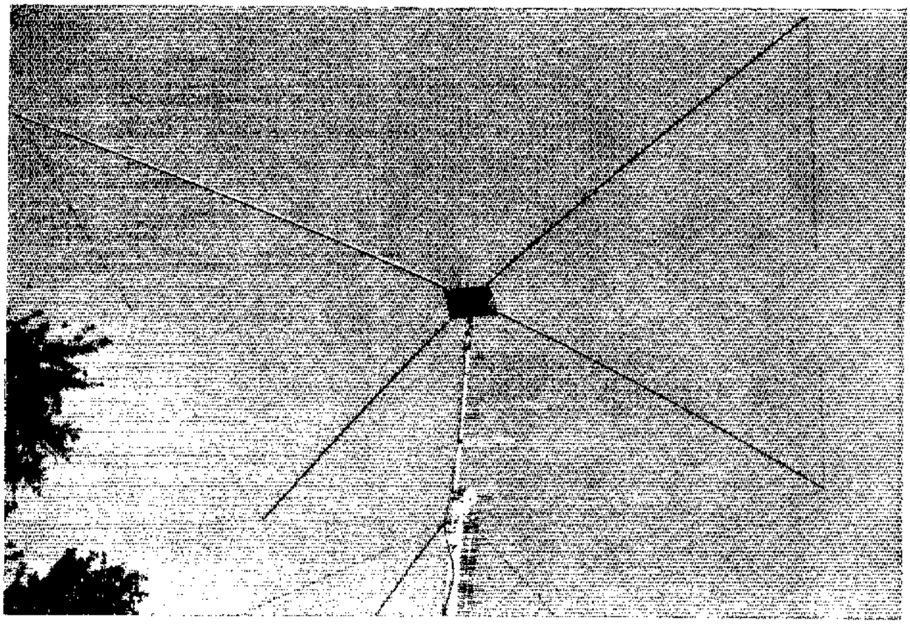
Horizontal X Beams for 15 and 20 Meters



Try this design from "across the pond" and enjoy BIG GUN performance from a small package.

By Brice Anderson,* W9PNE

Are you a serious 10, 15 or 20-meter operator who lacks a beam antenna? How would you like to build a compact, lightweight beam that offers good performance and a low SWR, band edge to band edge? This description fits the horizontal X-beam antenna. I have built "X" beams for 15 and 20 meters, and find their performance impressive!

The X-Beam Antenna

An on-the-air acquaintance, Bob Norwood, W6FWL, built an X antenna and then sent me an article from *Break-In*, journal of the New Zealand Association of Radio Transmitters, by J. F. Harper, ZL2NH, that describes it. The article covers the theory and construction of a compact 2-element beam antenna using aluminum-tubing arms and wire loading "tails." The X beam is derived from a 2-element Yagi design in which the parasitic element is self-resonant and serves as a director. The design apparently originated in England, where G4ZU had built a number of antennas with the "X" format. The concept traveled to Australia and to New Zealand, where VK4RF and ZL2NH built and used it with enthusiasm.

Fig. 1A shows a typical 2-element Yagi antenna. Suppose the centers of each element were pulled inward until the arms were at right angles to each other. This would form an X-beam antenna, which is shown in Fig. 1B.

This X design eliminates the need for a boom, but the overall physical size is not reduced significantly because of the long element lengths. By shortening the elements, the physical size becomes manageable. Resonance is restored by adding wire extensions to the element ends. This is shown in Fig. 1C. The effective spacing between the elements is 0.05 and 0.10 wavelength. For 20 meters, the element arms may be as short as 12 feet.[1] I felt that the antenna might have greater bandwidth, however, if the elements were a bit longer and the wire tails shorter. I used arms 13 ft 9 in. long — a convenient dimension for the tubing I had on hand.

Construction of a 20-Meter X

A trip to the lumber yard netted the necessary aluminum tubing and associated parts. I bought two 8-foot pieces of tubing in the following sizes: 1-inch OD, 7/8-inch OD and 3/4-inch OD. I also purchased 1 foot of 1-inch ID heavy-wall, clear-plastic hose; eight 1-1/4 inch pipe brackets; a 15-inch-square piece of 5/8-inch plywood; a 30-inch length of 2 × 4; a supply of lag screws; and some 1/4-inch stove bolts and nuts. The total cost was less than $30.

The ZL2NH design called for short pieces of angle iron, welded in the form of an X, with a stub mast welded on, to serve as the hub of the beam. Plywood is used as a hub in my design, with two 15-inch lengths of 2 × 4 wood bolted to the underside, spaced 2 inches apart. I used lag screws to fasten a 2-1/2 foot mast of 2- × 2-inch wood to the 2 × 4s. Fig. 2A shows the hub assembly. This arrangement gives me the option of vertical or horizontal polarization.

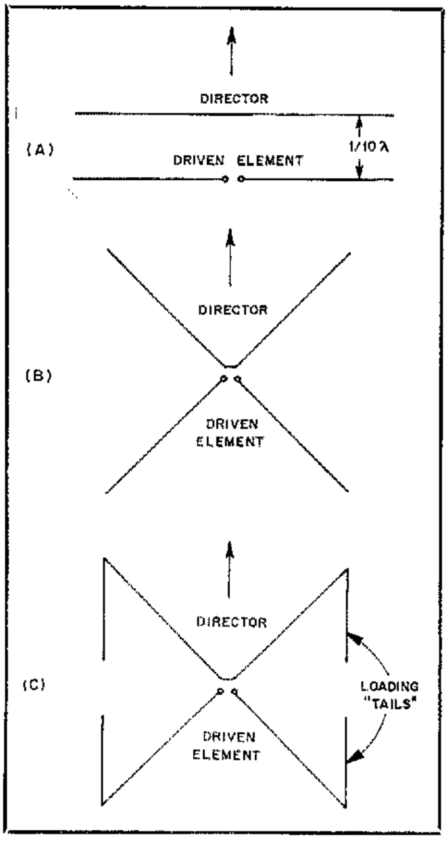


Fig. 1 — Derivation of the X beam from the Yagi design. See text for details.

Assembly

Each piece of tubing is sawed in half, deburred inside and out and lightly polished with emery paper until the sections telescope together. Old TV-antenna elements can be used for the 5/8-inch-OD end sections on the arms.

The 4-foot pieces of 1-inch tubing are mounted on the plywood square in the shape of an X, with a separation of 3

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[1] m = ft × 0.3048; mm = in. × 25.4.

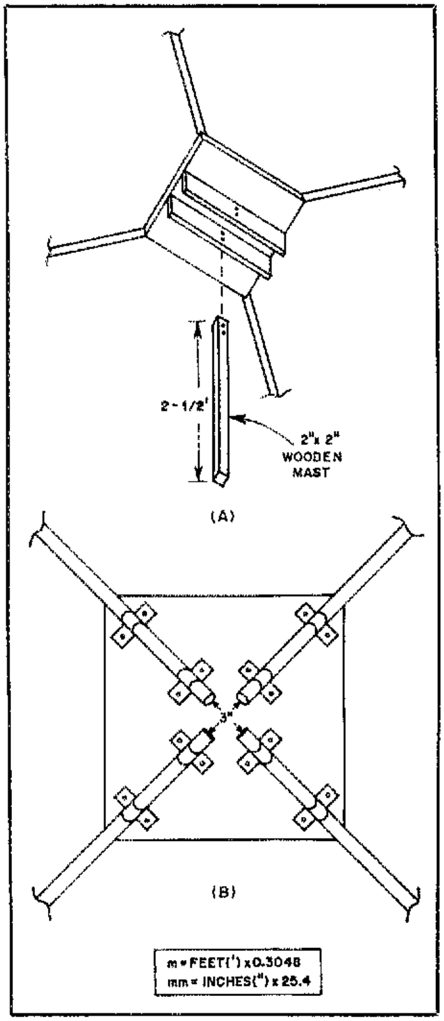

Fig. 2 — Details of the hub assembly. A shows the bottom view, and B details the top assembly.

inches between tubing ends at the center. Insulation for the tubing is provided by 1-1/2 inch pieces of plastic tubing, which slip over the aluminum tubing. Stove bolts hold the brackets to the plywood. This provides a very strong and well-insulated mounting as shown in Fig. 2B.

Insert the 7/8-inch tubing pieces 2-1/2 inches into the 1-inch tubing and secure with two no. 6 self-tapping screws. Likewise, the 3/4-inch tubing is fastened to the 7/8-inch tubing. Four pieces of 5/8-inch tubing, each 2 feet 4-1/4 inches, are fastened to the 3/4-inch tubing in the same way. The total length of each arm is 13 feet 9 inches. See Fig. 3 for details on the arm assembly.

An SO-239 type coaxial connector is mounted to the hub by means of short standoffs. Solder lugs are fastened to the ends of each arm, and to the inner ends of each arm at the hub, with no. 6 self-tapping screws. A piece of no. 12 wire connects the director arms together, with the wire bent into a 3/4 turn to aid in coupling during tuning. The coaxial connector is wired directly to the driven element with no. 12 wire.

Tail-wire length will vary with different wire sizes. This length must be determined experimentally. Nylon cord runs between the ends of the arms to reinforce the assembly and to serve as a support for the tails. After finishing the mechanical construction, give the hub assembly several coats of aluminum paint. Be sure to mask the plastic insulators and coaxial connector with tape to keep them free of paint. The hardware is also sprayed with aluminum paint. The completed antenna is light enough to be carried up a ladder in one hand.

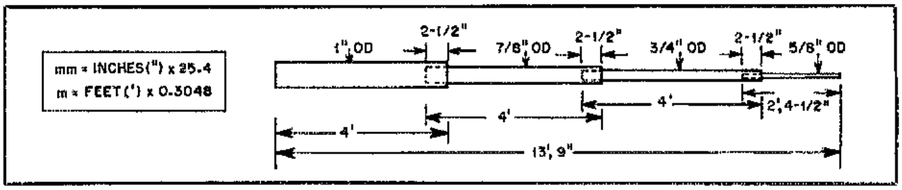

Fig. 3 — Details of the antenna-arm construction. No. 6 machine screws are used to hold the tubing together.

Tuning and Checking

It is important that the tails be longer than necessary at the start, and that each driven-element tail be 12 inches longer than each director tail. All four tails are trimmed 1 inch at a time until the director is resonant at the desired center frequency. This may be checked by mounting the antenna on a 10-foot mast, placing a 50-ohm load across the driven element feed point and checking the director resonance with a dip meter. After tuning the director, remove the 50-ohm load and trim the two driven-element tails until resonance is indicated on the dip meter. For the best frequency coverage, the antenna should be tuned for 14.100 MHz. At this point, the tail-wire lengths should be 7 feet 8 inches for the driven element and 6 feet 8 inches for the director. Fold back and tape the tail-wire ends to prevent ionizing effect of a sharp point.

Results

After tuning my antenna, I connected a Ten-Tec Argonaut 515® to the antenna and checked the SWR. The readings were so low that another bridge was used to confirm the results. The antenna was then raised to its final height of 30 feet. As expected, the resonant frequency increased, but the SWR remained low across the band. The SWR curves for the X antennas are shown in Fig. 5.

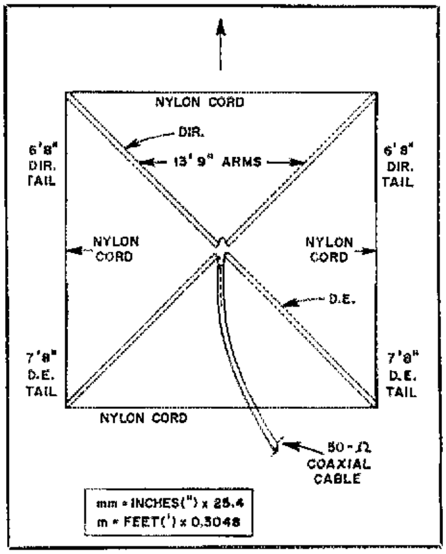

Fig. 4 — Layout of the 20-meter X. The nylon cord is used to hold the wire tails taut.

On the Air

Well, does it work? As ZL2NH says, "She works, mate." I had three other antennas to compare with my X beam: A horizontal V with 160-foot legs, 50 feet high, a four-band trap vertical on top of a 20-foot pipe; and a dipole broadside to Europe, up 30 feet.

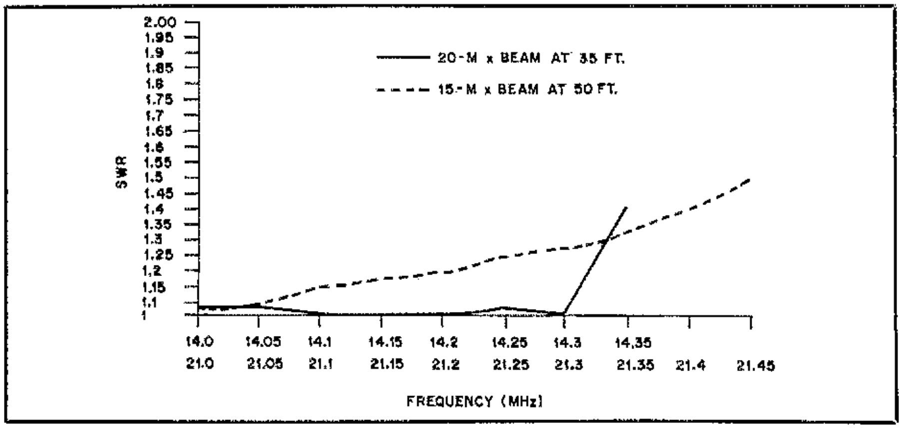

Fig. 5 — SWR curves for the 20- and 15-meter X-beam antennas.

Input power for my on-the-air tests was 5 W; there was no difficulty in raising DX stations with the X beam. I received many encouraging signal-level comparisons from U.S. and DX stations. In every case the X Beam produced the best signal reports, even though the inverted V was 15 feet higher. In general, the X Beam was 1 to 2 S units stronger than the V, and was always stronger than the trap vertical or dipole antennas.

A 15-Meter X

I decided to scale the 20-meter X to 15 meters and erect it next to a vertically polarized 4-element, 20-meter Yagi on my 50-foot tower. The 20-meter X was replaced by a 5-element commercial "tribander." Because of the size and weight of the tribander, it was raised to a height of only 30 feet.

Mechanical Changes

To change the 20-meter X to 15 meters, the arms are shortened to 9 feet 3 inches. Apply the same tuning procedure as before. The director tails should measure 4 feet 2 inches, and the driven-element tails 4 feet 10 inches. Prune the tails until resonance is indicated at 21.110 MHz. The SWR should be low across the band.

15-Meter X Performance

The performance of the 15-meter X beam at 50 feet has been spectacular! In normal operation, DX stations usually can be raised on the first call. During the CQ WW cw contest in November 1981, I ran the Argonaut 515 at an output of 4 W. During a 70-minute operating period, 23 stations were worked. Fourteen were raised on the first call and five on the second call. The X again proved its worth in the 1982 ARRL DX contests in the QRP division, resulting in 70 QSOs in 30 countries in the cw section and 53 QSOs in 30 countries in the ssb section.

A comparison of the performance of the X-beam antenna and the commercial tribander was made. Of course, the low height of the tribander (30 feet) was a disadvantage. The two antennas were equally good for medium distances, with the tribander a little better for short skip. However, on the long hauls, especially when the band was just opening or closing, the high X beam was superior. Transmitted and received signal-strength reports were at least 1 S unit better. Contacts made with the X beam were impossible to achieve with the tribander.

Conclusions

Since this article was written, I have found that the addition of a coaxial balun, mounted at the antenna feed point, will improve the azimuthal pattern considerably. Also, the director does not have to be insulated from the hub; I removed the element insulators and performance remained identical.

The X beam has a lot going for it. I wish the design were my invention! I am looking forward to building an all-metal "plumber's delight" version for 10 meters using inexpensive aluminum clothesline props and aluminum angle stock. I also hope to try a 40-meter version in which the arms would be only 25 feet long.

New Books

☐ *Three New Directories for Amateurs.* Ever wondered how many hams there are in your town? Unless you know everyone in town, you would probably be surprised at just how many hams there are. Or, how about hams with the same name as yours? There are many uses for this information, not the least of which is to build a list of other hams who might want to start a club.

One of three new directories, the *Amateur Radio Call Directory,* can make an otherwise impossible task easy. Every U.S. amateur is listed alphabetically by state, town, street address and call. It's interesting to pick a town, any town, and observe the number of hams who live there. For example, opening the book completely at random, and placing my finger blindly on a page produced the information that there are 55 hams in Cinnaminson, New Jersey, and 76 hams in Conyers, Georgia. Of the approximately 80 hams shown in Newington, including many staff members who use Hq. as their FCC address, more than 40 were unknown to me. Our club secretary will be contacting them about coming around to club meetings.

The second directory is more of a curiosity at the moment, though it will no doubt prove of value in the future. It indexes, by last name, every ham in the country. There are, for example, only two Auricks: my son in Pennsylvania and myself. Information is listed by first name, initial call and state. There are more than 28 columns of Smiths, and only one listing for Sneary. It's fascinating to see the diversity of names, and the duplication of middle initials of hams who are undoubtedly never had the faintest idea that there was another ham with exactly the same name.

The third directory is similar to the listing we are all familiar with one important exception: There is no break between the name of the community and the state and ZIP code. It appears to make for easier reading. Everyone is listed by call district, name and QTH.

The three directories are available from Buckmaster Publishing, 70 Florida Hill Rd., Ridgefield, CT 06877. Prices: *Amateur Radio Call Directory* (by districts and by call signs), $12.95; *Geographical Index,* $25; *Name Index,* $25. — *Lee Aurick, W1SE*

☐ *The 10 Meter FM Handbook,* by Bob Heil, K9EID. Published by Melco Publishing, P.O. Box 26, Marissa, IL 62257. First edition, 1980. Soft-bound volume, 6 × 9 inches, 80 pp., $4.95.

Many hams seem to be interested in 10-meter fm so it would appear that *The 10 Meter Handbook* might go a long way toward answering many questions. There have been articles about converting CB transceivers to operate on the 10-m band, and that seems to be the main idea behind this book. Almost half the book is devoted to describing the advantages of 10-m fm operations, what is involved, some of the problems and other introductory information.

The later sections are used to describe the steps in converting a surplus Cybernet (HyGain) CB transceiver board so that it can operate on 10-m fm. I was looking forward to the technical details, but was greatly disappointed by the coverage provided. The descriptions of the conversion steps are poorly written, and a great deal is left to your imagination.

For example, the first step appears to be a checkout of a surplus board on the citizens' band to be sure it is operating. This is a good idea, since you don't want to "convert" a defective board. However, here's a typical description: "All check out is done with frequency programming on channel 1, if it is a 23-channel unit or channel 20 if it is a 40-channel rig. This will become 29.5 when conversion is finished." This left me a bit confused, since there was no mention of *how* the unit was supposed to be "programmed" for these channels. Remember, you're supposed to be working with an open pc board, with no external controls. Other steps assume that you know exactly what parts are needed, and that you can identify solder connections on the pc board without a diagram. Eight pages later, a wiring diagram is shown, but it is dually labeled as the MELCO FM I.F. BOARD and the Cybernet board. It is also missing the resistance values for the volume and squelch controls and the current range of the meter.

Since the CB transceiver doesn't have the ability to process fm, an fm detector must be added. A detector circuit is shown, but component values are missing from both the diagram and the text. Likewise, the schematic diagram shows an LM3065 fm detector IC, while all the descriptions mention a 1358P IC. Over 20 pages later, the chips are mentioned, along with others, in a two-page chapter about fm detection systems. The two chips appear to be functional equivalents, but not pin-for-pin replacements for each other.

Diagrams and figures are hand-drawn, and the lack of complete information about parts and connections makes much of the information less than useful. The book suffers from lack of detail and from poor organization. It is difficult to see how this 80-page book can be called a handbook.

Since many of the needed parts, as well as the main CB transceiver board, are available from the publisher, the book can be best viewed as a "sell job" for their kits and assemblies. You shouldn't have to spend $4.95 for a short, incomplete introduction to 10-m fm. The book is also billed as a "must" for builders of the Melco kits. I hope the builders don't have to rely on the information in the book to assemble their systems. — *Jon Titus, KA4QVK*