A 6-METER SPECTACULAR—Part I

"TECHNICIANS’ DELIGHT" TRANSCEIVER

Part I is a complete 6-meter station in one package from the bench of W2GYV that features a simple six-tube circuit, 4.5 MC fixed-frequency superregenerative detector, speaker doubling as a microphone and a novel "pi-network" overtone oscillator circuit. The next issue will feature Part II, the "Simple-sixer Serious Converter"; and the November-December issue will present Part III, the "Bonus 100-watt Transmitter."

—Lighthouse Larry

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Have you ever wondered how more than one germanium diode would work in a crystal receiver? Well, I found out when tests were made on these entries I received recently. Fig. 1 is a full-wave detector using a split coil and a 2-section tuning capacitor, which can be any old broadcast type, ranging from about 10 to 25% inch from L1 to L2, spaced a 2½-inch diameter. The coil is wound in the middle of a 6-inch long, 1½-inch diameter form. L1 and L2 each have 148 turns wound with side and spaced ½ inch from L1. All coils are wound in the same direction. The series antenna capacitors, C9, a 15-400-mmf variable, and C10, a 500-mmf fixed, help resonate most any antenna and ground system. Les Trude, W2OXX, of Clyde, N. Y., submitted this first of several full-wave circuits received.

The circuit shown below makes use of a bridge-type detector circuit which, when tested, showed greater selectivity than a single crystal connected across the same tuned circuit. The audio output voltage was about the same for either detector. The selectivity becomes greater and sensitivity decreases as the spacing between the coils is increased. The two varichoke sticks may be placed either end to end or parallel with about ½ inch spacing center to center. J. L. Knaus of Glassport, Pa., submitted this circuit.

The circuit diagram shown for the simple two-crystal circuit I have received comes from R. J. Baker, W8JIA, North Industry, Ohio. Several of the local hams glanced at the circuit and told me, "Impossible!! There's no ground return path." So, try it yourself. It only takes a couple minutes. If you have more than one local broadcast station, the selectivity will become very high for a 2-crystal circuit. The two variable capacitors are separate—and for simplicity the two in the antenna circuit could be the microphone type.

W8JIA also submitted a design with one crystal and high selectivity, shown in Fig. 3. The coils are wound on a G-E tube carton 1½ inches square. L1 is 50 turns of No. 26 wire. L2 is 25 turns spaced ½ inch from L1 and L3 is 50 turns spaced ½ inch from L2. All the variable capacitors are separate—and for simplicity the two in the antenna circuit could be the microphone type.

The simplest two-crystal circuit I have received came from R. J. Baker, W8JIA, North Industry, Ohio. Several of the local hams glanced at the circuit and told me, "Impossible!! There's no ground return path." So, try it yourself. It only takes a couple minutes. If you have more than one local broadcast station, the selectivity will become very high for a 2-crystal circuit. The two variable capacitors are separate—and for simplicity the two in the antenna circuit could be the microphone type.

**FIG. 1.**

**FIG. 2.**

**FIG. 3.**
This simple transceiver has many possibilities as a general-purpose 6-meter for Technician class amateur radio licensees who want to take advantage of their recently-granted privileges on this band. It should particularly interest those who have no regular station receiver into which a converter may be used.

The original idea was that a few of the local gang wanted to build these units and leave them running all the time for a little private communications network. This idea was dropped because the sensitivity from receiver to station was well above expectations and the rig seemed to be a failure for the above-mentioned reason.

The reliable working range between two of these units over fairly level terrain using a simple ground-plane antenna at roof-top height seems to be ten to fifteen miles. This set would also be useful for CD communications installations located where only one two-way radio unit is needed. As the power requirements were tailored to fit the popular 300-volt, 100-milliamperes vibrator-type plate supply, it will run for many hours on one "filling" of a storage battery. The heater power requirement is only 2.4 amperes at 6.3 volts. Total plate power drain at 300 ma on 50 ma on a "receiver" position and 100 ma on the "transmit" position. The high efficiency G-E HAM NEWS Mobile Portable Power Supply described in Volume 8, No. 2, would be ideal for powering this rig from 6 volts.

**RECEIVER CIRCUIT**

The schematic diagram, Fig. 1, shows that only six tubes are required for this transceiver, with the audio section serving a dual role as plate modulator and receiver audio amplifier. The receiver section uses a 12AT7 mixer-oscillator with the IF output at 4.5 megacycles. The high-frequency oscillator tunes on the low side of the 55 to 54 megacycle signal frequency to minimize image difficulties in areas where TV channel 2 is in use. Miser grid circuit tuning capacitor (C1) was not ganged to oscillator capacitor (C2) to eliminate tracking problems. Normally, C1 will only have to be touched when more than a half megacycle change frequency is required in the oscillator tuning.

A standard 4.5 megacycle television sound discoloration circuit is used here to reduce the noise from the oscillographic action. This circuit will be re-emphasized by many old-timers as a being notorious for bad times. The short answer is that the action is an inherent characteristic of the grid circuit that is difficult to overcome in this disadvantages. The desired properties of grid sensitivity, gain, plate rejection and inherent AEC action make possible a good performing but simple set.

For the information of "new-timers," this detector is simply an oscillator at 4.5 megacycles in which the values of the grid resistor and capacitor have been increased to the point where a "knocking" action or second oscillation takes place simultaneously about 29 KC. The grid capacitor (C3) accepts a high negative charge which decreases at a slow rate through the high value grid resistor, carrying the oscillator up from the point. In a normal regenerative detector, further amplification stages will oscillate continuously. The superregenerative detector can oscillate at the signal frequency only when the positive detector decreases to the point where the grid is no longer biased beyond cutoff. Thus, the regeneration can be greatly increased with a large amount of amplification resulting.

One half of another 12AT7 handles this function, the second section being used as an audio voltage amplifier. A 655-beam-plate automatic output stage provides plenty of drive for the 45-ohm voice coil, 35-inch FM speaker.

**TRANSMITTER CIRCUIT**

The transmitter section uses a third 12AT7 as an overtone crystal oscillator and frequency doubler. Novel use of a pentode tank circuit is used to provide feedback for encouraging third-overtone operation of any crystal god for fundamental operation by 8334 and 8906 KC.

Variable air capacity C1 tunes the network to the 25 megacycle output frequency and static pad capacitor C2 allows easy and precise adjustment of the proper amount of feedback necessary for overtone output from highs to extremely or extensively sluggish crystals. Tests indicate that this circuit is much simpler to adjust than other more complex types in which a collap- or separate feedback coil is required, feedback is at a minimum when this pad is at maximum capacity.

The other half of this 12AT7 in a conventional frequency doubler provides about 3 ma grid current for the 5763 C class power amplifier. Another pi-network tank circuit is used for the amplifier output, to simplify the problem of providing mechanical means of varying the antenna loading. Parallel feed is used to isolate the plate voltage from the output circuit. While a conventional parallel-tuned tank circuit with a balanced line output might be more desirable for feeding the rig into a 30-ohm twin-lead, the unbalanced output circuit can be led into a small antenna coupler or line-balancing balun made from a variable air capacity. This circuit is also handled more easily with the unbalanced circuit.

As a safety measure, enough cathode bias is provided on each transmitter stage to keep the plate dissipation within reason when no crystal is plugged in, or the tank circuits are off resonance.

 Provision for metering the doubler and amplifier grid currents, the amplifier cathode current and the plate supply voltage is made by placing appropriate resistors in three circuits. Leads from these resistors connect to an octal socket installed in the rear of the chassis. The same test meter used with the G-E HAM NEWS 6-meter C-D transmitter (see page 8, also Volume 7, No. 1 for details) can be plugged into this socket when testing the units. The leads are inserted into the appropriate socket holes so is can be connected to the 10-volt DC scale on the meter.

**AUDIO CIRCUITS**

Plate and screen modulation of the final amplifier was to be done preferably with the kind of transformer that every watt of output really counts, than the lower efficiency of filament modulation. The 655 pentode was used in this power amplifier stage using a 25-volt DC plate feed, an input transformer for the rear screen heater, and a plate current regulating circuit. The plate rating is that the bias voltage should vary from 12.5 volts to about 314 volts in applications. If the grind is too low at 220 volts or less, the LA05 miniature-tube version would suffice. Always test the transmitter after switching from the secondary of the output transformer to the cathode of one section of a pair of 12AT7 with the 12AT7 used in this grid voltage amplifier. The output of this stage feeds the voltage amplifier stage used for both receiving and transmitting. And the other half of this tube is not used. The audio output transformer, T1, serves as a center-tapped modulation choke. The 47-henry resistor across primary avoid d-c reactions and position ties down the secondary.

If the rig is to be used for 30-meter mobile operation in either an under-dash or on-the-seat installation, the speaker is more easily modified to be conveniently used as a microphone. No, a closed- circuit phone is provided as the cathode of the transmitter voltage amplifier. When a single-button carbon microphone is plugged in, the speaker is dis-
Fig. 1—Circuit diagram.

Fig. 2—Chassis drilling diagram.

COIL TABLE

<table>
<thead>
<tr>
<th>Coils</th>
<th>Type of Wire</th>
<th>Inside Diameter</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>16, enamel</td>
<td>1/4 inch</td>
<td>1/2 inch long</td>
</tr>
<tr>
<td>L2</td>
<td>16, enamel</td>
<td>1/4 inch</td>
<td>11/4 inch long</td>
</tr>
<tr>
<td>L3, L5</td>
<td>16, enamel</td>
<td>1/4 inch</td>
<td>1/2 inch long</td>
</tr>
<tr>
<td>L4</td>
<td>16, enamel</td>
<td>1/2 inch</td>
<td>2-inch leads</td>
</tr>
</tbody>
</table>

LEGEND

"A" drill—No. 32 spaced to fit tube sockets.
"B" drill—No. 26 as shown.
"C" drill—1/4-inch diameter.
"D" drill—1/2-inch diameter.
"E" socket punch—1/4-inch diameter.
PARTS LIST
C1—1.8-8.7 mmf Variable Midget Capacitor
    (Johnson 9 M 11 Cat. 160-104).
C2—2.3-14.2 mmf Variable Midget Capacitor
    (Johnson 15 M 11 Cat. 160-107).
C3—15-130 mmf Variable Mica Padder Capacitor
    (Elenco 202-M).
C4, C9—65-340 mmf Variable Mica Padder Capacitor
    (Elenco 302-M).
C5, C6—2.7-19.6 mmf Variable Midget Capacitor
    (Johnson 20 M 11 Cat. 160-110).
Cr—1000 mmf, 1000-volt working disk ceramic.
C8—3.5-27 mmf Variable Capacitor—0.030-inch air gap
    (Johnson 25 L 15 Cat. 167-102).
C7—0.006 and 0.005-inch air gap (Johnson 20 M 11 Cat. 160-100).
C9—0.005 and 0.004-inch air gap (Johnson 20 M 11 Cat. 160-100).
S1—6-pole, 2-position steatite miniature Rotary Selector
    Switch, non-shorting (Centralab PA-2019).
T1—4.5 megacycle TV Replacement Sound Discriminator
    Transformer (Miller No. 6204).
T2—18-watt universal speaker output transformer
    (Sfancor A-3852).
RFC1—5-7 mh RF choke (Miller No. 19-1995).
RFC2—1 mh RF choke (Miller No. 952).
RFC3—16 mh RF choke (Meissner 19-1995).
RFC4—1 mh RF choke (Ohmite Z-50).
Xtal—Quartz crystal 8334 to 9000 KC with socket to match.

All capacitors in mmf 600-volt disk ceramic unless otherwise specified.
Capacitors marked in mfd are 600-volt paper. Electrolytic capacitors
are marked in mfd and voltage rating.
All resistors %W unless otherwise specified. K=1000, M=megohms.

Fig. 3—Bottom view of chassis. RFC3 is the large disk at the right of the inverted mixer tube.

Fig. 4—Top view of chassis. A 6V6-GT audio output tube was used in the test model.
CONSTRUCTION

The entire project easily housed in a 6 x 6 x 9-inch utility box. If much portable work is planned with this unit, the aluminum panel is least objectionable, but preferable to a steel one, weighing about two pounds less. All parts mount on either the removable front panel or a 4 3/8 x 8 1/4-inch open-end aluminum chassis, drilled as shown in Fig. 3.

The mounting plate furnished with Ti, is used as a drilling and filing template to cut identical holes in the chassis and is then discarded. The transformer is then fastened directly to the chassis with the mounting spring clip. The lower panel edge is located 3/4 inch down from the bottom of the chassis and machining 1/4-inch holes are drilled for all parts except the crystal socket. A 3/8 x 1/4-inch plate cutout allows the crystal to be plugged in. Holes for C5 and B6 are located 1 1/8 inches down from the panel top edge, with C5 2/3 inches in from the side. B6 is centered on the panel and C6 locates 3/8 inches directly below it. C5 is mounted 1 1/4 inches from the panel edge and 1 1/2 inches below C6.

A piece of thin sheet aluminum, 4 x 4 inches, bent into an angle bracket and fastened to the front of the chassis, provides a good RF ground path for C5, C6, and B6. C6 mounts on another small aluminum angle bracket fastened with the same screws which hold the larger bracket. A 1/4-inch diameter hole for the speaker is bored in the panel with a circle cutter centered 3/16 inches down and 2 3/8 inches in from the panel edge, and covered with a small square of perforated felt-yourself aluminum. The entire mounting panel is fastened to the chassis with four 6-32 screws.

All parts can now be fastened to the chassis front edge and the rear of the chassis, and wiring cut from 3/4-inch OD tubing is slipped over the 3/8 x 3/8-inch terminals. The leads are trimmed to protrude about 1/8 of an inch.

The mixer and RF section on a single 6 x 8 1/2 x 1/2-inch long machine screw as shown in the bottom view, Fig. 3. The mixer-oscillator tube socket is installed to allow short RF leads pictures in the top view, Fig. 4. The larger capacitors and resistors are located to a 3 x 4 and a 6-terminal tie-point fastened under convenient mounting screws. The power terminal strip, microphone jack, meter socket and antenna connector mount on the rear of the chassis and matching holes are cut in the back cover of the utility box to clear these parts.

Power and antenna wiring connections to Ti are laced and run through two rubber grommets near Ti and along the edges of the chassis to the switch, to avoid the RF circuits. All coils are air-wound and mount directly on the designated tuning capacitors. One end of Lk is connected to a tie-point terminal so that the 1000-megacycle input voltage reading on the meter is zero. Short leads connect the antenna transfer switch section to (a) the chassis, (b) the plate of the mixer tube and (c) 1/4-watt composition resistors. A short length of RG-59/U coaxial cable connects the 30-inch pickup loop to the 1/4-watt load through a 100-ohm carbon resistor.

RECEIVER ADJUSTMENT

The heater voltage of 6.3 volts before the test of the wiring is completed so that any alterations can be made more easily. Before plate power is applied, a calibrated grid-dip oscillator is very handy for adjusting the tuned circuits to the correct frequency range. With Cs set at the proper point, Cs should tune the oscillator between 43 and 50 megacycles with the constants shown. Switch B7 can now be set in the "receive" position, with the mixer-oscillator tube removed and plate voltage applied to the unit. With the volume control set at the mid-position, the 100,000-ohm potentiometer controlling the superregenerative detector plate voltage should be advanced until a sharp hiss becomes noticeable. If no noise is present, a grid-dip oscillator or other signal generator should be closely coupled to the detector and tuned from approximately 4 to 5 megacycles. If no output is to be seen, the detector and the modulated voltage to the audio amplifier, and no output will be heard when the plate voltage control is fully advanced. If this is the case, a higher resistance than the 10 megohms specified may be necessary to initiate a superregenerative type oscillation. RFCC and its associated by-pass capacitors form a filter that keeps the quench oscillation out of the audio circuits. If a signal generator is not readily available, two or three feet of wire clipped on pin 6 of the microphone tube socket should provide enough pickup of outside signals in the 4 to 5 megacycle range to check the operation of the detector. The mixer-oscillator tube then can be inserted and the detector set to a clear frequency by tuning the trimmers. If a signal generator is not available, the entire microphone plate circuit plug on the top of the transformer should then be tuned until the detector goes out of oscillation when the resonant frequency is raised. Raising the detector plate voltage slightly should again cause the detector to oscillate. With the detector grid circuit values specified, oscillation should begin when the plate-voltage control is advanced about halfway. On the test model, a reading of 60 volts was measured at the center tap of the 10-mf transformer secondary. Dial calibration of the receiver oscillator can best be done with harmonics of a crystal frequency standard or signals of known frequency.

TRANSMITTER ADJUSTMENT

The test meter, shown in Fig. 5, can now be plugged into the metering socket, with the selector switch set on position one. The 12AT7 oscillator-doubler and 3963 amplifier tubes are inserted in their sockets and B7 tuned to the "transmit" position. A fundamental type crystal oscillator is inserted in the C9-C10-R9 circuit of the crystal between 25 and 27 megacycles is plugged into one socket. The two sockets are set about two turns from maximum capacity and oscillator voltage slightly reduced. Short leads connect the mixer section to a 30-inch lead wire 3.5-megacycle grid is noted in the 0- to 10-ma range of the test meter. The meter should read about 0.5-ma with a signal of 1000 microvolts.

A "clapper" type oscillator can be slightly adjusted for increasing capacity until oscillation stops. The final setting will be about 5-9 megacycles away from the plate resistance of the oscillator. A signal generator can now be substituted for the two parts and a fresh 60-ohm tail current should be noted when the doubling capacitor Cs is next adjusted.

The test meter is now set on position three, which reads 1-watt output. A 60-ohm transmitting load made from six 350-ohm, 2-watt composition resistors in parallel is connected to the antenna terminal. This circuit is capable of producing 0.5 watts of audio out at 500 cycles with about 1000 volts applied to the crystal voltage supply. Cs is tuned to resonant. A reading of about 30 ma indicated a proper voltage is applied to the oscillator in position three. Capacitor Cs should then be slowly decreased in capacity keeping Ck tuned up to the maximum electrode current, until the meter reads about 50 ma. After re-adjusting Ck, the grid meter indicates a plate input of 14 watts with a 300-ohm plate load. The test meter read more than 3 watts output to a 24-ohm load when checked in the laboratory. Two self-supporting screws driven 1 1/2 inches in from the rear of the chassis where the gear is placed in the box will make the unit rigid.
If you have thumbed through a recent receiving tube price list or characteristics handbook, several bewildering new type numbers may have come to your attention. Most of these additions are the result of tube manufacturers' attempts to cater to the demands of the television industry for tubes that will handle special color-TV applications as well as give better performance and longer life in any receiver.

With the introduction of 600-milliamphere tubes specifically for color TV operation, some confusion has resulted in regards to interchangeability with their prototypes. Also, the use of suffix A and B, in addition to the common ones of Q and GT, has raised some questions as to their meaning.

The following is an attempt to clarify these questions.

One—All types that originally had 600-milliamphere heaters which were used in series receivers were revised only to the extent of controlling the heater warm-up time. In these cases the suffix A or B may indicate such a feature, but to avoid confusion can be disregarded as all future production of such types will have only the new heater. Examples are the 6HA and 6HN-7GB. Obviously, no problem exists in using any types in parallel-connected receivers but use of any old type tube numbers (e.g., 6SA, 6SN-7GA) in series-receiver tubes is not recommended.

Two—All types that originally did not have 600-milliamphere heaters but were desired for use in series sets had to be registered as an entirely new type and as such will have the controlled heater warm-up characteristic. Examples are the 8B6TA and 8AP6A. In these cases the suffix has no meaning in connection with heater characteristics. Those—It is safe to assume that any 600-milliamphere heater rated receiving type that may be developed in the future will have a controlled heater warm-up characteristic regardless of its intended application, consequently no suffix will be used in the original registration. Example—6A59.

Three—It is also possible that use of suffixes A and B have no consistent meaning except as an indication of the order in which they were assigned numbers by the Radio Electronic-Television Manufacturers' Association. Their presence indicates a change has been made in the tube but this change may be electronic or mechanical or both. The RETMA designation system for receiving tubes states: The letters A, B, C, D, E and F indicate DESCENDING numbers. The suffix M is a later and modified version of a specific type which can be substituted for any previous version but not vice-versa. As examples the 12BH7A is a merely a controlled heater warm-up version of the 12BH7. The 12BH7A is a short bulb version of the 6BMF while the 21CD6-GB is an entirely new 25-milliamphere version of the 6CD6-G with improved electrical characteristics, controlled heater warm-up and improved reliability.

Generally speaking, there should be no problem in using later designs in old equipment. The only possible difficulty would be minor mechanical, such as base clamps or withdrawing shorter tubes from recessed sockets. Future equipments present no problem so as designer would specify as obsolete type and the present rate of consumption will soon eliminate inventories of old style tubes.

Through a request for back issues of Q-S HAM NEWS, existence of a unique amateur radio club has come to my attention. J. G. McKinley, Jr., W3OB, secretary of the Maritime Mobile Amateur Radio Club, states that the club publishes a periodical newsletter, but never holds a membership meeting! Because a majority of the 160 members serve as Captains or Radio Officers on ships throughout the world, all club business has to be transacted by mail or amateur radio schedules. Instead of a "President" and "Vice-president," they have a "Commander" and "Vice-commander." They are: J. H. van Weldeeren, W3KW, Captain of the Gulf Victory, and Kurt Carnell, W7XMM, Captain of the Flying Enterprise H, respectively.

W7XMM is the famous, "Captain Stay-put," who remained alone aboard his storm-damaged ship off the coast of England until shortly before she sank, early in 1943.
Since the test meter for the 6-meter CD transmitter (see G-E Ham News, Volume 7, No. 1, for details), met the metering requirements for this unit, the circuit, shown in Fig. 5, is being repeated for those who do not have access to this issue. A few of these meters may be available in locations where these CD rigs are in use. 

In switch positions 1 and 2, the resistor R1 causes the meter to act as a 0 to 10 volt meter; in switch position 3, resistor R2 makes the meter into a 0 to 5 volt meter; in switch position 4, the meter is used as a voltmeter with the range 0 to 1000 volts in switch position 5, the meter is used as a 0 to 1 milliammeter; in position 6 the meter is shorted (the recommended "off" position).

The following tabulation indicates the "current" and voltage which the meter reads when it is switched to the various positions:

Position 1: Full scale equals 10 ma doubler grid current.
Position 2: Full scale equals 10 ma final grid current.
Position 3: Full scale equals 100 ma final cathode current.
Position 4: Full scale equals 1000 volts plate voltage.
Position 5: Relative power output reading (Not used).
Position 6: Off.

For accurate scale readings, the resistors specified should be as accurate as possible. Strictly speaking, however, accuracy is not paramount, inasmuch as the metering system will undoubtedly be used mainly as a tune-up aid.

CIRCUIT CONSTANTS

| C | 270 mmf mica or high-K ceramic |
| M | 0 to 1 ma d-c meter |
| F | Octal plug |
| R1 | 10,000 ohm, ½ watt (see text) |
| R2 | 5000 ohm, ½ watt (see text) |
| R3 | 5 megohms, 1 watt (see text) |
| S | Two-pole, six-position rotary switch |

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