GADGETS
Three Useful Accessories for the Shack

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ARTISTIC

An audio oscillator can be very useful, but very few ham shack can boast of one. The reason for this is understandable, as many types of audio oscillators are complicated and difficult to construct. The type to be described here is not only easy to build, but it also is easy to get working properly.

By reference to the circuit diagram in Fig. 2 it will be seen that a 6SK7 is used in a transistor oscillator circuit. This type of oscillator may be made to oscillate over a very wide frequency range, from tens of cycles per second to megacycles per second. If the oscillations are confined to the audio spectrum it is possible to design it so that the entire audio range may be covered by a variable grid resistor.

Several of the uses which suggest themselves for a gadget of this sort are: (1) Code practice oscillator; (2) Oscillator for ICW operation; (3) Source of continuous audio voltage for use while testing a speech amplifier and modulator.

The transistor oscillator puts out an audio wave which is essentially a sawtooth wave. Inasmuch as this waveform is difficult to interpret on an oscilloscope this oscillator is not recommended for use in running audio response curves on audio amplifiers. For work of this sort it is advisable to use an oscillator with sine wave or square wave output.

CIRCUIT DETAILS

A power supply is incorporated in the unit so that the audio oscillator would be self-contained.

Two diode transformers are employed in this connection. One transformer supplies filament voltage to the 6SK7 and the other one is used as the power transformer. The selenium rectifier, XR, rectifies the 115 volts. Resistor R3 is a protective resistor and resistor R4, with condensers C4 and C5 form the filter circuit. Resistor R5 is the frequency control potentiometer, seen on the left in the photograph, and R1 is the output gain control, which is on the right-hand side of the panel. Other components on the panel are the pilot light in the center, with the output jack directly below. The on-off switch and the tuning jack are on each side of the output jack.

Two output arrangements are shown, A and B. When the output of the audio oscillator is used to modulate a transmitter, for test purposes, or for ICW use, it will be necessary to use the setup shown at A. Resistor R3 and C4 form a filter which tends to cut off all high frequency variations so that wide sidebands are not present. When this circuit is being used the audio frequency should be between 500 and 1000 cycles.

The setup shown at B indicates that a pair of earphones may be placed directly across the output. This would be the case when the oscillator was used for code practice work. Keying is done in the cathode circuit.

CONSTRUCTION

The entire unit is built in a 6 by 6 by 6 inch box. For convenience in wiring a small sub-chassis was
Circuit Diagram of Audio Oscillator

Circuit Constants

- R1 = 0.5 megohm potentiometer
- R2 = 25 ohm 1/2 watt
- R3 = 1700 ohm 1/2 watt
- R4 = 1 megohm 1/2 watt
- S = B&K toggle switch
- T = 0.1 uf transformer
- X = Selenium rectifier
- F = Earphone
- L = 6.3 volt pilot light

Heat out of aluminum sheet. The photograph, Fig. 3, indicates how this is made. The tube is mounted near the front panel, with the two flanged transformers in line to the rear. A dual 40 mf. electrolytic capacitor occupies the other side.

The under-chassis view, Fig. 4, shows the layout of the rest of the components. The selenium rectifier is attached directly to the rear of the chassis. This is done so that the heat generated by the rectifier does not affect the other components, and also so that the chassis itself can carry away some of the heat. No critical layout is required, and no special precautions need be taken with the wiring.

Testing

After the unit is completed, the first step is to check the audio frequency range. This may be done easily by monitoring with a pair of earphones. If accurate measurements are desired, a vacuum calibrated audio oscillator can be compared with this one by means of an oscilloscope. The output of one oscillator is fed into the vertical plates of the scope and the output of the second oscillator is fed into the horizontal plates. By means of Logarithmic figures, the two frequencies can be compared.

If the audio frequency range is not wide enough or does not cover the desired range, several adjustments may be made. Reducing the value of C2 will raise the maximum frequency of oscillating. Varying the value of the screen resistor, R3, and the capacitor C4, will also affect the frequency range covered. When adjusted properly, the frequency control should be capable of producing a continuous audio range from below audibility at low frequencies to above audibility at the high frequencies.

Fig. 2. Circuit Diagram of Audio Oscillator

Fig. 3. Rear View of Audio Oscillator

Fig. 4. Under-Chassis View of Audio Oscillator.
Fig. 5. Minimum Volt-ohmmeter

No head shack is complete without a volt-ohmmeter of some sort. Their greatest use is in checking continuity, and reading a-c and d-c voltages. An instrument of this sort need not be elaborate, nor is extreme accuracy required.

Fig. 7 shows the circuit for a volt-ohmmeter which will measure 0-10, 100, and 0-1000 volts a-c (switch positions 3, 2, and 1 respectively); 0-100 and 0-1000 volts d-c (positions 1 and 4); and 0-100,000 ohms (position 2). These ranges can be added to quite easily, as later data will show, but they represent ranges which are used most.

Practically any type of construction arrangement can be followed, but a little effort will produce a very handy device. Fig. 6 shows how the entire volt-ohmmeter may be placed in a shielded can, with a small 1½-inch hole on one end and the probe and range switch on the other end. In use the device may be held in one hand much like a probe. The probe with the clip is the negative lead, with the probe proper being the positive lead.

Ohmmeter Calculations

In deciding what resistance scale can be obtained, it is first necessary to determine how much battery voltage you wish to provide. This, together with the meter, determines the resistance scale. In the ohmmeter shown it was not practical to use more than three volts. Full scale on a one-millimeter meter, with three volts in series, requires a series resistance of 3000 ohms. The ohmmeter will therefore read 3000 ohms at mid-scale. (Mid-scale reading is always the same as the total circuit resistance.) This 3000 ohms series resistance is made up of the resistance of the meter (100 ohms), Rs of 3000 ohms and 900 ohms on Rs. To calculate the resistance values indicated by various meter readings, use the formula: $R = \frac{V}{I}$, where $R$ is the resistance to be read, $V$ is the battery voltage (3 volts in this case), and $I$ is the series resistance (3000 ohms) and is the voltage read by the meter. This latter voltage is determined from the ratio of meter reading on battery voltage. Full scale is three volts, half-scale (0.5 ma.) is 1.5 volts, etc.

Carrying out these calculations through for this particular ohmmeter we find the following resistance readings for each 0.1 ma. scale division—starting from 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 ma.: 333, 373, 423, 500, 600, 750, 1200, 2000, 3000, 4500, 6000, 7500, 12,000, and 27,000. The last value is for a meter reading of 10 ma. Insomuch as 0.035 ma. may be read, the highest value of resistance which may be read is 517,000 ohms. If desired, values may be calculated for each meter division, and a chart made up which may be pasted to the ohmmeter. To design an ohmmeter to read higher values of resistance, other than the usual ranges of series and battery sources, and then calculate the series resistance by dividing the battery voltage in volts by the full-scale meter reading in amperes. The formula given above will then permit you to calculate the resistance range which can be covered.

Voltage Calculations

D-c voltage calculations are very simple. Start with the lowest range (0-100 in the case). The resistance to use in series with a 1 ma. meter to read 100 volts is merely the voltage divided by the current, or 1000 ohms. The next scale of 0-1000 volts gives a resistance of 1 megohm. Since these two resistors are in series, the resistor for the 1000 volt range would be 1 megohm less 0.1 megohm, or 0.9 megohm. The resistance of the meter is so small that it may be neglected. Now designing a voltmeter to read about 1000 volts, take care that adequate insulation is used with the voltmeter lead that not more than 1000 volts appears across any one resistor used as a multiplier.

The resistance shown has a sensitivity of 1000 ohms per volt on both d-c ranges. A more sensitive volt-meter can be made only if a more sensitive meter, such as a microammeter, is employed.

For measurement of a-c voltages, a rectifier is required. The rectifier shown in Fig. 7 consists of two germanium crystal diodes. One acts as the rectifier proper while the other passes current in the opposite direction on the other half-wave so that a high voltage is not built up across the first diode. The action is that of a half-wave rectifier. Because of this, and because the meter will read the average voltage of alternating voltage of all sorts must be used to calculate resistance.

A circuit in which 10 volts is applied to the volt-meter circuit, the meter would only read 4.5 volts. A circuit to make the meter read full scale on 10 volts would therefore calculate on the basis of 4.5 volts. The same resistance to use in series is therefore 4.5 volts divided by 0.004 amperes or 4500 ohms. Similarly for 100 volts a total resistance of 45,000 ohms is required and for 1000 volts, 450 megohms is required. Doing the proper subtraction, because the resistors are in series, shows us that we need 45 megohms, 450,300 ohms and 695,200 ohms. The value used need not be that exact, and those specified will be close enough.
CIRCUIT CONSTANTS

R1 = 0.47 meg 1/4 watt
R2 = 4100 ohm 1/4 watt
R3 = Double pole six position (Mallory 3316 J)
M = 0.1 ma. meter (Gr. 411209)
X = Germanium crystal (13N4 or equivalent)

Push the unit in at the same time as the negative lead is pushed through its hole. When the unit is together slide the knob over the probe and tighten the screws which hold the knob to the shaft and the probe to the knob. Fastening the case to the bakelite completes the assembly.

CALIBRATION

After the volt-ohmmeter is completed it is desirable to check its accuracy. To do this easily locate another voltmeter that you can trust and check the two together. Some juggling of resistance values may be necessary for extreme accuracy, although the unit can be adjusted within three percent without changing resistance values.

For the ohmmeter circuit, short the two probes and adjust R1 so that full-scale deflection of the meter is obtained. While it is possible to now calibrate the meter, for most uses this will be unnecessary. However, you may wish to check some known values of resistance against the calculated meter readings that you have made.

As the battery voltage drops it will be necessary to readjust R1 for full-scale meter deflection.

PARASITICS

The Five-band VFO circuit diagram (November-December 1941 Ham News) is in error. Another five position switch should have been included in the place circuit of the GL-407 stage. With reference to the circuit on the top of page 5, the connections which are made from the right hand side of meter M0 should be removed. A five-pole single-pole switch should then be inserted so that the pole connects to the meter and the five positions each connect to their respective input coil where the other connections formerly went.

In the original switch, section S-11 and is shown in Fig. 4 in the original article. It is on the same switch page as section S-12 (The circuit as originally shown shorts out the B plus voltage to ground.)
MODULATION MONITOR

While serving primarily as a guide to proper modulation of a phone station, the device pictured in Fig. 8 is a valuable addition to any setup. It will serve as a carrier shift indicator, a field strength meter, a neutralization indicator, a phone monitor and a sensitive wavemeter.

Referring to the circuit diagram in Fig. 9, meter M1, which is on the left in the photograph, is a rectifier carrying the carrier level, or indicates the pressure of r-f when the device is used as a field strength meter, a neutralizer or a wavemeter. Meter M1 is used only to give per cent modulation readings. If the neutralizer feature is not desired, meter M2 and the copper-oxide meter rectifier CD may be omitted, and the device will still retain its versatility.

To use this gadget as a wavemeter, a pickup loop is coupled to the input circuit and switch S3 is placed on the proper position. With Ls tuned to 50 and 40 meters, Ls tunes to 30, 15 and 10 meters, Ls tunes to 6 meters and the tap M2 tunes to 2 meters. With switch S4 on the proper tap, condenser C3 is used to peak the reading of meter M1. Using a calibrated dial, frequency may be read directly. Switch S3 should be on the RF position for these readings.

For use as a phone monitor, r-f should be fed into the input via a link or a pickup wire on the positive terminal, and the LC circuit tuned to the frequency involved. Earphones inserted in jack J1 will allow you to monitor the signal. Switch S5 should be in the AF position.

Field strength readings can be taken with this device by using a short pickup antenna on the positive input terminal. Again the LC circuit should be tuned to resonance. Meter M2 will now give an indication of field strength. With S5 in the RF position the meter is very sensitive, but if the input is too great, switch S5 can be thrown to the AF position which will greatly reduce the sensitivity of M2. Sensitivity can be reduced still further by using switch S2 connected to B6. This is a 2.5-m. r-f choke, and tunes the input very broadly. Ls still has some effect and may be used as a variable attenuator.

Modulation measurements are made by coupling the device through a pickup link to the tank coil, with B6 in the RF position. When the LC circuit is tuned to resonance, the gadget acts as a very sensitive r-f indicator. As a matter of fact, it is so sensitive that it is doubtful when any stage could be sufficiently well neutralized so that the meter could be made to indicate zero r-f.

To use the device as a modulation monitor, use a pickup link to couple to r-f energy. Tune the LC circuit to resonance on the proper band, and then adjust the pickup link coupling until meter M2 reads your calibrated point value. (Calibration procedure will be discussed later.) Now, meter M4 will respond to voice modulation and permit a constant check on the percentage of modulation. In addition, meter M3 will give a constant check on the carrier level, which normally should stay constant.

Fig. 8. Front View of Modulation Monitor

ELECTRICAL CIRCUIT

The part of the circuit to the left of the germanium crystal X, referring to Fig. 9, is the r-f pickup and
Fig. 9. Circuit Diagram of Modulation Monitor

Circuit Constants

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>25 mfd mica</td>
</tr>
<tr>
<td>C2</td>
<td>75 mfd variable</td>
</tr>
<tr>
<td>C3</td>
<td>0.001 mf mica</td>
</tr>
<tr>
<td>C4</td>
<td>0.1 mf paper</td>
</tr>
<tr>
<td>L1</td>
<td>Open circuit jack</td>
</tr>
<tr>
<td>L2</td>
<td>10T No. 20 enameled wire wound on 1/4 inch diameter form</td>
</tr>
<tr>
<td>L3</td>
<td>14T No. 30 enameled wire wound on 1/4 inch diameter form</td>
</tr>
<tr>
<td>L4</td>
<td>0.02T No. 14 wire spaced wound, 1/4 inch diameter, 1/8 inch long with tap 1/5 turns from ground end</td>
</tr>
</tbody>
</table>

Tuning Section: C1, is employed as a blocking condenser and C2 acts as a turning condenser. The crystal acts as a half-wave rectifier, while C3 and L2 serve as an r-f filter, so that the input to resistors R6 and R7 is a-c with a superimposed audio waveform.

When switch S3, is in the RF position, the d-c component of the r-f in the input circuit. With S3 in the A-F position, meter M3 is shunted with resistor R6 and again reads a value of current which depends upon the r-f input, but M3 is much more sensitive. The portion of d-c voltage with superimposed audio which raises resistor R6 is now picked up by the full-wave copper-oxide rectifier, rectified, and gives as a d-c current to the preamplifier, meter M3. Condenser C2 acts as a d-c blocking condenser so that audio voltage only is present to the copper-oxide rectifier. The phone jack at this point permits the insertion of earphones for monitoring purposes.

Conclusion

The unit shown in Fig. 8 was constructed in a 4 by 4 by 1 inch chassis. The particular chassis shown is not a commercial chassis but was made out of aluminum. A switch is shown on the front panel marked plus and minus. This was used in an earlier version and is not included in the present circuit.

One precaution only should be observed when laying out such units. The r-f section should be separated from the meter circuit to prevent stray fields from interfering with meter movements.

Although a 0-200 microammeter is specified for meter M3, a 0.1 ma meter will work just as well and no circuit changes need be made. The unit will be less sensitive when it is used as a field-strength meter, neutralization indicator or wavemeter. Operation will be much improved with modulation monitoring use, as resistor R6 acts as a shunt and can be adjusted to accommodate either a 0-200 vamp. meter or a 0.1 ma. meter.

L6L6 = 2.5 mh r-f choke
M1 = 0.01 ma. meter (G.E. 41LXH)
M2 = 0.1 ma. meter (G.E. 41LXJ)
R6 = 50 ohm semi-adjustable
R7 = 6000 ohm 1/4 watt
S6 = Single-pole, five-position switch
S7 = SPDT toggle switch
X = Germanium crystal (3N4 or equivalent)
CO = Full-wave copper-oxide meter rectifier

With reference to Fig. 8, the band switch is placed on the left panel and the RF-AF switch is on the right panel. The front panel contains the two meters, the tuning condenser in the center, and the phone jack is placed where the switch is shown.

Wavemeter Calibration

To check coil L6, the unit should be coupled to a source of 4.5 megacycle energy, and meter M3 peaked for maximum current. The condenser setting should be such that most of the capacitance is in use. If this is true, put 1 megacycle r-f in and again resonate the LC circuit. The condenser should now be approaching minimum capacitance. The coil should be adjusted until both hands can be resonated with the condenser. The same procedure is followed with coil L5. The 15 meter band should peak with the condenser approximately half-wave method, in which case the 30 and 15 meter bands should fill up each side. In this manner the proper winding has been found, and the tap on L6 can be adjusted until this meter band is peaked when the switch is in position 4.

Modulation Meter Calibration

To prepare for the job of calibrating the modulation meter, it is first necessary to use an oscilloscope and set the scope so that it is reading trapezoidal patterns. This is discussed fully in radio handbooks and will not be repeated here. Once this setup is complete, the modulation monitor should be coupled lightly to the final tank coil and the LC circuit in the modulation meter brought to resonance. S6 should be in the AF position. The coupling should now be adjusted so that meter M3 reads half scale.

The main goal in modulation, the voice modulation, and the voice level maintained so that the trapezoid pattern indicates 100% modulation on the audio peaks. Under these conditions, check the maximum deflection of
By changing the voice level so that the topspod pattern indicates 75% modulation peaks, the reading of meter M4 can be noted which corresponds to 75% modulation. This same process may be carried out for other modulation percentages.

The unit pictured read 100% modulation at full-scale, when M4 was adjusted to half-scale, and the Value of R4 was 6 ohms.

As usual there is a possibility that some error will be introduced if the meter is calibrated on 75 meter phone and then used on 3 meter phones, it is advisable to make the calibration on the band that will be the most widely used.

After the unit is calibrated, it will always give the same readings as a modulation indicator, whenever the LC circuit is resonated and the pickup adjusted so that M4 reads at mid-scale.

**TRICKS AND TOPICS**

**SCREEN GRID KEYING**

Keying the screen grid of a beam tube used in a r-f amplifier stage of a c-w rig has not been very popular. Perhaps one reason for this is the fact that when the screen is open (key-up position) there is a certain small amount of feed-through from the control grid circuit which will affect the plate circuit. If the beam tube is driving a final stage or is driven to an antenna, this feed-through effect generally causes a back wave to be heard at the receiving end.

A system for eliminating this feed through which has been very effective is shown in Fig. 10. It consists of placing a high resistance negative voltage on the screen during key-up periods. During key-down periods the regular screen voltage is applied. Clean cut keying is the result.

A battery is used to supply negative screen voltage and in practice this battery has long life because even with the key down, only a mill or so of current will flow.

The break characteristic is easily controlled by changing the capacity of C1. Plate C-R, is the "spark kitter" for eliminating BCT. For a starter, use 0.01 mf for C1 to 0.003 mf for C2 and 100 ohms for R4.

**WAVE AWARD**

The May-June 1947 Ham News carried details of six amateur radio achievement awards. It has been called to Lighthouse Lerry's attention by CAPRO (Canadian Amateur Radio Operator's Association, 40 St. George St., Toronto) that the WAVE Award was not mentioned. This award was sponsored originally by RCA and to date certificates have been awarded to only FOUR persons, thus 1947's and 1948's. Here then are the details about WAVE (Worked All VE Districts). The medals are from

Xtal Magazine, October, 1947.

Submit proof of contact with two different stations in each province, contacts being on two different bands. (A total of 18 confirmations—Yukon and Northwest Territories shall be considered a part of British Columbia.) All contacts must be made on or after January 1, 1948. Applicants residing in territory designated as non-preferred shall sign off with the calls of stations from within the province or state. A handsome certificate awaits those who qualify.
That new final of yours has just been completed, and you anxiously throw the high voltage on, and dip the final plate current to resonance. Then you couple in the antenna, again dip to minimum plate current, and finally make sure that you have maximum radiation from the antenna by checking with a neon bulb or the antenna, by again returning the final plate condenser. In this simple operation you have passed over several points which will inform you as to how the final and the feeder system is working. When final plate current is dipping to a minimum value with no load to the tank coil, make a mental note of the tank condenser setting. Now couple the antenna to the final tank coil and again tune the tank condenser for minimum plate current. If the con-
derser is not on the same dial setting as before, you definitely know that your feeder system has sending waves on it. If the line is not flat, or if the loaded minimum plate current occurs at the same condenser setting as the unloaded minimum plate current you may or may not have standing waves on the feeder system. This is important. In other words, if you have a flat line the two con-
derser settings will be the same, but the fact that they are the same does not necessarily mean that the line is flat. It will be necessary to check the line by other methods to guarantee the absence of standing waves. The next thing to examine is how the condenser setting changes when going from minimum loaded plate current to maximum power output. That is, check the condenser setting when you have minimum plate current and the final is loaded. Next, check the antenna output by means of a field-strength meter and tune the plate condenser until the final is putting out the maximum power as indicated by the field-

strength meter. If these points coincide, the final tank circuit has a proper load. Q. However, if these two tests do not give the same condenser setting the Q is not right in the final tank circuit. To correct this add more C across the final coil. Maximum power output and minimum loaded plate current depend upon the power factor and the impedance in the final tank circuit. Zero power factor and maximum impedance occur together only in high Q circuits (Q of 12-15). If you have too low a Q you must operate with either one condition or the other, that is, with minimum loaded plate current, which does not give maximum power output, or with maximum power output which will not give the lowest possible plate current. If you operate with minimum loaded plate current, you effectively lose power output due to poor plate-
circuit efficiency. If you operate at maximum power output the tube efficiency is low and it is not possible to obtain full use of the tube. Obviously, therefore, it is desirable to operate at the minimum loaded plate current and maximum power output occur at the same setting of the final tank condenser. Another reason to make sure that you have a high Q tank is that harmonic radiation is suppressed in a low Q tank circuit. This type of thing occurs most often on the lower frequencies, and is a simple matter to remedy. Add capacitance across the final tank coil, removing turns from the coil as you go, until you have sufficient capacity to make the two points mentioned above coincide. Too high a value of C will cease high circulating current in the tank coil, but this will not occur unless you add a great deal more capacity than is needed to get a high Q tank. Once you have this fixed, these two points will be inseparable, regardless of your feeder system. However, these two points, which are now coinciding, may not coincide with the unloaded minimum plate current point. However, all three points will be the same when you have a flat line, and the first two points will differ from the unloaded minimum plate current point when you have standing waves. The same precaution still holds if all three points coincide. This does not guarantee that the line is flat, and separate tests must be made to verify that point.—Lighthouse Larry.