The new G-E 7077 micro-miniature ceramic triode opens the door to greater DX for amateurs on the VHF bands through lower noise figures. Read herein how W2ZMH has designed RF amplifiers using this tube for his 144 and 432-megacycle converters.

—Lighthouse Larry
MEET THE DESIGNER

WJZEN—William (Bill) N. Coffey, developed the 144- and 432-megacycle R.F. amplifiers described herein as part of noise figure studies in his work as a research engineer with General Electric’s world-famous Research Laboratory in Schenectady.

It should be obvious that Bill is a VHF enthusiast, with rigs ranging in power from a few to several hundred watts on these amateur bands. Much of his operating time is spent on the 144-megacycle band. He has been a licensed amateur for 21 years and holds an Extra Class license.

WJZEN will best be remembered for his pi-network overtone crystal oscillator circuit shown in our 1955-vintage 50-megacycle equipment.

NEW HEATERLESS MINIATURE CERAMIC TUBES

DEVELOPMENT OF AN ELECTRONIC TUBE not much larger than a shirt button has been announced by the General Electric Research Laboratory. The miniature tube is capable of operating at temperatures of from 900° to 1500° Fahrenheit.

THE EXPERIMENTAL MODELS now being evaluated, shaped like flat disks, measure only 1/4 inch in diameter and 1/8 inch thick. Their extremely small size is due in part to the fact that they contain no heater, all that is necessary being provided by their environment. The design is still in the laboratory stage and no tubes are commercially available at this time. They are constructed of layers of silicon and a special ceramic.

The views at the left (upper) show an exploded tube; and (lower) the heaterless tube actually operating in the flame of a blowtorch (flame temperature about 600 degrees C), producing the characteristic curves visible on the oscilloscope screen in the background. This demonstrates the new tube’s ability to withstand high temperatures. Much lighter equipment might be used for military and space vehicles thus possible by eliminating heavy, bulky cooling equipment.

DEVELOPMENTAL TYPES of the new tube have been made with a wide range of characteristics, of which two are given below:

<table>
<thead>
<tr>
<th>DESIGN VALUES</th>
<th>No. 1</th>
<th>No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire tube temperature</td>
<td>600°</td>
<td>600°</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>250</td>
<td>6000 microamperes</td>
</tr>
<tr>
<td>Plate current</td>
<td>0.5</td>
<td>5 microamperes</td>
</tr>
<tr>
<td>Grid voltage</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Plate voltage</td>
<td>50</td>
<td>100 volts</td>
</tr>
<tr>
<td>Grid current</td>
<td>0.1</td>
<td>0.7 microamperes</td>
</tr>
<tr>
<td>Amplifier power</td>
<td>13</td>
<td>100</td>
</tr>
</tbody>
</table>

Look, men—no heater ratings!

—Lighthorne Larry
7077 R.F. AMPLIFIER

for the 420-450-megacycle band

Here are circuit and construction ideas for oper-
ating the new 7077 as r.f. amplifiers in converters
for the 420-450-megacycle band.

LOWER RECOVER NOISE FIGURES are now
possible on the popular v.h.f. and u.h.f. am-
ateur bands with r.f. amplifiers using General
Electric's new 7077 microminiature triode. This
improvement really shows up above 400 megacycles, where the two-stage
grounded-grid r.f. amplifier in the converter
described here has a measured noise figure of
5 decibels, about 3 to 5 decibels lower than
similar circuits with conventional tubes.

CIRCUIT TECHNIQUES are not often seen in am-
ateur radio circles were employed in these
stages: namely, flat plate type one-quarter
wavelength linear tuned circuits. These de-
vices, shown as L1, L2, and L3, in the sche-
matic diagram, FIG. 1, consist of a strip of
sheet metal 1/4-inch wide running parallel to
the chassis. One end is joined to the chassis
electrically, the other end—having a high
r.f. impedance—connects to the tube ele-
ment. The characteristic impedance of these
particular flat plate lines is 115 ohms.

Signals on the 420-450-megacycle band, fed
into J1, are applied to L1 and thence to the
cathode of the first 7077 tube. The plate of
this tube is connected to L2, the latter forming
an impedance step-down transformer to the
cathode of the second 7077 through a

500-megacapacitor.

The plate of the second 7077 is coupled to
the cathode of a 6AH4 triode, operating as
a grounded-grid mixer through L3. The
local oscillator signal—on 406 megacycles in
this particular converter—is fed into J3, through
a small coupling loop, L3, on J3, next to L3.

All tube elements in these stages were
mounted onto the tuned circuits at optimum
points determined by experiment. The 20-
to 30-megacycle difference signal at the mixer
tube plate runs through a p-n network bloc-
tuned band circuit—consisting of the 2.2
mfd capacitor from the 6AM4 plate to the
chassis, C2, and L4 to J3. A trap tuned to
406 megacycles—C3 and L5—keeps the local
oscillator signal from feeding into the con-
verter output.

Several r.f. chokes are used in these cir-
cuits to prevent signal loss: RFC1, RFC2,
and RFC3, in cathode bias leads; RFC1,
RFC2, RFC3, RFC4, and RFC5, in the
heater leads; and RFC6, in the mixer stage
plate supply lead.

FIG. 1. SCHEMATIC DIAG-
GRAM for the r.f. ampli-
 fier and mixer portions of the 420-450-meg-
cycle converter. All resistors are in ohms, % watt unless
otherwise specified. All
capacitances are in micro-
farads unless otherwise specified.

PARTS LIST—CONT.

C1, C2, C3, C4, C5, 0.5-3.5-mfd plate type mica trimmers.
C6, 15-330-mfd ceramic-encapsulated mica trimmer.
C7, C8, special bypass capacitors formed by
a chassis and a 1/4-inch brass plate with a 0.001-
inch thick micro spacer. See FIG. 4 for construc-
tional details.
L1, L2, L3, 1/4-inch diameter, flanged, coaxial solid core
coils. See FIG. 4 for constructional details.
L4, 4-inch, shielded d.tuned coil (C&T 5/15-10; Mu; RFC).
RFC1, RFC2, RFC3. 20 turns, No. 22 enamelled wire, 1/4-
inch inside diameter, 1/4-inch long.
RFC4, RFC5, RFC6. .25 ohm, 10 turns, No. 22
enamelled wire, % of an inch winding length, on
1/4-inch diameter polyurethane or Teflon wire.

RFC1, RFC2, 0.34 ohm, bifilar wound choke consisting of
two strands of No. 22 enamelled wire, 10 turns in
each coil, clearance-wound on %-inch diameter rod.
RFC3. 100 u.h.f. wound r.f. choke (National 803, 100 u.h.
). RFC4. 0.25 ohm, 10 turns, No. 18 enamelled wire, %
of an inch diameter, on %-inch diameter rod.
RFC5. 0.33 ohm, 10 turns, No. 18 enamelled wire, %
of an inch diameter, on %-inch diameter rod.
RFC6. 406-megacycle trap, consisting of a 0.05-ohm coil—
3 turns, No. 12 enamelled wire % of an inch long, wound
on the shank of a No. 22 drill (0.146 inches in diameter)—connected across C6.

Continued on page 3.
OVER-ALL BOTTOM VIEW of the 430-megacycle converter. Major parts have been identified. Although 1/16-inch-thick sheet brass was used for chassis and partitions on this model, 1/16-inch-thick brass is suitable. All chassis parts were nickel-plated together and then silver plated for highest conductivity of c.f. converters. Note that there is a 0.001-inch thick insulator between the side wall and the mounting plates on L4, L5, and L6. The cathode bias circuit for the first 7097 runs through RFC to L4. Plate voltage for both 7097's is fed into L4 and L5 through 18,000-ohm resistors via 0.001-ohm feedthrough type ceramic capacitors.

DETAIL VIEW of the first r.f. amplifier compartment, showing L2 connected to the cathode ring of the 7097 tube. The 12.5-ohm cathode bias resistor connects between RFC and a ground lug below it.

THE SECOND R.F. AMPLIFIER compartment. A small angle bracket formed from 1/22-inch-thick sheet brass supports Cu. The micro capacitor tapped onto L3 feeds signals into the cathode of the second 7097. Cathode bias for this tube runs through RFC, located right underneath the micro coupling capacitor.

THE MIXER COMPARTMENT, showing L,—the oscillator injection loop—running between L6 and the 21-ohm terminating resistor for the coaxial cable. All grid lugs on the 6AM4 mixer tube socket—pins 1, 3, 4, 6 and 9—have been bent over and soldered to the chassis.
have been made. The pi-network circuit in the mixer should be tuned to 28 megacycles and will then pass 26 to 30 megacycles.

Alignment of the flat plate lines, LF, L0, and L2 should be in that order, using a signal in the 410-450-megacycle range. If you wish to concentrate on the popular 432-456-megacycle section, use a 434-megacycle signal. The antenna input tap position on L2, 5.0 inches from the grounded end, was found to provide lowest noise figure when checked with a noise generator. If this instrument is available, try shifting the tap a bit in both directions to see if a lower noise figure results. Much data has been published on making adjustments to receiver input circuits with noise generators, but this subject will not be covered here. At 420 megacycles, the 7077J is capable of providing as low a noise figure as any other tube presently available—and it can be used in proven circuits with which most radio amateurs are familiar.
7077 R.F. AMPLIFIER
for the 144-megacycle band

IS YOUR LOCATION QUIET? If so, this cascode
c.r.f. amplifier using two 7077 triodes will really
build up those weak, long-haul 144-megacycle
signals.

RADIO AMATEURS who specialize in 144-mega-
cycle DX can now improve the performance of
their receivers with this two-stage r.f. amplifier. It will achieve a substantially
lower noise figure—between 2.5 and 2.8
debcibels—than amplifiers with conventional
miniature tubes. The usual cascode r.f. am-
plifier at 144-megacycles, with a 6H8C, 6H87, or 6387 twin triode, will have a 6-
to 8-decibel noise figure. Two-stage grounded-
grid amplifiers using 6AM4 or 6BN4 tubes
usually have noise figures in the range of
4.5 to 6.5 decibels.

CONVENTIONAL TUNED CIRCUITS
having lumped constants were used throughout the
144-megacycle converter shown in the sche-
matic diagram, FIG. 1. The input signal from the
coastal cable input jack (J1) feeds through the first 7077, in a grounded-cathode
circuit, then into the cathode of the second
7077, a grounded-grid amplifier. A neutral-
izing coil (L7) prevents the first stage from
oscillating and improves the noise figure
when properly adjusted.

A conventional miniature triode—the 6AM4, 6BN4, or triode-connected 6AK5—
could be substituted for the second 7077 with

little degradation in noise figure if lower cost
is desired.1 The cascode stage is followed by a
6AK5 pentode r.f. amplifier. This stage and
the balance of the circuit is quite conven-
tional, a 6US triode section as the mixer, and
the pentode section as a 14- to 18-megacycle
broadband r.f. amplifier.

The triode section of a second 6US func-
tions as a crystal oscillator at 65 megacycles,
operating a 21.667-megacycle crystal on its
ninth overtone. The oscillator employs the
p-network feedback circuit described in G-E
HAM NEWS a few years ago.2 A 65-mega-
cycle crystal can be used instead, but be sure
to operate it in the circuit recommended by
the manufacturer.

The 7077 STAGES were constructed on a sep-
ate copper plate about 4 inches square,
simplifying the addition of this amplifier to
existing 144-megacycle converters. One of the
special sockets3 for the 7077 tubes was modi-
fied—it was originally designed for grounded-
grid circuits—by trimming away some of the
metal shield on the grid contact to clear the
cooper plate by 1/4 of an inch. Rectangular
holes were cut in the plate to clear legs on the
sockets. Locations for the other major compo-
nents can be determined from the top and bottom
view photos. Sockets for the 6AK5 and 6US
were potted to permit shortest possible leads. The oscillator section was shielded from the rest of the converter with
a metal partition.

FIG. 1. SCHEMATIC DIAGRAM
of the 144-megacycle converter showing the two 7077
microamplifiers in a cascode r.f. amplifier circuit.
Link coils, coupled to L1 and L2 and connected with a short
length of coaxial cable, feed the 100-megacycle oscillator
signal into the mixer stage. All inputs are in ams, 5 V \text{pp}
otherwise specified. All capacitance values are
millifarads, capacitance values other than marked are

6
PARTS LIST—COIL TABLE

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1-dow side diode filament</td>
</tr>
<tr>
<td>C2</td>
<td>16-505/5116 valve socket</td>
</tr>
<tr>
<td>C3</td>
<td>5-505/5116 valve socket</td>
</tr>
<tr>
<td>C4</td>
<td>3-30-120 red al. dissector (Kensington ARC-25)</td>
</tr>
<tr>
<td>C5</td>
<td>1-dow type point coil connector</td>
</tr>
<tr>
<td>L1</td>
<td>0.10 oh, 8 turns, No. 18 wire, 3 inch inside diameter, 1/4 inch long, wound 8 turns per inch.</td>
</tr>
<tr>
<td>L2</td>
<td>0.10 oh, 8 turns, No. 18 wire, 3 inch inside diameter, 1/4 inch long, wound 8 turns per inch.</td>
</tr>
<tr>
<td>L3</td>
<td>0.12 oh, 3 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L4</td>
<td>0.12 oh, 3 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L5</td>
<td>0.12 oh, 3 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L6</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L7</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L8</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L9</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L10</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L11</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L12</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L13</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L14</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L15</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L16</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L17</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L18</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L19</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L20</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L21</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L22</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L23</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L24</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L25</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
<tr>
<td>L26</td>
<td>0.05 oh, 5 turns, spaced 4 inch, 1/4 inch long, with 2 turns link coil of hookup wire.</td>
</tr>
</tbody>
</table>

The alignment sequence is as follows: (1) get the crystal oscillator stage working on 65 megacycles; (2) tune the multiplier for maximum output on 130 megacycles; (3) feed 15- and 16.5-megacycle signals into the grid of the 6FU mixer and align L5 and L6, respectively; (4) feed a 146-megacycle signal into the grid of the 6AK5 and peak L7; (5) feed a 145-megacycle signal into J1, and peak L7; (6) shift the signal to 146 megacycles and peak L5; (7) shift the signal to 144.5 megacycles and peak L5.

Finally, remove heater voltage from the first 7077 and adjust L2 for minimum signal at 144.5 megacycles. Adjust C1 for lowest noise figure should be done with a noise generator; the calculated capacitance value for this condition is 4 muf.

The above alignment frequencies will result in a fairly flat bandwidth between 144 and 147 megacycles, with best performance between 144 and 145 megacycles.

The 7077 tube should make an excellent rf. amplifier tube for the 220-megacycle amateur band. In either the cascode or grounded-grid circuit. However, we have not checked it out yet, but expect to do so at an early date.

1. Supposed user price at the time of the 7077 as of prices then is $25.00 each.
3. Catalog No. 8970, Jetron Products, Inc., Route 10, Hackett, N. J.

Note: The information for any given detail varies as to whether or not the parts were manufactured by General Electric Company or others. In the absence of all but the manufacturer's data to the contrary, the General Electric Company part numbers are given as a convenience. The part numbers are intended only for ready reference, and the catalog data should be consulted for the purchase of the specified item.
TECHNICAL INFORMATION - 7077

Micro-miniature triode for UHF amplifier applications

ELECTRICAL AND MECHANICAL DATA - MAXIMUM RATING

<table>
<thead>
<tr>
<th>Component</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode Voltage, AC or DC</td>
<td>6.3 ± 0.25 Volts</td>
</tr>
<tr>
<td>Heater Voltage</td>
<td>85.8 ± 0.64 Volts</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>250 Volts</td>
</tr>
<tr>
<td>Plate Resistance</td>
<td>5000 Ohms</td>
</tr>
<tr>
<td>Plate Current</td>
<td>6.4 Milliamperes</td>
</tr>
<tr>
<td>Transconductance</td>
<td>6000 Microhms</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td>82</td>
</tr>
<tr>
<td>Cathode-Grid Resistance</td>
<td>80 Ohms</td>
</tr>
<tr>
<td>Plate Resistance, approximate</td>
<td>8000 Ohms</td>
</tr>
<tr>
<td>Bandwidth, approximate</td>
<td>7.5 Megahertz</td>
</tr>
<tr>
<td>Noise figure (Measured with power-matched input, using argon lamp noise source)</td>
<td>5.5 Decibels</td>
</tr>
<tr>
<td>Grid to Cathode</td>
<td>0.6 uA</td>
</tr>
<tr>
<td>Plate to Grid</td>
<td>1.0 uA</td>
</tr>
<tr>
<td>Plate to Cathode</td>
<td>1.0 uA</td>
</tr>
<tr>
<td>Plate Voltage, DC</td>
<td>50 Volts</td>
</tr>
<tr>
<td>Plate Voltage, DC Grid</td>
<td>50 Volts</td>
</tr>
<tr>
<td>Plate Voltage, DC Cathode</td>
<td>1.0 Vom</td>
</tr>
<tr>
<td>Plate Supply Voltage</td>
<td>165 Vom</td>
</tr>
<tr>
<td>Resistance in plate circuit (by-passed)</td>
<td>18000 Ohms</td>
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<tr>
<td>Cathode-Grid Bias Resistor</td>
<td>82 Ohms</td>
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<td>Amplification Factor</td>
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<tr>
<td>Plate Resistance, approximate</td>
<td>8000 Ohms</td>
</tr>
<tr>
<td>Transconductance</td>
<td>6000 Microhms</td>
</tr>
<tr>
<td>Plate Current</td>
<td>6.4 Milliamperes</td>
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<tr>
<td>Bandwidth, approximate</td>
<td>7.5 Megahertz</td>
</tr>
<tr>
<td>Power Gain, approximate</td>
<td>14.5 Decibels</td>
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<tr>
<td>Noise Figure (Measured with power-matched input, using argon lamp noise source)</td>
<td>5.5 Decibels</td>
</tr>
</tbody>
</table>

PHYSICAL DIMENSIONS

The 7077 is a High-frequency triode of ceramic and metal/aluminum construction primarily intended for use as an rf amplifier in the 50 to 1200-megacycle frequency range. It features an extremely low noise figure throughout its frequency coverage. The 7077 is especially suited for use where unfavorable conditions of temperature, mechanical shock, and mechanical vibration are encountered.

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Available FRIE from your G-E Tube Distributor

E. A. Noel, W2IGX - Editor

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