Low-Noise 220-Megacycle Converter

You have to hear 'em before you can work 'em, the saying goes. So here's a 220-megacycle "hearing aid" that will give the UHF old-timers a lift—and give the UHF tyro a good start. It's a 220-225-megacycle crystal-controlled converter that feeds a 10-15-megacycle signal into a communications receiver. Take a look, fellows.

—Lighthouse Barry

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A silicon crystal diode must be used and the one shown here is a surplus 1N23 held inside the circuit with a fuse clip and a pin taken from an octal socket. The time spent in constructing such a noise generator will be more than made up in optimizing performance of the converter.

The general procedure used for this converter was to first set it up for maximum gain (as measured at the detector of the station receiver) with a signal generator that will put out a 220-megacycle signal. After this was done the noise figure of the converter was measured and found to be 6 db. Then the home-built noise generator was connected to the receiver, and adjustments made as described below until optimum noise performance was obtained.

When finally checked against a laboratory-type noise generator, the noise figure was between 5 and 6 db—fairly respectable performance at 220 megacycles. It should be noted that optimum noise figure is not necessarily obtained at the point of optimum gain. Thus, in the absence of laboratory-type noise generators which can actually measure the noise figure, it is important to adjust for minimum noise figure on the home-built noise generator rather than for maximum gain.

PRELIMINARY CONSTRUCTION

Construction is not difficult, but should closely follow the layout and wiring of the model illustrated. The converter contains a total of 55 parts to be wire into— that is, capacitors, resistors and coils. This averages only about nine parts for each of the six stages—and only five of the connections are particularly critical. This model has been illustrated and is shown made with a view to assisting the reader in following the construction as closely as possible.

A 1x5-inch aluminum chassis should be laid out according to Figure 4—although slight variations are permissible to accommodate the actual parts the builder has gathered. It is wise to have on hand all the necessary parts—including the coils—before starting construction, care will be taken to drill tube-mounting screw holes so that sockets will be properly oriented. After the chassis has been drilled and the following parts can be mounted: RF connectors, terminal block and its feed-through capacitors, crystal socket, IF coil forms, the 4-30 micro-ferroceramic trimmer, the tubular ceramic trimmers, the variable air capacitor, and the four tie-points which support 220-MEGACYCLE CONVERTER

CIRCUIT DESCRIPTION

This 220-megacycle converter uses 6AJ7 and 6AM7 type tubes developed by General Electric especially for high-frequency service. These tubes have been shown on the circuit diagrams, two stages of radio frequency amplification are used. These are 6AJ7’s in grounded grid service rather than in cascade circuits because of the relative ease in getting the circuits into operation. Performance does not seem to be impaired, because the noise figure was found to be between 3 and 6 db. These are used instead of 6AM7’s in grounded grid service rather than in cascade circuits because of the relative ease in getting the circuits into operation. Performance does not appear to be impaired, because the noise figure was found to be between 3 and 6 db. In addition, the circuit is not critical to adjust.

A 1N277 is used as a fixed oscillator, the first stage operating at 70 megacycles with an overtone crystal in a Butler-type circuit. The second half of the 1N277 triples to 210 megacycles, and this frequency is injected into the 6AM7 mixer by means of a 1 micro-ferroceramic coupling capacitor. The resultant intermediate frequency varies from 10 to 15 megacycles, depending upon the frequency of the signal being received. The 220- to 222-megacycle antenna band thus is covered by tuning the station receiver between 10 and 15 megacycles.

Two tube-type circuits were built, both using a 70-megacycle overtone crystal, and each oscillator circuit was designed so that when it was not necessary to be used, it will be necessary to reinsert the circuit and add another multiplying stage. In this event, a 7.77-megacycle crystal could be used in a stage which picks off the third overtone of approximately 230 megacycles—and then multiplication continued to 210 megacycles as in the circuit described here. The oscillator circuits were set up initially with a grid-dip oscillator and required some later adjustment in tuning and coupling to optimize performance. The variable capacitors provided allow plenty of tolerance for circuit variations.

The 6AM7 mixer stage is a grounded cathode circuit. This tube has five grid pins, and no trouble was encountered in using two of these pins. The three unused grid connections were removed from the socket to minimize stray capacitance. A single-stage IF amplifier uses slug-tuned coils and a 6AS. The 6ASs used were frequency range 12 to 150 volts of B plus rated at 50 to 60 milliamperes and a 6.3-volt filament supply that will handle a 1.5 ampere. Both the filament and high-voltage leads are by-passed at the terminal block by feed-through capacitors (C6 and C7) to prevent possible interference from a strong station on the low-frequency band. Each might enter the converter through the power connections. If such a station is already in the circuit, it may be necessary to cover the 6AM7 and 6AS5 and use a bottom plate or some other circuit by-pass. Such circuits are not particularly necessary when trying to copy 200 DX.

NOISE PERFORMANCE

As always at these frequencies, noise is an important factor and must be reduced to the extent consistent with reducing this figure.

In the third stage of the UHF range the ultimate sensitivity of a receiver or converter is limited by its noise figure. It is important to reduce noise figure as low as possible. If the noise figure is reduced from 15 db (a not uncommon figure) to 10 db, the useful signal may be raised by 10 times the power output of the station sending to the converter. The 6AJ7 and 6AM7 tubes were designed to provide top performance at the UHF terminal range, and they perform beautifully at 220 megacycles.

A noise generator should be used to optimize performance. Such circuits have been described numerous times in amateur publications, and the circuit of the one used to set up this converter is shown in Figure 1.
the RF choke and the 100-ohm decoupling resistors. Miniature ceramic stand-off insulators made by Cambridge Thermionic Corporation are used for this latter purpose in the model shown, but ordinary 1- or 2-point terminal strips will serve.

Before mounting the tube sockets, some of the unused lugs of the tube sockets of the first RF stage and the mixer stage are removed to reduce stray capacity. In the first 6AI7 stage, tube socket lugs 1 and 3 should be removed, and in the 6ALM3 stage tube socket lugs 3 and 6 must be removed. This operation is easily accomplished by flattening the locking dents in the lugs and forcing them out through the top of the socket.

When mounting the tubular ceramic trimmers (C1, C2, C3, and C4), note they should be oriented so their hooks can be soldered directly to the tube socket lugs. Small strips of copper about 3/16-inch wide are fashioned for soldering between pins 4 and 9 of the first 6AI7 socket, and between pins 1, 3, 4, 6 and 9 of the second 6AI7 socket. As shown in Figure 3, these shields are connected to the base sleeve of the socket.

COIL WINDING DATA

While coil specifications in the component list accompanying the schematic diagram are complete, it might be well to mention that L4 and L5 can be wound on any type form as long as the finished product, in the circuits, tunes the RF frequencies of 10 to 15 megacycles.

After winding RFC1 and L2 on the threads of a 1/4-20 bolt, it is possible to carefully unscrew the bolt from the coils without disturbing the spacing. It is wise to leave the leads longer than necessary until ready to wire the coils into the circuit.

WIRING DIRECTIONS

The filament leads, RF chokes and high-voltage leads can be wired first. Wiring of the remaining components should follow—with the exception of C1, C2, and C4 and the input lead from the RF connector to the cathode of the first 6AI7. Care should be taken to keep RF leads as short as possible.

In wiring, note the placement of C4 and C6 on each side of pin 2 of the 6AM5 socket. Two capacitors are used here to reduce lead inductance. In the model shown (Fig. 5) two 200-ohm resistors are used for R15, one connected to pin 2, the other to pin 7 (both cathode pins) of the 6AS7. One 100-ohm resistor connected to either pin will serve, however.

Connection of C4, C5, and C6 and the RF input lead to their associated coils is somewhat critical for optimum noise figure and the adjustment procedure is described below.

ADJUSTMENT PROCEDURE

The home-built crystal diode noise generator does not give noise figures in actual dB. It is a comparison device only, and merely tells the experimenter whether the adjustments he makes on his converter are in the right direction. With the particular crystal and component used in the home-built noise generator shown, it was found that 1 milliamperes of reverse crystal current—indicated on the noise generator meter—is equal to approximately 10 db of noise when compared with a laboratory noise generator.

Unless the builder has access to such a laboratory instrument, he will not be able to measure precisely the noise figure of his converter. However, if the construction and adjustment instructions are closely followed, he can be sure that when he has attained optimum performance as indicated with his own home-built noise generator, the noise figure of his converter will be comparable to the converter described herein.

The adjustment procedure for obtaining the best noise figure involves moving the connections of the RF input lead, C4, C5, and C6. Of course, before these adjustments are made, these components must be soldered in to check voltages and set the converter up for maximum gain. It is suggested that as a starting point, the RF input lead to L6 should be soldered directly to the cathode pin of the socket of the first 6AI7. The connection of C4 to L2 can be made at the center of L2. Then C5 can be soldered from a point about a half-turn down from the plate end of L4 directly to pin 9 of the 6AM5. C6 can be connected between grid pin 4 of the mixer tube and tapped down about a half turn from the plate end of L6.

With these connections made, the first step is to use a signal generator as mentioned above—the fellow ham's 270 mc transmitter—and make the usual adjustments of the tuned circuits to get maximum gain. Once this is accomplished, the objective of subsequent ad-
C, C1, C2—2.5 to 12 mfd tubular ceramic trimmer (CST-3B, Cambridge Thermionic)
C3—0.001 mfd disc ceramic
C4, C5, C6—.001 button ceramic or mica
C7—500 mfd ceramic coupling capacitor
C8—.002 mfd disc ceramic
C9—.0001 mfd disc ceramic
C10—100 mfd ceramic coupling capacitor
C11, C12—.002 mfd disc ceramic
C13—.005 mfd ceramic
C14—100 mfd ceramic coupling capacitor
C15—500 mfd ceramic
C16—.005 mfd disc ceramic
C17, C18—.005 mfd disc ceramic
C19—500 mfd ceramic
C20—.04-12 mfd mica
C21—25 mfd ceramic coupling capacitor
C22—.001 mfd disc ceramic
C23—.001 mfd disc ceramic
C24—.001 mfd disc ceramic
C25—.001 mfd ceramic
C26—2.7-19.6 mmf miniature variable (John- son 20M11 or equivalent)
C27—.015 ceramic feed-through
R1, R2—5 megohms
R3—36 ohms
R4—30 ohms
R5—200 ohms
R6—7000 ohms
R7—10000 ohms
R8—9000 ohms
R9—10,000 ohms
R10—20,000 ohms
L1, L2, L3—3t. No. 14 wound on 1/4-inch form, 1/16-inch long
L4—3t. No. 22 wound on 1/4-inch form, 1/16-inch long
L5—1t. No. 14 wound on 3/16-inch form, 5/16-inch long
L6—3t. No. 30 en. close-wound on 1/4-inch slug-tuned form (CTC–LS7)
L7—40-45t. No. 30 en. close-wound on same type form as L6.
L8—4t. link insulated wire on cold end of L6.
L9—3t. No. 24 wound on 1/4-inch form, 1/4-inch long
RFC1—121 No. 24 en. in wound in threads of 1/8-inch bolt
RFC2—121 No. 24 en. close-wound on a 1/4-inch length of 1/8-inch diameter polystyrene rod
XTAL—70-megacycle overtone-type crystal (Midland or equivalent).

Fig. 3—Circuit diagram of 220-megacycle converter.
Fig. 5—Bottom view of 220-megacycle converter. RF input at top left, second RF amplifier at bottom left corner; mixer tube and slug-tuned plate coil (L3) at bottom center; and IF amplifier and final tank coil (L7) at bottom right. At top right is crystal socket, the 12AT7, C2, C3, and other components associated with the oscillator circuit. The 6AM4 plate resistor and plate by-pass are hidden under the lower lip of the chassis. In this view most of the parts can be identified by checking their connections to tube pins.
When the noise generator is switched on, the meter reading varies as the noise generator is tuned. The percentage change in the output meter reading is found by setting the noise generator at the best point and then setting it at the worst point. If the percentage change is more than 5 or 10 per cent, it is worthwhile to make further adjustments.

The next step is to turn on the noise generator and adjust its potentiometer so that the generator meter reads about mid-scale. If the noise generator shows that it is 1 milliampere. Now note the percentage of increase in the output meter reading as compared with its reading when the noise generator is off.

From here on the object is to make changes in the converter's input and coupling circuits which will result in this same percentage increase in the output meter reading. The output meter reading as compared with its reading when the noise generator is off.

The following procedure should be used to determine the correct point to tap the input lead. Every time the input lead is moved so that it changes the percentage of increase in the output meter when the noise generator is tuned on, the potentiometer on the noise generator is adjusted to bring the output meter reading to a point where the percentage of increase is the same as it was before the adjustment procedure was started. If the coil tap points are not the same, the output meter is tuned at the right point and the coil tap adjustment was made in the wrong position.

The next adjustment to make is to tap on the output lead. The lead from C1 should be soldered on the coil at various points—each time reducing the noise generator potentiometer to see if the noise generator current goes down when the same increase on the output meter. If the same results are obtained, this procedure of noise generator current. The coil tap adjustment was made in the wrong position.

The third important adjustment is the amount of coupling voltage in the circuit. This can be changed by trying various values of capacitance (C6) and adjusting the input lead. In making these adjustments, the same procedure outlined above is followed. If the noise generator current increases in one microfarad coupling capacitor tapped about 1/2 turn down from the plate end of L4, adjustment of C6 did not seem to make much difference in noise performance in the converter shown. However, it might be worth while trying tapping the leads of this capacitor at different points on L4 and L14.
We've apparently found there are no secrets in a ham wedding—which with mobiles all over the place reporting your every movement, "Ham Hound," published by AK-Sar-Ben, found mobiles were stationed at the church and at the happy couple's "hidden" getaway car.

A note in "Sparks," published by the Brandon (Manitoba) Amateur Radio Club, informs us that VE4PA visited VE4WW and VE4BS and "spent a couple of fruitful hours watching the snowflakes on Gordon's 2-inch video screen." Also, "Gordon (VE-

A note in "Sparks," published by the Brandon (Manitoba) Amateur Radio Club, informs us that VE4PA visited VE4WW and VE4BS and "spent a couple of fruitful hours watching the snowflakes on Gordon's 2-inch video screen." Also, "Gordon (VE4WW) is quite happy over those and a half minutes of trapezoid. It appears to comprise a set ago last something—don't know. Anyway, it's a nice piece of literature," VE4PA adds. "Did we mention to one of us in the '60 set a month ago that we were wondering if the lads up that way knew really how well off they are?"

1 "Show me a man who has a hobby and I'll show you a conscientious man whose effort and success is above average. Of all the hobbies, it is safe to say ham radio is the most complete both politically and technically. No other hobby can serve the public as adequately as can ham radio. Probably no other hobby has as many jealous commercial interests crying our assets. No other hobby can or has helped the advance of electronics as ham radio has done."

Thus writes WY3NE in "Marc Sparks," published by the Michigan Amateur Radio Club (WBY4B). He adds that none of these achievements can or could be accomplished without the co-operative efforts of individual hams organized into clubs. Individually, he points out, we are but persons with hobbies; collectively, we constitute a powerful force that can help not only ourselves but our community, our nation and the world. And I might point out all that is in addition to the fun and fine friendships club activities can bring.

Our first Bound Volume was so popular, we are getting a lot of requests for a second Bound Volume. The first volume contained all the issues of QST HAM NEWS published from 1946—when QST HAM NEWS began—through 1950. We plan to make up another bound volume at the end of our second five-year period of publication. Thus our second Bound Volume will contain all issues published in the years 1951 through 1955.

We're sorry it is so long between Bound Volumes, but publishing bi-monthly as we do, it takes long to accumulate sufficient issues to make binding worthwhile. If by any chance you wish to make reservation at this early date for the second Bound Volume of QST HAM NEWS, we'll be glad to keep your name and address on file until the book is ready. But please do not send any money now! We sell the Bound Volumes at the cost of binding and handling (the first one cost $2 per copy) and we cannot tell at this time just what binding will cost a year and a half from now.

The editor was looking over ARRL's bibliography of TVI literature the other day and reminded us to remind you that we will have back copies of the issue of QST HAM NEWS which described our "TVI High Gains." This highly effective filter of a TV receiver input incorporates an interesting design feature and for a very few cents can be put together without cost. The filter is described in the April, 1951, issue of QST HAM NEWS (Volume 6, No. 5). I'll be glad to send you a copy, if you want one. Incidentally, one of the fellows who used one of these little filters reported it was highly effective as a fear when lightning struck his TV line. He said the filter just seemed to evaporate. He couldn't find more than a few droplets of copper left. But the TV set was still there, and he remarked that the filter also served as a substitute for normal lightning attracting precautions, however.
A. R. KOCH, W2RMA

Art Koch, W2RMA—designer of the 220-megacycle converter described in this issue of G.E HAM NEWS—makes G.E UHF klystrons tick during the day. Then he goes home and makes UHF ham rigs tick. He’s a design engineer at the industrial and transmitting tube plant in Schenectady and has supervised the installation of UHF klystrons in a number of the nation’s most progressive TV stations.

G.E’s 12-kilowatt klystrons come in six types—each covering a segment of the 470 to 890-megacycle UHF TV band. They are tunable within their ranges and are triple-resonator type tubes. Klystrons stand about five feet high, draw 35 amperes of heater current at 5.5 volts, and require 17,000 volts d-c at 3 amperes. Driving power averages 25 watts—and most stations use a 4X150 as driver. Two klystrons are used in a UHF-TV station—one to amplify the visual signal, the other to amplify the sound—and the two are mixed in a “Filtrexer” before being fed into the antenna.

Art, shown here setting up some gear to test a klystron, is the designer of one of the UHF cavities illustrated in the ARRL Handbook, and the Super 430 (G.E HAM NEWS, Volume 8, No. 4).