PART II of the three-part series on high power mobile radio systems by WBDOG and WBOFPH describes their bandswitching and single band converters, plus conversion suggestions for the BC-453 receivers which function as tunable IF amplifiers. This series started with PART I—Mobile Power Supply Ideas—in the July-August, 1960 issue. PART II—MOBILE LINEAR AMPLIFIER—will appear in the November-December issue.

WBDOG's bandswitching converter, and the metering panel and power control box, all form a neat under-dash package in the above view. The tuning dial on the converter actually tunes the BC-453 receiver—hinged up on the firewall at the right side of the car—through a flexible shaft.

—Lighthouse Larry

SEPTEMBER-OCTOBER, 1960

in this issue:

Scanning the Spectrum................. page 2
Bandswitching Mobile Converter.... page 3
Single Band Mobile Converters.... page 7
BC-453 Conversion Suggestions.... page 10
1960 Edison Award Announced.... page 12

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MOBILE 55B RECEPTION . . .

Successful reception of single and double sideband signals in a mobile radio system re-
quires that the receiver have excellent fre-
quency stability, in the order of cycles at
several megacycles. Also, sufficient selectivity in adjacent signals on adjacent channels is
highly desirable.

The double conversion superhetrodyne re-
ceiver circuit, when properly applied, will
meet all of these major requirements. It makes
possible using crystal control in the high
frequency oscillator for the first fre-
quency converter when a band only a few
hundred kilocycles wide — such as an ama-
teur band — will be tuned by the receiver.

The tunable portion of the receiver can
then be operated much lower in frequency
where tunable oscillators for the second con-
verter can easily be built with a stability
within a hundred cycles. Some top-perform-
ing amateur radio receivers utilize this prin-
ciple.

The double conversion receiver principle has been applied by W8DLZ and W2WPJ to
attain excellent stability and selectivity at
low cost by using the BC-653 Command set
receiver, covering 300 to 550 kilocycles, as
a tunable i.f. amplifier preceded by high-fre-
cuency converters with crystal-controlled os-
cillators. The selectivity and stability of the
BC-653 are widely recognized in amateur
radio circles.

The tunable oscillator in the BC-653 oper-
ates sufficiently low in frequency and is
mechanically rigged, to minimize the effects
of temperature and power supply voltage
variation, and shock and vibration upon its
stability. Of course, the crystal-controlled
oscillator in the amateur band converters have excellent stability too.

Incidentally, here is a more complete list-
ing of crystal frequencies which can be used
in the converters described herein than the
crystals covered in the coil tables. The list-
ing also shows the harmonic of the crystal
oscillator required for injection to the mixer,
the signal frequency ranges covered, and the
 tuning range of the BC-653 receiver for each
crystal.

The BC-653 receiver will work fine with
150 volts on the plates. If 300 or more plate
volts are applied, bypass capacitors may
fall. W8DLZ suggests using a VR-150 or
GA2 regulator tube to hold the plate voltage
down to 250 volts. Use a power supply with
at least 200 volts output and drop the voltage
with a 10-watt adjustable resistor, so that
the VR tube is gated at all times.

Try the converter/BC-653 receiving com-
bination described in this term. I'm sure
you'll be pleased with the performance.

SUPER POWER RIGS . . . . .

The one-kilowatt power maximum input of
the highest amateur transmitters is dwarfed by
General Electric's new 550-kilowatt short
wave transmitters being constructed for the
Voice of America. They're also many times
larger in one ~ 22 feet long, 10 feet high,
and 12 feet wide — as compared with most ama-
teur power outputs.

Six of the new transmitters, being built
for the U.S. Information Agency's VOA East
Coast installation near Greenville, N.C., are
the largest high frequency transmitters manu-
factured by General Electric in its 40 years
in the communications field.

Each transmitter will include special en-
geineering devices to meet VOA requirements
for increasing the intelligibility of reception
in foreign lands, where listeners rely on a
wholesome signal, again by comparison with
amateur radio signal levels.

To fill next issue.

Lighthouse Larry
MOBILE OPeration: on several amateur bands requires that the transmitting and receiving equipment in the installation— as well as the antenna—be constructed to be switched readily to the band on which operation is desired at a particular time. A band-switching converter with crystal controlled oscillator, designed to work into a receiver covering an established intermediate frequency tuning range, can be constructed in little more space than is needed to house a converter covering only a single band.

The converter used at W6WYN/W, however, also incorporates a remote tuning dial which simply drives a flexible shaft coupled to the receiver, mounted up under the right side of the dash in the car. Other controls for the i.f. receiver—r.f. gain, audio gain, A.V.C. switch, and sideband selector switch—also were built into the converter, although these controls and the dial could easily have been located elsewhere.

Separate Coils were used in each of the r.f. circuits of the converter shown in the schematic diagram, Fig. 1, to cover the five amateur bands from 5.5 to 70 megacycles. A 6C75 sharp cutoff r.f. pentode functions as the r.f. amplifier, while the pentode section of a 6UB (or 6UG-A) is the mixer. The triode 6UB section is the crystal oscillator.

(continued on page 4)

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**TABLE I—PARTS LIST**

<table>
<thead>
<tr>
<th>Part Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C........</td>
<td>5-35 mydidget air variable</td>
</tr>
<tr>
<td>L........</td>
<td>5-140 mydidget micro proder</td>
</tr>
<tr>
<td>814c......</td>
<td>auto radio type antenna connectors; or, mydidget phone plugs</td>
</tr>
<tr>
<td>1 to L...</td>
<td>r.f., mixer and oscillator coils on CTC 12-0 iron slug-tuned coil formes; see COIL TABLE for details on windings</td>
</tr>
</tbody>
</table>

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**FIG. 1. SCHEMATIC DIAGRAM OF THE BANDSWITCHING MOBILE CONVERTER**

The BC-453 receiver with which this converter is used. Only one set of coils is shown for Ls, Lc, and Lp; actually there are five coils in each of these locations, each connected to a separate position on S1, to S5.

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3
The crystal oscillator functions at the crystal fundamental frequency to cover the 3.65-4.4 and 7.0-7.7 tuning ranges, as shown in TABLE II—COIL. TABLE I—16.6-18.5 MHz megacycles, the second harmonic (18 megacycles) of the 9.3-megacycle crystal is the injection frequency, while the fourth harmonic of a 5.25-megacycle crystal (21.0 megacycles) is used to cover 21.10-21.45 megacycles. Five crystals in the range of 5.85 to 7.9870 megacycles are required for complete coverage of the 38-megacycle band. However, the fourth harmonic (23.5 megacycles) of a 7.615-megacycle crystal will give coverage of 28.5 to 28.85 megacycles where most sideband operation occurs on this band. Other crystal combinations are suggested in FIG. 2. FRONT AND REAR panel drilling diagrams for the bandswitching converter. The slide switch marked "100 KC" applies plate voltage to a 100-kilocycle crystal oscillator which the author included in his converter, but is not shown in the schematic diagram, Fig. 1. All the BC-633s could be mounted as a separate panel to reduce crowding in the converter, if desired.

<table>
<thead>
<tr>
<th>COIL</th>
<th>TABLE II—COIL TABLE—BANDSWITCHING CONVERTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMATEUR BAND (kHz)</td>
<td>CRYSTAL (MHz)</td>
</tr>
<tr>
<td>4</td>
<td>3.35</td>
</tr>
<tr>
<td>7</td>
<td>6.86</td>
</tr>
<tr>
<td>14</td>
<td>6.9</td>
</tr>
<tr>
<td>21</td>
<td>5.35</td>
</tr>
<tr>
<td>28</td>
<td>7.075</td>
</tr>
</tbody>
</table>

*Small ceramic capacitor across coil where indicated — otherwise only circuit separation.

*Wid 26-KC coils are used (0-4 form).
the CRYSTAL FREQUENCY CHART for the converters on page 2 of this issue. Oscillating coils (Ls) tune to the crystal harmonic frequency being used.

A 2.5-millihenry r.f. choke, tapped between the first and second pins from the end on the transformer, is located in the converter output circuit and is peaked at the desired frequency. The 100 to 550-kilocycle tuning range of the BC-453 receiver with C1.

An automatic output circuit, shown in Fig. 3, of the single band converter article on page 8, also is suitable for this converter.

CONSTRUCTION of the model shown in the photos was accomplished in a 6 x 6 x 3-inch home-fabricated box made in two sections. However, the converter can be constructed into a 7 x 5 x 3-inch Minibox (Bud CU-3008) if the remote tuning dial and BC-453 controls are not included in the box. Or, these controls can be included when the converter is constructed in a Minibox 8 x 6 x 3 1/2 inch (Bud CU-3009) in size.

Dimensions are given in the panel layout diagram, Fig. 2, the box layout diagram, Fig. 3, and the schematic layout diagram, Fig. 4, for the 6 x 6 x 3-inch box, but will serve as a guide for the larger standard Miniboxes suggested above. It is best to select the box size to fit into the space available in each individual mobile installation.

Major parts were mounted in the locations shown in the above diagrams, and should be kept in the same relative positions in the larger box. The chassis has a 9/16-inch step, as shown in the side view, and was made with narrow flanges along the upper, lower and rear edges to facilitate rigid mounting.

Wiring should be handled in the usual manner for high-frequency circuits: shortest possible ground, plate and coil leads; disc ceramic bypass capacitors soldered with shortest possible leads; unterminated run of the r.f. coils; and short lengths of coaxial cable for the frequency, input and output connections to the BC-453 receiver.

FIG. 3. TOP LAYOUT DRAWING of the converter. The chassis should be labeled to clear the top flanges on the box.

THE TUNING PROCEDURE is quite simple, once construction is completed and a check has been made of the heater and plate power circuits to ensure that the correct voltages appear on both tubes. Plate voltages will be the same as the power supply voltage, and screen voltages will range from 100 to 120 volts on both the 4CH6 and 4T8 tubes.

The crystal oscillator should be adjusted first. A general coverage receiver is helpful in checking to see that the oscillator works on all bands, and that the plate coils (L1) are tuned to the correct harmonic frequency. Set S1 to the 3.5-megacycle position, tune the receiver to 3.5 megacycles, and tune the 3.5-megacycle L, for maximum signal in the receiver.

Next, switch S2 to 7 megacycles, set the receiver at 6.8 megacycles and tune the 7-megacycle L, for maximum signal. For 14 (continued on page 6)
megacycles, set S3, tune the receiver to 15.8 megacycles, and tune the 14-megacycle L6 for maximum signal. For 21 and 28 megacycles, calculate the correct harmonic frequency of the crystal being used, set the receiver at that frequency, and peak the proper L6 coils.

**FRONT-END ALIGNMENT** consists simply of peaking the mixer grid (L5) and r.f. amplifier grid (L3-L4) coils at the center of the tuning range for each band. The converter output should, of course, be connected to the BC-453 receiver, and a signal generator — or amateur band signals from an external antenna — should be fed into the converter input, J2.

Set the BC-453 receiver at about 350 kilocycles and set C1—the r.f. stage grid peaking capacitor — at mid-capacitance. Tune the mixer grid coils (L5) first for maximum signal at those frequencies, and then peak the r.f. coils (L3-L4) for each band. Either the signal generator, or external signals close to the specified frequencies, may be used.

The alignment may be completed before the converter is "buttoned up" by installing the top half of the box, since the coils can be sufficiently removed from it to have little effect on the impedance values.

Both converter power and remote control connections were made through a 12-pin plug and cable running to the BC-453 receiver. Length of this cable, and the flexible shaft for tuning, will be determined by the space available in the constructor's car, and probably will be from 24 to 36 inches long.
THE SINGLE BAND approach appeals to many mobile amateur radio operators who concentrate their operations mainly on one or two bands because of space limitations, or the nature of local activity. The equipment can be constructed easier because of the absence of a bandswitch and multiple sets of coils. Those amateurs who work two bands can construct plug-in r.f. units for the receiver front end — and transmitter too — and achieve optimum performance at each band.

At WBDL/Mobile, five single-band converters were constructed to cover the amateur bands from 3.5 to 30 megacycles. All units have plug-in connections for easy changing, and follow the same basic circuit. Because of the fairly low frequency chosen for the tunable i.f. range — 300 to 550 kilocycles — four tuned circuits at the signal frequency were included in each converter for maximum rejection of image signals. These image signals will be twice the frequency to which the BC-453 is tuned away from the amateur band signal frequency. An image frequency 400 kilocycles below the signal frequency when the BC-453 is tuned to 200 kilocycles; and an image frequency 1,000 kilocycles below the signal frequency when the BC-453 is tuned to 500 kilocycles.

The triode section of a 6J5 plate-triode functions as a grounded-grid r.f. amplifier, as shown in the schematic diagram, Fig. 1. The antenna input circuit is untuned, with only a 2.5-milliampere r.f. choke in the cathode DC return. Coils L1 and L2 form a bandpass coupler which feeds the plate section of the 6L6 as a second r.f. Amplifier, with an r.f. gain control in its cathode circuit.

(continued on page 8)

### TABLE I — PARTS LIST — SINGLE BAND CONVERTER

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>0.1-mf disc ceramic capacitor; try values from 1 to 3 and for optimum results try values of 1 and 3 microfarads.</td>
</tr>
<tr>
<td>C2</td>
<td>5-140-mf disc ceramic capacitor.</td>
</tr>
<tr>
<td>H1</td>
<td>0.1-mf disc ceramic capacitor.</td>
</tr>
<tr>
<td>1.0 to 1.6-ma bandpass transformer made from silicon steel.</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>TV-104 or TV-108 shielded coils; see TABLE II.</td>
</tr>
<tr>
<td>T2</td>
<td>Same types of coils as T1.</td>
</tr>
<tr>
<td>34-C</td>
<td>Crystal-controlled converter; use with 34-CX-3401 or 34-CX-3402.</td>
</tr>
<tr>
<td>2.5-A</td>
<td>2.5-A plug-in power plug.</td>
</tr>
</tbody>
</table>

### TABLE II — COIL TABLE, for frequencies.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Coil Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-500</td>
<td>34-CX-3401</td>
</tr>
<tr>
<td>500-5,000</td>
<td>34-CX-3402</td>
</tr>
</tbody>
</table>

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**fig. 1. SCHEMATIC DIAGRAM for the single band converters designed and constructed by WBDL. All resistors are in ohms, 1/2-watt rating, and capacities are in microfarads. If not otherwise marked, the output signal runs through pin 3 on the power plug, P1. Note that 6 volts DC should be applied to pin 5, and pin 1 grounded, for operation of the converter from 6 volts.**
The second pair of coils, L9 and L10, couple the signal into the pentode section of a second 6L6, operating as a mixer. The triode section of this tube is the crystal oscillator, operating either on the fundamental or harmonics of the crystal, as described in the bandwidthing converter. Oscillator signal injection is through a small coupling capacitor. Values from 3 to 5 mmf should be tried, to obtain optimum oscillator injection.

Plate circuits of the mixer is again a 2.5-milliampere r.f. choke (EPC), with the l.f. output signal tapped off between the first and second jacks. An optional mixer output circuit, using a Miller No. 70-A broadcast receiver antenna coupling coil, is shown in Fig. 2. The antenna winding is used for the output link to the power amplifier, P1.

THE CHASSIS on which all converters were constructed is a 5 1/2 x 3 x 2 1/4-inch Minilab (Bud CU-3006) and provides plenty of room for the components and power transformer.
for the components specified in TABLE I—

PAR T LIST. The same general parts lay-
out, shown in the drilling diagram, Fig. 9, 
was used for all converters.

The alterations necessary on coils L1 
through L8, as described in TABLE 11—
COIL TABLE, and the coils checked for 
proper frequency coverage with a grid-dip 
oscillator — should be made before the shield 
cans are fastened to the chassis.

The usual precautions regarding short c.f.
setting and bypass capacitor leads apply to 
all converters, and especially the 51 and 
22-megacycle models. The tube heaters 
may be operated from either a 6 or 12-volt 
source by making the proper connections when 
adding the 220-volt cable jack which connects to Pt.

ALIGNMENT of the crystal oscillator stage 
consists simply of peaking L6 for maximum 
signal in a receiver tuned to the proper har-
monic frequency for the crystal and band in 
use. After coupling the RC-453 receiver to the output, and feeding in a signal of the proper frequency into J1, the signal circuits, L1 to L4, may be aligned. For proper L1 and 
L4 (for hum adjustments) about 20 kilo-
cycles inside the high edge of the amateur 
band is a good place for starting the trimmer.

Peak coils L1 and L4 from 100 to 200 kilo-
cycles lower in frequency, so that the con-
verter has nearly uniform gain across the 
portion of the amateur band in use. Coils 
L1 and L4 are made the top adjustments so 
that the converter bandwidth can be easily 
changed for maximum performance either at 
the American phone, or CW assignments of 
the amateur bands.

The converters, when completed and 
aligned, may be mounted on top of the RC-
453 receiver, as shown in the picture above.

At W1DSL-Mobile, the converters were 
mounted on top of the linear amplifier for 
the sideband transmitter in the rear of the sta-
tion wagon (as shown in the view on the top 
left corner of page 7 of the July-August, 
1950 issue). This permits a short connection 
to the antenna chopper-relay — also on 
the linear amplifier — and changing con-
verters when bands are switched in the 
amplifier. A coaxial cable feeds the i.f. out-
put signal from the converter to the RC-453 
receiver, mounted below the dash (see pic-
ture on page 4 of the July-August, 1950 
issue).

Converters of this type have traveled over 
120,000 miles in W1DSL's mobile installa-
tions, and the models described incorporate 
the lessons learned during this vast amount of 
“field testing.”
CONVERTING THE BC-453 RECEIVER

By A. F. Pross, W6QUD, and W. C. Louden, W6WH

CONVERSION DATA for the BC-453 Command Set Receiver has been published. However, here are suggestions for making the basic conversion, plus adding a more powerful audio amplifier, fast-acting AVC and 3-meter circuit, and a sidestand selector switch.

HEATR CIRCUIT - To operate the BC-453 tube heaters from a 6-volt supply, rewire all heater connections to the sockets in parallel. Install 6-volt tubes: three 6SK7's, one 6KB, one 6SR7, and one 626 or 625 in the audio (V9), changing no socket connections other than tying pin 7 to pin 1.

For 12-volt heater supply operation, either rewire all heaters in parallel and use the original 12-volt tubes (three 12SK7's, one 12KB, one 12R7, and substituting a 12L7 for the 12A6); or, use the original heater circuit and install 6-volt heater tubes which each draw 0.3 amperes (same 6-volt tubes as shown above).

AUDIO AMPLIFIER - The original audio amplifier in the BC-453 may be sufficient for home-station operation under quiet conditions, but more volume is needed to overcome the various noises encountered in mobile operation. A 6-watt amplifier and speaker in the 6 to 8-inch diameter range will provide plenty of sound.

A 3-stage amplifier circuit, shown in the schematic diagram, Fig. 1, was devised, and is easily driven by a 6I5 or 12L7, substituting for the original 12A6 pentode power audio amplifier in the BC-453. One section of a 12AX7 twin triode is a voltage amplifier, the other section functions as a phase inverter, driving the grids of a push-pull output stage (V9) which drives the 626 or 625 (V8, a 6-volt heater supply).

The constants shown provide good frequency response, but the higher audio frequencies will be accentuated if a 0.1-mf capacitor is wired across the cathode resistor of the 12AX7 audio amplifier. A 0.006-mf capacitor across the output transformer attenuates higher audio frequencies.

The audio amplifier was constructed on a small metal plate about 4 inches square with flanges on all sides for mounting. Wiring should follow the usual practices for audio amplifiers. Note that the audio output signal from the BC-453 is taken from pin 2 of the plug on the rear of the chassis, as shown in the view on page 9.

FAST-ACTING AVC/3-METER CIRCUIT - The operation of this fast-acting AVC circuit which can be added to the BC-453 receiver must be heard to be appreciated. The 3-meter section was designed to work on CW, sideband or amplitude modulated phone signals.

The two-stage, locked amplifier, shown in the view on page 9, is designed for CW and SSB work. The AVC amplifier stage, 12A5E5 pentode, will be completely free of stray RF voltage. The selectivity of this amplifier must be broader than the signal channel in order to reduce the gain of the receiver when strong adjacent channel splatter is present. The "Q" of the output filter should not be too high, or the 625/0.5-mf filter circuit formed by it and the 190-190-mfd pad will be too sharp. A 0.5-mfd fixed trimmer (or r.f. choke (Bad-Ch 92OW, or equivalent) should be used for R6.

The AVC voltage is rectified by the IN34 diode and applied through a decoupling network back into the BC-453 receiver at the lower end of the AVC control transformer. The resulting 12-volt plate voltage is applied to control grid of the 12A7C7 triode, which drives the output transformer through a vacuum tube buffer type 3-meter circuit. An SPDT switch provides for full-range coverage for higher "SS" or 3-meter readings, or lower AVC for "Local" 3-meter operation from strong signals.

FIG. 1. SCHEMATIC DIAGRAM of a 6-watt audio amplifier added to the BC-453 receiver. Audio output from the receiver is taken from the output transformer through a 3-meter circuit on the rear of the receiver chassis. Capacitors are in microfarads, and resistances are in ohms, 15-watt unless marked.

[Diagram of schematic diagram showing components and connections, including an audio amplifier with a 12AX7 and 626/625 output stage, AVC circuit, and 3-meter receiver input and output connections.]

10
Note that a phone jack connection to the plate of the 12AU7 AVC amplifier provides a place to feed the l.f. sweep signal to the vertical plates of an oscilloscope. By setting the horizontal sweep on the scope at 30 to 40 cycles, both incoming signals, and your own transmitter, may be checked for linearity.

The AVC/8-meter unit was constructed in a 4 x 2 1/2 x 2-inch Minchot (Broi CU-2015) and mounted on the left side of the BC-453. Extension shafts run from the controls to knobs, with the shafts supported on a small bracket. Exact arrangement of the AVC and 8-meter circuit components will depend on the space available on each side of the BC-453 receiver in each module installation.

**SIDEBAND SELECTOR SWITCH**

When properly aligned, the 85-kilocycle l.f. amplifier in the BC-453 has a bandwidth of about 2.5 kilocycles. This makes possible good SSB reception with considerable rejection of the unwanted sideband when the BFO switch is closed. However, it is likely that some of the upper or lower sideband signals will be received. This is because the BFO frequency is only inaudible when it is exactly equal to one of the upper or lower sidebands. To eliminate this possibility, the SSB selectivity is increased by adjusting the selector switch to the desired position.

With the SSB selectivity switch set to the desired position, the upper or lower sideband signals are properly received (BFO will be at upper edge of l.f. amplifier passband). Then, close the sidetone selector switch and tune a signal transmitting lower sidetone, which also should sound normal.

When a station transmitting, say, lower sideband is properly tuned in, and the station shifts to upper sidetone, the SSB switch should then be closed, and the BC-453 receiver dial is tuned to 3 kilocycles higher in frequency, to properly receive the upper sidetone. A bit of practice in changing sidetones will allow this shift to be made in a matter of seconds.

The combination of the amateur band converter and BC-453 receiver modified as described herein is capable of providing excellent amateur radio mobile reception.

**FIG. 3. SIDEBAND SELECTOR switch is added to BFO in BC-453 by adding a 30-mef capacitor across BFO coil to shift BFO frequency, locates switch and capacitor to close so possible to BFO coil to prevent radiation of signal from wiring.**
NOMINATIONS for the 1960 Edison Radio Amateur Award are now open. All radio amateurs and others who know of a worthy public service which has been performed during 1960 by a duly licensed radio amateur while pursuing his hobby within the limits of the United States, are urged to nominate that person.

Simply state the candidate’s name, call letters, full address, and a description of the service performed, in a letter to the Edison Award Council, General Electric Company, Electronic Components Division, Owensboro, Kentucky.

Full details of the Edison Award are given in the full-page announcement (at right) which appears in the October issues of amateur radio magazines. The award is sponsored annually by General Electric.

You will help increase the stature of all radio amateurs by naming a suitable candidate for the acclaim, distinctive Edison Award trophy, and $200 gift that the recipient is presented at a public ceremony in Washington, D.C.

Nominating letters must be postmarked not later than January 2, 1961. Compile the public service record during 1960 of your candidate and mail it before the deadline approaches!