SUCCESSFUL 144 MHz

EME ANTENNAS

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One of the most important decisions that an amateur planning a moon-bounce system must make is the choice of antenna. There are many variables that enter into the decision as there are both practical and technical topics to consider. In the practical category are:

1. What will the system cost?
2. What is the availability of the materials?
3. What is the available real estate?
4. What are the esthetics as judged by the neighbors and the wife?
5. What are the electrical and mechanical abilities of the amateur and his helpers?

In the technical category some of the considerations are listed below. Quite often the technical desires must give-in to some of the previously listed practical considerations.

1. What system gain should be sought after?
2. Should the array be fully steerable, partially steerable, or fixed?
3. Should the array be on a high tower, or on the ground?
4. Is the array for EME only, or is it to be used for other propagation modes?
5. If the array is to be steerable, should an AZ-EL mount or a Polar mount be used?
6. What kind of feedline should be used?
7. Should the preamplifier be mounted at the antenna?
8. What kind of transmission line should be used in the phasing lines?
9. Should power dividers be used?
10. What type of antenna should be used? (Probably the hardest decision is the choice of antenna type.)

Amateurs tend to become quite emotional when discussing the relative merits of collinears, yagis, log-periodic yagis, rhombics, and dishes. All of the antennas mentioned have been used successfully in EME systems. The relative merits of each antenna probably change as the discussion moves from band to band. For example, the dish is quite acceptable on 432 MHz, but is too big to be practical on 144 MHz.

Included in this EME Note are pictures of successful 144 MHz antennas. Pictures of antennas for other bands are not available at this time but as pictures are collected they will appear in subsequent issues of the EME Notes.

When deciding whether to use a collinear, a yagi or a log-periodic yagi, the capability of the amateur must be considered. The lower the "Q" of the antenna, the better the chances of operational success. It is difficult to fail with a low-Q collinear array. The log-periodic yagi is a band-pass type of antenna of medium-Q and is therefore easy to assemble into an array. Short yagi antennas are a little more critical. The long and very long high-Q yagis are even more critical to assemble into an array. Also, their performance is optimum only over a narrow part of the two meter band.

It is very important to be certain that your chosen yagi design has been carefully checked out before building eight or sixteen identical antennas. If this is not done, a lot of time and money can be spent on an array with inadequate gain for EME work. With proper antenna-to-antenna spacing, the yagi and log-periodic yagi tend to have a cleaner pattern than other types. The cleaner the pattern, the better the antenna will perform for receiving.

The main idea to keep in mind when thinking about the antenna array to put up is the minimum system requirement as pointed out in earlier issues of these Notes. For two stations each running 500 watts output with a system noise figure below 2 dB, the minimum antenna gain each station should strive for is 20 dB. Actually what is required is a "round trip" gain of 40 dB. That is to say, if one station has 17 dB antenna gain and the other station has 23 dB gain, their total gain is 40 dB round trip. Therefore, if the two stations schedule each other often enough, they will be successful in completing a contact. Two stations with 17 dB antenna gain would probably not be able to make contact very often, if at all. If the constraints on your antenna project relegate you to something under 20 dB, you still can work those stations having an extra amount of antenna gain. There are several 144 MHz stations with antenna gain in the 23 to 24 dB range. There are even some having close to 30 dB gain.

Remember that the previous discussion on system requirements is for 144 MHz. As EME activity and interest increase, there will be bigger and better arrays built.

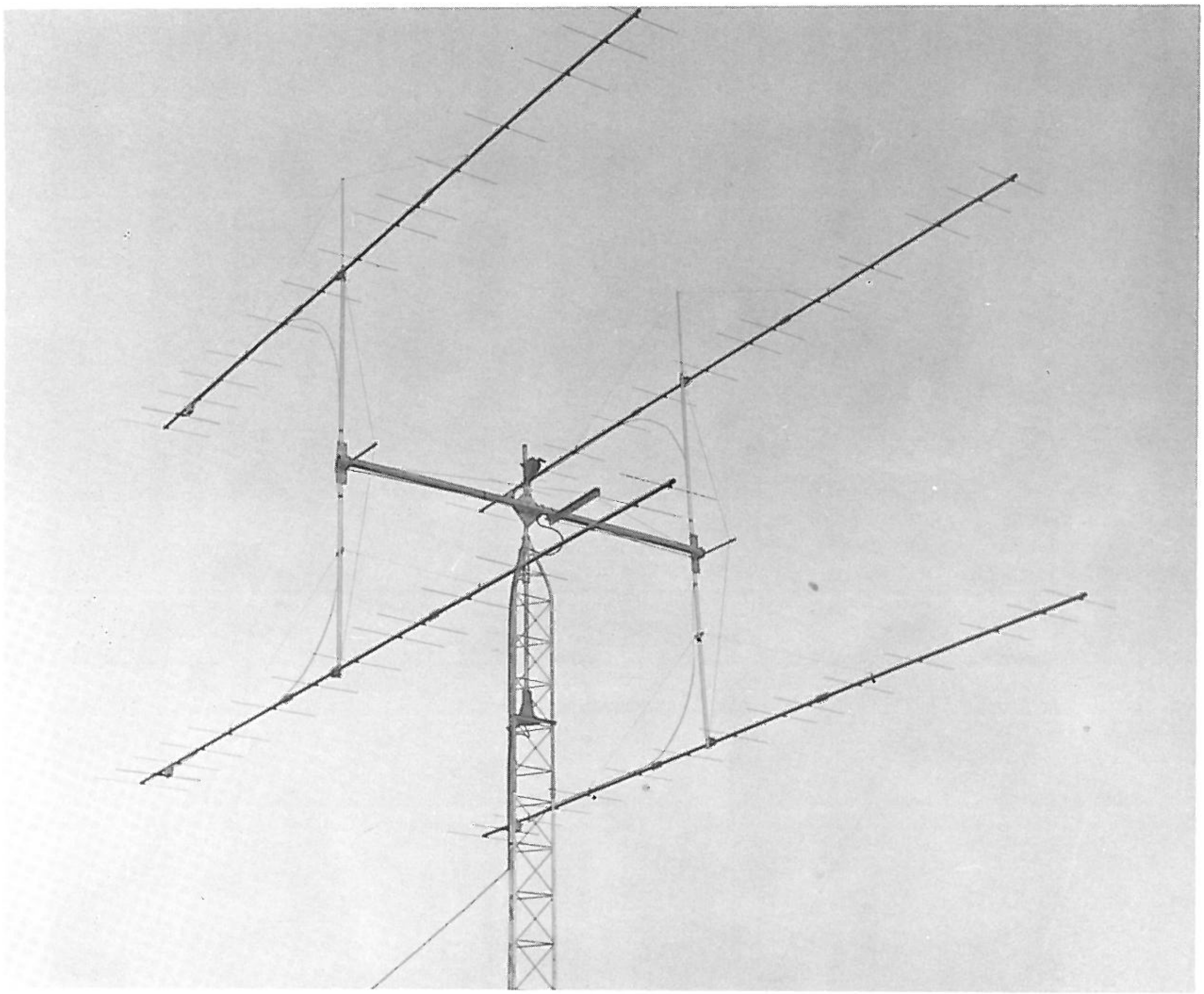


Figure 1

The array of John Allen, WAØCHK consisting of four Hy-Gain 15 element Yagis. The antennas have been modified as per the instruction from K6MYC. As the antennas come all of the parasitic elements appear to be one inch too long. The "H" frame is made from a 14 foot length of three inch diameter 6061-T6 aluminum pipe with an eighth inch wall thickness. The vertical members are made from two pieces of 1.59 inch diameter 6061-T6 aluminum pipe 13' long with a .140 inch wall thickness. The gusset plates are quarter inch 6061-T6 aluminum. The clamps are muffler clamps and electrical conduit "U" bolts. Small antenna tuners are mounted 6 1/2 inches away from each feed point and are tuned for 50 ohms. The phasing lines are 75 ohm .412 O.D. surplus CATV aluminum coax. The antenna is mounted on a 25' Rohn #45 tower. The boat winch mounted above the center of the "H" frame is for lifting the antenna up and down the tower for maintenance. The antenna is elevated manually by loosening the four muffler clamps on the "H" frame center gusset plate and twisting the three inch pipe and antennas to the desired elevation angle.

The rotor shown in the photos is a CDE TR-44. Struts are made from quarter inch polypropolyene rope to keep the antennas aligned when elevated. The gain of this antenna array is probably around 19 to 20 dB.

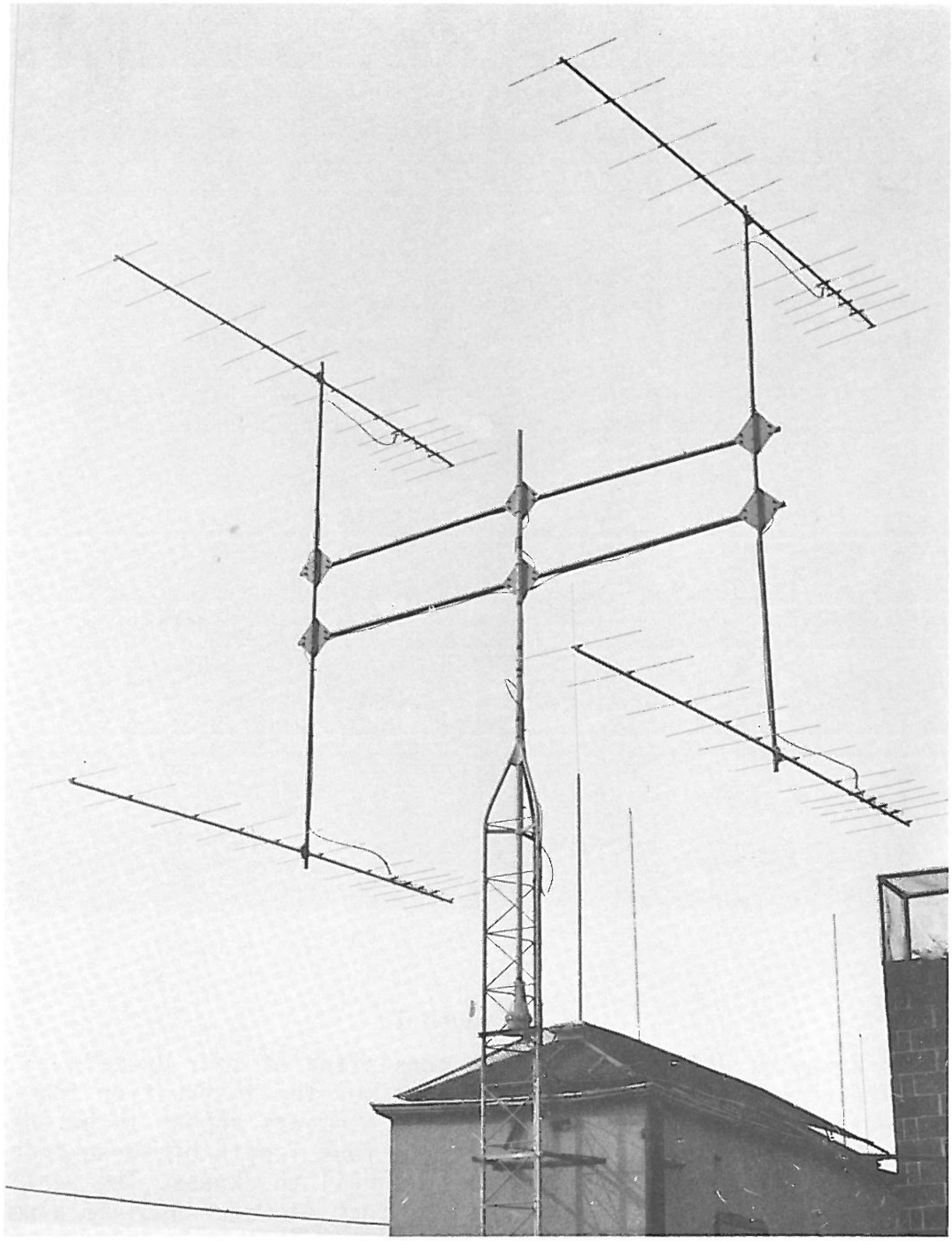


Figure 2

The antenna array of Herb Power, WA2WOM consisting of four KLM log-periodic Yagis. The array is located on top of an apartment house near Prospect Park in Brooklyn. The location is probably not the most desirable for an EME station. The tower is 19' 9" high. The booms are 14' long with an antenna to antenna spacing of 13' 6". Extensive tests between Herb and Carl, W2AZL seem to indicate that the array has a gain of 20.5 dB over a dipole.

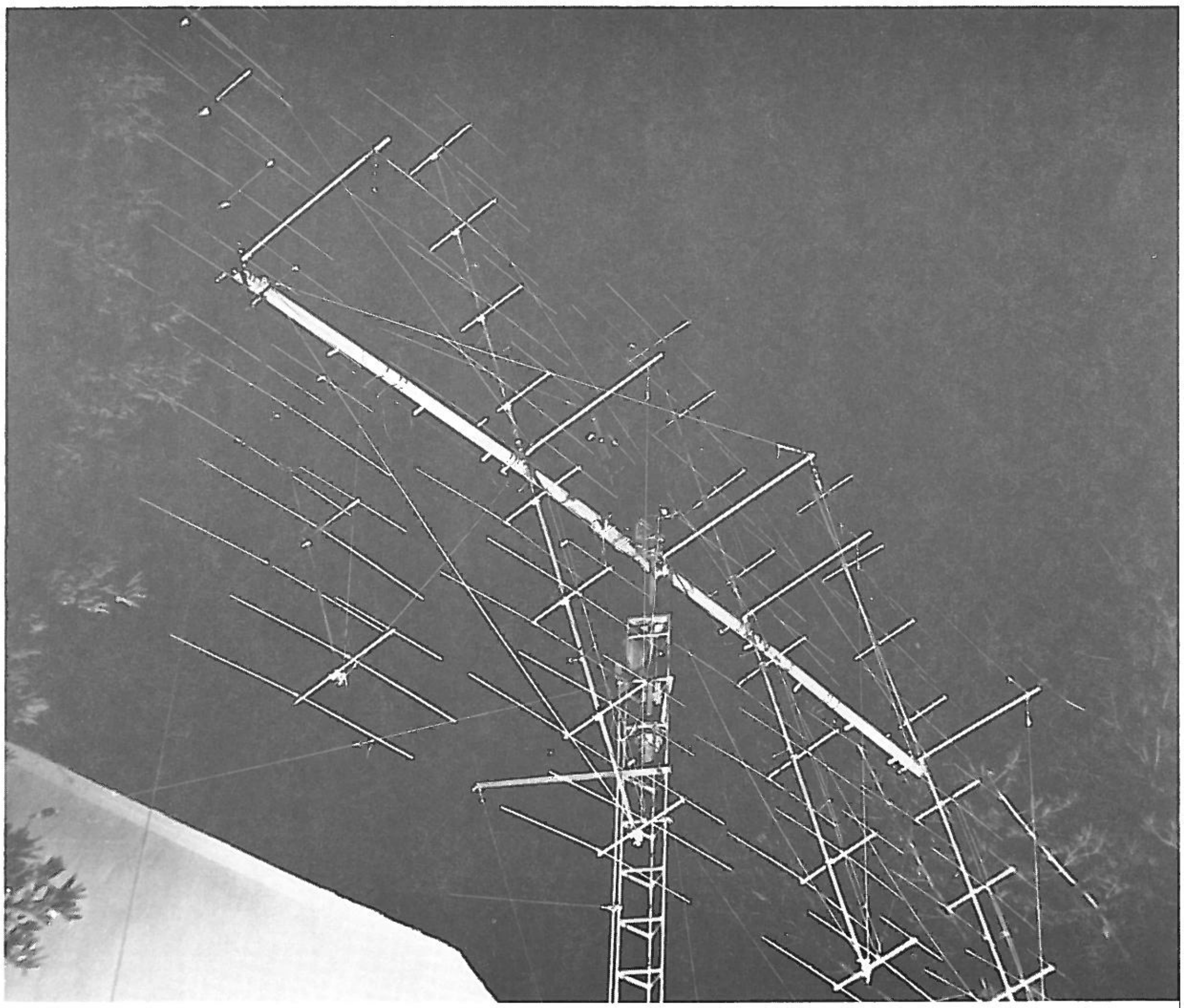


Figure 3

The array of Bob Sutherland, W6PO consisting of eight Cushcraft 20 element collinear antennas. The main boom is 30' of four inch diameter aluminum irrigation pipe. The four secondary booms are each made from two pieces of 10' and one piece of 5' long steel TV mast. The boom guys are all made from quarter inch polypropolyene rope. The phasing lines are made from Belden 8275 tubular twin lead. Each bay of 40 elements is matched with a universal matching stub. All four bays of 40 elements are then fed from another universal matching stub. The antenna array is Az-El mounted with motor drive and selsyn readout. The elevation drive consists of a hinge, a jack screw and a direct current gear motor. The azimuth drive is a converted prop pitch motor. The gain of the array should be between 23 and 24 dB.

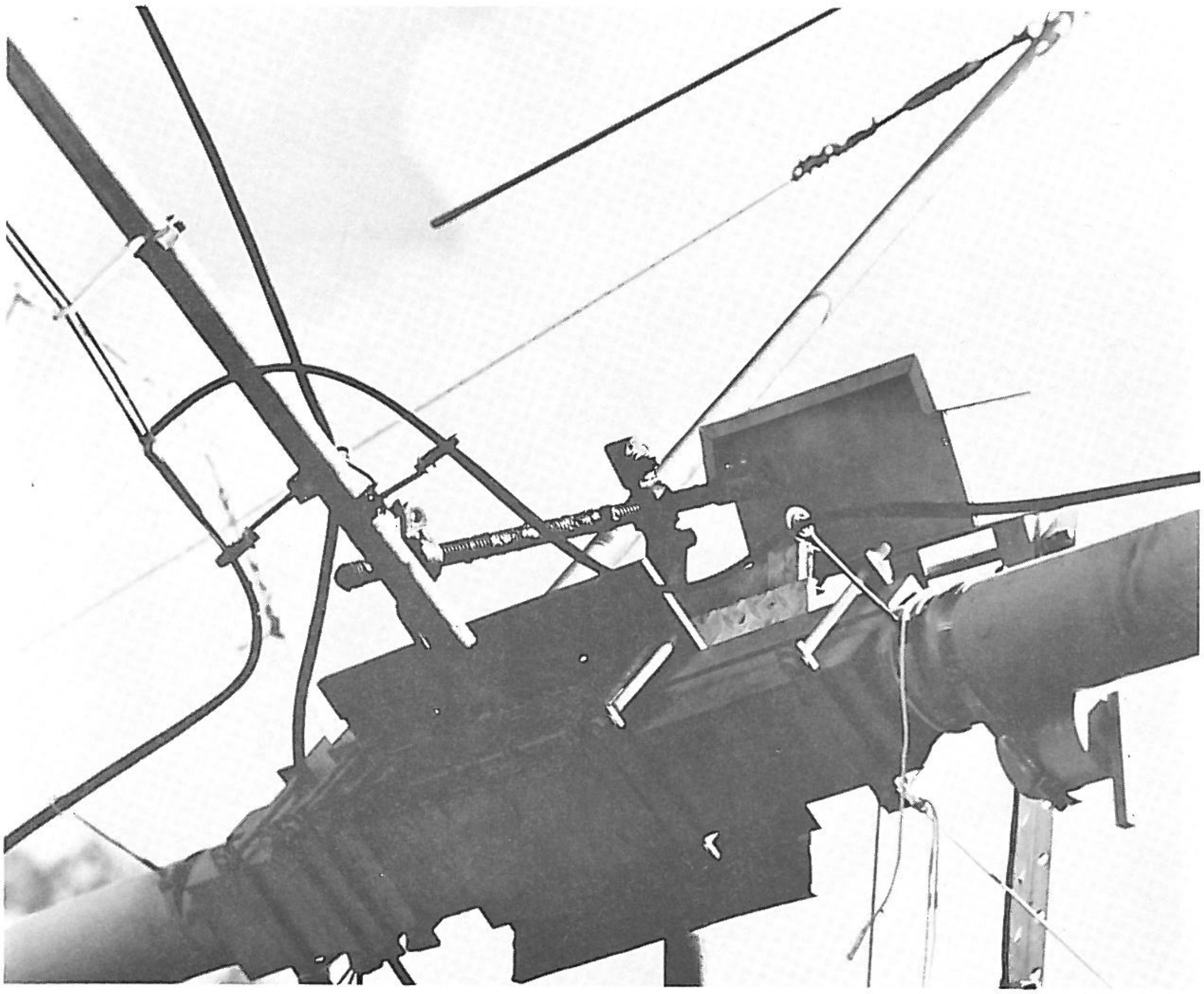
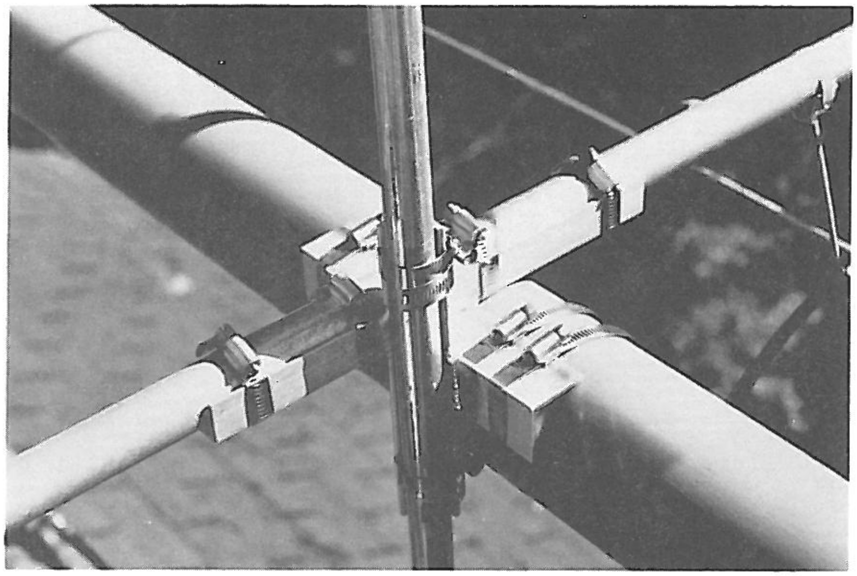


Figure 4

This picture shows the elevation hinge and drive mechanism on the W6PO array. The box at the right end of the jack screw houses the gear motor. Just under the boom to the right is the housing for the elevation selsyn. The housing is held to the boom by means of a stainless steel hose clamp. The half inch square aluminum rod hanging straight down at the end of the selsyn housing, and connected to the shaft of the selsyn, always points to the center of the earth regardless of the elevation angle. Thus the selsyn measures the elevation angle and transmits it to the readout selsyn at the operating position.



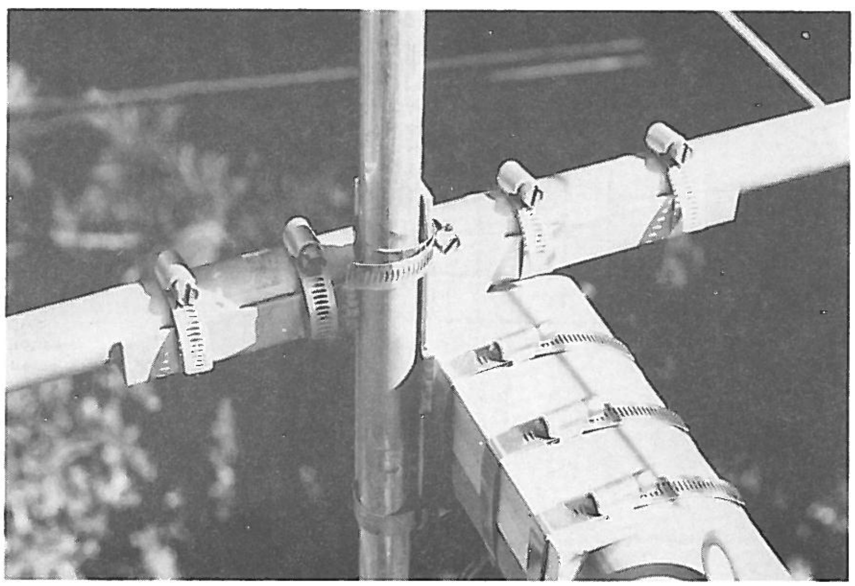


Figure 5

These pictures are of the technique used in the W6PO array for fastening the secondary booms to the main boom and to support the aluminum guy post. The guy post is about four feet long and is used to anchor the polypropolyene rope which supports the secondary booms. Three pieces of aluminum angle are arranged mutually perpendicular to each other and fastened by means of machine screws and nuts. The assembly is then heliarc welded along each common edge. The machine screws can then be taken out if they interfere with the booms, or post, that are positioned in the angle. Stainless steel hose clamps are then used to assemble the array. The result is a strong and light weight assembly. This idea was gleaned from K6MYC's bag of tricks.

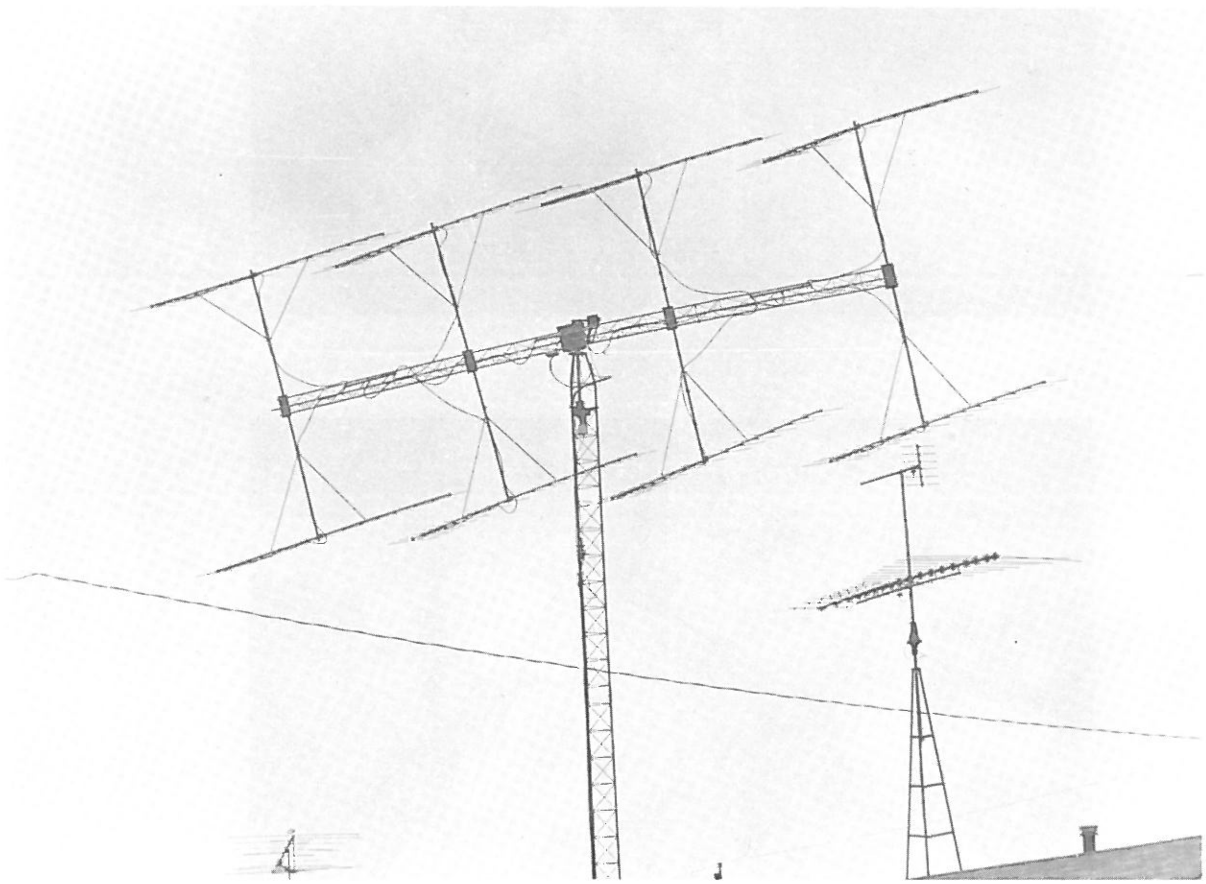


Figure 6

The array of Kelly Scheimberg, W8KPY consisting of eight 16 element KLM log-periodic antennas. The boom is made from ten foot section of 11" Universal aluminum tower. Each section weighs 12 pounds. The vertical spars are 15 feet long and are made from 1 1/2" 6061-T6 aluminum with a .058" wall thickness. The vertical spars are spliced at the 12' point with 1 1/4" tubing. Two four port and one two port power dividers of the WØEYE design are used to feed the antennas. RG-14A/u coaxial cable is used in the phasing lines. The whole array is fed with 7/8" heliax. The antenna is on Az-El mount. The elevation system is a hinge, jack screw and a gear motor drive. The elevation readout system has a selsyn with a plumb mounted on the boom. The readout is at the operating position. The azimuth drive is a HyGain Rotobrake 400 modified for selsyn readout as per the system devised by Vince Vargas, W7JRF/8.

Figure 7

This is the elevation drive mechanism from the W8KPY array. The hinge is driven by a jack screw, or lead screw, from an engine lathe. Lead screws of this type can be obtained from companies that rebuild lathes and milling machines. The gear motor is inside a protective enclosure located at one end of the lead screw. The reduction gear can be seen just outside the enclosure. You will notice that the support for the gear motor is allowed to change positions. This is necessary to allow the hinge to close. The nut traveling along the thread of the lead screw must also be allowed to change attitude to prevent binding. A piece of 1/2" superflex coax cable is used between the 7/8" heliax and the antenna to allow unimpeded rotation and elevation change.

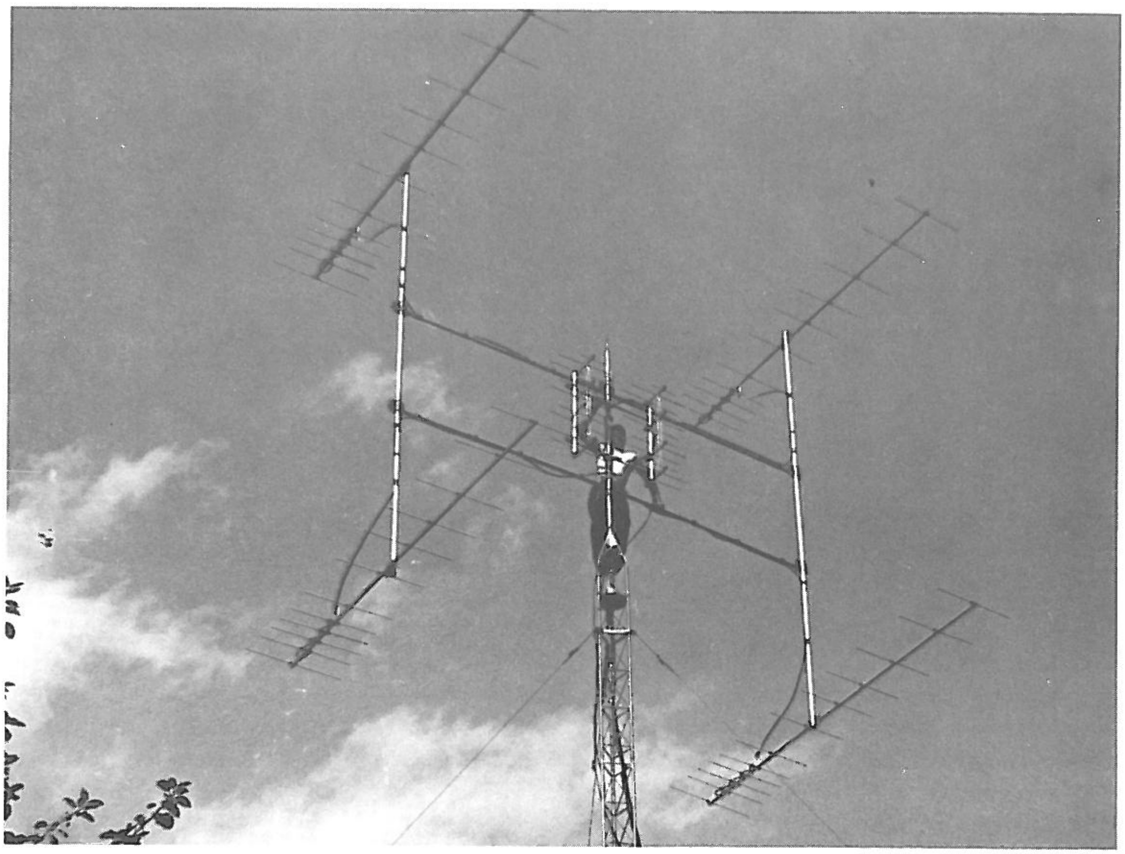


Figure 8

The antenna array of Steve Powlishen, WA1FFO consisting of four 12 element Swan Yagi antennas. The antenna-to-antenna spacing is 16' 8". The center of the antenna is at 55 feet. The antenna is variable in azimuth only. Successful moonbounce contacts have been made using the setting moon. The antenna in the center of the two meter array is a 40 element collinear for 432 MHz.

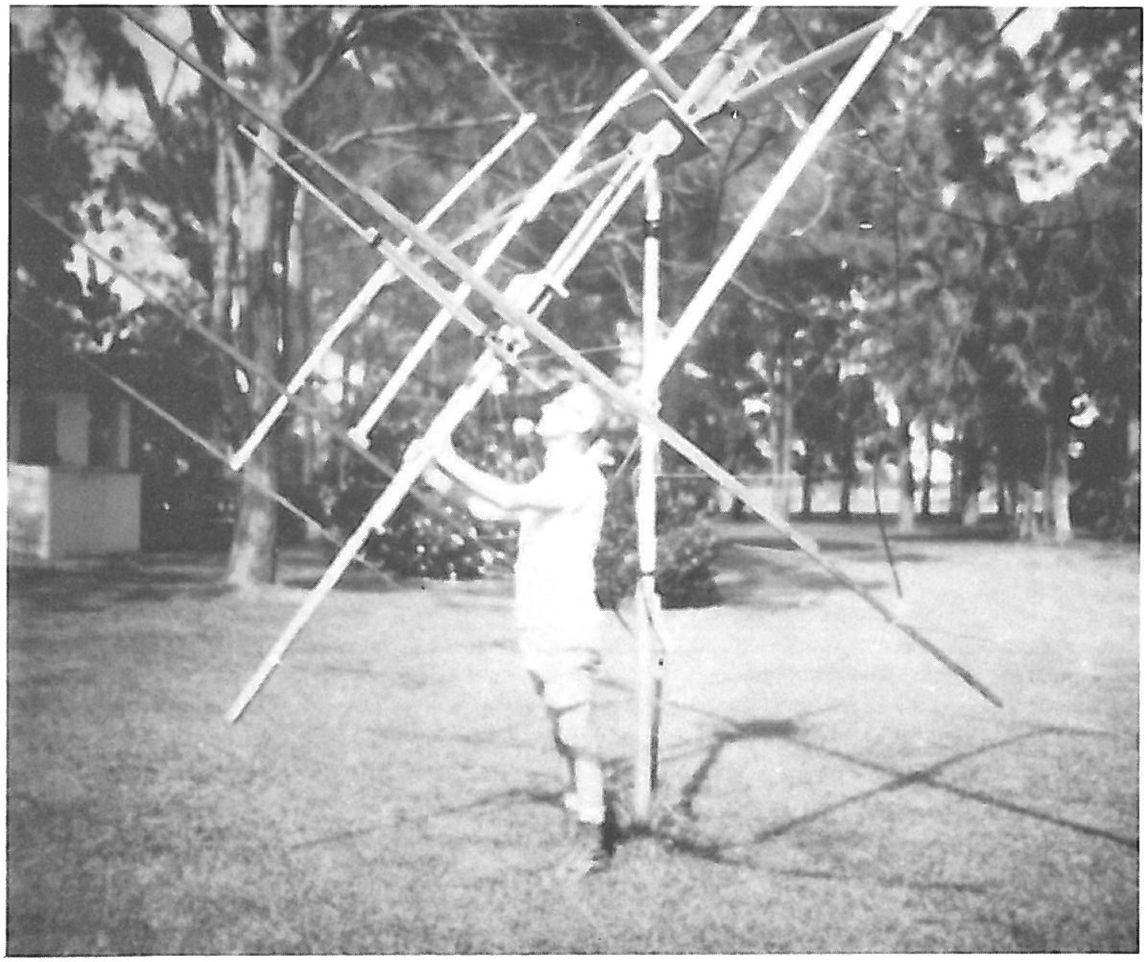


Figure 9

The array of John Perchalski, K4IXC, is easy to reach from the ground. The array center is nine feet above the ground. The array is made up of eight, seven element Yagis spaced ten feet apart, both vertically and horizontally. The main boom is approximately 30 feet long. The individual Yagis are patterned after the seven element units in the ARRL VHF Handbook. The booms are ten feet long and are made from 1"x1" fir strips. The wooden booms are protected from the elements by several coatings of polyurethane varnish. The parasitic elements are one-eighth inch aluminum wire. The driven element is a folded dipole made from 3/8" tubing in parallel with 1/8" diameter tubing. The phasing lines are cut to multiples of one-half wavelengths of Columbia wire number 05790 Dura-Foam 300 UHF-TV Twin Lead. The mount is made of two pieces of aluminum tubing; one rotating inside the other. The elevation mechanism simplicity can be seen in the picture. Counterweights on the handles balance the array.

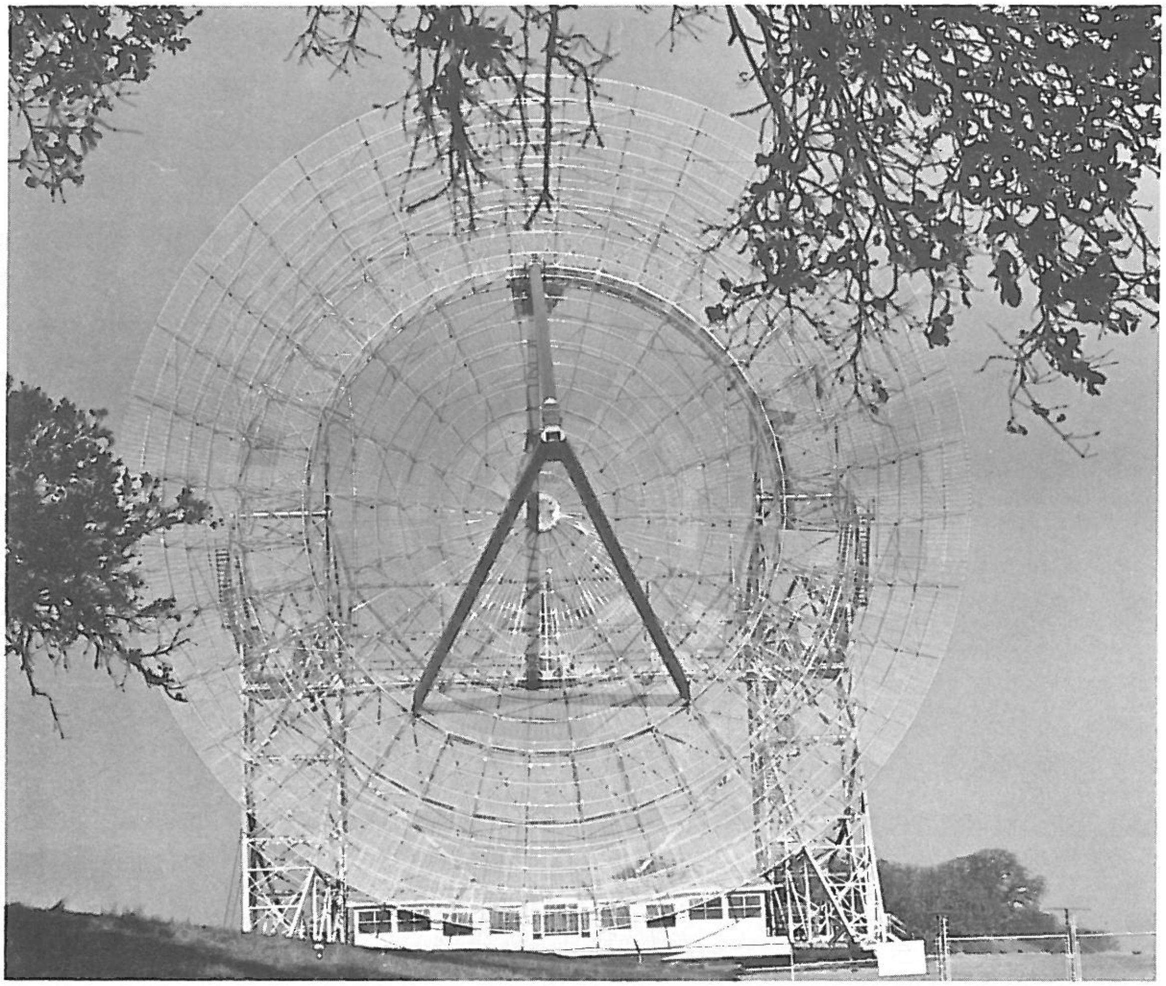


Figure 10

This is a picture of a typical California two meter EME antenna. It was last used by WA6LET to run a series of moonbounce tests from Stanford, California. The antenna is 150 feet in diameter and has a gain of 35 dBI at 144 MHz. The beam width is 2.7 at the 3 dB points. The antenna is fully steerable in azimuth and elevation using two U.S. Navy 5-inch gun mounts. The antenna and the house below all rotate on a track. The aiming of the antenna is accomplished with a PDP-8 computer which up-dates every two minutes. The feed antenna is a NBS Standard 144 MHz antenna and is rotatable from zero to ninety degrees polarity. The feed-line is 1-5/8" coax.