ADRIAN WEISS, K8EEG, ON

QRP

Being a "wandering scholar" does have its drawbacks when it comes to enjoying amateur radio operation. It seems that everytime I get a decent antenna up, I've got to pull it down and move elsewhere. This time, I thought, I'd beat the problem by getting one of those miniaturized beams that can be broken down into a six foot box for easy transportation, and then easily erected at a new QTH. All the oldtimers warned me that such an antenna couldn't do the job of a full-sized one, but I paid them no heed. Woe was me as a result. After about 15 hours tuning the miniature yagi for a decent f/b ratio and some forward gain, both field strength measurements and S-meter reports over thousand mile paths confirmed the wisdom of the oldtimers. The miniature beam was 2db *below* a reference dipole. Imagine, then, gentle reader, in what frustration and despair the following antenna was conceived.

Taking survey of available materials that were at my disposal, the following criteria emerged as project goals for the antenna: it had to be cheap, easy to toss together, easy to tune, durable enough to take South Dakota winter gales, light enough to turn with a standard TV antenna rotor, and provide good gain and f/b ratio. The antenna that was born in desperation has turned out to be a joy indeed when fed with my puny 700 milliwatt signal. Read on.

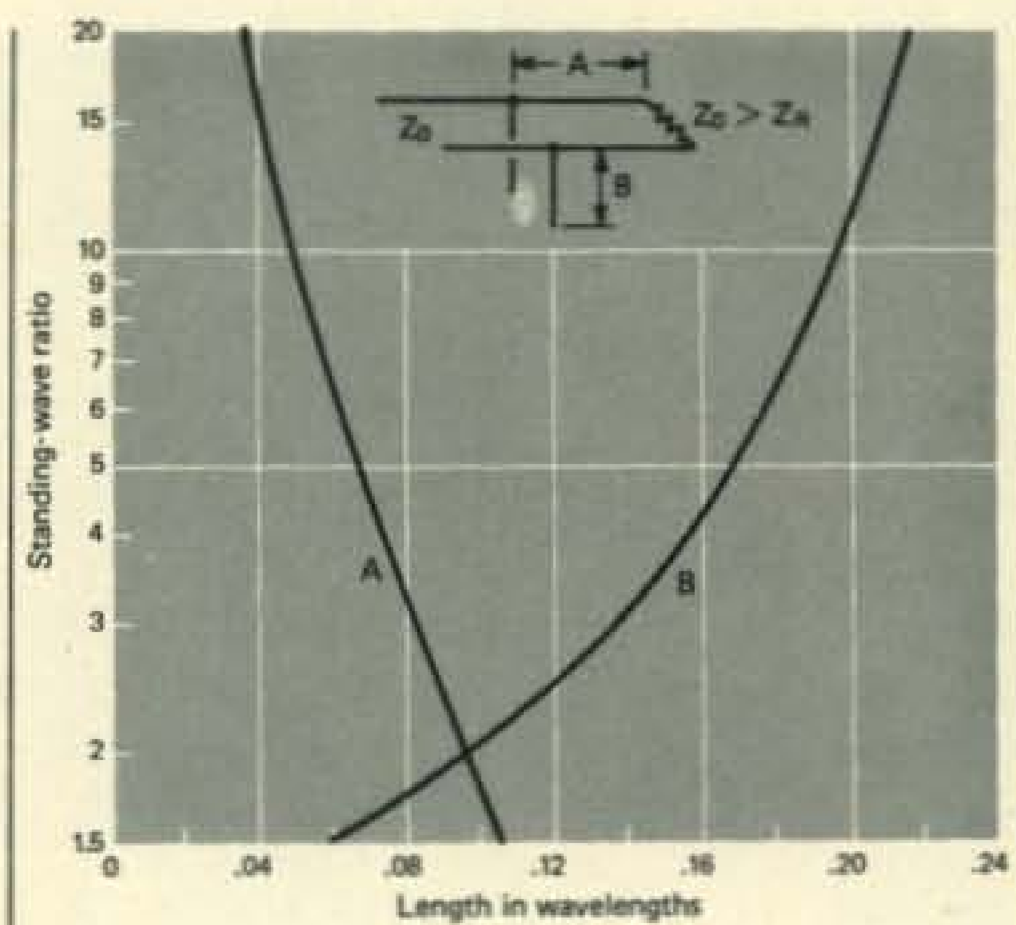


Fig. 1 — Comparitive graph of element position and length of the open stub as a function of s.w.r.

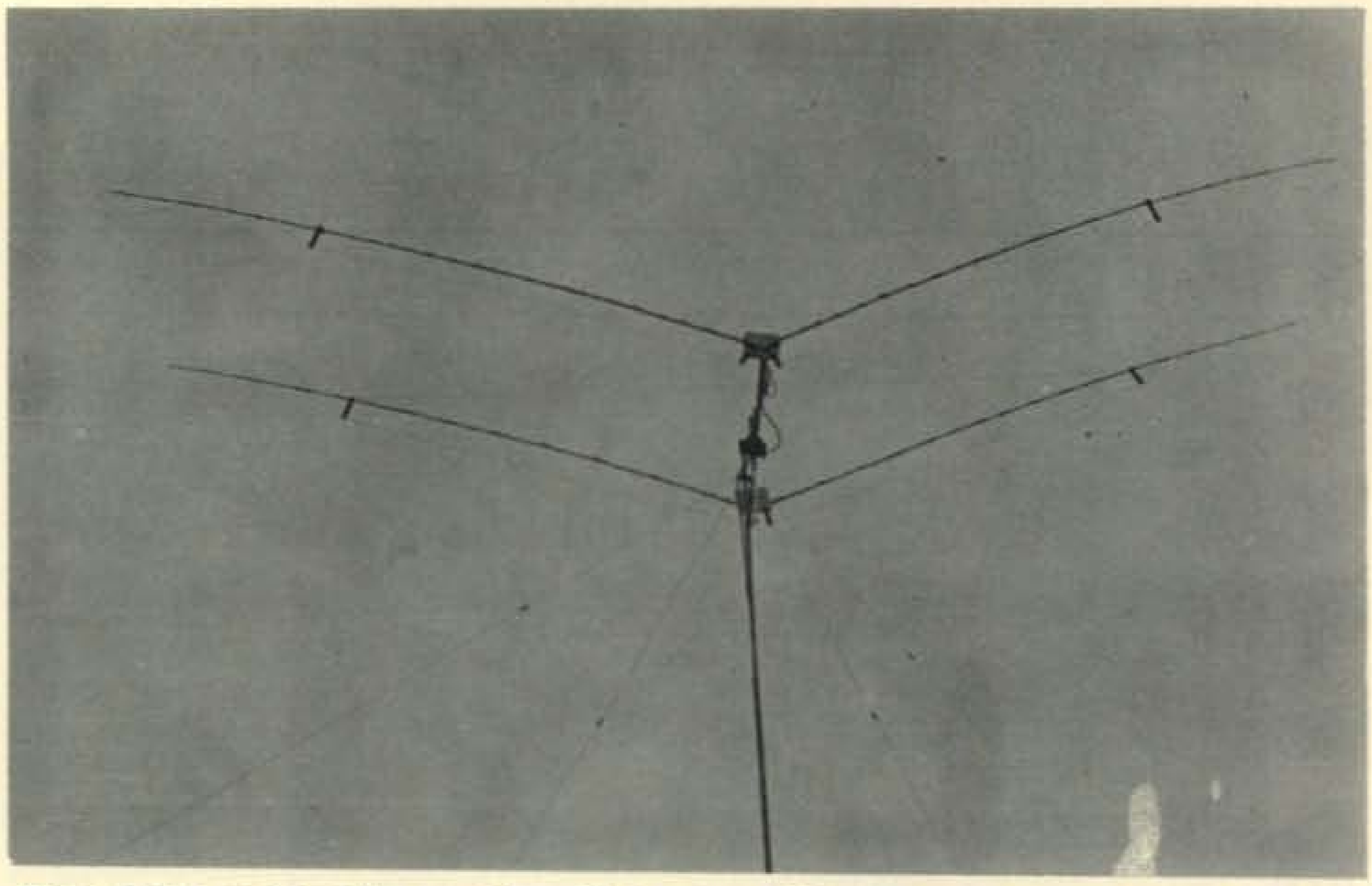
Design Theory

A bit of research into the antenna handbooks led to the conclusion that a close-spaced two element yagi with parasitic element tuned as a director would allow for maximum performance. The decision to use the parasitic element as a director—in contrast to current practice of using it as a reflector—stemmed from several factors. First, the relationship of element spacing, attainable f/b ratio, and feedpoint to the physical sizes of the corresponding types of tuning suggested the use of a director. Optimum spacing for a two element yagi using a director is about 0.1 wavelength it is about 0.16 wavelength for a reflector. In practical terms, this comes out to approximately 6.5 feet and 10 feet, respectively. The torque resulting from wind-loading is easily twice the amount for the 10 foot spacing as for the 6 foot spacing — an important consideration when contemplating the use of a standard TV rotor. Secondly, the director case has some advantage in terms of attainable f/b ratio. With the closer spacing, there is greater interaction between driven and parasitic element and this results in greater cancelation off the back of the antenna. This also results in higher-Q which in practice can mean a decrease in the effective bandwidth over which the close-spaced yagi will allow a match below a certain specific s.w.r. This had me worried a bit, but the finished product, with open stub matching to the feedline, exhibits less than 1.5:1 s.w.r. over the entire band. Thirdly, the input resistance of such an array is in the neighborhood of 30 ohms, a not unreasonable match to 50 ohm line. And finally, since we are dealing with a full-sized yagi, design and construction is straight forward with no tricks needed.

Fig. 2—Mechanical details for the economical 14 MHz two element yagi. The director tuning is done the same with a shorting bar that is moved up and down until the greatest f/b ratio is achieved.

Construction Approach

The next problem was arriving at a physical form of construction that would allow us to reach our cost, weight, and durability requirements. Aluminum tubing was out of the question because of price; weightwise, it seemed acceptable. But it simply wasn't available hereabouts. I discovered that the local hardware store carried bamboo poles for 82¢ each, and this seemed to offer some promise. The original idea was to use bamboo poles to support wire elements, but after more research, this appeared undesireable, since the effectiveness of a yagi is related in part to the diameter of its elements. An old trick occurred to me at this point. Some years back, I had used a bamboo pole wrapped with aluminum foil as a ground-plane element—after two years in the sky, the pole was remarkably well-preserved. I decided to try this approach. So far, the antenna cost me $5.28 for the poles and four boxes of cut-rate 25 ft. aluminum foil, 12 inches wide. Next, the question of the actual physical configuration was tackled. There was something unwholesome about the way the bamboo poles acted in a wind when held horizontally. It seemed that the only way to simply hold the elements in their respective planes was to mount them in a wide-angle upright "V" with a piece of nylon string strung from the ends of the elements to form a triangle. The logical way of mounting the elements was ¾ inch exterior plywood, which is much stronger than pine or other cheap woods. This could be easily done with pipe strap brackets clamping the elements to the plywood templates. After a couple of false starts, we struck upon the right method of attaching elements and templates to the boom, which was cut from an old TV mast laying around here. Four ninety-degree angle brackets could be bolted first to the boom, and then screwed to the element templates. A plywood template similarly could be used to attach the boom to the mounting mast.



When it was up I had the most beautiful antenna I'd ever seen winging its way to DX.

Assembly

The actual time to put this all together was about five hours, not counting false starts. When purchasing the bamboo poles, the correct way to evaluate a pole is to check the diameter of its small end — the larger the better. If you can get 18 ft. poles, use two for the driven element instead of a 16 footer with wire loading loops at the ends. Assembly follows this procedure. Varnish each of the bamboo poles with a heavy coat of exterior varnish—paint could be used also. By the time the fourth pole is done, the first pole will have dried to a "tacky" consistency. Roll out one of the 25 ft. boxes of aluminum foil on a sidewalk or other flat surface, cut it at the proper length, and lay a pole along its edge. Next, press the edge of the foil to the pole from one end to the other, and then simply roll the foil onto the pole. Then, beginning from the large end of the pole, twist-tighten the foil in the same direction as it is wound; leave about 6 inches of foil loose on each end so that the end loop of the driven element and the 18 inch feedline connecting wires can be inserted between two layers of foil. Insert the feedline wires and loops, twist-tighten the foil and clamp tightly with regular hose clamps. At the outer ends of the driven element, insert one end of a 48 inch piece of aluminum guy-wire, tape securely, and loop back 24 inches. Wrap the tin foil with tape for insulation, and then tape the end of the loop wire to the pole at that point. The elements are completed by wrapping plastic tape helically the entire length of the pole, with a pitch of about one turn per foot. This tape will keep the foil from peeling back during high winds. The completed elements are then mounted on the plywood templates with pipe straps, as shown in the photo. Use 1" × #10 woodscrews to hold the pipe straps in place, and make sure that the pole is held very firmly to the template. The elements are ready to mount on the boom.

To prepare the boom, cut it to the right length (6 foot in my case) and clamp four ninety-degree brackets to each end of the boom using standard muffler clamps (1½ inch dia. in the case of the typical TV mast used for the boom). After very carefully lining up the angle brackets with the edges of the boom, drill through the holes in the brackets, through the boom, and out the holes in the bracket on the opposite side of the boom. Then insert ¼ inch bolts and secure firmly. Tighten the muffler clamp all the way. Next, cut out the plywood template for mounting the boom to the mast, and pipe strap it to the boom with #10 woodscrews. Do the same for the mast. In order to avoid rotation of the mast relative to the antenna, drill a hole through the mast and template, and insert another 3 inch ¼ inch bolt and secure (once the antenna is complete and the elements are aligned with respect to horizontal, a similar hole is drilled through the boom and template, and bolted).

The yagi is ready for attachment of the elements to the boom. A suggestion here. With the element laying on the ground, place the boom on the template and use 1×12 woodscrews to secure the angle brackets to the template; before attaching the director element to the boom, resonate the driven element at about 13050 kHz (for a later resonance at about 14100 kHz). This can be done by hooking up the driven element to

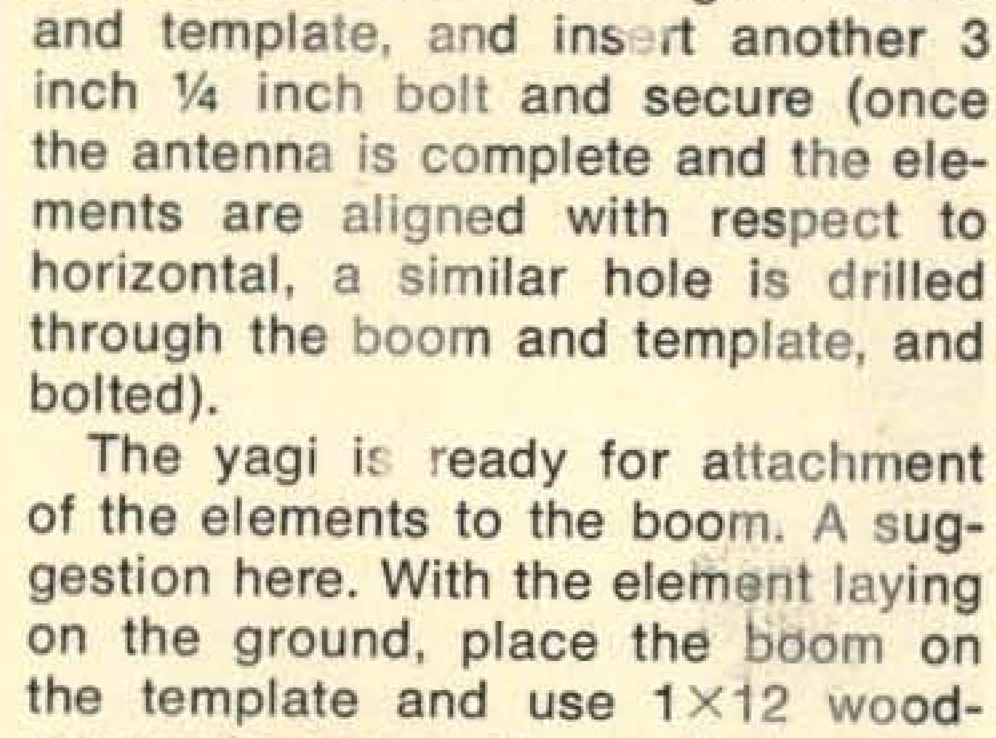
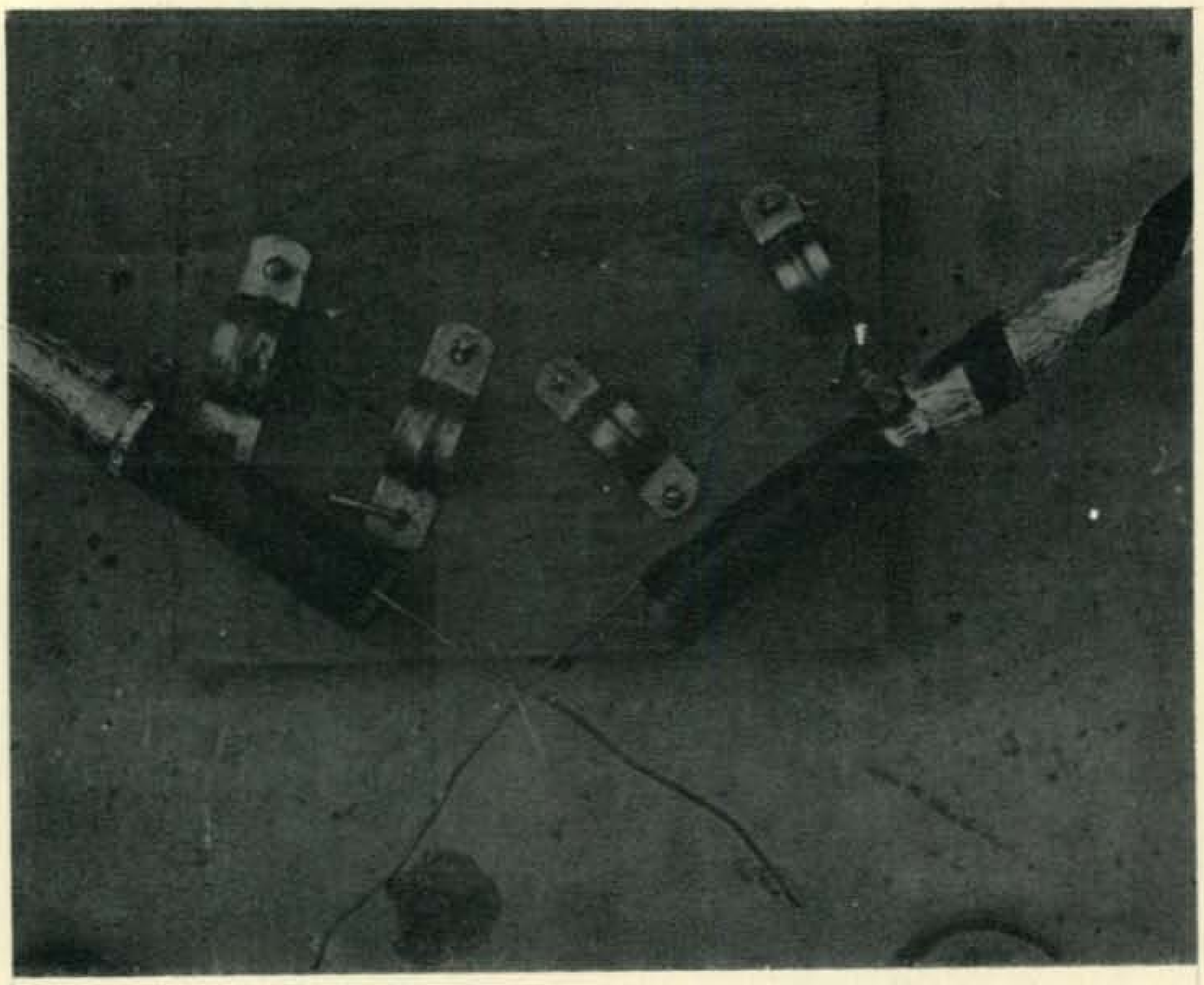


Fig. 3—The optimum theoretical gain of a parasitic element over a half-wave antenna. This assumes no inherent losses.

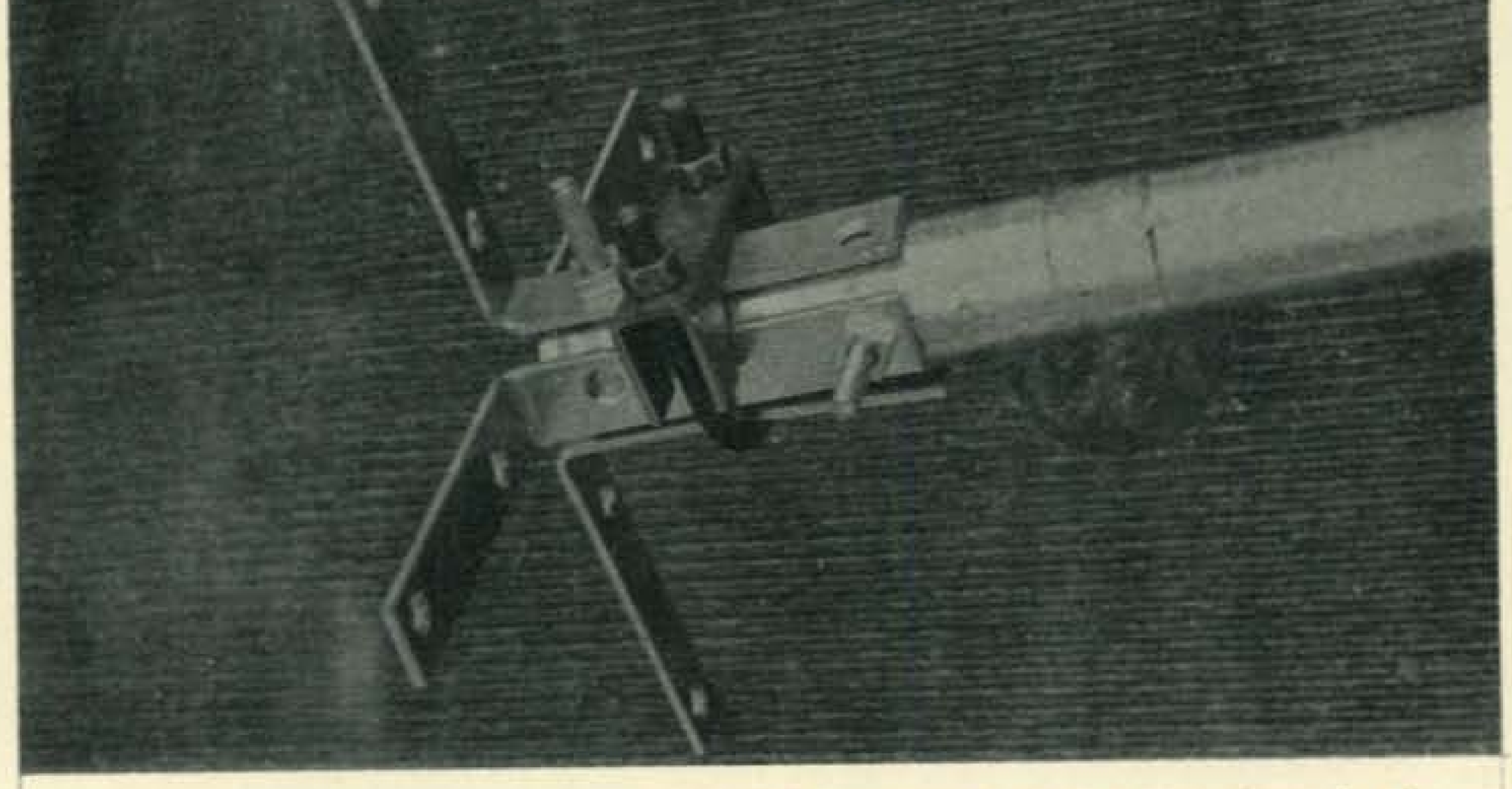


The template for the element mounts and the pipe straps used to screw the elements to the template. The wire leads are taped to the ends of the elements and secured firmly with hose clamps.

the transmitter, and tuning for a low s.w.r. at the low end of the band. The resonant frequency of the driven element is varied by moving the feedline along the feedline wires until the proper position is reached. Then the other element can be mounted on the boom in the same way. I mounted my director element with the rest of the antenna mounted on the mast, but this procedure can be done by having someone hold the driven element up while the boom is placed upon the director element as it lays on the ground. In any event, take care to align the elements so that they share the same planes. Once the director is attached to the boom, the beam can be tuned.

Tuning

Two methods are viable for tuning the beam. First, you can mount a field strength meter a couple of wavelengths from the antenna, and hook the transmitter to the antenna. A pickup antenna for the field strength meter should be sufficient to give full scale reading on the meter. It is best to tune for maximum f/b ratio, so point the beam in the direction opposite the field strength meter. Then the sliding short on the director wire leads is moved back and forth until the field strength meter gives the lowest reading off the back of the beam. Once this point is found, you can swing the beam around and see if you get a great increase in field strength reading. You should. The other approach is to tune the antenna in its receiving capacity (law of reciprocality here—it does the same on receive as on transmit). In this case, the transmitter feeds an antenna a couple of wavelengths away from the yagi, and the field strength meter is coupled to the driven element (feedline should be connected to the antenna, but unterminated at other end). Again the director tuning lead short is adjusted for minimum signal off the back end of the yagi. And that's it—it's tuned up. The actual adjustment should take about ten minutes.



Close-up of the mounting brackets and the boom end. The muffler clamp is shown in place.

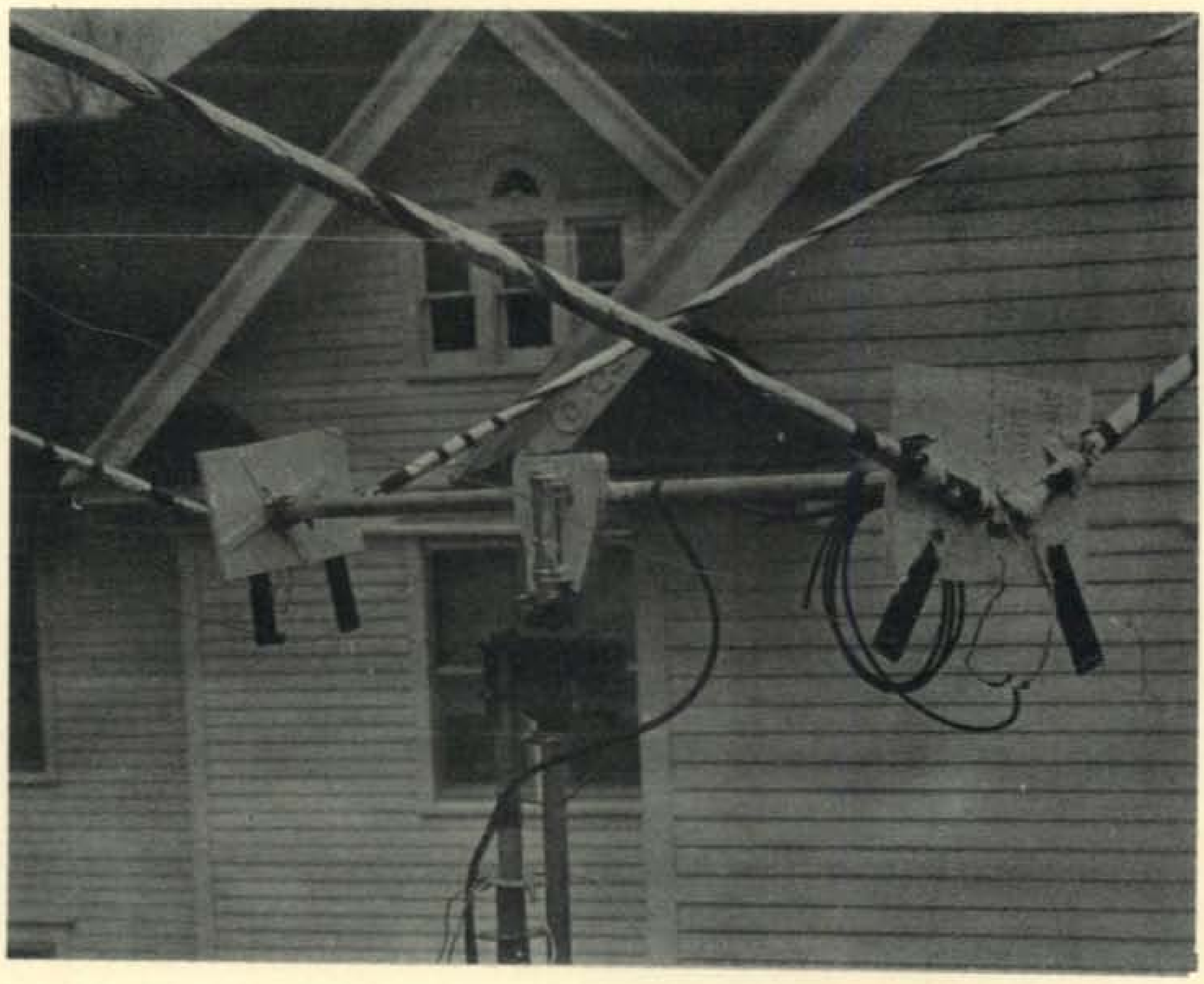
Matching

After this procedure has been completed, hook the transmitter to the antenna through a quarter wave *electrical length* (44.5 ft.—one wavelength approximately for RG-58U and RG-8U) and load up. You will notice that the s.w.r. is somewhere around 2:1 to 3:1. This is normal because of the interaction of the driven and director elements. Don't attempt to "touch up" the driven element for lower s.w.r.—it isn't the cause of it. Explanation: when you tuned the driven element for resonance without the director in place, the input resistance of the driven element (actually a half-wave dipole) presented a close match to the 52 ohm coax, hence the low s.w.r. at resonance. When the director was mounted and tuned, however, the input resistance dropped by as much as one-half and perhaps more. What we have then is a problem involving the mismatch between the input resistance of the driven element and the impedance of the coax. We can solve this problem with an open line matching stub. Some antenna basics in this respect. In order to achieve an efficient transfer of power from feedline to antenna, the ideal case is one in which the impedance of the coax equals that of the antenna input resistance: hence, a 50 ohm input resistance fed with 52 ohm coax will exhibit a 1:1 s.w.r. anywhere along the coax feedline. However, when the input resistance and coax impedance are considerably different, a "mismatch" occurs that makes the feedline behave differently. Looking at the feedline from the transmitter end, the resistive impedance of the antenna will be "seen" by the transmitter at points one-half electrical wavelength, and multiples thereof, from the antenna. At all other points on the feedline, a different impedance will be "seen" consisting of a resistive component and a reactive component. What this means, then, is that if we can find a place on the half-wave feedline at which the resistive component is the same as our feedline, say 52 ohms, we can insert our 52 ohm feedline at that point and a proper resistive match will result. But we also have to take care of the reactive component present at that point in the feedline. To take care of this reactive component, we simply shunt the feedline with a reactance of the opposite sign—capacitive, or open end stub line, inductive, or short-ended stub line. What results, then, is a matched feedline which has no standing waves along its length, regardless of length.[1] That is the principle of the matching stub that is used here. Fortunately, there is no need to fool with complex formulas in practice: since the mismatch relates directly to s.w.r., we simply measure the s.w.r. at the transmitter end of a half wavelength feedline, and then refer to Chart I for the proper *electrical* length of matching line and stub line. For final adjustment of the match, however, the s.w.r. bridge should be inserted right at the insertion point in the match-stub line. So, when you cut the match-stub line from Chart I, leave a couple inches extra for final pruning at the antenna. Simply feed the antenna through the experimental match-stub line, and cut-off or add on pieces of coax until the s.w.r. between feedline and matching point is as close to 1:1 as possible. The s.w.r. should be 1:1 down in the shack too after this adjustment. In my case, the antenna is fed with about 100 feet of RG-8U, and the match-stub lines came out to A = 52" and B = 70 inches, see fig. 2. The antenna is ready to hoist into the wild blue yonder for its DX-chasing.

The antenna described here achieves all design objectives, and appears to approach the theoretical gain and f/b ratio given by antenna handbooks for a two element yagi. Conservatively rated, the f/b ratio is 15db, with about 25db cancellation

(Continued on page 71)

[1] *R. H. Fransen VE6TW, "Antenna Theory in Practice," CQ, Vol XXIV-#9 (September, 1968), pp. 67-71).*



Details of the boom assembly on the completed antenna.

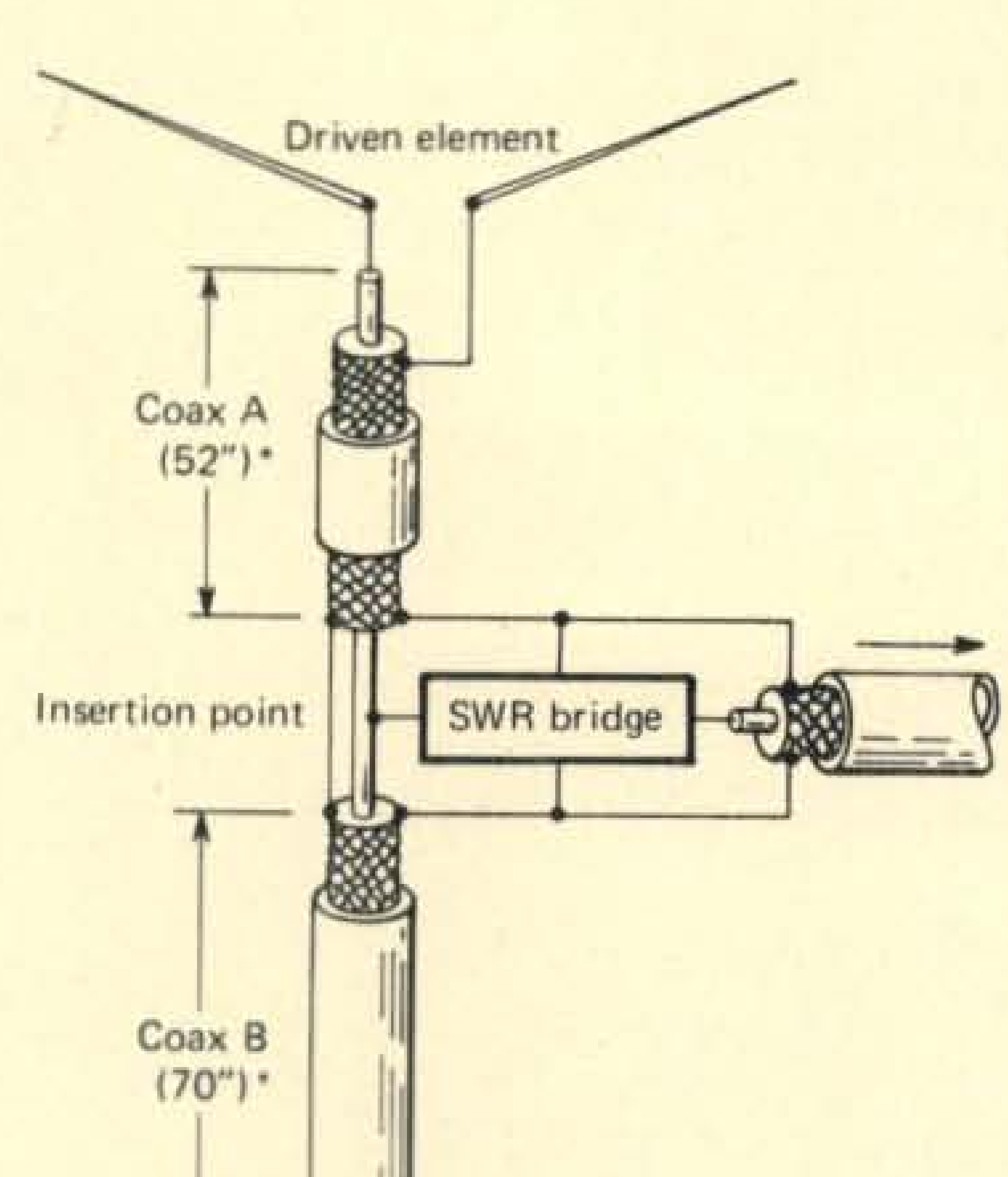


Fig. 4—Antenna stub set-up and tuning procedure. See fig. 1 for proper A and B lengths relating to the s.w.r. that you measure either at the antenna or back in the shack through a multiple B of ½ electrical wavelength of coax. The dimensions A and B shown are my dimensions for my antenna and feedline. The final tuning set-up is shown with the s.w.r. bridge between the feedline (any length) and feedpoint; after the s.w.r. is down to 1:1 nominally, remove the bridge and connect the feedline at the insertion point. A coax "T" connector could be used at the junction of coax B but it is easier to solder the feedline directly to the stubs. Use the same feedline coax for matching stub for the main feedline.

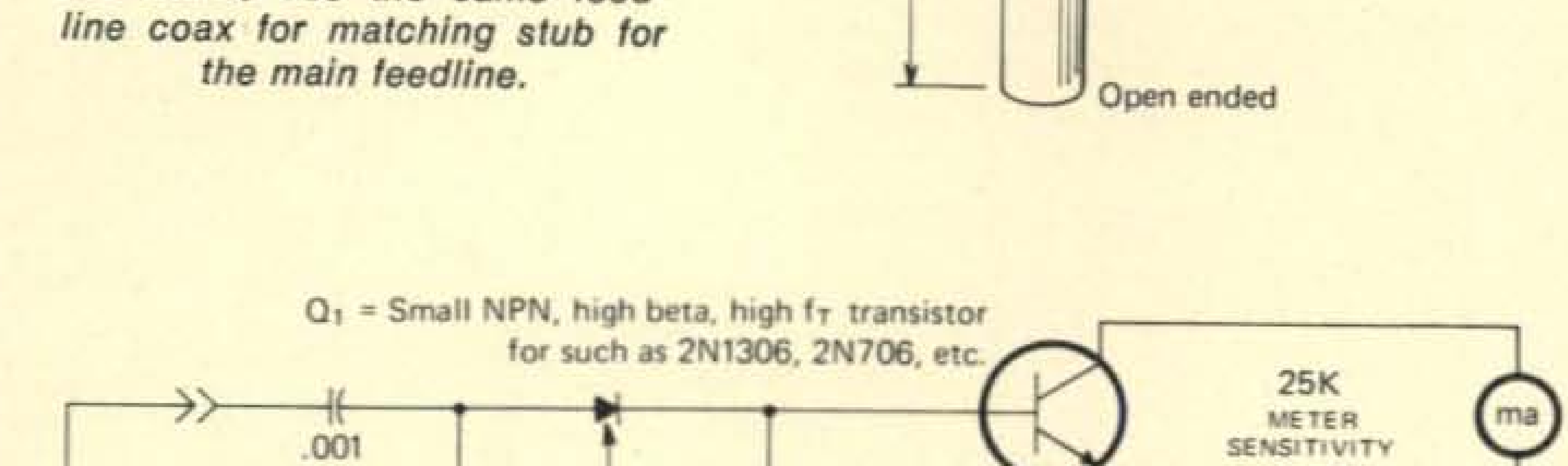


Fig. 5—A sensitive field strength meter. L1 can be anything from a single loop to at most several turns loosely wound around the driven element feedlin connecting wires sufficient to give an adequate meter deflector. The feedline should be connected at the feedpoint and unterminated at the far end (just left unconnected). This cicircuit was developed by W4EZW and published in The Milliwatt, August 1971, p. 4.

STATION OPERATORS

Multi-Operator Single-Transmitter

CT1OY & K7CBZ. **CY6AO:** CY6AGV, CY6GN, CY6CCB, CY6AVO, CY6AP, CY6ANO, CY6BK, CY6TK, CY6JD, CY6ASA, CY6CEC, CY6AMR, CY6AMU, CY6CFR, CY6CDA, CY6AYX. **XJ3AA:** VE3FFA & VE3ABG. **DLØWU:** DK4TP, DK5EZ, DJ4AX, DJ8SW. **DLØJK:** DK1DU, DK2XX, DK8ZK, DK8ZL, DF1FL, DF2FK. **DLØKL:** DJ2EH, DK7NM, DK6NN, DJ4BE, DK9NV, DK9NU. **DJØEK** & DJØBA. **DLØUE:** DL3LU, DJ5FW, DJ4GO, DK4OV, DK2SS, DL8RL. **DL8HA** & DL8CM, DL8CH, DL8FR. **DLØIB:** DF1SD, DF1SR, DF2SJ, DF2SR, DF4SN, DJ3SR, DJØRQ, DJØYI, DL1SE. **DK9RM** & DL3RJ, DL2RM, DK3RY. DLØ8W: DF3FB, DF3FD, DF2FJ. **DM2DUK** & DM2AYK. **EA8CR** & EA8LO, OH2MM. **F6DWY** & F6DXF. **FGØMM:** WA1JKJ, WA1JYY. **G3WYX** & G3HTA, G3RUV, G3TJW. **G4DAA:** G3FXB, G3MXJ, G3XBN, G3ZQW, G4BUE, G4BVH, G8KMQ. **G3RCV:** G3XMD, G3RZP, G3ZAY, G8KNW. **G3RAC:** G3XVR, G4BRK, G4ASV, G3ZZI, G8DMJ. **G8JC:** G3RMF, G3TOD, G3TOZ, G4BXS, G4CXM, G4DXD, G4DXE, G8JBU. **G5YC:** G5AQO, G8IPX, G4CEC, G4CEK, G8JQE, G8JON, G6VF, G3PAF. **G3KMI:** G3ZYW, G3WIE, G4AMI, G4CEN, G4AMH, G8KGG, G4DMY, G4ATU, G3ZER, G4DZC. **G3UNU:** G4BVY, G4DUA, GD8EXI, G8FXO, G8KDO, G8KYE, G8HNF. **G3EBH** & G3TGK. **GM3ZRC:** GM3HZN, GM3LRG, GM3LYI, GM3XNJ, GM4DGE. **GW4ENT:** GW3LDC, GW3NWS, GW4BLE. **GW3XNS** & GW3YFD. **HA3KMA:** HA3ME, HA3MG, HA3PG, Laszlo, Egon. **HA5KFN/5:** HA5HY, HA5GF, H5-513, H5-503, H5-504. **HA5KKC/7:** HA5MA, HA5MD, HA5MO. **HAØKLE:** HAØLO, HAØLZ, HAØMJ, HAØLJ, HAØ543. **HA5KDQ:** HA5KO, HA5HO, HA5FM. **HA4KYH:** HA4YL, HA4YO, Zoltan, Antal. **HA9KOL:** HA9OT, Geza, HA9PB. **HA6KNI:** HA6NN, Vegerti, Denesi, Tozer Gy, Szaboj. **HAØKDA:** HAØDI, HAØDV, HAØLK. **HA2KRB:** Dezso, Csaba. **HA3KHC:** Arpao, Ferenc. **HA6KVB:** Laszlo, Ferenc. **HA9KOV:** Istvan, Csaba. **HV3SJ:** DJ3HJ, JA4CBP, DF2GX. **I1DSG** & I1ANF, I1GUB, I1GJC, I1PCT, I1RBP, I1UW, I1VVZ. **I2VTB,** & I2OLW, I2ECV. **I1KN** & I1LBH, I1FNX. **I4JEK** & I4DZ, I4-NLO, I4MFA, I4BRC, I4YGG, I4MNY, I4MEY, I4CKM, I4XTD, I4ZRP. **I4XZC** & I4IJY, I4GZN, I4DLS. **JA2YAB:** JA2JW, JA2IYJ, JA2JSF. **KA6GYL** & KA6GRI. **JA6YAP:** Kondo, Tsutsumi, Sato, Watanabe. **JA9YBA:** JH1GUO, JH2FKX, JH2SGU, JA3VEN, JA9DZS, JA9FSU, JA9GGH, JA9DPR, JA9GLL, JA9GOE. **JA1ZLO:** Club. **JA3YCZ:** JA2UET, JH2FQW, JA3OGE, JA3XGF, JH3CFG, JA8JLT. **JA2ZAP:** Club. **KP4AXM:** K1OTI, WB2POJ, K1DPG, Grant McCartney. **LZ2KKZ:** Christo, Danko, Penkoen. **LZ1KDP:** LZ1-A-508, LZ2H57, LZ1F84. LZØBFR: LZ1CQ, LZ1KX, LZ1-E-198. **OE7UU** & OE3GSA, OE4SZW. **OH2BM** & OH2BCP. **OH6DX** & OH6JP, OH6JW, OH6KN, OH6KT, OH6UM. **OH4RH** & OH4RF. **OH3EW** & OH2CG, OH2BNP. **OK3KAP:** OK3TFN, OK3CWU, OK3TPV, OK3TFM. **OK1KSO:** OK1WT, OK1AMF, OK1JWA, OK1ADH, OK1SF. **OK1KCP:** Seti, Taclar. OK1-KSL: OK1AQ, OK1AHG, OK1FAF. **OK1KRQ:** OK1IDK, OK1AYQ. **OK3KFO:** OK3TFH, OK3TCY. **ON6MP** & ON6NL, PAØMJK, PAØEDN, PAØMPM. PI1PT: van Kessel, Saalbrink, Kokee, Klok, Bloem. **PJ8YFQ:** K4YFQ, WB4VVF. **PY1EMM:** PY1TC, PY1ZBJ PY1ZAE, PY7APS, F3TA. **PY3AHS** & PY3APH, Jacobus. **SM5AOE** & SM6BJI. **SK6AB:** SM2CUD, SM6AGR, SM6CZZ, SM6-ASB, SM7EAN. **SK2AU:** SM2DOS, SM2DYS, SM2BFL, SM2FQG. **SM5AZU** & SMØMC, SMØATN. **SP6PZB:** SP6FAF, SP6FIH. SP9KRT: SP9HMF, SP9FKQ, SP9ZW. **SP6KDA:** Club. **SP3GEM:** Club. **SP2DVH:** Club. SP9KOT: SP9ZW, SP3FYI. **SP3GUA:** Club. **UK9AAN:** UA9AN, UA9AEN, UV9AB, UW9BY, RA9AFC, UA9-165516, UL7-02671. **UK9QAA:** UA9RR, UA9-134-11, RA9QBE, RA9QAQ, UA9QAX, UK9OAD: UA9OAD, UA9ODW. **UK9CCE:** UA9EI, UA9-154-940.**UKØAAB:** UAØABY, UAØAEE, UAØ-103294, UAØ-10340, UAØ-103344, UAØ-10343. **UKØFAA:** UAØEH, UAØFBE, UAØFBA, UAØFBW, UAØ 153-69, UAØ 153-79. **UKØSAA:** UAØSCF, RAØSCO, UAØSBO. **UKØCBE:** Frolov, Turkin, Rubinshtein, Vlasov, Krivosheev. **VP2A:** WA2BCK, K2IGW. **VP2M:** VE7SV, K7JCA, VE7BD, W7EXM, VP2MF. **VP5WW:** WB4EYX, WB4-IAE, **W4EV/VP9** & WA1RFM. **WA1NZT** & K1YXK. **WA1STN** & WA1NNC. **W1MX:** WB2MZE, WA8WNU, WAØUCU. **WA1QNF** & WA1OCU. **W2HPF** & W2IIJ, WA2MBP, WA2UBM, WA3SWF. **K2BMI** & WB2RWY, WB2WID. **K2FL** & WA2POG, K3KNH. **W2YD** & WB2RKK, WA2UOO. **W2UI** & WA3KRD. **K2GXT:** WA3YBT, WA3YQE, WA2FQE. **K3GJD** & WA3VUQ, WA2KWB, WA3LQV, W3GHR. **W9SZR/3** & WB2EXK. **K3BW** & W3SS, K3JLK. **W3NX** & K3NEZ, W3DRD. **K3RLE** & WA3YHT. **WA4LZR:** W4LBT, W4LKG, WB4-HYN, WA4FCT, WB4JRM, WA4AZP, WB4OGW. **W4YWX** & W4BTZ, K4LRO. **WA4BTC** & WB4UZT. **WA4CTC** & WB4TPU. **K4WAR:** W6HGF, K7LSU, WB4GCL. **K4EBY** & K4LDR. WB5EPY & K5TSR. **WB5HVY** & WB5JWB, WA4BPK, WB5NSC, WB5NQS. **W5RRR:** W5LSZ, W5TFC. **W6ONV** & WA9-UCE. **W6PAA** & W6OWQ, WA6VEF, WB6AIN, KC6RS, OH1VR. **WB6KBK** & WA6PGB. **WB6GFJ** & WB6KRW, K6CQF, W6OAT. **W6KG** & W6DOD. **W6UA** & W6UM. **K3MNT/7** & WA1KKM, W5QQQ, WN7AGN, WA7TLK, WA7UQG. **W7VRO** & W7EKM, W7DQM, WA7ZWG. **K8YZW** & K8DVV. **WB8LDH** & W8LBM, WA8PPF, WB8RXN, WA8ILQ, WA1DXS, WB8DFK, W8CNL. **WB8-IAY** & WA8LXW, W8IMZ, B8VLG. WB8QJL & WB8NSF, WB8HNB, WB8-RMD. **W9LT** & WB9KTA, K9UF, K9UWA. **WA9PBK** & W9UDK, W9DOB, WB9NDP, WB9PUL, WA9LGT. **WB9BWU** & WA8RXM, WB9BJR, WA9AIB. **WA9IVL** & W9MLG, WA9JCO, WA9LZA. **K9KWK** & WA9FWY. **WØMYN** & WBØCMM, WBØHBS, WØMS. **WBØNHG** & WBØLEX, WBØHAD. **WØEEE:** WBØGQP, WB9FAT, Miller, Mery. **WØCIV:** WBØMHL, WBØKFM, WBØCQL, WAØUSW, KØYVI. **YO8KAN:** YO8ME, YO8MI, YO8GV, YO8AGZ, YO4KBJ: YO4WU, YO4CT. **YZ3TDX:** YZ3BU, YZ3EY. **YU4EXA** & YU1DIQ, YU1OIF, YZ4RS6633. **YZ1FJK:** Club. **YZ2CBM:** Grubisic, Koljatic. **ZL1AA:** ZL1ACG, ZL1ATX, ZL1TB. YZ1ABF: YU1OBH, YU1OBK, YU1OET, YU1OFJ, YU1NTG. 4U1ITU: K4IIF, OH2KH. **4M7AA:** Club. **ZS6ERB:** ZS6BNB, ZS6AJA, ZS6VA. **5LZA** & 5LZFT. **6D2MX:** XE2MX, W6DQX, WA6GLD. **UR2AAB:** Vlad, Al & Lenja. **UK2OAA:** Club. **UK2RBA:** UR2REN, UR2REO, UR2RDI, UR2FAB: Endel, Tonis, Margis, **UK6FAA:** UF601274, UF6FCO, UF601254. **UK7LAH:** UL7LEZ, UL7026133, UL7026177, UL7026233, RL7LAH. **UK7AAF:** Club. **UK7LAF:** UL7LBM, UL7026091, UL7026203. **UK7FAP:** UL7FAF, UL7FAE, UL702780. **UR2GKW:** UQ2ON, UQ2PJ, UQ2GBJ, UQ2OC. **UK2GAG:** Alex, Val, Alex. UK2GJB: UQ2MU, UQ2OP, UQ203791. **UK2BAS:** UP2PAJ, UP2-PAO, UP2038609. **UK2PAF:** UP2BCI, UP2BCR, UP2PAQ, UP2PAV. **UK2-PAT:** UP2BCW, UP2BCO, UP2BCT. **UK2BAV:** UP2NC, UP2MC, Jonas, Kestas. **UK2PBK:** UP2BCQ, UP20381518. **UK2BAB:** UP2BAF, UP2BBF, UP2CG, UP2038214. **UK6APA:** UA6APW, UA6101081, UA6APP, UA6ARD. **UK2AAO:** UV3CC, UA3147-19, UA3142303, UA3EAI, UA6150363, UA3ADM. **UK3ABB:** UW3BO, UV3CO, UW3FI. **UR3SAB:** UA3SCR, UA3SF, UA3SAQ, UA3151117, UA315125. **UK6LAZ:** UB50731024, UA6150262, UA6101152, UB5073470. **UK3AAC:** UA3HK, UA3AAH, UA9154139, RA3ACE, VA3AGX. **UK3ABO:** Club. **UK3QAA:** UA3QCR, UA3QAQ, UA3QDW. **UA3QAE:** UA3GO, UA3GBW, UA3GBJ, UA3QAX, UA3QDC, UA3RH. **UK3WAC:** Club. **UK4WAB:** Boris, Vlad, Gene. **UK3TBF:** Club. **UK3AAI:** Club. **UK3YAI:** Yuri, Alex, Nick. **UK3ACM:** Andrey, Andrey, Boris. **UK3MAA:** Club. **UK3EAA:** UA3EAL, UA3147146, UA3147115. **UK4LAC:** Yury, Harry. **UK3DBA:** UA3142141, UA3142531. **UK1WAA:** Boris, Igor, Oleg. **UK4AAA:** UW4AK, UA4156366, UA4156296. **UK6YAB:** UA610210, UA610280, UA6YAS. **UK6LKP:** UA6LLT, UA6150331, UA6150330. **UK6AAJ:** UA61011055, UA6101945, UA6101720. **UR4PAE:** Victor, Vlad, Mike. **UK4YAN:** UA4YAW, UA4YAL, UA409791. **UR3DCC:** UA3DBR, UA3DFT, UA3142370. **UK4PNZ:** Germ, Vlad. **UK5MAF:** UY5LK, UA6HZ, UB505922, UB5MDC, UB5MAK, UB5MCD. **UK5IAA:** Vlad, Valery, Valery. **UK5QBE:** Club. **UK5MAG:** UB5059610, UB5059611, UB50-5924. **UR5WAZ:** UB5068227, UB5WCW, UB5068398. **UK5EDB:** Vitaly, Vlad, Yury. **UK5VAD:** UB5VAO, UB5VBM, UB5VAI. **UK5IAI:** UA6LAC, UT-5AL, UB5073912. **UK5ZAK:** UB5ZAW, UB5ZAL, UB5069150. **UK5VAH:** Club. **UK5EDQ:** Club. **UK5LAS:** Club.

Multi-Operator, Multi-Transmitter

DK2BI: DK5WL, DK5WM, DK5WN, DK6WA, DK6WL, DK9WB, DC2WM. **DKØKX:** DJ1FG, DJ4PT, DJ6KA, DJ7YP, DK1AG, DK1QH, DK3RG, DK4QT, DK6QA, DK6QO, DK8BH, DK9QB, DL8OH, DL8QE. **DL0II:** DJ2YE, DJ5PE, DJ4TJ. **DL0PG:** DK2QL, DK3BJ, DJ9IE, DJ5KY, DJ9TQ, DK1QV, DK1FW, DJ1FC, DK7QC. **DLØWW:** DA2BD, DJ4OQ, DJ5NR, DK7FO, DK3ZC, DL3ZA, DL6NK, DL6OE, DB2FZ, DC6CK, DC6FF, DC6VD, DC8DE. **GB3MCG:** G3UKS, G4AYL, G3WGN, G3YPW, G3SJK, G3VCT, G4CDZ, G3RYV. **H3IKO:** HP1KC, HP1AC, HP1PM, HP1TS. **HB9H:** HB9LG, HB9AEB, HB9AGC, HB9AIB, HB9AIG, HB9AJM, HB9ALM, HB9ALX, HB9AQS, HB9AL, HB9BCD. **JA1YFL:** JR1GVZ, JE1TSD, JF1SMV, JG1CVR, JH2KKW, JA4JBT, JR6GD, JA0JCJ, JH1VSL, JH2NXZ, JF1HKX, **JH1YDT:** JH1BBT, JH1GNU, JH1AGH, JR1BSM, JH1KLA, JR1EYB, JR1FNR, JR1FVK. **JA3YDS:** JA3UOQ, JH3DDJ, JH3HRW, JR3PYW, JA4KPJ, JA9EBA, JA9FOR, JA9GLT, JA9OZG. **JA3YKC:** JA2VUP, JA3LDH, JA3ODC, JA3QJD, JA3REU, JA3RZN, JA3TRO, JA3UHW, JA3UPK, JH3AIU, JH3BBQ, JH3FZB, JH3GLP, JH3HBI, JH3-KWQ, JH3LIJ, JH3NYM, JH3PLE, JH3VES, JR3BVX, JR3WLK, JE3JBI, JE3KKC, JA5GZB. **JA6YTU:** JA6PEZ, JA6AD, JA6RCB, JA6QET, JH6AKT, JA6AAB, JA6BPA, JA6RLM, JA6BSM, JA6SVP, JA6QW, JA6ERR. **JA7YRR:** JA7CFB, JA7CLN, JA7CLX, JA7CXV. **K2CW/2** & W2LSX, K2BPP, K2JAO, K2JQR, W2BCU, WA3BNF, WB2BYW, W2FHN. **K3TGM:** WA3VVI. **K4CG:** K3WUW, WB8EAS, WB4BQX. **K6SEN:** W6PVB, WB6YBL, WB6PXP, K6BCE, K6SVL, W6BHY, K6SSN, WB6OLD. **KS6FF:** KS6DV, ZL1BTU, WS6FG, KS6FN. **LU1BAR/W3:** WA3UTA, K0CMF, LU2DX/W3. **OH1AA:** OH1NH, OH1NK, OH1NM, OH1LW, OH1IW, OH1SS, OH1SY, OH1XB, OH1ZK, OH1MD, OH1TV OH2FS, OH3NB, OH3ZC, OH6QY. **OH2AW:** OH2BR, OH2BAD, OH2BBM, OH2BCV, OH2BFS, OH2BGA, OH2BIA, OH2BMV, OH2BPB, OH2BPJ, OH2BPN, OH2EO, OH2KA, OH2VB, OH5XL. **PJ1AA:** PJ2ARL, PJ2BT, PJ2CL, PJ2CR, PJ2CW, PJ2DB, PJ2JW, PJ2MP, PJ2YD, PJ3BB, PJ9EE. **SK5AA:** SM5EUU, SM5FUG, SM5ELP, SM5FQS, SM5FYA, SM5FGU, SM5GRG, SM5FLO, SM5BVS, SM5FEX, SM5EDX, SM5FDD, SM5BFJ, SM5ACQ. **VX9A:** VE3MJ, VE3MR, VE3GMT, VE3IAA. **W2PV:** WA1ABV, W1GNC, W1GQO, WA1KID, K1OME, K1ZND, WA2AYC, WB2-OEU, WA2SPL. **WA2ZAA:** K?GL, W1GYE, K2KUR, K6SSS, W2SKE, K2UYG, W2GUH/0, W1HFB, K2BQO, WB2SQN, WA2DHF, W2GLM. **W3AU** & W3ZKH, K3EST, W3ADT, WA3AMH, W3IN, CX1EK/W4, W3AZD, WB2-JYM, WA3TAI. **W3BWZ:** K4CFB, W6AXX, WA3AFQ, WA3KSQ, WA3NGS, WN3ANE. **W3DHM:** WA3JLT. **W3FA:** W3ABC, W3GZQ, K3URZ. **W3FRY:** K3HTZ, K3DZB, W3KFK, WA3LNM, WA3RID, WA3JYB, WN3ZLU, WN3-ZLV. **W3GPE:** K3CY, K3O!O, K3W!V, WA3GUL, WA3PHO, WA3WIM, W3GM, W3GHM, WN3VYD, TI?JCC. **W3TV:** W3AOH, W3VW, K3GL. **W3WJD:** K3YUA, WA3LRO, W3BGN, W3DQG. **WA3ATX:** W5SCO, WA3COJ. **W4BVV:** K3ZNV, K4GKD, K5CIT, K6UA, K0DDA, WA3UHO, WB4BGV, WB4MRI, W3BOV, W4OCW. **W4MII:** WB?OHB, K5WTA. **W4OAW:** W4RVE, K4GTS. **W4USN:** W4DM, W4EZ, WA4JVO. **WA4YBV:** WB4GON, WB4GHF, WB4BAB. **WA5LES:** K5LZO, K5BGB, K5KYU, WB8FUO, WA5WCT, WA5ZNY. **WB5-DTX:** WA5UCT, W5BJA, W5ZSX, WB5OFP, K6MQG, WB5EEE, W5QWF. **WB5OOE:** WA5JMK, WB4JFZ/5, WB5IZN, W5TMN, K5KSI, WA5QXD, WB5KVM, WA5WWH. **W7SFA:** VE7ZZ/W7, K7HTZ, WA7OTT, CR6SM/W7, W7APN, W6BXO, WA7MEO. **WA8ZDF:** K3HZL, WA3GJU, W3GXF, K8HLR, K8IDE, K8EHU, K8RMK, IJMOI, WA8IUN, WA8VMO, WA8RWU, WA8YVR, WA8TBQ, W8KFL, WN8RIJ. **YZ2CBV:** YZ2RTG, YZ2RKE. **ZF1WW:** K3DPQ, K3JGI.

QRP *(from page 50)*

off the sides. Gain has not been measured, but judging from comparison with a dipole for receiving, it should be conservatively 4db. The small pieces of wood at both ends of the elements (see picture) support wire elements for 15 meters. Spacing is rather wide for optimum 15 meter operation, but it seems that the predictable gain is realized despite the use of #18 copper wire elements. A separate feedline and matching balun is used, and tuning procedures are the same as noted above for 20 meters. And the antenna really works on both bands. The first station that I called with the new beam on 20 meters was UA1PAA—I got him and had a solid ten minute QSO. That's not too impressive until you learn that I was running 700 miliwatts output at the time! That was my first QRPp DX and what a thrill! Over 20 countries have been worked with the minirig so far. I've really been bitten by the DX bug and gone QRO to four watts. The list stands at 54 countries now and WAC. And during a past SS contest, I racked up 27 QSO's in one hour —with 700 milliwatts. As far as stateside work is concerned, I'm thinking seriously of dropping to the 100 milliwatt level—it's too easy with 700 milliwatts and this beam. All I can say is that for about $9.00 and an afternoon's work, I've been working stations that I never dreamed of working with QRPp before. What's more, the antenna has held up beautifully under 60 mph gusting winds. And on top of that, this antenna is beautiful—it looks like some huge prehistorical eagle landing on my mast with wings outstretched. If you are looking for a cheap, dependable, and effective antenna, this could be it.

73, Ade, K8EEG/Ø

Novice *(from page 50)*

(Novice) and Element 3 (General, Conditional, and Technician) class written exams; so look for new License Manuals incorporating the new material shortly. The new study guides suggest the areas the student should study, rather than listing many sample questions, without changing the scope of the exams to any appreciable extent.

We will be looking for your News and Views, suggestions, entries for our Photo Contestant any other material of interest to the young of heart. Send all mail to: Herbert S. Brier, W9EGQ, Novice Editor, CQ Magazine, 409 S. 14 St., Chesterton, Ind. 46304.

Antennas *(from page 48)*

"It is the new Swan SWR-3 Pocket s.w.r. meter," I said. "Good for a kilowatt below 21 MHz, and 500 watts up to 30 MHz. It is rated to 55 MHz."

Pendergast reached for a screwdriver and started to remove the case.

"You don't have to remove the cover. The schematic is very simple (fig. 8). It is an uncomplicated version of the strip-line s.w.r. device, made up on a printed circuit board. Basically, it is composed of two directional couplers, back to back. One coupler is used for forward readings, and the other for reverse readings. The basic design was described several years ago in *QST* magazine."

"That looks like just the instrument for Field Day," exclaimed Pendergast as he removed the cover and peered into the little box. After a moment, he replaced the cover.

"I'll drop down to *Friendly Bob's Place* and pick one up. There's not much left in amateur radio that you can get for ten bucks." He paused as he headed for the shack door.

"What do you think about the Sunspot Cycle?" he asked. "When is it starting to go up?"

"Well," I replied, "My uneducated guess is that we will see the sunspot count starting up in August, 1976. I won't know until some time after that date that I have guessed right, but I'll make a modest wager that August will be the turning point. But conditions won't magically improve right after that. But by fall of 1977, I would