A Single Boom G4ZU Beam

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About a decade and a half ago Captain G.A. Bird, G4ZU, published several articles[1] describing an efficient, easily constructed tri-band minibeam that involved no traps or loading coils. This antenna was extremely popular – particularly with the European hams who were more inclined to build their own gear. The antenna was marketed commerically as the "Panda Minibeam." At W4VON we have experimented with several versions of the G4ZU beam for nearly a dozen years. In this present article we summarize published G4ZU beam technology and describe a mechanically rugged single-boom version of the antenna.

Electrical Principle

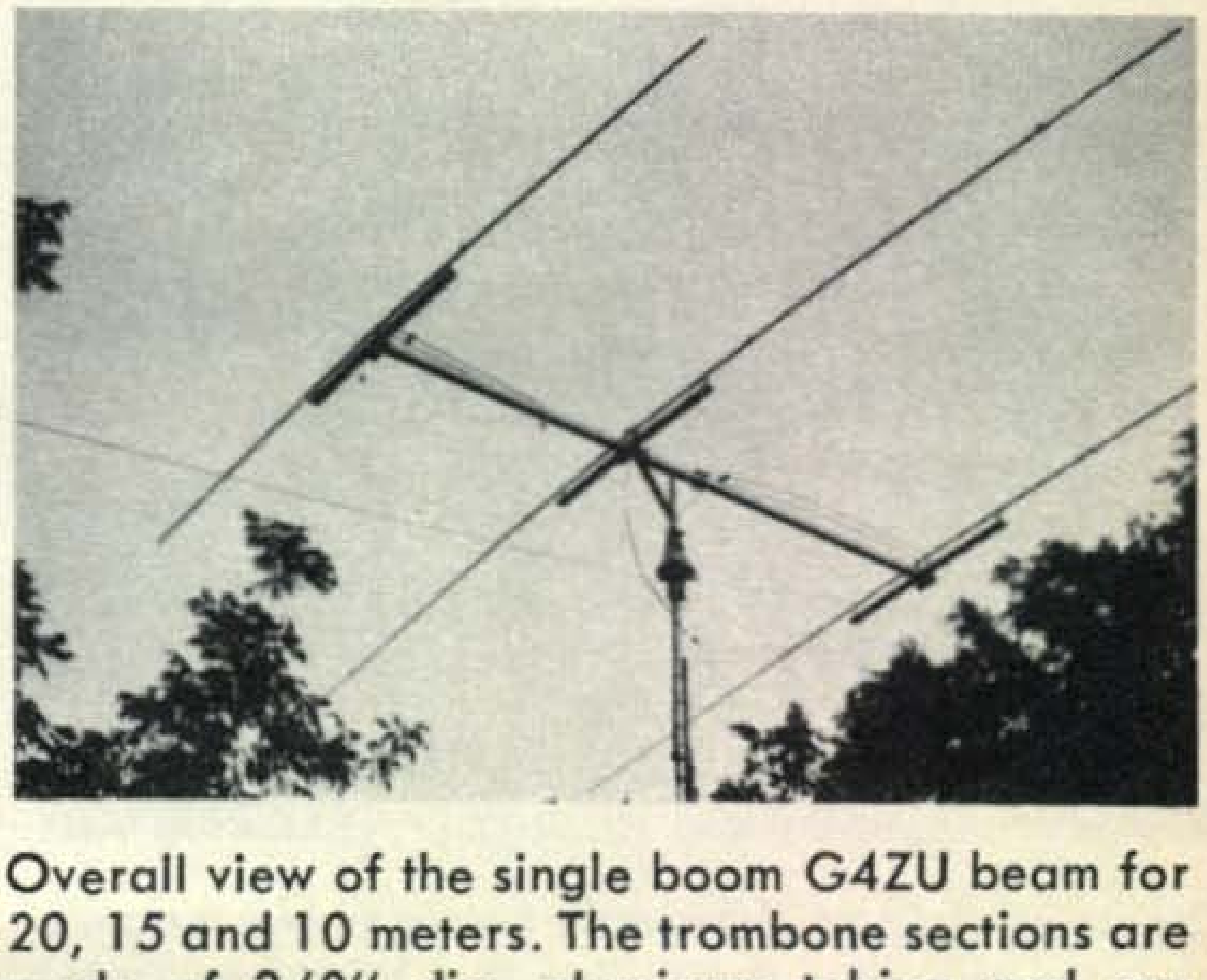
The G4ZU beam is in effect a three element beam on 15 meters, a short 2 element beam on 20 meters and something approximately equivalent to a five element beam on ten meters. The antenna employs an ingeneous combination of shorting stubs and "trombone tuning elements" to permit the director and reflector each to resonate on two separate bands. The earliest versions of the G4ZU beam employed coil loading and stub shorting components to accomplish this. The driven element is a center fed resonant antenna that is made resonant on the three bands by proper choice of open line feeders and "transmatch" components. In the present design the two boom trombone system is replaced by a single boom plus separate "trombone" sections made from lengths of 3/8" diameter aluminum tubing connected together by metal sliders.

Consider first the director. This element consists of a split dipole of an electrical half wavelength for ten meters. A stub cut from 5'6" of 72 ohm twin lead is connected across the dipole split and serves as an electrical short at 10 meters. On other frequencies this stub acts as a small capacitance across the split in the dipole. This same director is made to resonate simultaneously as a shorted 15 meter element by adjustment of the trombone section. The 15 meter resonating director element consists of the two dipole halves plus the trombone section. The 10 meter shorting stub on 15 meters merely acts as a small capacitance that is included in the overall 15 meter resonance.

Similiarly, the reflector is resonant on 15 meters as a half wave element closed by the 15 meter quarter wave stub and as a shortened 20 meter element consisting of the two dipole half elements plus the 20 meter trombone.

The driven element is a resonant antenna which incorporates the lengths of the driven element, the feed line and the capacitive and inductive components of a transmatch as a part of the resonating circuit. A great deal has been written about the matching network and more will follow here. Since it is a resonant antenna, the driven element may, in principle, be of any length. By making the element 24 feet long, or 3/4 wavelength on 10 meters the radiating element becomes a collinear array on this band. This provides additional 10 meter gain equivalent to that expected from an additional one or two elements.

In the original G4ZU beams the two



Overall view of the single boom G4ZU beam for 20, 15 and 10 meters. The trombone sections are made of 3/8" dia. aluminum tubing and are visible above the 2" square boom.

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[1]Articles by G4ZU have appeared in: *RSGB Bulletin,* Feb. '56; *Amateur Radio* (Wireless Institute of Australia), Sept. '56; *Break-In,* New Zealand Amateur Radio Transmitting Society, Aug. '56; *Malayan Amateur Radio Magazine,* March, Apr., May, June, Sept., Oct. '56; *RSGB Bulletin,* Dec. '56; *CQ,* March '57, p. 20; *CQ,* July '58, p. 52; *CQ,* Aug. '58, p. 28.

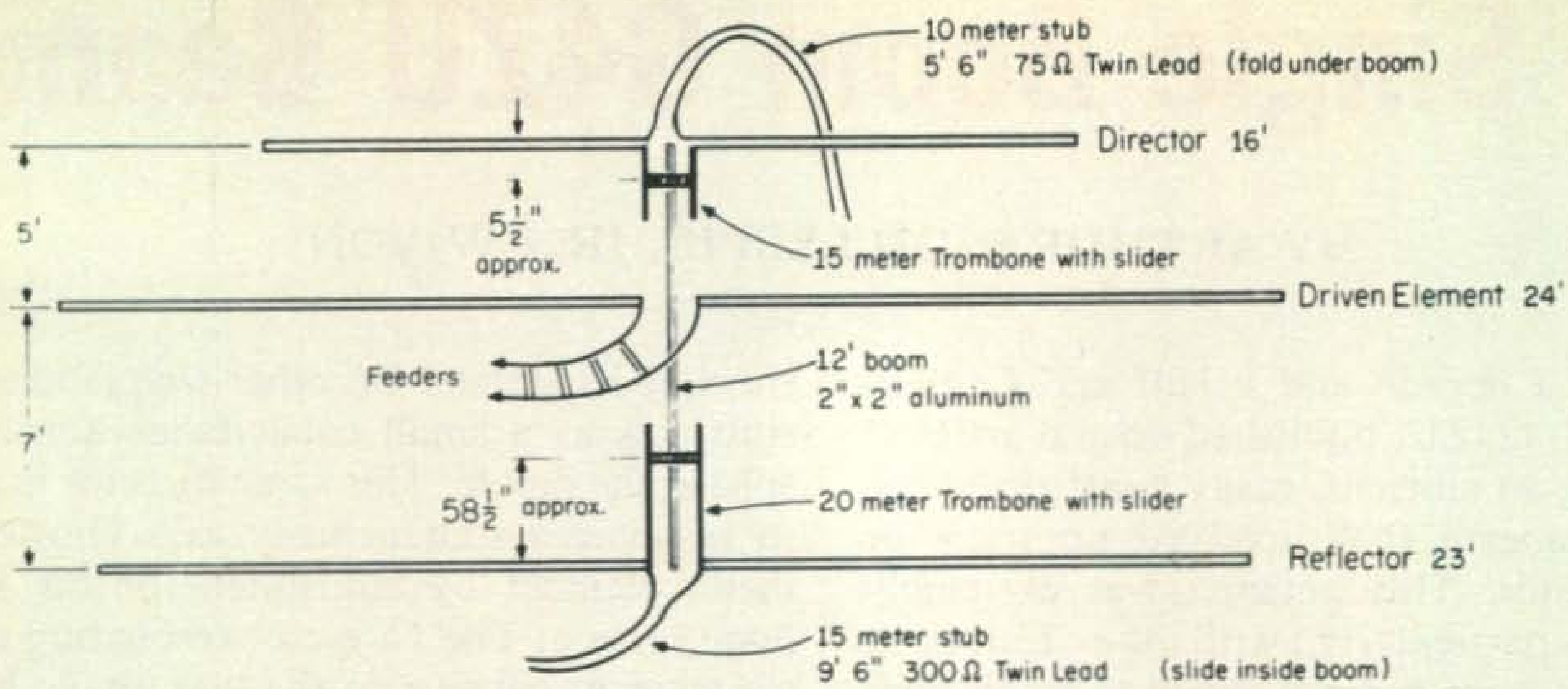


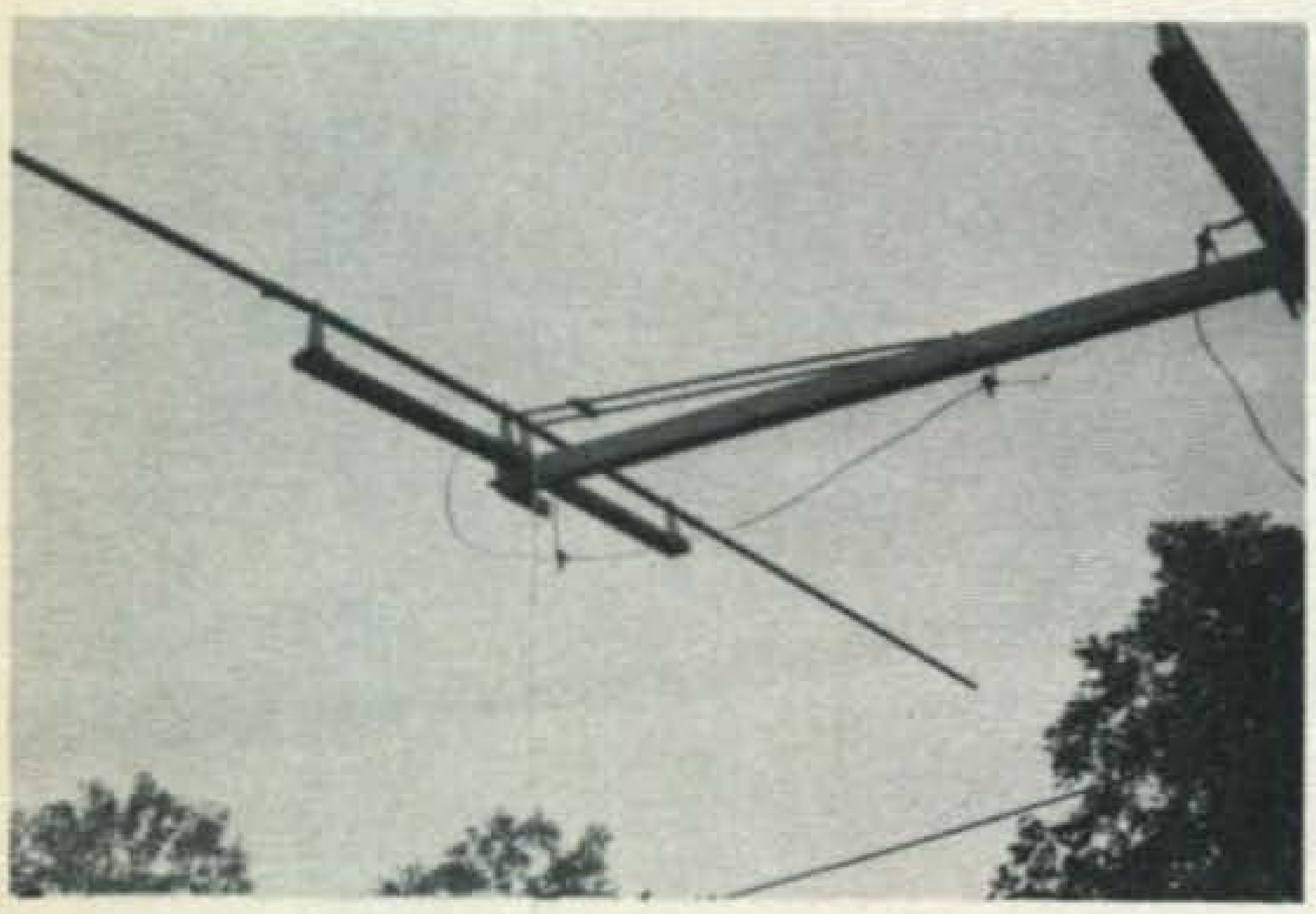
Fig. 1—The single boom G4ZU Beam for 10, 15 and 20 meters. The 10-meter stub is bent back and under the boom and supported on twin-lead stand-offs. The 15-meter stub is pushed inside the boom as described in the text.

quarter-wave shorting stubs were neatly stuffed into the two booms. Corks were used to center them in the metal tubing.

Single Boom Construction

The antenna design is shown in fig. 1. A 2″ × 2″ square boom was used. A round boom with appropriate fittings should be equally serviceable. The longer (15 meter) shorting stub is tucked into the boom using corks or sponge rubber balls to keep it away from the metal walls. The 10 meter stub is looped over the front of the beam and supported under it by means of TV twin line stand-off insulators.

The beam elements are constructed from 6061 aluminum alloy tubing. The center sections are made from 1″ diameter, .035″ wall tubing and the tips are made from 7/8″ diameter .035 wall tubing. These sizes slide together nicely. Radiator hose clamps are used to tighten the elements after adjustment.



Close-up view of the single boom G4ZU beam's director showing details of the 15-meter trombone and 10-meter stub.

The elements are supported on standoff insulators mounted on dried, knotless pine wood supports. The wood sections are painted before assembly.

The trombone elements consist of lengths of 3/8″ diameter aluminum tubing with a sliding member consisting of two strips of hard drawn aluminum and bolted in the center. The lower ends of the trombones are grounded to the booms.

All hardware should be made of stainless steel or heavily cadmium plated steel. Non-plated steel hardware rusts very rapidly and brass hardware in contact with the aluminum sets up galvanic cell action that causes the aluminum to corrode excessively.

Adjustments

First, the stubs should be cut and their quarter wave resonances checked before the beam is assembled. This may be done by temporarily shorting one end of the stub in such a manner as to form a single turn loop. Application of a grid dip meter should show a dip at 30.5 mc for the director and 20.5 mc for the reflector stub. After the reflector stub is inserted into the boom its resonance should be rechecked.

Trombone adjustments should be made with the antenna as high as possible off of the ground. Preferably they should be made with the antenna in final position. Alternatively, the antenna may be mounted on a 10 foot post or stepladder and adjustments made before elevation to final position is made.

The trombone resonances are adjusted by the insertion of the grid dip meter directly into the trombone while sliding adjustments are made.

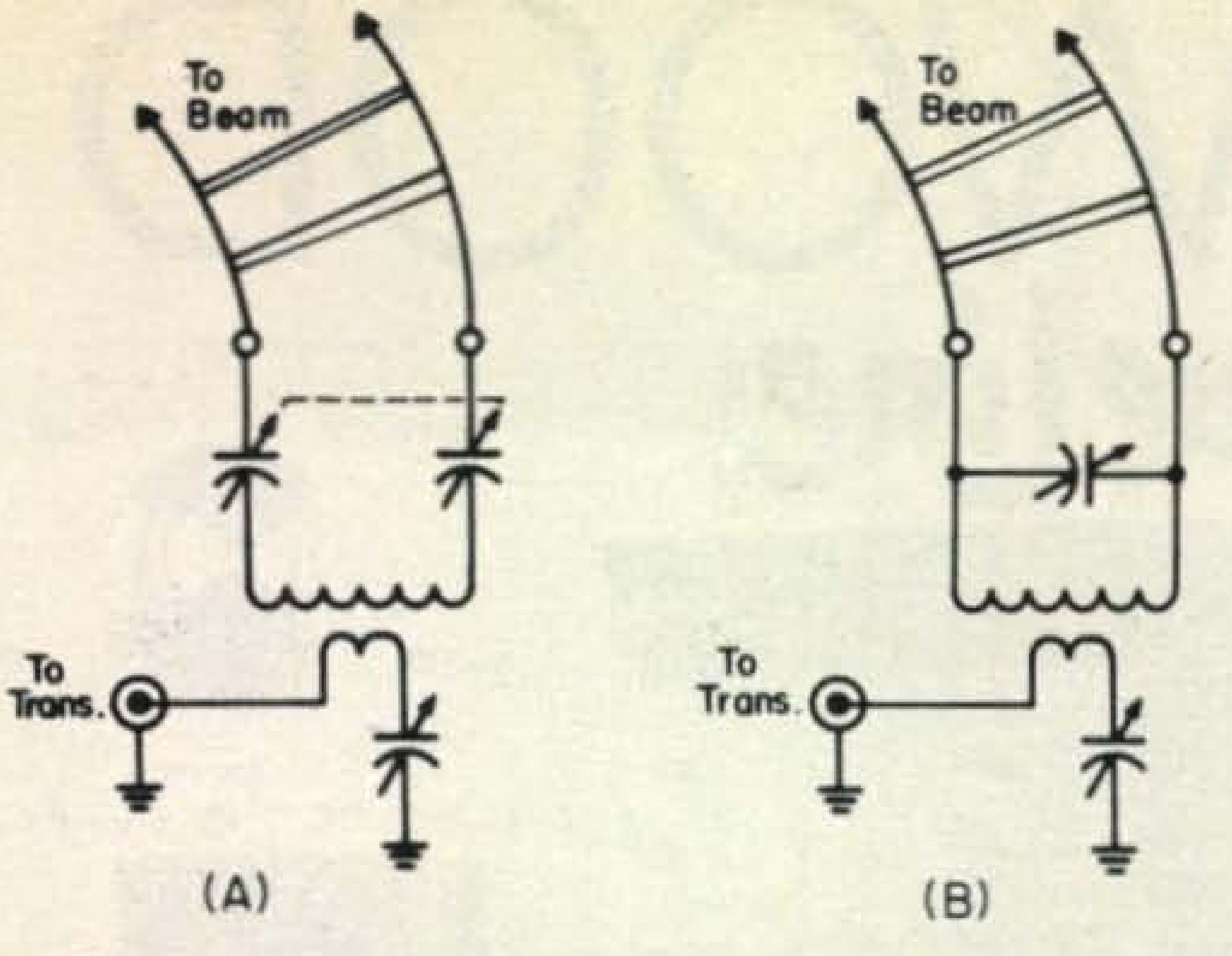


Fig. 2—Matching devices for feeding the G4ZU beam from a transmitter with coaxial output. (A) Series tuning. (B) Parallel tuning.

The director trombone should be set at 21.55 mc and the reflector at 13.4 mc. Grid dip meter calibration should be verified by tuning in the signal on a good communications receiver.

The purist will perhaps want to apply power (through an appropriate matching device) and make fine adjustments while observing a field strength meter situated several wavelengths in front of the beam. The advantage gained by this is probably not worth the extra effort.

Matching

Since this antenna is driven as a center fed resonant antenna, some type of matching device is required. The simplest and perhaps the most efficient system employs a suitable length of open wire feedline with an antenna tuner having capabilities for series or parallel tuning. Certain combinations of band frequency, feedline length, and transmatch components will require series tuning while other combinations will require parallel tuning. 450 ohm TV open wire line serves admirable for the feeders even at high powers. 300 ohm transmitting twin lead will serve as a good second choice. This matching system is shown in fig. 2A and 2B.

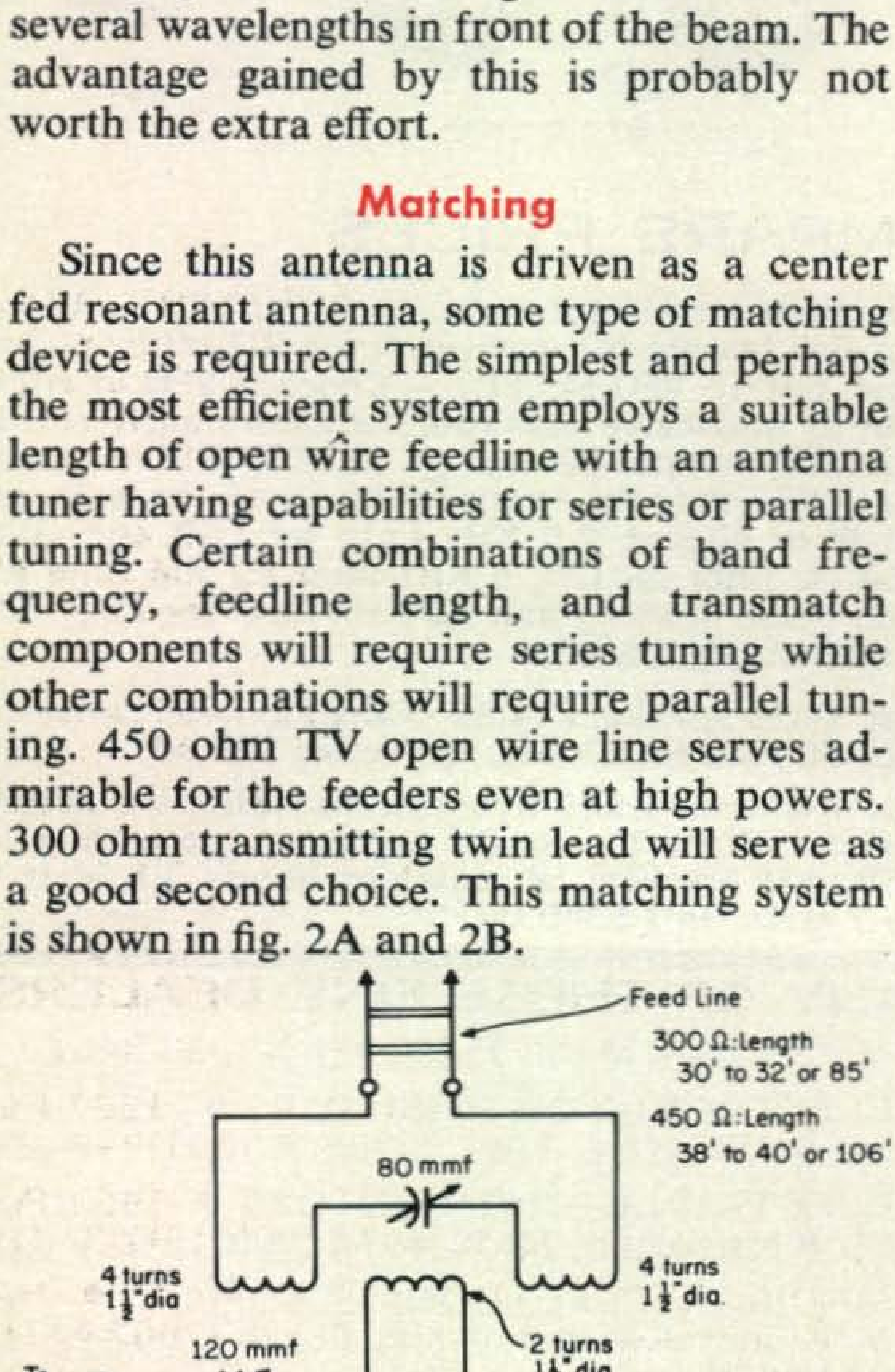


Fig. 3—G4ZU "Automatic matching device."

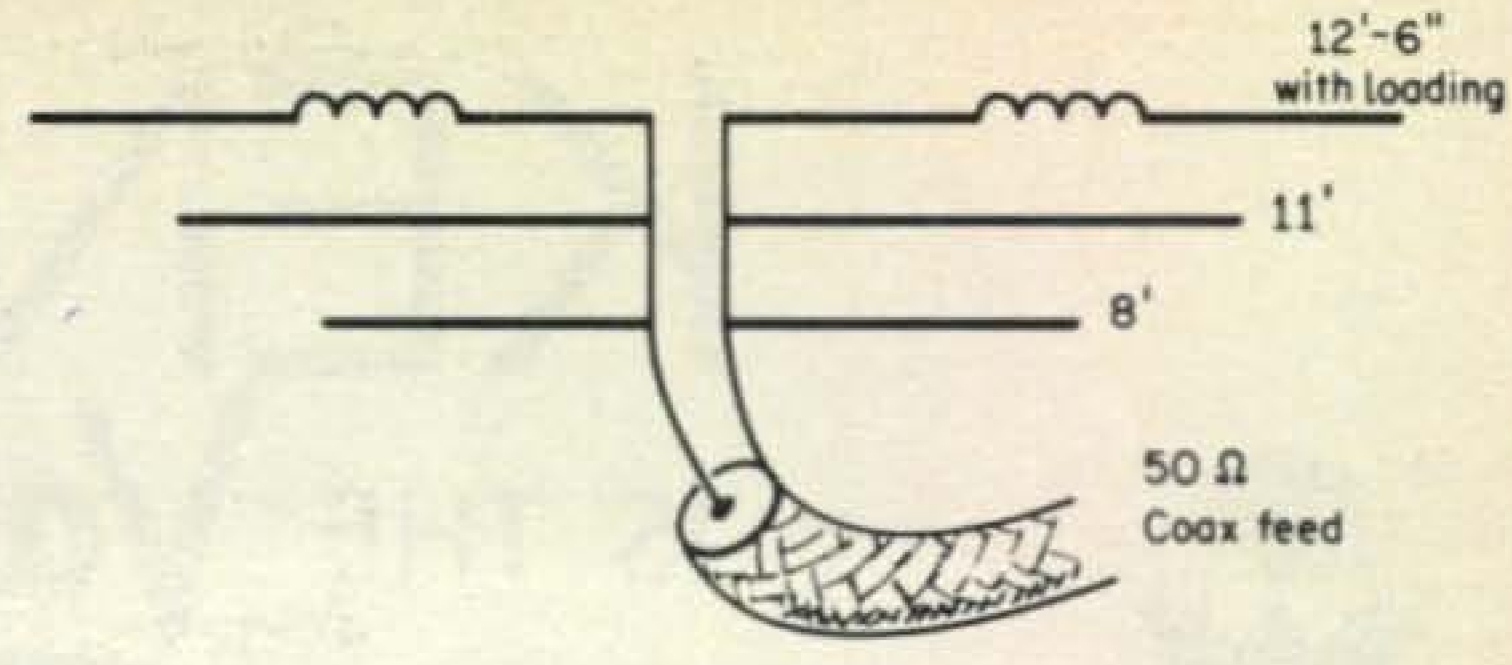


Fig. 4—As an alternative to feeding with open wire line, the G4ZU beam may be constructed with a parallel dipole driven element and fed with coax. A coaxial line balun should be used to ensure semetrical operation of each dipole half. To keep the 20 m. dipole small, series inductance loading is employed.

Captain Bird, G4ZU, included an "automatic transmatch" system in his original antenna development. This device included a fixed length of feedline and a proper choice of inductive and capacitive components in an easily constructed antenna tuner that could be adjusted so as to effect a resonant condition on all three bands. Once adjusted, the tuner required no further adjustment when going from band to band. This was admittedly a compromise system but a thoroughly practical one that has been used with wide success. If desired, this tuner may be located at the bottom of the tower and a random length of coax run into the station. This system is shown in fig. 3. In any of these tuner systems an s.w.r. bridge is placed in the coaxial line between the antenna tuner and transmitter, power applied and the tuner adjusted for maximum forward and minimum reflected power.

A still more interesting matching device was developed by Arthur Blave, ON4BX[2] in which no antenna tuner is employed. He determined theoretically and experimentally that if a feedline consisting of approximately 43 feet of open wire line is attached to the antenna, the end of this matching section will show an almost purely resistive component with an impedance of approximately 20-40 ohms depending on frequency. 50 ohm coax may be connected directly to the open line with good results.

For those who will not use open wire feeders at any cost, a system of parallel dipoles was suggested by G4ZU.[3]

Loading coils will be required on 20 meters to keep the driven element in practical

[*Continued on page 100*]

[2]"Feeder Matching System for the G4ZU Beam," Blave, ON4BX, *QST*, June 1959, p. 18.

[3]"More About the Minibeam," Bird, G4ZU, part II, *CQ*, Aug. 1958, p. 28.

G4ZU Beam [*from page 41*]

dimensional perspective with the overall antenna. This system of matching is shown in fig. 4.

Performance

Performance over a number of years has been excellent. We have not had the facility for installing a dipole at the same height for comparative gain figures. In general, the antenna performs equally well with a good 3-element single-band yagi beam on 15 and considerably better than a 3-element beam on 10 meters. The 20-meter performance is the compromise expected from a 2-element shortened beam. It radiates very well and shows considerable gain and directivity over a 20-meter dipole.

Worries of radiation by feedlines are quickly dispelled by the excellent directivity obtained in receiving. Front-to-back ratios and front to end ratios vary somewhat depending on actual director and reflector settings, however, it is probably fair to say that these ratios are nearly equivalent to those for equivalent trap beams fed with coax cable.

Enlarged Two Band Beam

In addition to the standard three band minibeam, several years ago we designed and built a two-band 20/15 meter beam of this type. This beam was used with considerable success for several months but had to be taken down when the author moved into a home without room for a full 20 meter beam. This beam employed a 20 foot boom, a 33.5 foot split driven element and a single connected 35.2 foot reflector. The director was a 21.0 foot split element shorted by a 9'1" 300 ohm 15-meter stub and a 20 meter trombone resonant at 13.5 mc. Spacing were approximately 12 feet for reflector and 8 feet for director. Matching was done with 450 ohm open wire line and a good transmatch. The beam worked extremely well on 20 meters. 15-meter operation appeared satisfactory, however time and band conditions did not permit extensive testing before the antenna was dismantled.

The G4ZU beams are somewhat complicated in theory but are easily constructed and they perform very well indeed. They may be constructed at a fraction of the cost of equivalent commercially produced trap beams. A poor man's version could be made by constructing the beam from elements made by taping copper wires to bamboo poles. ■