The Connecticut Shorthorn

Here's a mobile multiband antenna that will deliver a signal — it'll also help you locate your car in a parking lot!

By Andrew Pfeiffer,* K1KLO

If you've read the August 1967 issue of *QST*, it might be said you've now seen the long and the short of it. [Sorry! — Ed.] That particular issue described the Connecticut Longhorn, a horizontal, monoband mobile antenna which sprawled across the rather impressive rooftop of my 1964 Ford Country Squire. Unlike its predecessor, the multiband Connecticut Shorthorn is confined to the diminutive rooftop of my 1979 Subaru station wagon. Diminutive, too, is the size of the presently used Kenwood TS-120S transceiver when compared to that of the Heath HW-12A which was carried in the Ford. That's not where the differences end, either. The TS-120S has five bands of potential rf firepower to that of the HW-12A's single 3.5-MHz gun.

Design Concept

The difficulties encountered in designing and building a multiband mobile antenna (as opposed to a monobander) increase as the square of the bands involved; or, according to Murphy's Law no. 10: "The probability of an occurrence is in inverse ratio to its desirability." This presentation is meant to serve as a guide and stimulus for further experimentation by others and not necessarily for exact duplication.

As shown in Fig. 1, the basic antenna circuitry follows that of the original Connecticut Longhorn. Changes include a reduction in total radiator length (because of the obvious difference in car sizes); a shunt-feed inductance, L1, which is provided by three separate plug-in inductors (Fig. 2A) using a common adjustable ferrite slug; and the use of plug-in coils at L2 (Fig. 2B). Three separate inductors are used at L2 and, in conjunction with the remotely controlled ferrite slug (see Fig. 3), perform the function of a fine-tuning control. They cover the full frequency range of the transceiver along with L3 (Fig. 4), which is used only on the two lower bands. Fig. 5 shows the complete antenna assembly.

The control box for the Longhorn contained an SWR indicator and a dpdt switch with a neutral OFF position. This switch controlled the 12-volt dc motor which positioned the ferrite slug up or down inside L2 for obtaining exact operating frequency resonance.

The Connecticut Shorthorn control center shown in Fig. 6 is a bit more sophisticated. In addition to the original control complement, there's a digital up/down counter. A switch (S2) that is operated twice for each revolution of the motor shaft activates the counter. Rota-

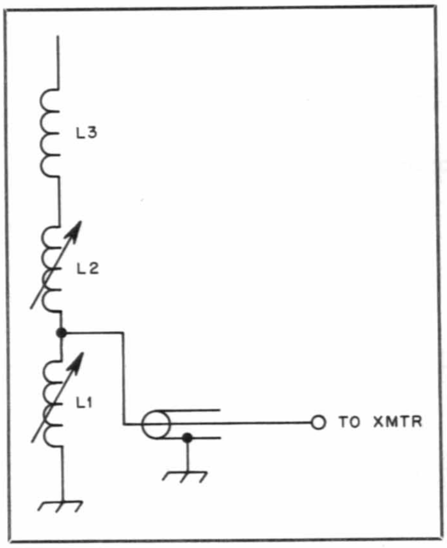
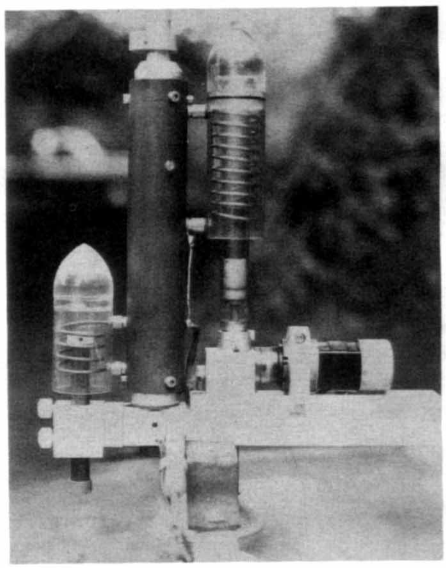
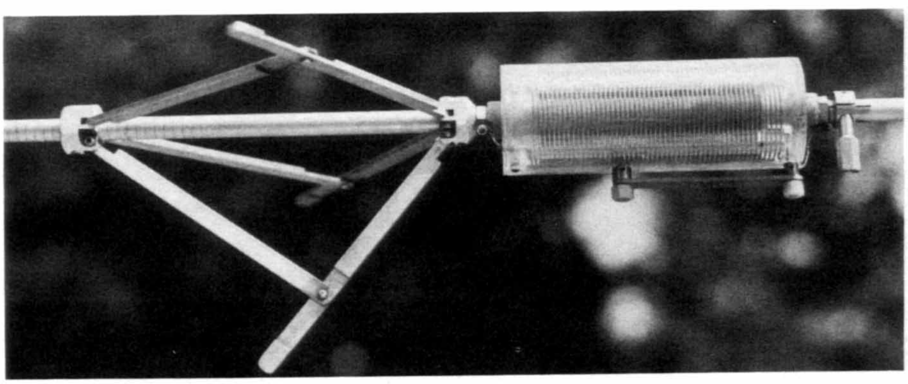


Fig. 1 — A schematic diagram of the Connecticut Shorthorn. L1 is the shunt-feed inductance and is used for impedance matching; L2 is employed for resonance adjustments; L3 is a loading coil used for 3.5 and 7 MHz operation.



A close-up view of the plug-in coil assemblies; L1 is at the left and L2 at the right of the antenna base. The tuning motor is horizontally mounted to the right of L2.



The capacitive hat and loading coil L3, used on 80 and 40 meters, are shown here.

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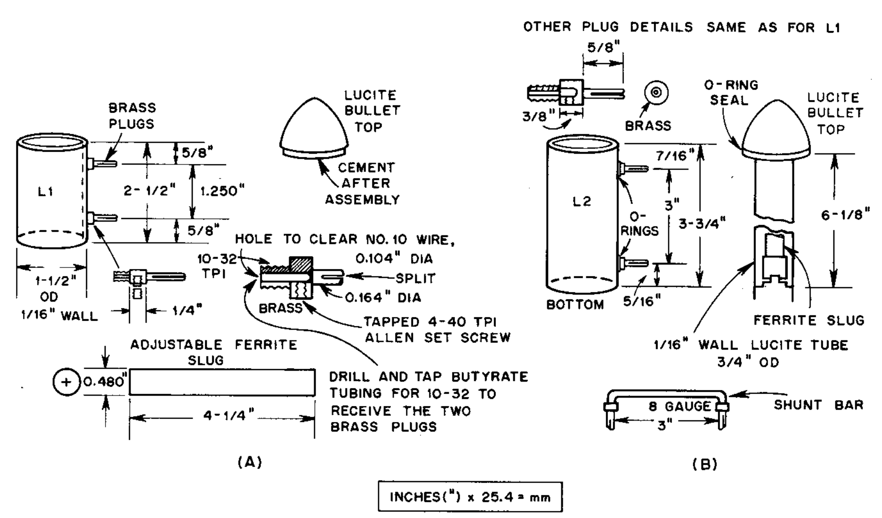


L1 Inductances

Band (MHz)	No. of turns	Wire size	Turns' spacing
3.5	7	10	wire diameter
7.0	4	10	0.25 in. (6.4 mm)
14, 21, 28	3	10	0.375 in. (9.5 mm)

L2 Inductances

Band (MHz)	No. of turns	Wire size	Turns' spacing
3.5	24	12	0.040 in. (1 mm)
7	10	10	0.190 in. (4.8 mm)
14	10	10	0.190 in. (4.8 mm)
21	3	10	0.50 in. (12.7 mm)
28	shunt bar used		

Fig. 2 — At A, the mechanical assembly of L1 and table of coil winding information are shown. Construction of L2 and its coil data are shown at B. All inductors are wound on 1 inch (25.4 mm) diameter forms. The individual L1/L2 coils are enclosed in 1-1/2 in. (38 mm) diameter, 1/16 in. (1.6 mm) wall sections of Butyrate tubing to protect them from weathering. The O-ring seal and Lucite tube attached to the bullet top were added to weatherproof L2. Note that the slug must be lowered before L2 is unplugged or else breakage will occur.

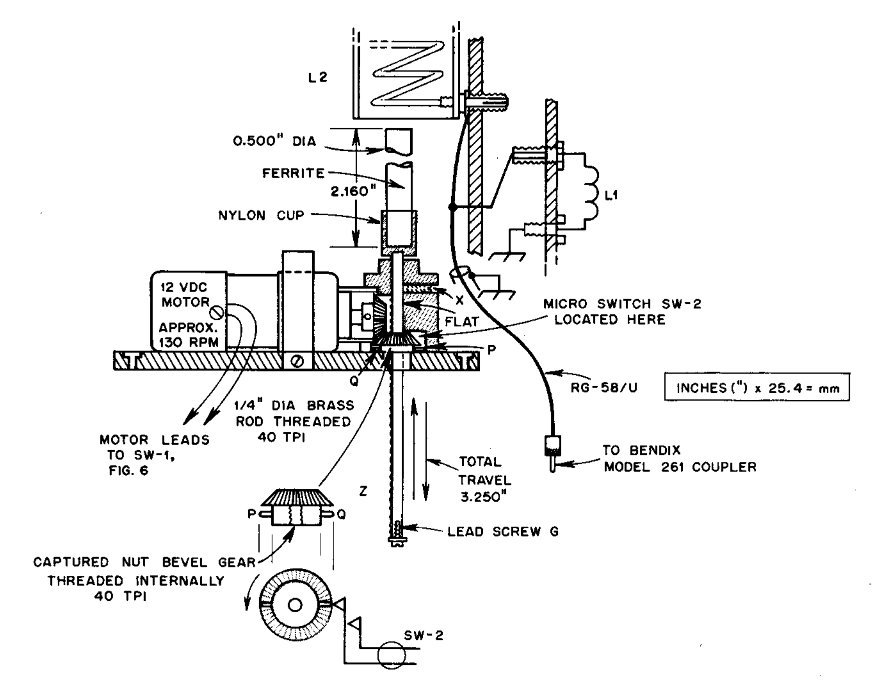


Fig. 3 — The remote variable-inductor drive assembly. Threaded drive rod G has a milled flat over its whole length; the rod is prevented from rotating by means of a set screw positioned against this flat at X. The hole in bevel gear Z is tapped for 1/4-40 threads per inch and mates with drive rod G. The motor-driven bevel gear drives the "captured nut" bevel gear Z, raising or lowering the ferrite rod inside L2. Projections P and Q on bevel gear Z activate switch S2 (see Fig. 6) twice per revolution. S2 will be activated for each 0.0125 in. (0.3 mm) of up or down travel of lead screw G. Two-conductor shielded cable is routed from S2 to the control center (see Fig. 6).

tion of the motor shaft is translated to a vertical travel of the ferrite slug in L2. The up/down counter display, visible to the operator at a glance, shows a relative number which is used to determine the position of the tuning slug in L2. Output from a free-running variable oscillator (U1) is controlled by S3 and programs the digital counter to any desired display independent of the action of S2. When a frequency change is made with the transceiver, it is important to know where the slug in L2 is located so that you can tell whether to move the resonance adjustment switch (S1) up or down in frequency.

Here's how the counter and its associated oscillator are used. The rig is set to operate at a particular frequency, say, of 7.200 MHz. The transmitter is keyed to produce a carrier and the resonance switch (S1) is activated until the resonance-indicating meter of the SWR bridge reads zero. The oscillator is then activated by S3 to display a readout of 7200. From then on, a comparison may be made between the transceiver frequency readout and that of the display counter to determine the correct direction, up or down, to move S1. The actual numbers can be logged for future reference.

Some Advice

A number of amateurs who are eager and willing to experiment with mobile, portable or fixed-station antenna systems find that, for whatever reason, the erection of a full-sized conventional dipole or vertical antenna is not feasible. Therefore, they turn to short radiators which must employ a loading coil. The following information is offered as an aid; hopefully, you can profit by my mistakes and not repeat them!

The wide-range pi-section output cir-

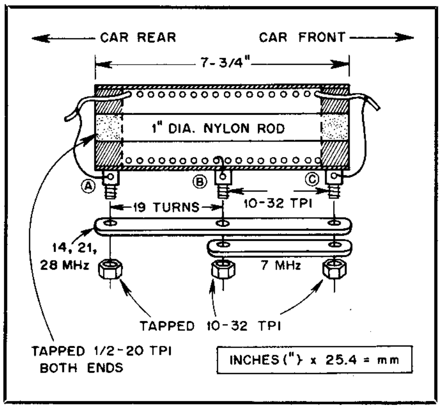


Fig. 4 — The main loading coil (L3) assembly. This coil is used on 3.5 and 7 MHz only. L3 consists of a total of 55 turns of no. 14 gauge wire wound on a 2-1/2-in. (63.5 mm) diameter form at 8 tpi. The inductor is enclosed in a 3 in. (76 mm) diameter, 1/8 in. (3 mm) wall Lucite tube. End discs are made of 1 in. (25.4 mm) thick Lucite. The brass shunt bar is placed across threaded studs at B and C, leaving a total of 19 turns of wire for 7 MHz operation; the entire coil is used on 3.5 MHz. Another bar, connected from A to C, shorts out all of L3 for 20-, 15- and 10-meter operation.

cuitry of the rigs of the past made it possible to correct for some antenna system mismatches. With modern broadbanded, no-tune rigs, we are obliged to correct any mismatch at the antenna itself. This is where corrective measures should be made in the first place — the broadbanded rigs keep us honest!

Many mobile hams I've contacted use so-called "antenna couplers" between the rig and the antenna coaxial feed line. The "coupler" will satisfy only the output impedance requirements of the transmitter and will do nothing to make the antenna resonant at the chosen operating frequency. This antenna resonance is a must if you are to realize maximum antenna efficiency.

In any and all antenna systems, two important conditions must be satisfied if we are to obtain the maximum potential output of any given transmitter. Simply, the output of the transmitter must like what it is looking into and, secondly, the antenna must be tuned to the operating frequency. In a physically shortened, loaded, quarter-wave antenna such as the Shorthorn, the Q is very high. Transmitter frequency excursions 10 kHz above or below the exact resonant frequency presented by the coil-loaded radiator adversely affect the rf output of the transmitter and attenuate the signal at the receiving point. I ran many tests that proved this. One 40-meter test, with Ole (N4ABM) in Reston, Virginia, indicated a six S-unit difference in signal strength between exact antenna resonance and frequencies 10 kHz above and below resonance during key-down cw conditions. S meters being what they are, the difference is relative, but significant. Results of similar tests at different times, bands and distances were much the same.

Shunt-feed inductance L1 and the adjustable ferrite slug used with the Shorthorn satisfy the first condition: The TS-120S is very pleased with what it is looking into. L2 and its remote-driven ferrite slug fulfill the second condition. Certainly there are other methods of accomplishing the same things — this is but one of them.

All the necessary specifications and dimensions for the construction of the Connecticut Shorthorn are given in the accompanying diagrams. Remember, however, that there are many variables. Slight changes in antenna height above the car roof (the counterpoise), physical placement of the various inductances in relation to each other and their relative position along the straight sections of the antenna system will change the resonance of the whole unit. The closer L3 is to the feed point, the lower the total inductance need be; the converse is also true.

The various inductances may be calculated, but somewhere along the line you will definitely need to use a GDO. Be sure to loosely couple the GDO to the feed line; a one-turn coil of wire is sufficient. A word about GDOs: They will see and indicate everything within their tuning range — each and every resonant response along the particular length of coaxial cable used. Be ready (particularly on the higher frequencies of 14, 21 and 28 MHz) for more than one dip!

Winding the various inductances may require experimentation. Use the largest practical wire size. Coils, with the exception of L3 and L2 for 3.5 MHz, are wound with no. 10 copper wire; L3 is wound with no. 14 wire; and L2 for 3.5 MHz is wound with no. 12 wire.

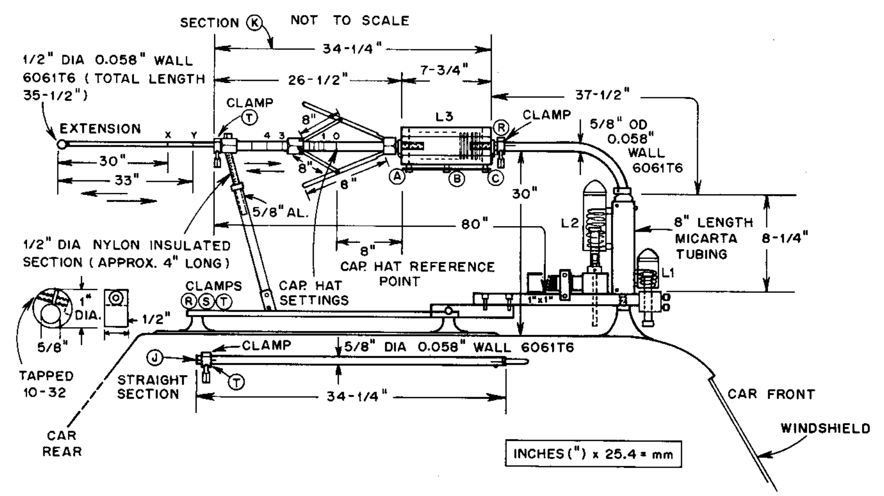
Good grounding is a must! Inadequate grounding — particularly on 14, 21 and 28 MHz — may introduce you to a new experience, rf burns. Before I'd grounded the "beast" efficiently, the car's indicator lamps flashed on and off during operation on the higher frequencies!

On-the-air tests run with stateside and European stations have indicated that the system is omnidirectional. A half-hour test run with Jim, G4JPM, during which I drove the car in a large figure-eight pattern, showed there was little or no effect upon the signal level as received abroad. Similar tests with stateside stations had more or less the same results. I've more than "held my own" in local and other stateside contacts on all bands and in DX pile-ups. During one 21-MHz DX contest contact with a station in Germany (where nothing more than the usual 5/9s were given out), I received my final pat on the back. In a "semi-pile-up," the response to my call was: "K1KLO, your signal is exceptional — 20 over 9! Good luck in the contest!"

The 3-1/2 months invested in the construction of the Connecticut Shorthorn have been rewarded. It's finished, road-tested and ready to add to the QRM!

Acknowledgments

I would like to recognize the following people who have helped with many aspects of this long and sometimes confusing project. My thanks to Ole, N4ABM, and Jim, G4JPM, for their time and patience in conducting the performance tests; to Chet, W1PE, Peter, N1AUT, and Mike Urban of the Veeder-Root Company, for their interest and help regarding the digital display counter and associated circuitry. And special thanks to my wife, Marianne. For three months she gave encouragement to an absent-minded husband who talked of nothing other than the inherent problems, goofs and glitches of this project. Marianne put up with all this, and with pride christened the finished product "The Connecticut Shorthorn"!



Freq. (MHz)	L1	L2	L3	Cap. Hat	Extension	Total Radiator Length
28	3 turns	shunt bar	J section replaces K section	0	1 in. high end 4 in. low end	84 in.
21	3 turns	3 turns	J section replaces K section	0	30 in. – X	110 in.
14	3 turns	10 turns	J section replaces K section	0	30 in. – X	110 in.
7	4 turns	10 turns	19 turns of L3*	3-3/4 in.	30 in. – X	110 in.
3.5	7 turns	24 turns	55 turns*	2-1/2 in.	30 in. – X	110 in.

*Section K with the adjustable capacitive hat and L3 are used on 3.5 and 7 MHz only.

Fig. 5 — The main antenna assembly. Details of the necessary antenna adjustments for each band are given in the table. Note: Section K with the adjustable capacitive hat and L3 are used on 3.5 and 7 MHz only.

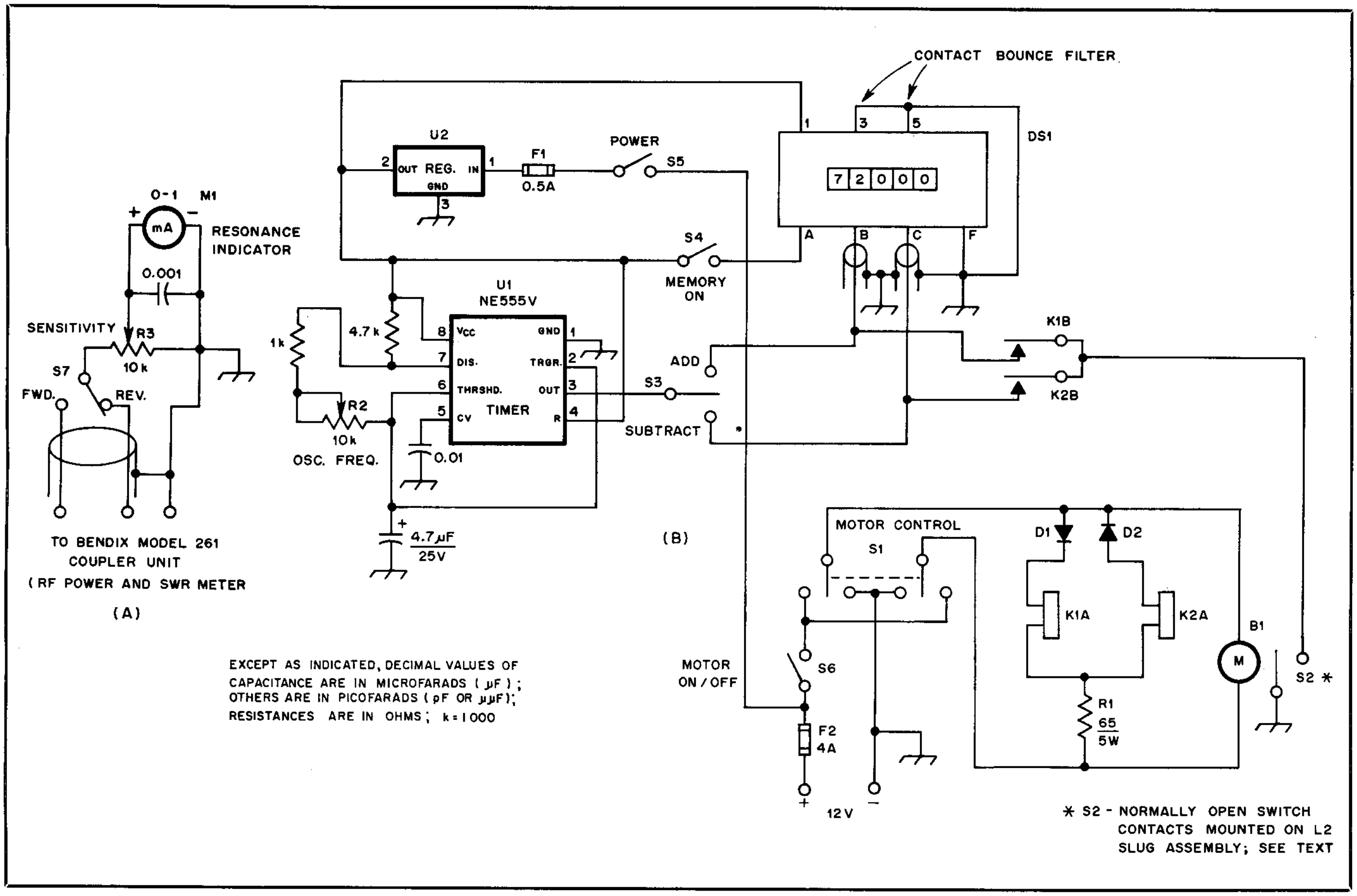


Fig. 6 — The control center diagram. Aluminum foil is used to enclose and shield the counter; the foil should be grounded to prevent receiver interference.

B1 — 12-volt dc motor, 130 rpm (surplus).
DS1 — Counter, Veeder-Root series 7996 mini-counter totalizer. (Veeder-Root, Digital Systems Division, Hartford, Connecticut 06102. Tel. 203-527-7201).
K1, K2 — Dpdt dip relay, 5-volt dc coil (Radio Shack 275-215 or equivalent).
S1 — Dpdt, center off, momentary-contact switch.
S2 — Normally open switch contacts mounted on L2 ferrite slug screw assembly.
S3 — Spdt, center off, momentary-contact switch.
U1 — NE-555 timer IC.
U2 — 12-volt regulator, LM-340-12 or equivalent.

Strays

GET IN ON THE FUN

☐ All unlicensed members: have you ever considered obtaining an Amateur Radio license? As an ARRL member, you must have. Some of the 1980's on-the-air events included special operations from the Lake Placid Winter Olympics, Voyager I Flyby of Saturn and even the special QSL from Davy Crockett's birthplace in Morristown, Tennessee. If you missed out during 1980, be sure you're in on the fun in 1981. Be prepared for future activities of this kind by getting into Amateur Radio. Write to the Club and Training Department for additional information. We'll be happy to put you in touch with a club in your area. — *Maureen Thompson, KA1DYZ, Training Assistant*

QRP MOVEMENT GROWS

☐ Low-power fans may be interested to know that the G-QRP Club has just signed up its 1000th member. He is a former RSGB president (G3HCT). John still serves RSGB as a member of its various committees. The G-QRP Club has members from 32 countries and all continents. *Sprat,* the quarterly QRP journal, is sent to all members. The club offers awards and trophies to winners of its contests, and also operates an internal QSL bureau. Club membership is open to any amateur or SWL in the world with an interest in QRP (very low power). Membership/subscription to this RSGB affiliate club is 3.5 pounds or $9 U.S. Applications should be sent to Secretary George Dobbs, G3RJV, 17 Aspen Dr., Chelmsley Wood, Birmingham, B37 7QX England.

A U.S.-based QRP organization, QRP Amateur Radio Club International, Inc., has recently changed its rules for QRP awards to a specified maximum of 5 watts output. Previously, the term "QRP" was defined by the club as 100 watts, which was rather absurd in the eyes of many QRP enthusiasts. Members must agree to run no more than 50 watts on cw and 100 watts PEP for ssb work, except in time of public service and emergency. Membership is for the life of the applicant. Information concerning membership and club activities can be obtained from President Tom Davis, K8IF, 11729 Merriman, Livonia, MI 48150. Most cw QRP activity takes place on 1810, 3560, 7040, 7060, 14,060 21,060 and 28,060 kHz. The 7030 frequency has become loaded with QRM from the "speed merchants" with their keyboard keyers in the past two years, so for U.S. operations it is better to use the 7040- or 7060-kHz frequency for low-power QSOs. In Europe use 7030 kHz. — *Doug DeMaw, W1FB*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