150-WATT SINGLE BANDER

**Features**
- EXTRA HIGH-C VFO
- TWO-STAGE CIRCUIT
- AUTOMATIC VFO SWITCH

—a 3.5 Megacycle Transmitter for Field Day or Home Station—

The 3.5-megacycle transmitter described in this issue is one of a series, each with similar panel layout, designed to operate on specific amateur bands. Details on transmitters for the higher frequency bands, plus built-in accessories, will appear in forthcoming issues of G-E HAM NEWS.

—Lighthouse Larry

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CIRCUIT DETAILS

Once the tube lineup has been chosen, the remaining transmitter circuit details were worked out, as shown in the schematic diagram of Fig. 1. This small, compact circuit, with space-consuming chokes and mechanical rigidity problems which must be overcome to obtain a true stable series-tuned Clapp, oscillator, the old parallellumped circuit was thrown over one bar (see Technical Talk—HIGH-C OSCILLATORS, on page 6, for details). This oscillator was found to have excellent short-term stability (point 5) without requiring temperature compensation, which was constructed from high-quality components. The frequency determin- ing circuit was designed to operate at half the transmitter output frequency to reduce interaction while using the final amplifier plate circuit.

To avoid a panel control for tuning the interstage coupling between the 6A07 plate and 877 con- trol grid circuits, a bandpass coupler (C2-C6, L2-L6) was used. The 807’s were connected in parallel, in- stead of push-pull, to eliminate a split-stater plate tank circuit tuning capacitor. A p-n-network output circuit was similarly ruled out to reduce the number of panel controls. A physically small tuning capacitor with nominal plate spacing (0.045-0.100 inches) will suffice for the parallel-tuned plate tank circuit (C—

200 pF). However, for a control capacitor, C6, it relaxes it from the high voltage fed in the 807’s through RFC’s. The 807 plate circuit caps, L6 and L6, small choke at the 807 plate cap leads, Lt and L6, eliminated a parasite oscillation, that appeared when this transmitter was first used.

A two-section broadcast receiver tuning capacitor, C6, was placed in series with the grounded side of the output leak coils, Lt, for an antenna loading adjustment. This capacitor also helps compensate for any reactance reflected back into the transmitter output coupling circuit from the antenna. Measurement of the grid, screen, and plate currents in the 807 stage, plus RF voltage at the antenna con- nector, J6, and the power supply high voltage, was included in the metering circuit. Oscillator tube per- formance can be judged from the 807 grid current. Measuring the 807 plate current is even more revealing (point 6).

A new meter, used as a voltmeter with a 1.6- volt full scale reading, measures the voltage drop across relay coil in series with the above cathode circuit 807, when S6 is turned to positions A, B, and C. In position D, a portion of the RF output voltage is applied to a diode, D6, changed into direct current and applied to the meter through a filtering circuit. The 807 plate supply voltage, up to 1000 volts maximum, is measured by switching multiplier resistors in series with the meter.

For CW operation, keeping the screen voltage simul- taneously on both the oscillator and amplifier stages

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The diagram shows all units that comprise the complete 150-watt single band transmitter.
to strong nearby signals (from other closely grouped Fidel Day transmitters).

Attenuation of harmonic energy (point 7) in the transmitter output was accomplished with a half-wave type filter not shown in the diagram (see The HARMONIKER, G-E HAM NEWS, November-December, 1949, Vol. 4, No. 6, and May-June, 1957, Vol. 13, No. 3, for details). This type of filter attenuates signals only of frequencies that are harmonics of a fixed design frequency. It thus will help reduce overloading in a receiver on overtones resulting from other transmitters. The HARMONIKER type filter, plus the steel cabinet, eliminated all traces of interference to both sound and video on television receivers operated only a few feet from the transmitter in an area served by stations on VHF channel 6 and four UHF channels. More elaborate TVI precautions (described in the ARRL Handbook) may be necessary if the transmitter is to be operated in locations served by other channels, especially with a weak TV signal. Shielding and filter-

ING suggestions will be covered in the next issue of G-E HAM NEWS.

The power requirement for this transmitter is 500 to 750 volts DC at 150 to 200 milliamperes; 250 to 300 volts DC at 50 milliamperes; and 6.3 volts AC at 2.7 amperes. The model transmitters were operated from a variety of bridge rectifier type power supplies previously described (see DUAL VOLTAGE POWER SUPPLIES, G-E HAM NEWS, September-October, 1957, Vol. 12, No. 3, for details).
When the tuning knob is pushed in while being turned, the knob shaft pushes on the flyer rod. This closes the normally open contacts on $S_2$, and applies screen voltage to the oscillator tube.

If $S_2$ is pushed in going out when it is released, adjust the position of the knob shaft bushing so that the shaft slides freely after lubricating it with powdered graphite. Locate the angle bracket so that $S_2$ closes when the tuning knob is pushed in.

In the 3.5-megacycle transmitter, the push-button switch was replaced by a closed circuit phone jack with the contact blades spread apart. The fiber rod was cemented to one blade and the jack was then mounted on an angle bracket so that the fiber rod contacted the knob shaft. However, this switch was more difficult to adjust properly than the push-button switch.

The RF plate tank coil, $L_4$, was mounted atop the tuning capacitor with a 3/16-inch-high cone insulator at the back end, and a tubular metal spacer the same length at the panel end. The link coil, $L_3$, was wound at the grounded end of $L_4$, using a single length of wire which also forms the twisted leads running down through the chassis to $C_7$ and $J_2$. A small pilot lamp was mounted on the panel directly above the oscillator tuning dial pointer. The milliammeter was centered 3/16-inch from the top, and 3 inches in from the side panel edges, respectively.

The relay shown in the phone jack was constructed in a 3 x 4 x 3 high Minibox (Radio Craft 995), and fastened to the panel. Seats may be located wherever convenient in this unit. The connecting cable on $P_2$ was made from insulated hookup wire.

WIRING DETAILS

All leads running between the tube grids and plates to other related components were made from No. 11 tuned copper wire. Insulated hookup wire, rather than the shielded wire usually used for TVS prevention, was used.

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Oscillators are a type of devices in the amateur radio station. Superhet communications receivers usually contain at least two of them: (high-frequency oscillator and band-frequency oscillator). Simple transmitters usually employ one oscillator, but more complex rigs (and those with parasitics) may have two, or even three oscillators.

Oscillators are usually a major concern to all persons who use this equipment (and the FCC, too), especially in view of increasingly crowded amateur band conditions. More radio amateurs are adopting advanced transmission techniques, such as frequency shift keying for radio telegraphy, and single sideband or other suppressed-carrier systems. These techniques require oscillators having excellent frequency stability.

Introduction of the Clapp series tuned oscillator circuit several years ago did much to improve oscillator stability in amateur transmitters. This is quite apparent to all of us who have been on the air long enough to compare the performance of a 500-kHz circuit designed with a permitted remote tank circuit placement, which helps reduce drift by isolating the frequency controlling elements from the heat producing portions of the equipment. The Clapp circuit is now so widely used that little else appears in Amateur Radio literature—and there must be quite a few newcomers who are hardly aware that any other oscillator circuit ever existed.

The Clapp circuit does have one weakness which many amateurs have discovered when they first tried constructing this type of oscillator. Most circuit performance requires that relatively large-HQ inductors and low-capacitance tuning capacitors be used. With such components, extreme mechanical rigidity is essential.

Make no mistake—if mechanical construction is necessary for good frequency stability in any oscillator—it is simply more difficult to achieve with components the size of a 150-watt tank circuit! This is particularly true when compact construction is desired for portable/mobile equipment.

More in the spirit of adventure than anything else, the writer decided to see what could be done with a straightforward high-capacitance Colpitts type oscillator circuit. The Clapp oscillator as we see it in a derivation of the Javits-Forman circuit is shown in Fig. 1. As you may note, there are some amazing figures—the values of capacity in the feedback loop are quite constant, for instance. Even this circuit indicated by the formula for the feedback ratio must be calculated by using a process of elimination for parasites in the slide rule, and instead of a single formula for a specific feedback ratio, a number of different ones must be tried. Digging into the junk box, we pulled out an unused 550-kHz slug-tuned coil, together with 0.01 and 0.003-mfd micro capacitors (vintage)! When these parts were all put into a box, the coil was tuned, and power was applied, it oscillated readily with lots of output. Being designed for reception at 1 megacycle, it was tuned so that the 1-megacycle zero was best with WWV's 10-meter signal.

Several pleasing characteristics became apparent during the next few minutes. First of all, hand capacitance effects were extremely small. In fact, the coil terminals could be touched with the fingers without affecting oscillations, and the frequency shift under this abuse was very small (a few kilocycles at the 10-megacycle harmonic). Secondly, a few sharp raps with a screwdriver confirmed that the mechanical stability of the small coil form was very good. Thirdly, radiation of RF energy from the small coil was very low, similarly indicating that it would be a poor pickup device. Shielding requirements, to keep RF energy from succeeding stages in a transmitter from being inductively coupled back into the oscillator tank circuit, would thus be minimized. In other words, the oscillator had the very features desired for the 13.5-watt single-ended, 6125 or 6146, high-impedance output, component values for both of the series-tuned Clapp and high-Q Colpitts oscillators are shown in Fig. 1. As you can see, a physically large, high-Q inductor is required to prevent the coil from picking up stray RF energy, or it should be housed in a shield box that is large enough to have little effect on the coil Q (Q = 0.5 x 0.9 inches for a 2-inch separation between the box walls and coil).

In contrast, the corresponding 1-megacycle inductance in the high-Q Colpitts circuit, Fig. 1B, may be wound on a 0.5-inch-diameter slug-tuned coil form (National XR-10). This small coil can be tucked into a corner of a chassis, or even in an IF Transformer shield can. In the Clapp circuit, a bandwidth having a capacity change of about 10 kK will tune the oscillator from 350 to 700 kilocycles. Comparable bandwidth in the high-Q oscillator requires a capacity adjustment range of about 200 kilocycles. The latter variable capacitor usually will have better mechanical rigidity.

The 0.003-mfd capacitor connected between the control grid and cathode of the Clapp oscillator is much larger than any likely variation in tube and stray capacities. However, the corresponding 0.004-mfd capacitor between grid and cathode in the Colpitts circuit is likely to be in direct contact with the tube and its metallic components, and there is the danger of inductive coupling and swapping out these variables. In both oscillators, slugs are almost always employed in the inductors, and very little attention has been paid in obtaining maximum possible in a high-Q circuit oscillator is limited by the transconductance (g) of available tubes; and that present tubes often have a transconductance too high for the tube volatility twenty years ago. The improvement in oscillation stability is, in practical purposes, proportional to this improvement in tube transconductance.

The Clapp circuit, which results from the application of this "old" circuit to modern tubes and components, is a refreshing change from the circuit complications which have characterized so many recent designs. The results obtained with the high-Q oscillator have equaled or bettered those of the "modern" source.

It is perhaps time for a long-awaited remanence of some good old circuits to revolutionize the Ka line ignition panels of the 1940's. Give these "old" circuits a try—when combined with modern components—you'll be delighted with the results.

Fig. 1. Schematic diagram of an A— the frequency-determining components in a typical series-tuned Clapp oscillator for X5 megacycles. The values of the various component values for high-parallel-tuned oscillator.
MEET THE DESIGNER—W2FW/7 (now officially K8RIG), B. G. (Ted) Repp, shown herein that you can teach an old oscillator circuit new tricks. Of course, Ty is an expert at this, having designed several of the most popular gadgets that have ever appeared in G.E. HAM NEWS. These include the original Economy Hifi Kitway, Interpreting Frequency Standard, Emergency Portable Rig, Mobile Modulator, TVR Hi-pass Filter, Mobile/Portable Power Supply, the Field Meter, and several “Technical Tidbits” items.

Formerly associated with G.E.’s General Engineering Laboratory, Ty now counsels the new G.E. Computer Department, in Phoenix, Arizona, as an engineering consultant. His professional background also includes stints with the General Electric Research Laboratory, and the then Transmitter and Tube Divisions.

“2FW” has been Ty’s favorite call-letter suffix, having first received W2FW in 1932 before settling in W3-land. A DX chaser for many years, Ty now finds the 14-megacycle CW band just right for keeping in touch with his many ham friends.

The 1957 Edison Radio Amateur Award program is now in full swing, so don’t let this deadline for submitting nominations—postmarked not later than January 2, 1957—pass you by without submitting your letter to the Edison Award committee. It is, fully, totally worthwhile. The Edison Award was introduced by Edison in 1925, and finally by a United States radio amateur while perusing his hobby.

Selecting a nominee in behalf of a public-spirited radio owner is also a worthy project for your radio club or other group. Address of nominating letter to the Edison Award Committee, General Electric Co., Owensboro, Kentucky.

Rules for the 1957 Award were announced in the September, 1957 issues of QST and QG magazines. Additional copies may be obtained from the Award committee or from now—simply by sending a postal card requesting them.

Wow! My incoming mail stacks have been loaded with postal cards requesting the telegraphic display of a simplified version of the 100-Watt Mobile Power Supply we described in the July-August, 1952 issue of G.E. HAM NEWS! I casually mentioned this display in the September-October issue, and judging from the response, many hams are aiming for greater efficiency in their high-voltage supplies.

We did not profess this circuit to be the ultimate, but rather an improvement over older mobile power supplies. Already newer circuits have been developed that promise a more promising improvement.

At present, however, suitable high-voltage transformers similar to the one mentioned in the text are scarce (there’s always a catch). But we’re watching these new mobile power supplies and will publish additional information when the components become available.

Following the successful application of the instant and honorable Colpitts circuit—high-C, that is—to the transmitter described in this issue, we have continued our experiments with it in other equipment. In due time you’ll be seeing the results in future issues of G.E. HAM NEWS.

While researching during these experiments, we dug back through our archives of amateur radio journals and found only a few articles which covered this type of oscillator, including: “Remote tuning for the High-C VFO,” by N. D. Lackey, W4DGW, on page 35 of the September, 1933 issue of QST; and, “Packaging 33 Watts for 80 and 40,” by R. M. Smith, W2F/7, in November, 1932, QST, on page 11. Still another milestone on the path toward reevaluating the high-C oscillator was an article by Captain W. B. Bernard, U.S.N., W4EEL, on page 66 of the October, 1933 issue of QST. It’s called, “Let’s Increase V.F.O. Stability.”

We’re sure you will find all these articles of high interest and even kick out your own, experimental units (see picture opposite page 15). The high-C oscillator will become as popular as the “standard” circuits in amateur radio equipment designs.

H N

If you think that the final amplifier tubes in your transmitter are hard workers, take a look at the conditions under which the 6A4U HP oscillator tube in your television receiver must operate. To meet the low-inductance, low-capacitance demand for operation at frequencies up to 900 megacycles, small electrodes with close spacing are required. High cathode emission and current flow density live for six times that of other tubes subject the grid and plate to high temperatures. These tube elements must resist gas-forming tendencies that can destroy tube efficiency.

Add more torture from lack of ventilation through unnecessarily tight HP oscillator shielding and the decline in efficiency as circuit components age. Little wonder that the 6A4U often literally roasts itself to an early demise, accompanied measurably by a steady dropoff in picture quality.

Even with TVI-sharing, operating conditions for the average transmitting tube aren’t that tough. But now even receiver and design engineers have combined new materials with new manufacturing and test methods, resulting in an improved 6A4P that for the first time is fully as efficient and dependable as other tubes. Tests on thousands of tubes have proved that after 250 hours and more of service, the new 6A4P will perform like the 6A4U in all respects. Moreover, the life of 6A4P is another example of the wide variety of tube types that can be utilized in tube design today, in turn reflected in the longer life and increased dependability of the tubes we use.

—Lighthulme porous

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150-WATT SINGLE BANDER
(Continued from page 2)

used for all power and miscellaneous wiring. However, it was found that by laying the insulated wire flat against the chassis, the capacitance from wire to chassis was nearly as effective as using shielded wire in the transmitter. The longer leads were placed in the corners of the chassis and held in place with short lengths of plastic insulating tape. 

The complete transmitters was dressed up with desired lettering to mark the various controls and switch positions. Direct frequency calibration can be added to the oscillator tuning dial with detail, if desired. A rim type lock was placed above the tuning dial for C4, in addition to a shunt lock on C2. These precautions prevent these controls from being operated accidentally during the excitement of content operations.

OPERATION—3.5-MEGACYCLE TRANSMITTER

First, momentarily apply 6.3 and 115 volts AC, and about 330 volts DC, to J1 and the proper terminals on TR, to check for Short circuits and incorrect wiring. If no trouble is found, plug the cable from the keyer into J2, a key into J3, and a dummy antenna into J4. A 100-watt lamp secured in a porcelain lamp socket, wired to a short length of enamal cable with connector, is a suitable dummy load at this frequency. Plug in the 9AG and OA2 tubes and apply power. 

The oscillator should start readily, since the test model worked with as low as 10 volts on the 9AG screen grid. The keying should be located by tuning a receiver between 3.3 and 3.5 megacycles. After the oscillator frequency has been determined, adjust the slug in L4 until the oscillator covers the desired 200-kilocycle segment of the 3.5-3.0-megacycle amateur band that can be covered with the 300-kilowatt tuning capacitor, C4. A two-section broadcast receiver tuning capacitor, with the sections in Deferit (same as C5), is required to tune the band without readjusting L5.

Remove the power while plugging in the 807 amplifier tubes and again apply power. With the meter selector switch, S3, in position "A," tune C2, for a dip in plate current (assuming that a plate current reading is obtained). The dummy load lamp may glow when the 807 plate tank circuit is examined. Set S4 in position "A" (to read grid current in the 807 stage and tune L6 for maximum grid current with the oscillator on 1000 kilocycles; and tune L10 for maximum grid current on 2000 kilocycles. Start with minimum spacing between L4 and L5 and move L4 away from L5 until a fairly uniform 807 grid current reading (1 to 8 milliamperes) can be obtained when tuning the oscillator from 3.3 to 3.0 megacycles.

Check the operating speed of the keying relay, especially if an automatic key will be used with the trans- mission. If the relay is mounted in the keyer box so that gravity helps open the contacts, the armature spring tension can be reduced to obtain high-speed operation. The VFO switch, S2, should be adjusted for proper action, as described under MECHANICAL DETAILS.

Apply full DC voltage to the transmitter and set the VFO to the midpoint of the desired 200-kilocycle tuning range. Adjust C5, until the meter reads 200 milliamperes with S2 in position "C," keeping C1 tuned for a dip in 807 plate current. No retuning of either C4 or C5 should be necessary within the VFO range when the transmitter operates into a well-matched antenna system (standing wave ratio of less than 2 to 1 on the feedline). By contrast, Lighthouse Larry says that he has operated rigs on Field Day in which six kilowatts had to be reduced when moving only a 20-kilocycle change in frequency.

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