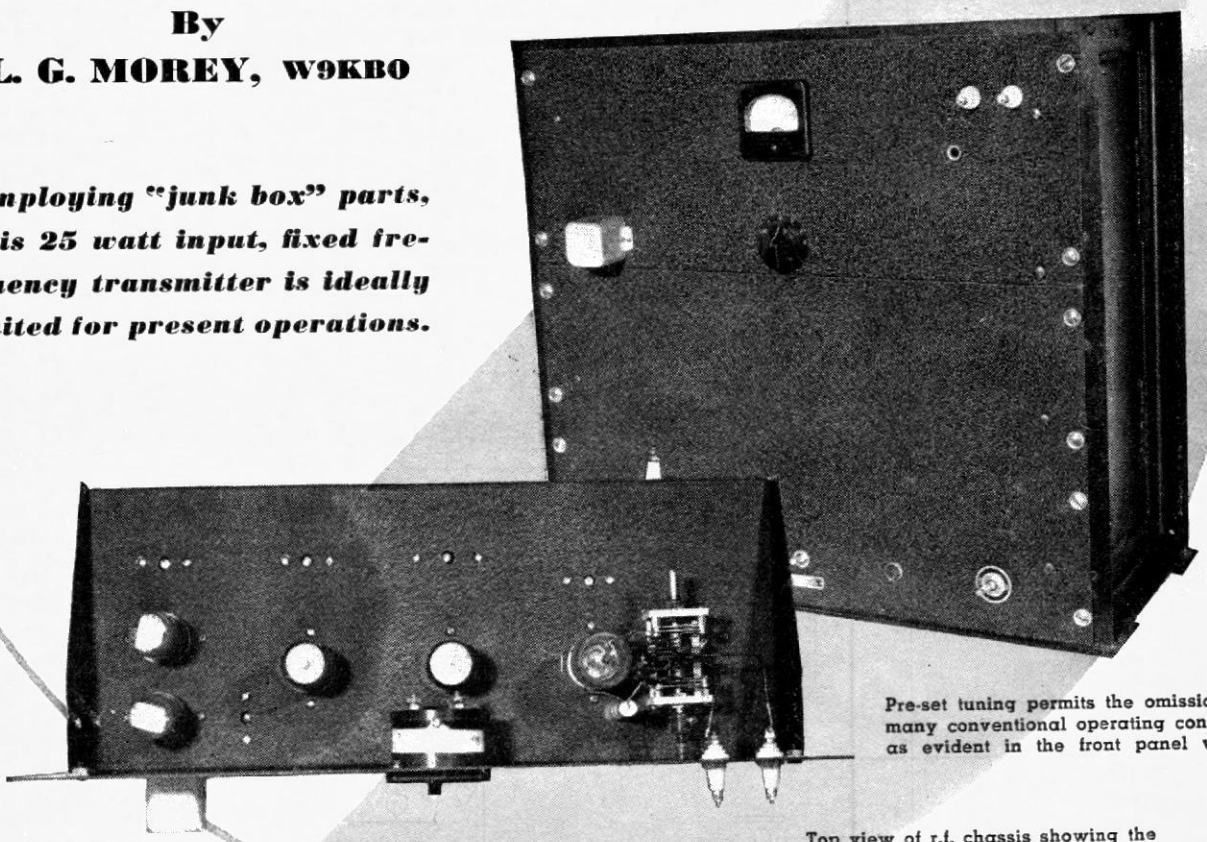
112 MC. Crystal-Controlled TRANSMITTER

By
L. G. MOREY, W9KBO

Employing "junk box" parts, this 25 watt input, fixed frequency transmitter is ideally suited for present operations.



Pre-set tuning permits the omission of many conventional operating controls, as evident in the front panel view.

Top view of r.f. chassis showing the proper placement of component parts.

IN THE design of a station for WERS net control, some of the problems that beset the average amateur at present are rather easily surmounted by the large number of junk boxes available from which to choose parts. However, even with this large selection there must be many compromises. Seldom, if ever, is the final appearance the same as it would be if the standard catalog items were available.

The design and construction of the transmitter described was the result of the ingenuity of E. J. Stanley, W9DXU. Parts obtained from many amateurs and WERS operators were used in the final rig. Although there is little that is startlingly new in the completed unit, it is felt that it will serve as an indication of what can be done at the present time.

The power limitation of 25 watts imposed on WERS stations allows the choice of several tubes for the final stage. Among those available was an HK-24. This tube offered the advantages of low inter-electrode capacities, together with low grid driving requirements, with the possibility of using more plate voltage and so increasing the power at a later date. By experiment it was determined that a 6V6GT operated at 400 volts plate supply would furnish ample grid drive.

As this transmitter was to be used for net control, it was imperative that the frequency be stable, and this indicated either a very stable oscillator of the self excited type or the use of crystal control. Search of the available crystal indicated a large quantity of 7 mc. crystals in the hands of various members. The use of 7 mc. crystals required that the frequency be multiplied sixteen times to arrive at the output frequency.

Experiment showed that sufficient drive for the final stage could be obtained by the use of a tri-tet oscillator using a 6V6GT on 7 mc. with the plate circuit tuned to the second harmonic, followed by three 6V6GT doublers, capacity coupled, and the third one in turn, link coupled to the final. With 300 volts on the plates of the oscillator and first two doublers, the 6V6GT third doubler is driven sufficiently hard to push the final to 10 ma. grid current under load.

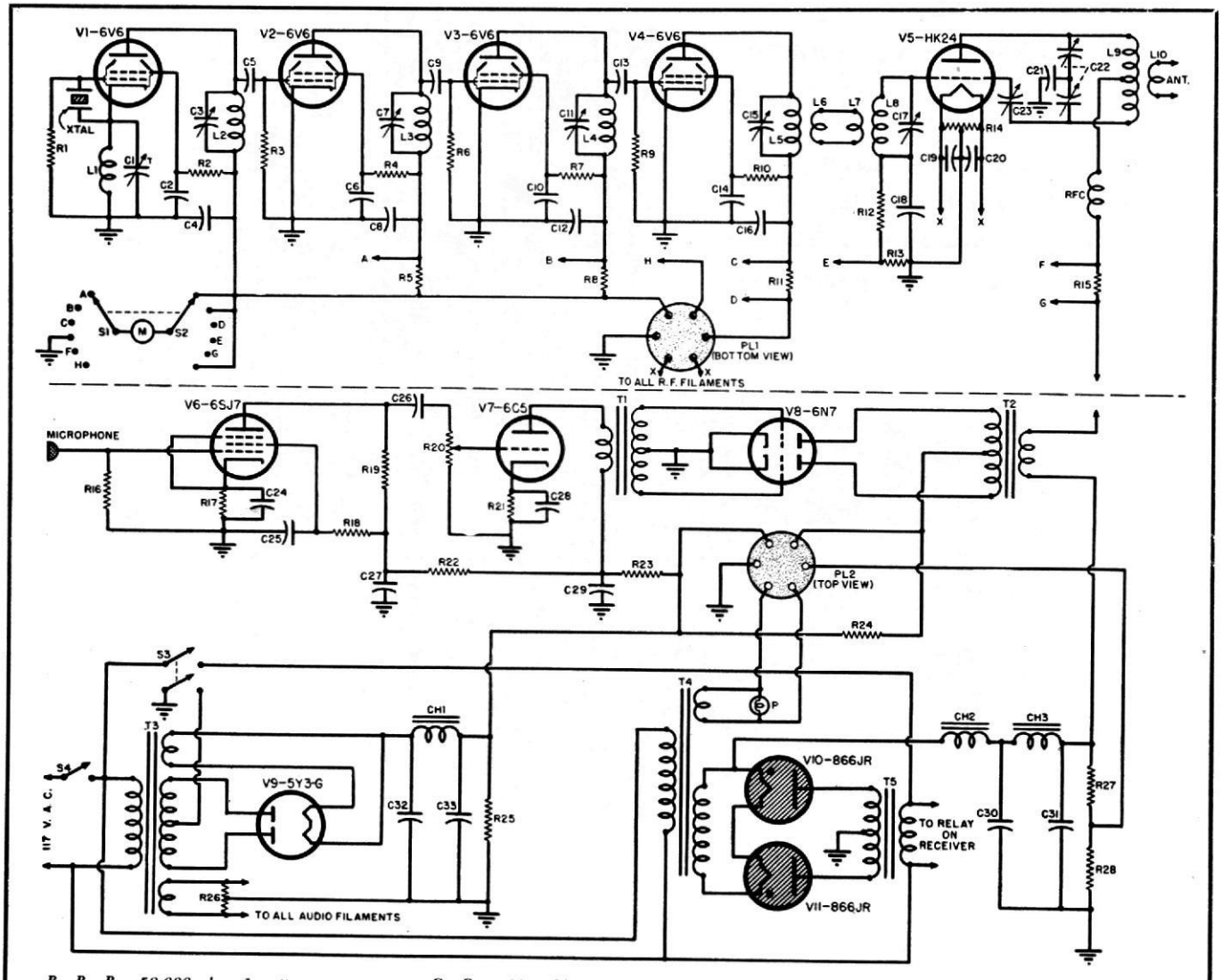
The entire transmitter is constructed in two sections with standard rack and panel construction and mounts in a homemade rack, welded from 1¼" angle iron. Sides for the rack, made of thin sheet metal, are

welded in place to give the effect of a cabinet enclosure. The lower section is constructed on a 7" x 17" by 3" chassis and contains the speech and modulator system, together with both power supplies. The front panel for this unit is 10½" x 19" and is made of 16 gauge steel notched to standard panel dimensions. Controls along the lower edge of the front panel are, from left to right, microphone input, gain control, send-receive switch, pilot light, and power switch. Parts are located on the chassis where most convenient. A general idea of the layout in this particular model may be obtained from the photograph of the lower portion.

The speech system consists of a crystal microphone, followed by a high-gain 6SJ7 which feeds the 6C5 driver for the class "B" modulator. A common power supply, consisting of a replacement type power transformer together with the 5Y3G rectifier and the filter circuit Ch_1, C_{32} and C_{33}, furnishes the plate power for the audio system and the first three tubes of the r.f. section, along with the filament current of the audio section. The plate supply for the r.f. final and V_4 driver is furnished by the transformer T_5. While this transformer has considerably more capacity than required, it was the only one available at the time this unit was constructed. If a 5R4GY rectifier is available it may be used to replace the pair of 866 Jr's used.

The switch S_3 is used as a standby switch, cutting the plate voltage of both the final power supply and the low voltage power supply. When the switch is thrown to the send position, the voltage appearing across the primary of T_5 is used to energize a normally closed relay mounted on the receiver. This relay is wired to the

Diagram showing the r.f. portion of the transmitter segregated by a dotted line from the modulator and power supplies.



R_1, R_2, R_3—50,000 ohm, 1 watt res.
R_4, R_7, R_{10}, R_{22}—20,000 ohm, 2 watt res.
R_5, R_8, R_{11}, R_{13}, R_{15}, R_{24}—25 ohm, ½ watt res.
R_6, R_9—100,000 ohm, 1 watt res.
R_{12}—4000 ohm, 10 watt res.
R_{14}, R_{26}—50 ohm, C.T. wirewound res.
R_{16}—5 megohm, ½ watt res.
R_{17}—3000 ohm, ½ watt res.
R_{18}—2 megohm, ½ watt res.
R_{19}—250,000 ohm, ½ watt res.
R_{20}—500,000 ohm, gain control pot.
R_{21}—2000 ohm, ½ watt res.
R_{23}—10,000 ohm, 10 watt res.
R_{25}, R_{28}—20,000 ohm, 50 watt res.
R_{27}—2000 ohm, 25 watt res.
C_1—10-70 μμfd. mica padder cond.
C_2, C_4, C_6, C_8, C_{10}, C_{12}, C_{14}, C_{16}, C_{18}, C_{19}, C_{20}—.005 μfd. mica cond.
C_3—50 μμfd. midget variable cond.
C_5, C_9—100 μμfd. mica cond.
C_7, C_{11}, C_{15}, C_{17}—25 μμfd. midget variable cond.
C_{13}—50 μfd. mica cond.
C_{21}—.001 μfd. 1000 v. mica cond.
C_{22}—15 μμfd. per section dual—.030" spacing variable cond.
C_{23}—Neutralizing condenser—National NC-600
C_{24}—5 μfd. 25 v. elec. cond.
C_{25}—.05 μfd. 400 v. cond.
C_{26}—.01 μfd. 400 v. cond.
C_{27}, C_{29}—4 μfd. 450 v. elec. cond.
C_{28}—10 μfd. 25 v. elec. cond.
C_{30}, C_{31}—4 μfd. 1500 v. oil filled filter cond.
C_{32}, C_{33}—8 μfd. 450 v. elec. cond.
T_1—Driver transformer—Single plate to P.P. grids
T_2—Modulation transformer—8000 ohm primary to 10,000 ohm secondary
T_3—375-0-375 @ 150 ma., 5.0 v. @ 3.0 a., 6.3 v. @ 5.0 a. power trans.
T_4—5.0 v. @ 2.5 a., 6.3 v. @ 2.0 a. fil. trans.
T_5—600-0-600 v. @ 200 ma. plate trans.
Ch_1—150 ma. filter choke
Ch_2, Ch_3—150 ma. filter chokes
RFC—Ohmite type Z, r.f. choke
S_1, S_2—2 pole 6 position meter switch
S_3—D.p.s.t. toggle sw.
S_4—S.p.s.t. toggle sw.
V_1, V_2, V_3, V_4—6V6GT
V_5—HK24
V_6—6SJ7
V_7—6C5
V_8—6N7
V_9—5Y3G
V_{10}, V_{11}—866 Jr.
M—0-100 ma. meter
L_1 to L_{10}—See coil table
P—6.3 v. pilot light

standby terminals of the receiver and disables the receiver when the transmitter is on. The additional socket mounted along the rear edge of the chassis is used as the terminal for this connection. All power connections from the power unit terminate in the six prong socket located near the center of the rear edge of the chassis. The standoff insulator mounted near the left hand side carries the plate lead for the final amplifier.

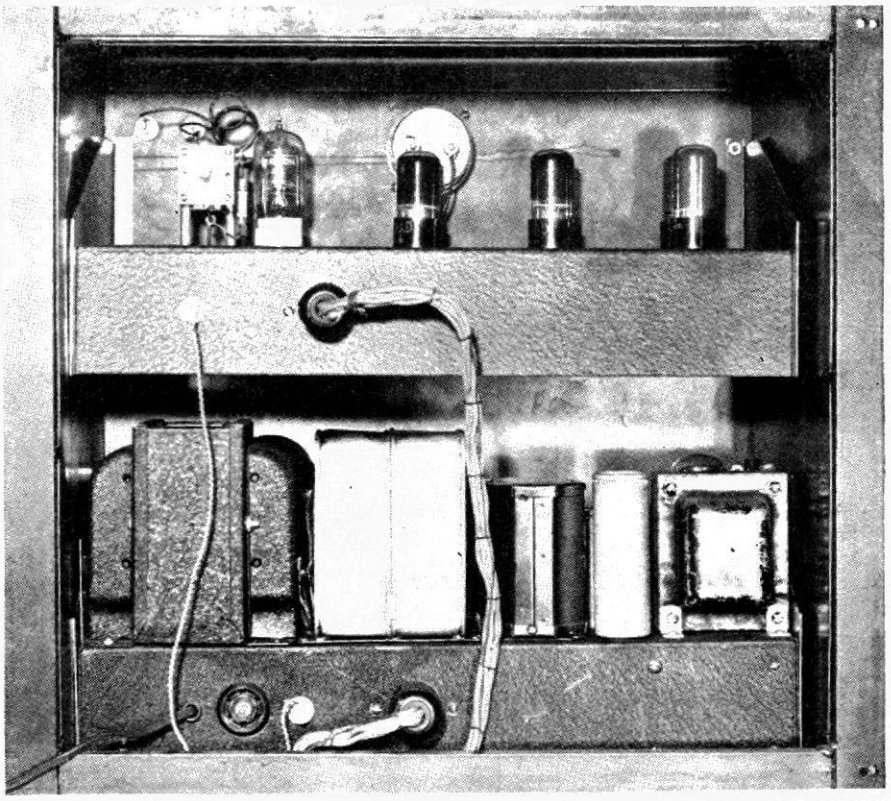
The upper deck contains the r.f. section mounted on a 7" x 17" by 3" chassis and uses a standard 7" by 19" front panel. To give more clearance for the tubes, the chassis is mounted so that it projects about one inch below the lower edge of the panel. The abbreviated shield can, at the left hand side of the panel, is used to cover the crystal holder to prevent "borrowing." A 0-100 ma. meter is mounted in the center of the panel with its meter switch below it. Antenna terminals are mounted in the upper right hand corner. The small hole located below these terminals is to allow screwdriver adjustment of the final tank condenser, C_{22}. While it is unusual to have a transmitter with no tuning controls on the panel, this unit was built to operate on a fixed frequency, and it was felt desirable to put the controls out of reach of the curious. In a transmitter for general use it would be preferable to bring the tuning controls out to the front panel.

In the top view of the r.f. section the holes allowing screwdriver adjustment of the tuning condensers may be seen near the front edge of the panel. R.f. coils in all cases are mounted directly on the tuning condensers, allowing the minimum of lead length. The neutralizing condenser, C_{23}, is of the type made for neutralizing 6L6's and is mounted above the chassis by means of its standoff insulator.

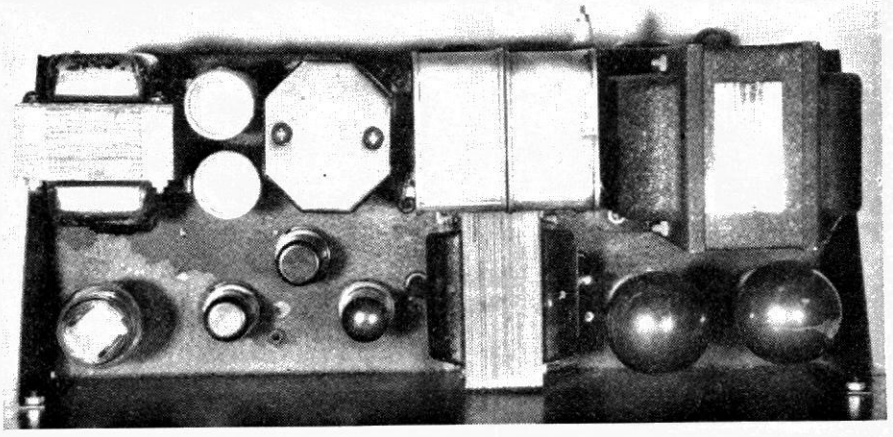
As meters are scarce items these days, only one meter was used in the entire transmitter and provision was made to switch it into the circuits it was desired to meter. This is accomplished by means of measuring the drop across the resistors located in the appropriate circuits. In the case of the doubler circuits this also includes the screen circuits, so this should be taken into account when measuring the plate current of these stages.

The power cable interconnecting the two units, as well as the lead carrying the modulated plate voltage for the final, are made of sufficient length to allow the units to be placed side by side on the bench for preliminary testing. If desired, they may be cut to the proper size when adjustments are completed.

When construction has been completed, the tubes should be placed in their proper sockets, leaving the plate lead to the final disconnected. After the tubes have had a chance to warm up, the plate voltage should be applied



Employing standard rack and panel construction, this rear-view photo shows the r.f. chassis top and modulator and power supplies bottom.



Top view of power supplies and modulator chassis. Transformers along with the other component parts are properly placed to prevent intercoupling.

and the stages tuned, starting with the cathode circuit of the crystal oscillator. The proper adjustment for this condenser is near minimum capacity. The plate condenser of the oscillator, C_2 should then be adjusted to give the maximum output on the second harmonic of the crystal. Varying the cathode condenser slightly should result in a position which will allow the plate condenser to be tuned through resonance with little effect on the crystal frequency. The optimum adjustment for the cathode condenser is that one which gives the desired output with as low a capacity setting as possible. This will result in low crystal current and consequently little heating and drift.

If an absorption type wavemeter is available, it will prove very useful in locating the proper harmonics. Lacking this piece of equipment it will be rather difficult to determine which harmonic is actually being used.

The plate circuit of the first doubler should now be tuned to the 28 mc. band. Resonance is indicated by a dip in the plate current of this tube. The dip on the third harmonic will not be as pronounced so it will be fairly easy to determine the harmonic to which the circuit is tuned.

After the first doubler has been tuned to the proper frequency, the same procedure should be followed for the second doubler, tuning its plate circuit to the 56 mc. band. In this case also, resonance will be indicated by a

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ing for *Minneapolis-Honeywell*, will also assume the responsibilities of E. B. Evleth, general manager of *Brown Instrument*, who has requested that he be relieved of his duties because of ill health.

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COLBY H. KNAPP has been named supply sales manager for *Stromberg-Carlson Company's* telephone division according to an announcement by Lloyd L. Spencer, vice-president in charge of sales.

Mr. Knapp joined the company in 1927 and has served as assistant Chicago supply manager, Chicago supply manager, radio and telephone representative in the states of Illinois and Iowa, telephone sales representative in Indiana and Wisconsin, and Chicago office manager and cashier. During the war period he was a member of the priorities department at the main office in Rochester, N. Y.

Mr. Knapp will continue to make his headquarters at the company's Chicago branch office located at 564 West Adams Street.

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EDWARD H. FRANK has been named office manager for the *Westinghouse* lamp division's northwestern district headquarters in Chicago.

Mr. Frank joined *Westinghouse* in 1916 in the St. Louis office of the lamp for the central district office in Pittsburgh since 1940. He succeeds George A. Olsen, who has joined the *Westinghouse Electric Supply Company* division and has been office manager in Milwaukee, Wisconsin.

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dip in the plate current although it will not be so pronounced due to the greater circuit losses.

The tuning of the third doubler is similar, although in this stage the dip in plate current will be very slight. This plate circuit should be tuned to the 112 mc. band in this case. This will complete the preliminary tuning of the exciter stages.

The meter should now be switched to read the grid current of the final, and the tuning of the final grid circuit adjusted to give the maximum reading. It will probably be necessary to re-adjust the tuning of the third doubler slightly as the final grid is varied. If sufficient drive is not obtained the links around both the third doubler tank and final grid should be adjusted.

The final amplifier is now ready for neutralizing. The plate circuit of the final should be tuned through resonance, at the same time watching the grid current. Proper neutralizing is obtained when the final can be tuned through resonance without affecting the grid current. It will probably be necessary to retune the grid circuit as the neutralizing condenser is adjusted. When neutralizing is perfect, all stages should be retuned for maximum output.

Plate voltage should now be applied to the final by connecting the lead from the modulator. With no antenna connected, the plate current of the final at resonance should dip to about 10 to 15 ma. A 25 watt bulb should now be connected across the antenna terminals and the loading adjusted to give maximum output by varying the coupling of the output link. As the legal limit of input power for WERS work is 25 watts and the plate voltage is 500 volts, the maximum plate current will have to be kept below 50 ma.

A microphone can be connected to the input, and the gain control adjusted for proper level. The lamp bulb should increase in brilliancy as the microphone is spoken into, 100% modulation being indicated by a nominal increase in brilliancy. If operation appears satisfactory, the output frequency should be checked by means of a reliable wavemeter or well shielded receiver. The antenna may now be connected and the output link again adjusted for proper loading, and the transmitter is ready for use.

Table I. Coil data providing necessary electrical and mechanical requirements.

COIL	FREQ.	TURNS	WIRE SIZE	DIAM.	LENGTH
L_1	7 mc.	8	#20 p.e.	¾"	Close wound
L_2	14 mc.	11	#20 p.e.	1"	½"
L_3	28 mc.	7	#12 tinned	⅞"	¾"
L_4	56 mc.	4⅛	#12 tinned	⅝"	⅝"
L_5	112 mc.	2	#12 tinned	⅝"	½"
L_6	Link	2	#20 push-back	⅝"	At "cold" end of L_5
L_7	Link	2	#20 push-back	⅝"	At "cold" end of L_8
L_8	112 mc.	2	#12 tinned	⅝"	½"
L_9	112 mc.	4	#12 tinned	1"	1⅛"
L_{10}	Output	2	#20 push-back	⅞"	At center of L_9

This transmitter has been in use three times a week for the past two years with no adjustments whatsoever and has maintained consistent communication with stations located in a radius of twenty miles. Signal strength has been reliably good and the quality of speech reported excellent. Just an example of what can be done with a little ingenuity combined with several junk boxes.

Now that FCC has announced the resumption of amateur operation on the 112 to 115.5 mc. band, a transmitter of this type will be necessary for the crowded conditions of the near future.