and see. Maybe it can be done with stripline.

Good news for you! It works very well, tunes fine, even to the tripling frequency of 1800 MHz! The input, output, and transistor impedance can be matched and there are three variable capacitors to do it with, all built-in and homemade of spring-brass or copper strap. See Fig. 7A. You do

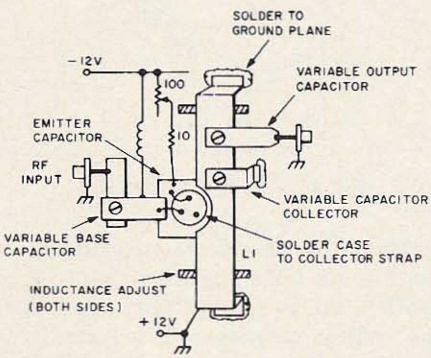


Fig. 7A. Strapline doubler, 600–1200 MHz.

have to use nylon bolts, but after all, this is 1200 MHz, the beginning of microwaves. You need some spring copper also (I think it's beryllium copper I'm using).

See also the regular schematic, Fig. 7B, which does show the circuit but not the shape, which is of course always important from UHF on up. So alright, let's get into the meat of it.

Having made straps over ground planes work at 4000 MHz and even at X-Band on occasion, I figured I could do it with the strap-type of construction, at least as long

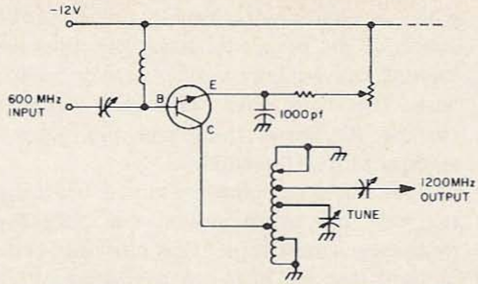


Fig. 7B. "Regular" schematic, 600–1200 MHz doubler.

as my supply of nylon nuts and bolts held out. If you order some you probably should get some fours and twos, as the number sixes I'm using are rather large for the little capacitors being made.

Stripline, as practiced commercially, uses thin copper plating over an insulating sheet over a ground plane. This is hard to cut up properly on the bench, difficult to make into tuned lines, and does not lend itself to variable inductance circuits or variable capacitor construction. The method described here avoids all these difficulties. We start with the ground plane, copper clad Bakelite or surplus copper clad fiberglass as I happen to have here, but we are not going to cut it, etch it, or do anything except solder to it, which is extremely easy.

The base input variable capacitor should be made because you cannot buy them, except very expensive ones which are not as handy or as good as you can make.

Referring to Fig. 7C, a copper strap 1 in. long x 3/8 in. wide is soldered to the input connector and bolted to the ground plane with a nylon bolt and two nylon nuts, one between used as a spacer, and one underneath to fasten it to the ground plane which happened to be 4½ in. square.

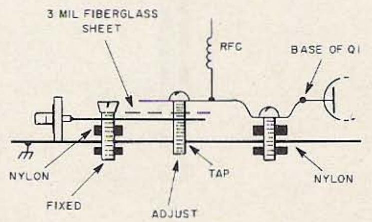


Fig. 7C. Variable capacitor, base input.

The second strap is of spring copper sheet 1¼ in. long x 3/8 in. wide, not critical, and one end is bolted (always with nylon bolts) away from the ground plane and the other end with three mil fiberglass or mica in between goes over the top of the first piece, and a nylon bolt tapped into the ground plane serves to change the capacity by varying the distance between the two straps. This distance varies from three mils to about 1/16 in. For convenience the ground plane is held up off the bench by four 3/8 in. long 6/32 bolts, one in each corner, which provides space underneath for the protruding nuts and bolts of nylon.

Note that the above mentioned capacitor also forms the strapline connection between the input connector and the base of Q1. That it works fine is proved by the milliamperes in the collector of Q1, which go easily to 20 or over, from the 600 MHz doubler driving it. There is no assumption here of a perfect match, which could involve a lot of more expensive equipment. It is only a question of "does it work?", and it does!

The emitter capacitor is also homemade for the same reason; you can't buy one! It is just a thin brass plate, perhaps .022 in. thick, ½ x ¾ in., and nylon bolted to the ground plane with a three mil insulating sheet between. Smooth and polish both metal surfaces to avoid puncturing that thin sheet.

Q1 is soldered, wires down, to the base input strap which also forms the input connector, and also to the emitter capacitor. These leads should be no more than 1/8 in. long, preferably less. The collector is soldered to the collector strap itself, using a small iron and the least amount of heat possible.

The main item comes next which is of course the half-wave collector circuit. It is made of brass strap 4 in. long by ½ in. wide, bent down and soldered to the ground plane at each end, air-spaced about 3/16 in. from the ground plane. Figure 7D shows a side view of this item.

The sliding shorts are simply pieces of thin spring copper bent as shown in Fig. 7D. They work surprisingly well, considering their simplicity of construction. They

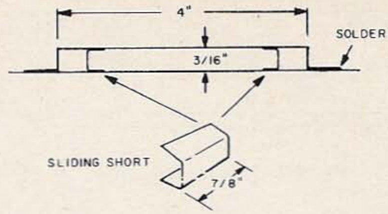


Fig. 7D. Half-wave collector resonator, side-view.

serve to set up the approximate frequency, which is then tuned precisely with C2. I was able to move them along to tune up even to the tripling frequency of 1800 MHz (not used in this stage) with about 1¼ in. between shorts.

Figure 7E shows the rf voltage distribution along the collector inductance L1. This can be checked by an rf probe, or even by the old reliable pencil test, which should show maximum detuning at the center when touched with a lead pencil tip,

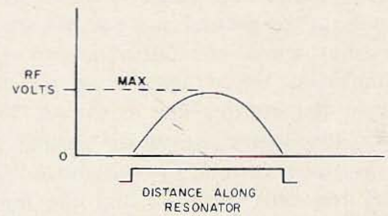


Fig. 7E. PF voltage distribution along half-wave collector circuit.

while watching an rf indicator at the output. It is important that the voltage standing on the strap should be as shown, otherwise you may not be on the proper frequency at all. Note that this is essentially two quarter waves front to front.

Capacity tuning is accomplished by sliding shorts as in Fig. 7F. You will find it very convenient to sit back, after lining up the inductive tuning, and peak up the output with a turn or so of that nylon bolt.

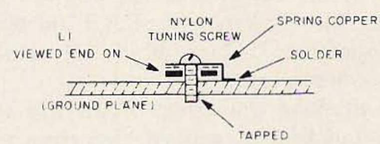


Fig. 7F. L1 collector resonator tuning capacitor.

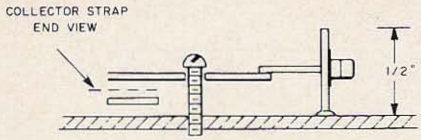


Fig. 7G. Output connection.

The output connector and cable matching capacitor is another spring tab, 3/8 in. wide by 3/4 in. long, soldered to the output connector and adjusted by a nylon bolt, cleared through the tab and tapped into the ground plane with a three mil sheet of fiberglass between as usual.

Tuneup

Applying the 600 MHz input to the base, and 12V on the collector, as per Figs. 7A and 7B, a rise in current from near or at zero should be observed. I usually put the milliammeter in the emitter lead between the emitter and the −12V. If you were to attempt to lift the collector inductance return from the ground and put the meter there you would of course destroy the continuity of the rf circuit, so put the meter in the emitter line as shown. This line is conveniently already off ground. As soon as some current shows, adjust it to around ten mils with Re and the input capacity to the base, and check the collector tuning for resonance at 1200 MHz. The wavelength of 1200 MHz is close to 25 centimeters, the half wave about 12½, which makes it about 5 inches. The inherent resistance of the half wave circuit to loading effects is shown by the use of a 4 in. long strap, even though the collector-emitter diode portion of the transistor is directly across the high voltage part of L1.

Checking the final length between shorts, after tuneup, I find it is exactly 3 in., showing the use of C1 tuning L1 to resonance. A good circuit should always include some capicitance for best Q. Resonance was indicated by rf at 1200 MHz on a detector circuit as in the block diagram, test setup.

By thinking this strap circuit through before building, it worked well from the start, even tuning to 1800 MHz. No changes were needed during tuneup, which is an exception to my usual work.

I still use the RCA type phono jacks for the meter circuits, with a simple shorted plug closing it when the meter moves on to the next stage.

Always use a certain amount of Re (emitter resistor) in the circuit as a frequency multiplier requires bias in order to operate correctly. While I have shown this stage as a complete circuit in itself, it can be built onto one board along with the other stages. A word of caution: certain interreactions *can* occur when everything is on one board. For the moment we will just mount everything on a set of small shelves and try it out. We still have one more multiplier to go, which is a duplicate of this one, just smaller and shorter, for 2400 MHz.

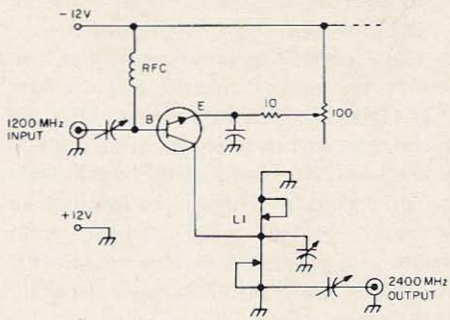


Fig. 8A. Schematic. Doubler, 1200–2400 MHz.

The 1200 to 1400 MHz Doubler

It also works with strap-line. Figure 8A shows the schematic which again is almost identical with the last doubler. Figure 8B is a top view pictorial showing the scaling down used in size from the 1200 MHz unit. Smaller nylon bolts and nuts would help

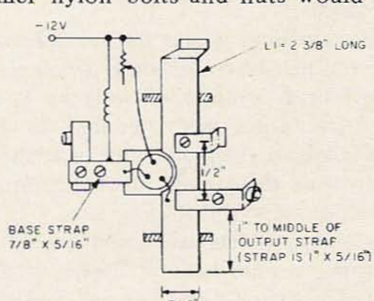
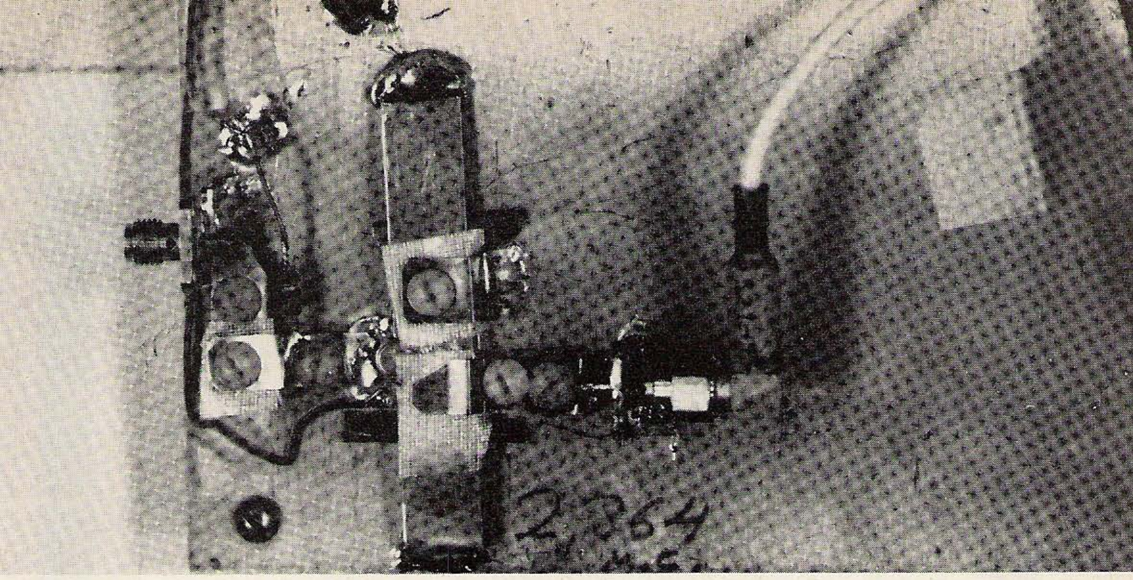


Fig. 8B. Top view. 2400 MHz.



Detail of 2364 MHz doubler.

here also as the 6/32's I'm using are pretty big for the straps used at 2400 MHz.

For this last doubler I also mounted the half-wave collector resonator closer to the ground plane, which made things such as the addition of the transistor a little more difficult, but not too. It worked out as shown in Fig. 8C. So on I went, clipping, polishing and drilling copper straps, some of the spring type for the three capacitors,

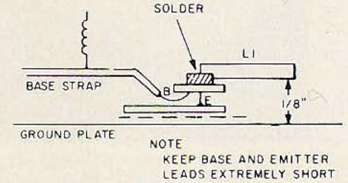


Fig. 8C. Transistor details. 2400 MHz.

tapping the baseboard for the nylon bolts making up the capacitor adjusting screws (see Fig. 8C), and soldering in the 2502, as in Fig. 8B.

Once again, be sure to smooth and polish all capacitor bypass plate surfaces, as well as the three variable ones, input to base, collector tuning, and output coupling.

True to my philosphy of using high gain power doublers as frequency multipliers, this one worked well, showing as much as 20 mA collector current from the base input drive on 1200 MHz, and even showed output at 3600 MHz (not used here) which is the tripling frequency of 1200 MHz.

The half wave resonator gets reduced at 2400 MHz, showing a total of only 1 1/8 in. between shorts. I ran them in pretty close in order to get good tuning with C2, and the resonator responded well, peaking up good and sharp on 2400 MHz.

The 2N2502 is really being pushed at this frequency. Later, an rf power amplifier using a Fairchild MT1116 will be described, with which I have already put out 100 mW at over 3000 MHz.

Incidentally, when one speaks of solid-state power at these frequencies we are talking about tens or a few hundreds of *milliwatts*, not watts.

If you have even half of the fun building this exciter that I did you can call yourself a bona fide dyed-in-the-wool ham. Why anyone would want to sit around and wait for a kit to come out when it is so easy and fun to build, is more than I can answer. All this project takes is a few simple tools and a desk top. Even the test equipment requirements are almost zero. Not bad for putting a real live signal into one of the rarest of amateur bands: 2400 MHz!

When you do duplicate my little project please send a picture of your unit to 73 so your efforts can be used to encourage others. Perhaps we can get the ball rolling again toward homebrewing.

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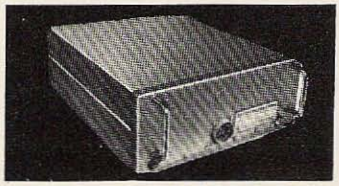

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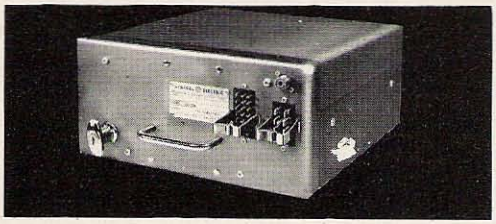

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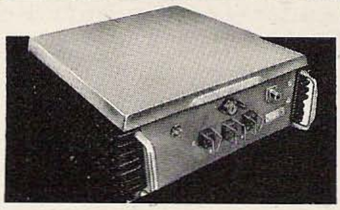

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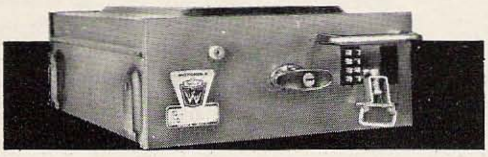

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"What are QSL cards, Daddy?"

"Well, Marc, before you were born I used to be a ham . . . "

"Ha ha, you were a ham, Daddy, you mean like the ham we had for dinner?"

"No, it's a different kind of ham. You see, there once used to be about 300,000 people in the United States who were very much interested in radio, and liked to fill up a whole room in their house with radios and put up tall antennas in their yards, and talk to other people who had radios in their houses and antennas in their yards."

"Could they see each other over the radio?"

"No."

"Then why didn't they just call each other on the picturephone like we do?"

"Well no, son, the picturephone was different then, you couldn't see the other person. Besides, we liked radio and enjoyed talking with people we couldn't see. It was a wonderful hobby. Why, I remember my first contact as a Novice. What a feeling to hear your own call through the static! But that was nothing compared to the time I worked Japan, England, Denmark and Sweden all on the same day."

"I guess you really had a lot of fun, didn't you, Dad?"

"You bet. I don't know where I had more fun, on the six meter net, or burning up the airwaves while driving along at sixty. I must have put out more signal in one day than the Voice of America did in a week!"

"Why did you stop, Dad, if you had so much fun? Your radio is still up in the attic. Can you show me how it works?"

"Well, I wish I could, Marc, but it's illegal now. You wouldn't want me to go to jail, would you?"

"Gee, no, Daddy! How'd it happen? I mean, it wasn't against the law then, was it?"

"No."

"Then why is it now? What happened to all those hams? Didn't they want to keep being able to talk on the radio?"

"Oh, they wanted to keep talking on the air, all right, but nobody did anything to tell the rest of the people how good ham radio was. They thought that everybody knew hams helped in emergencies . . . "

"You mean like rushing medicine to sick people in south America, and helping people in floods, and calling the Red Cross and things like that?"

"Yes, but how did you know that hams did things like that?"

"I saw some old newspaper clippings you had near these cards."

"That's right. Hams did things like that, and a lot more. They let soldiers talk to their families by radio, and they made people from different countries become friends with each other."

"Daddy, was it the government that made you stop being hams?"

"Yes. Well, not exactly *our* government. You see, all the countries met in Geneva, and they all decided that hams weren't

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very useful, and they voted to give away all the ham bands to short wave stations, business radio and a lot of other commercial stations."

"Did our country vote the same way as everybody else?"

"Yes, I'm afraid it did."

"Why didn't all the hams get together and tell everybody all the great things they were doing?"

"Well, they did, son. A lot sent letters to congress, but a few big trucking, oil, and construction companies got together and put ads in all the papers, and had announcements on television saying that they didn't have enough frequencies to carry on their business, and that if they didn't get more frequencies they would have to charge more for shipping, building, and gas. So our government voted against ham radio, like the others."

"Gee, so you had to stop talking on the radio, huh?"

"Yes, but not all at once. One year later they gave 80 meters to the broadcast stations, two years later 40 and 20 were turned over to the short wave stations. What really hurt was when they took my favorite band, 15 meters. The day they closed it up, all I could hear on my favorite frequency, 21.4 mc, was the Voice of China telling the world how peace-loving Red China was.

"Do you think that if hams all over the world had gotten together and put things in the paper and on TV saying all the good things hams were doing, that everybody would have voted to keep ham radio?"

"Yes, I think they would have. A few hams had the idea of hiring public relations men, and of getting a lobby in Washington, but no one did anything about it."

"Gee, that's too bad, Dad. Maybe they could have saved it. I guess it was a lot of fun. Well, good night, Dad."

"Good night, son . . . let me see those cards . . . hmm, I remember that ZL, worked him off the back of the beam too . . . WA1ELA, wife just had their third daughter . . . wonder what 6 sounds like now . . . "

. . .WA1GFJ■

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November 1971

SUN	MON	TUES	WED	THUR	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	3A	3A	7	3A	7	7	14	21	14
ARGENTINA	14	7	7	7	7	7	14A	21	21	21	21	14A
AUSTRALIA	14	7A	7B	7B	7B	7B	7B	14	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	14	21	21	21	21	21
ENGLAND	7	7	7	3A	7	7B	14	21	21	14	7A	7
HAWAII	14	7A	7	7	7[	7	7	7B	14	21	21	21
INDIA	7	7	7B	7B	7B	7B	14	14	7A	7B	7B	7
JAPAN	14	7B	7B	7	7	7	7	7	7B	7B	7B	14
MEXICO	14	7A	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	14	7B	7B	7B	7B	7B	7	7	7	7B	7B	14
PUERTO RICO	7A	7	7	7	7	7	14	21	21	21	14	14
SOUTH AFRICA	7A	7	7	7B	7B	14	21	21A	21A	21A	21	14
U. S. S. R.	7	7	3A	3A	7	7B	14	14	14	7B	7B	7
WEST COAST	14	7A	7	7	7	7	7	14	21	21	21	14A

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	3A	3A	7	3A	7	7A	14	21	21
ARGENTINA	14	7A	7	7	7	7	14	21	21	21	21	21
AUSTRALIA	21	14	7A	7B	7B	7B	7B	7B	14	14	14	21
CANAL ZONE	14	7A	7	7	7	7	7A	14A	21	21	21	21
ENGLAND	7	7	7	3A	7	7	7B	14	21	14	7B	7
HAWAII	21	7A	7A	7	7	7	7	7	14	21	21	21
INDIA	7	7	7B	7B	7B	7B	3B	14	14	7B	7B	7B
JAPAN	14	14	7B	7B	7	7	3A	7	7	7B	7B	14
MEXICO	14	7A	7	7	7	7	7	14	21	14	14	14
PHILIPPINES	14	7A	7B	7B	7B	7	7	7	7	7B	7B	14
PUERTO RICO	14	7	7	7	7	7	7A	21	21A	21	21	21
SOUTH AFRICA	7A	7	7	7	7	7	14	21A	21A	21	21	14
U. S. S. R.	7	7	3A	3A	7	7B	7B	14	14	7B	7B	7

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	7	3A	3A	7	3A	3A	7	14	21	21
ARGENTINA	14	14	7A	7	7	7	7B	14	21	21	21	21
AUSTRALIA	21	21	14	7A	7B	7B	7	7	14	14	14	21
CANAL ZONE	14	14	7	7	7	7	7	14	21	21	21	21
ENGLAND	7B	7	7	3A	7	7B	3B	7B	14	14	7B	7B
HAWAII	21A	21	14	7A	7	7	7	7	14	21	21	21
INDIA	7B	14	7B	3B	3B	7B	3B	3B	7	7	7B	7B
JAPAN	21	14	7A	7B	7	7	7	7	7	7	7B	14A
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14A	7A	7B	7B	7	7	7	7	7B	7B	14
PUERTO RICO	14	7A	7	7	7	7	7	14	21A	21	21	21
SOUTH AFRICA	14B	7	7	7	7B	7B	7B	14	21	21	21	14
U. S. S. R.	7B	7	7[	3A	3A	7B	3B	7B	14	7B	7B	7B
EAST COAST	14	7A	7	7	7	7	7	14	21	21	21	14A

A = Next higher frequency may be useful also.
B = Difficult circuit this period.