ANOTHER LOW-NOISE VHF CONVERTER
144-148 Megacycles

Believe it or not, I do heed the "Why don't you publish..." comments and suggestions which many fellows write in their letters to me—and here's one result from designer W2RMA—a 144-megacycle model of the excellent low-noise 220-megacycle converter which he originally described in the September-October, 1956 issue of G-E HAM NEWS.

—Lighthouse Barry

CONTENTS

144-Megacycle Converter ........................................ page 2
Tricks & Topics ..................................................... page 6
Sweeping the Spectrum ........................................... page 7
Technical Information—6AM4 .................................... page 8
144-MEGACYCLE CONVERTER

Many requests have been received for information on changes required to operate 144-megacycle band operation from both the 320-megacycle converter published in September-October, 1954 and the 560-megacycle converter described in the September-October, 1953 issue of CIEHAN NEWS. A consultation with UHF expert Art Koch, W2ZMA, indicated that the 320-megacycle converter could more easily be re-designed for the lower 144-megacycle frequency, then adding a modulator stage (removing another tube) to the 560-megacycle converter. He concluded that two excluded 560-megacycle grid RF amplifier stages might have a lower noise figure than this band cut off. In a similar band tuners designed for operation with 150-500-megacycle converters. Several design changes included making larger coils, substituting midget air variable capacitors for ceramic trimmers, and constructing the converter on a larger 600-ohm type chassis. This open-sided chassis eliminates those hard-to-get-into corners encountered in a small IF chassis, and complete shielding is obtained when the box halves are assembled.

A separate noise figure charting below 4, and 5 dB was obtained from this converter after final alignment tests using a laboratory type VHF noise generator. This reading probably is the lowest practical noise figure usable at most amateur station locations. Mismatched noise (auto igniton, electrical appliances, etc.) picked up by the antenna and feedline in populated areas usually masks weak signals which might be heard on a converter with a lower noise figure. In other words, a hermit station location may be necessary 2 or 3 to gain full advantage of a 144-megacycle RF amplifier using an expensive UHF tube.

CIRCUIT DETAILS

The converter circuit, shown in the schematic diagram, Fig. 1, is basically the same as the original 320-megacycle converter, except for the aforementioned changes. Second band RF amplifiers are used to 144-megacycle grid input impedance match between the coaxial cable antenna leads and the 144-megacycle IF amplifier stages, and the grid-tuned grid RF tank circuit designed for operation with a 560-megacycle RF tube. Two staggered-tuned circuits, C-I to C-L, coupled by a 1/4-muf capacitor, are necessary for proper operation with RF amplifier stages and a mixer grid tuned to 144 megs. A 560-megacycle IF amplifier has the same disadvantages in operation as this smaller-grid RF tube. The 144 megacycle IF amplifier is a grounded-grid type, and a tube similar to this in the 600-ohm chassis. The crystal oscillator tank also is coupled to this RF amplifier grid through a small 80-muf coil. The first section of the 12AT7 operates as a crystal controlled oscillator at 44.6 megacycles. A B1 type vacuum tube was used to output from oscillator crystals grid biased in this frequency. Most 144-megacycle triode orientations intended for use with 30-megacycle transformers, and available in the 600-ohm-megacycle fundamental crystals will operate on their fifth overtone in this particular converter arrangement.

The crystal oscillator tank may be operated on 67 megacycles by using the size of holes in RF RFC, and coil LL. Alternate sizes are shown in the PARTS LIST and COIL TABLE on page 3. Either a special 67-megacycle or a 28.75-megacycle third overtone was operated on its seventh overtone is required. However, if you live in the fringe area of a channel 4 transmitter, radiation of even the small output from this oscillator could enter intermodulation in the third overtone channel. A TVI-proofoing operation on the 12AT7 oscillator section would be necessary.

A 10-14-megacycle bandpass is achieved in the 60 drift tube and GAN 1357 type IF amplifier frequency amplifiers. In IF amplifier circuits employing low Q slug tuned coil, LL, 60 MHz, allowed only Q 5 tube and IF cap. A low inductance short turn link coil, L,, coupled this output to a communication receiver tuning range through a coaxial cable connected to J, Coils in the oscillator and intermodulation frequency amplifier sections may be altered for other output ranges, such as 6-10, 14-18, 20-30, or 30-35-43 megacycles, required when the converter is fed into some special amateur-band only-type converters.

MECHANICAL DETAILS

6 x 8 x 3.5-inch Minibond (Body CU-2106) comfortably houses all components, without crowding, although VHF tuned circuits are short through careful panel layout. Holes are drilled in the base section having the 6 x 3.5-inch cut-out, according to the chassis drilling diagram, Fig. 1. After drilling, larger parts are mounted on this chassis in the locations marked on this illustration. Tube socket pins are positioned on the direction indicated on each socket circle and fastened with 4-40 x 0.5-inch long chrome screws through holes for mounting these on the socket. The lugs for plugs 3, 4, and 6 on the 6AM4 mixer tube socket were removed to reduce stray capa-

city between remaining lugs.

Next, the heater and plate voltage leads are run to the tube sockets, met botom connectors and the six insulating terminal posts, as pictured in the bottom view, Fig. 3. These terminals require little space, but conventional one and two-terminal strips are also suitable. Leads in the VHF circuits are made from No. 18 instrument wire, but insulated hookup wire may be used for all power connections.

Resistor and by-pass capacitors which run between the tube socket and ground leads are then assembled. All AC low impedance parts in the 560-megacycle IF amplifier tube sockets are connected together with short tuned coils, LL, 60 MHz, allowed only Q 5 tube and IF cap. The first and second stages, respectively, all coils and RF amplifier stages, are made from stock available according to the data in the PARTS LIST and COIL TABLE, and mounted between associated components with short point leads. Placement of coils and chokes in the RF amplifier stages is shown on the 144-megacycle circuit detail view, Fig. 4. Note in Fig. 4 that the connection from plate pin 5 on the 6AM4 mixer tube socket to coil LL is made at the chassis end, while the plate lead from pin 5 on the 5AKS IP amplifier tube socket to LL runs to the open end of the coil. This wiring arrangement reduces ground leakage between these coils. By-pass capacitors in this stage should be flat against the chassis. Good connections are used through a heavy copper wire terminal strip on this model, but no controversy will be submitted to experiment by removing the heater and plate voltage leads into the chassis through 0.050-inch solid copper or graphite conductors. Disc ceramic by-pass capacitors wired with short, parallel leads are suitable for other power connections. The coaxial input and output con-

nections are picked up on a four terminal connector of the chassis, also to minimize this signal leakage.
The 12AT7 oscillator tube and a variable crystal are next inserted, and a 0-25-multimeter is temporarily connected in the plate voltage lead to Ls. Output may be obtained from the oscillator over a wide adjustment range of Cs, but a sharp dip in plate current should occur when oscillation at the crystal frequency takes place. Oscillator operation should be checked with a receiver tuned to 44-667 megacycles. If a series of oscillations is heard, RFCp should be reduced in size a turn or two at a time until a single crystal-controlled oscillation and the sharp plate current dip occur. The 6AG6/300B amplifier tube then is inserted, and a steady, low-level 144-megacycle signal is fed into the antenna jack. Loose-wound local amateur

**COIL TABLE**

| L1—4 turns No. 16 tinned wire, 1/8-inch inside diameter, 1/8-inch length, 0.5 turn from ground end for antenna and 6AG6 cathode, respectively. Ls—Same size as L1, 0.5 turn from ground end. L2—2 turns No. 24 enamelled wire wound in two 1/4-turn coils, spaced 0.5 inch; 1 turn from ground end. L3—3 turns No. 24 enamelled wire wound in two 1/4-turn coils, spaced 0.5 inch; 1 turn from ground end. L4—4 turns No. 22 insulated wire of chassis end of L1. L5—For 6AG6/megacycle operation 4 turns No. 24 enamelled wire of chassis end of L1. L6—3 turns No. 16 enameled wire 1/4-inch diameter, 1/8-inch length, 0.5 turn from ground end. L7—5 turns No. 16 enameled wire 1/4-inch diameter, 1/8-inch length, 0.5 turn from ground end.

**PARTS LIST**

- C1, C2, C3, C5—2.2-14.5-mfd niadcap variable.
- C4—2.2-1.9-0.6-mfd niadcap variable.
- J1—Chassis coconut capacitor.
- RFC, RFC,—1-2 turns No. 24 enamelled wire wound on threads of 1/4-20 bolt.
- RFC—For 44-667-megacycle operation, 26 turns No. 24 enamelled wire closewound 1/4-inch length on 1/4-inch diameter polypropylene rod, or a 0.5 turns, 1-watt EIA type resistor.
- RF2—For 67-megacycle operation 16 turns No. 24 enamelled wire closewound, same turn as above.
- RFC, RFC—32 turns No. 24 enamelled wire closewound, same form as RFCp.
- X5X, Quartz crystal, 44.667 megacycles (26.8 or 26.933 megacycles may work). (For 67-megacycle, see CIRCUIT DETAILS.)

All capacitors marked "A" are mica or ceramic button. All capacitors marked "B" are tubular ceramic. All other capacitors are disc ceramic or mica.

All resistors are 1/2 watt, 10%.
Fig. 3. Bottom view of the 144-a quadruple converter showing placement of several parts. RFC is in a row between RFC and RFC, connected to the crystal and 12AU7 tube anode. The nine bottom capacitors divide on six pairs for 1, 2, 3, and the decoupling capacitors.

Fig. 2. chassis drilling diagram. Holes marked "A"—No. 32 drill for tube sockets and terminal party. "B"—No. 35 drill for ground legs. "C"—5/8-inch diameter for air variable capacitors and 1N5 nylon. "D"—5/8-inch diameter for crystal socket and C1. "E"—5/16-inch diameter socket panels and "F"—5/32-inch diameter socket panel.
stations are a convenient signal source. Toned circuits \(C_{1\text{-}L_0}\) and \(C_{2\text{-}L_0}\) are adjusted for maximum signal by spreading or compressing these coil turns for \(120^\circ\) frequency coverage, if necessary. If no antennae are encountered, the same rf amplifier grid pin and around may help stop an oscillation.

The RF amplifier section may be adjusted either for a nearly flat 144–146-megacycle bandwidth, or the 144–146-megacycle portion of the band may be favored. Full bandwidth is obtained by adjusting \(C_{1\text{-}L_0}\) to 145, \(C_{2\text{-}L_0}\) to 146.5, \(C_{1\text{-}L_1}\) to 146, and \(C_{2\text{-}L_1}\) to 144.5 megacycles, respectively. The external signal source, and not the converter output noise, should be peaked at each specified frequency.

When all stages are operating properly, as indicated by the rough tuning adjustments, final alignment may be made by observing the converter output on coils \(L_2\) and \(L_3\) for lowest noise figure, or a VHF noise generator is available. The generator should be calibrated in decibel noise units and the noise figure of the converter being measured.

Before attempting noise filter adjustments with the generator, a circuit must be set up to measure the noise output. An AC or vacuum-tube voltmeter may be connected to the speaker voice coil through a 1,000-ohm matching transformer, or to the headphone output on the receiver. The noise generator should have a resistor connected across its output equal in value to the impedance of the coaxial cable which runs from your antenna or antenna tuner. Turn off the AVC, BFO and noise limiter on the communications receiver and advance the AF and RF gain controls until a one-half scale reading is noted on the output meter. The RF gain control is not moved again during subsequent adjustments.

Next, connect the noise generator to the converter with a short length of coaxial cable and adjust the noise output control until a full-scale receiver output meter reading is obtained. A calibrated dial on the noise output control will be helpful in determining whether the noise figure is improved with each adjustment. The antenna tap on \(L_0\) should be shifted a fraction of a turn from the specified setting, and the noise control set for a full-scale meter reading. If the noise figure control setting is lower (e.g., less noise output from the generator is required for the same noise output from the receiver), the tap should be moved a bit further in the opposite direction. When the setting is found which gives the lowest noise figure, the cathode tap on \(L_0\) should be adjusted. Back out the antenna tap if the cathode tap was changed from its original position.

The same procedure is followed for the taps on \(L_1\) and \(L_2\), but no change in noise figure may be observed. The 1.0-mw level coupling capacitor between the noise grid and \(L_0\) is then connected temporarily to the plate end of \(L_0\). If no improvement in noise figure is noted, the capacitor is returned to the original tap. Cross-modulation in the converter resulting from strong local 144-megacycle signals may be reduced by tapping this capacitor further toward the by-pass and of \(L_0\).

Moving the taps on \(L_1\) and \(L_2\) toward the plate ends of (continued on page 8, column 1)
VENTILATION FOR UTILITY BOXES

Reading details of recent Q.E. HAM NEWS equip-
ment which has been constructed inside standard utility
boxes having suitable let in and back panels reminded
me of a stunt I've used for ventilating similar equip-
ment in my shack without drilling any vent holes.

I simply place washers on each self-tapping screw
which secures these covers, providing ventilation slots
which can all the way around the box, both front and
back. This system really works off equipment when the
box is not used as a TVI shield.

—Dr. R. G. Mordan, WSGJY

MAKING LONG-LIFE FOLDED DIPOLLE ANTENNAS

Breakage of folded dipole antennas fashioned from
300-ohm twinline, resulting from constant flexing
and vibration by the wind, can be eliminated by suspen-
sing the twinline from a "mesenger" cable. First, measure
a length of plastic clothes line (be sure it has a non-
metallic core) about two feet longer than the antenna.
Fasten it at a convenient height under slight tension
and attach the antenna twinline to this line every
few inches with plastic insulating tape. The load-in cable
also is taped to another length of cloth line tied to
the center of the antenna supporting line. Next, tie the
clothes line to the insulators on the supporting hatyards
and "loop" up.

I have three such antennas, for 80, 40 and 20
meters. One antenna has been up for more than three
years with no maintenance or twinline failure.

—Stanley L. Allen, W7REH

144-MEGACYCLE CONVERTER

(continued from page 3)

these coils also may help eliminate this interference, as
this reduces the RIP amplifier gain. The 55-ohm cathode resistor in the 6AM4 mixer may be changed to
500-ohms to overcome severe cases of cross-modulation.

When the converter is used with a poorly shielded or
high-volt receiver, strong signals in the 16-16-mega-
cycle range may be heard if the manual cable connection
to the receiver antenna terminal is not well shielded.
Helpful suggestions for eliminating this interference
were described in "Communications Receiver Hints for
the V.K.F. Men," by R. P. Tilson, WHQD, VE8F
Editor of CQ magazine, on page 36 of the April,
1955 issue. Signals from surprising distances will be
heard when a high-gain home antenna is fed into the
converter. If an open wire or twinline feedline runs from
this antenna, the converter may be connected to it
through a balun rod designed for this band.

—Ozzy Davis

BASE INSULATORS FOR VERTICAL ANTENNAS

Discharged high-voltage insulators, of the type used
by your local power company on their high-tension transmission lines, are an inexpensive source of base insulators for vertical and ground plane type antennas. They are made in a variety of shapes and sizes and have very high resistance to ground even when wet, due to the construction. Slightly chipped insulators of this type can usually be obtained for little or no cost.

The cup shaped insulator (left) is more suitable, but
some form of tubing clamp can be fastened with wire
to insulators having a "knob" on one end (right).

—Dale Holland, WeRXM

SAVING METER PLACES

Whenever a new scale is being added to a panel
meter face, such as making a 0-1 milliammeter into a
volt-ohm-milliammeter, don't paint the new paper scale
over the original. Instead, remove the mounting screws
for the face, turn it over, and cement the new scale to
the reverse side of the meter backing. When the meter
is being restored to its original form, simply turn the
scale back again. CAUTION—do not bend the indicating needle—otherwise the meter's accuracy may
be impaired.

—Harry J. Miller

TEST PROBES FROM PLASTIC PENCILS

Handy and useful plastic test probes may easily be
fashioned from "ScripRo" pencils simply by remov-
ing the outer and adding a length of flexible probe
wire into the cap and wrapping the exposed metal with
plastic insulating tape. A steel sharpened needle which fits tightly into the lead chuck makes a good
point that penetrates insulated wire when read-
ings cannot be taken from exposed terminals.

—Ozzy Davis

PARASITES

In the schematic diagram, Fig. 3, for the Tri-
Range VFO described in the March-April, 1955 issue
of QST, the consists in output circuit is connected
rectly to the chassis instead of through the 0.01-
0.47 ufd capacitor (C3). The motor rotor gets its ground
between the lower end of L1 and ground. Eliminate
the direct connection between L1 and the motor
shaft of C9. (Circuit as shown would require insulating the
motor and shaft of C9.)
GENERAL DESCRIPTION

NO—the 6AM4 in this photograph (right) definitely does not lie down on the job! A novel horizontal structure, with five grid leads connected in parallel to both ends (in extra low-inductance) permits excellent isolation of the input and output circuits in grounded-grid RF amplifier and mixer service. Its steep cutoff and high transconductance characteristics contribute to efficient performance over the entire range of VHF-UHF television frequencies.

Heater Voltage (AC or DC) 6.3 Volts
Heater Current 0.325 Amperes
Envelope T-6½ Glass
Base 89-1, Small Button 9-Pin

DESIGN CENTER VALUES MAXIMUM RATINGS

Plate Voltage 150 Volts
Positive DC Grid Voltage 0 Volts
Plate Dissipation 2.0 Watts
Heater-Cathode Voltage 80 Volts

AVERAGE CHARACTERISTICS AND TYPICAL OPERATION

Plate Voltage 150 Volts
Cathode Bias Resistor 100 Ohms
Amplification Factor 81
Plate Resistance (Approx.) 9000 Ohms
Transconductance 7.5 Milliamps
Plate Current 0.5 Milliamps
Grid Voltage (Approx) for L=—30 Micrometers —5 Volts

* When the 6AM4 is operated in series d.c. with a second tube, as for example in cascade or direct-coupled circuits, the heater-cathode voltage of the 6AM4 may be as high as 200 volts maximum under cutoff conditions with the heater negative with respect to the cathode.

**Operation with third bias is not recommended.

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[Diagram and additional text related to the tube specifications and use are present but not fully transcribed here.]