Low Cost AUDIO OSCILLATOR

By ROBERT W. EHRLICH

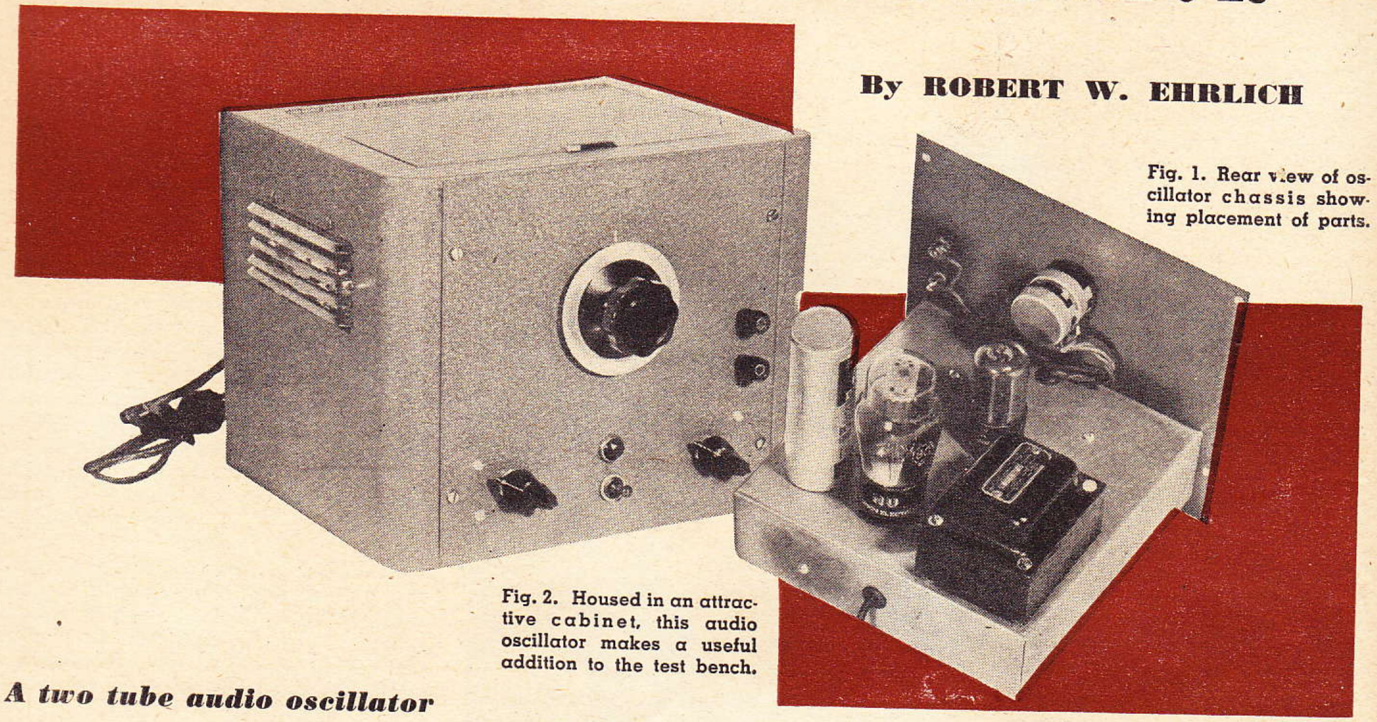


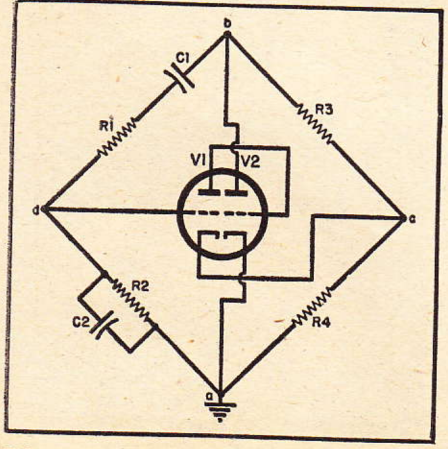
Fig. 1. Rear view of oscillator chassis showing placement of parts.

Fig. 2. Housed in an attractive cabinet, this audio oscillator makes a useful addition to the test bench.

A two tube audio oscillator utilizing resistance tuning which may be built for $10 at present day parts costs.

THE audio oscillator described in this article was designed with the idea of providing the experimenter with a low-cost, easily-built, foolproof test instrument that could provide a good quality audio test signal at any frequency for use in testing receivers, audio amplifiers, modulators, etc. The device fulfills these conditions admirably, at only a small sacrifice of the features that appear on more expensive commercial models.

Fig. 3. Basic Wien Bridge audio oscillator circuit. Feedback takes place from the plate circuit of tube 2 to the grid circuit of tube 1.



As the unit appears in Fig. 2, all parts can be purchased at amateur rates for about $10. It is to be expected, however, that most of the necessary parts will be found in the junk box, thereby lessening the actual cost of construction. In fact, the oscillator lends itself quite well to junk-box production, because none of the parts, with the exception of the tuning potentiometer, are at all critical.

As for performance, the oscillator will deliver an excellent sine-wave signal at frequencies between 100 cycles and 25,000 cycles, with no band changing. The maximum r.m.s. output ranges between ten and twenty volts, with an output impedance of approximately 10,000 ohms. This impedance is low enough so that hum pickup in the output leads is minimized and conventional test prods can be used.

A standard Wien Bridge circuit is used which is basically similar to that used in many commercial audio signal generators, but it contains two important modifications that make for simplicity. One is the use of a two-gang variable potentiometer as the tuning element rather than a large variable capacitor. This not only reduces the expense considerably, but also makes possible a tremendous range of frequencies in one band (over 100 to 1). The sacrifice here is, of course, some loss of accuracy in frequency calibration; however, the majority of applications do not require extremely accurate frequency information.

The other modification is that control of the feedback necessary to sustain oscillations is brought out to the front panel. This makes it unnecessary to undertake any involved alignment procedure when the oscillator is first put into operation. Furthermore additional flexibility is introduced in that it is possible to set the feedback control to produce either a sine wave or a highly distorted pulse wave that might be required for special applications.

The basic Wien Bridge circuit used in this oscillator is shown in Fig. 3. R_1, C_1; R_2, C_2; R_3; and R_4 constitute the bridge circuit through which feedback takes place from the plate of V_2 to the grid circuit of V_1. This bridge is balanced when:

$$f = \frac{1}{2\pi\sqrt{R_1 C_1 R_2 C_2}}, \text{ and}$$

$$\frac{C_2}{C_1} = \frac{R_3}{R_4} - \frac{R_1}{R_2}$$

Note that the frequency of balance depends only on values of R_1, R_2, C_1 and C_2, and that a suitable adjustment of the ratio of R_3 to R_4 will bring about a balance at that frequency.

Determination of the conditions necessary for oscillation in the circuit of Fig. 3 is most easily carried out by assuming a voltage between the plate and ground of V_2, and then using vector analysis to determine whether or not the voltage between the cathode and grid of V_1 will be of such a nature as to sustain the assumed voltage. Fig. 7A shows vector relationships in the bridge circuit when it is perfectly balanced. Points *a, b, c,* and *d* in the vector diagram correspond to similarly

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...ed points in Fig. 3. Note that ... conditions, the cathode-... possible $(c\text{-}d)$ on V_1 is zero, and it ...oved to sustain the voltage $(a\text{-}b)$ ... the plate and ground of V_2. ...ore there will be no oscillation. ... 7B shows the vector relation-...s when circuit values remain the ... as those in Fig. 7A, but different ...encies are assumed for the ap-...ed voltage $a\text{-}b$. As the frequency ...ges, the junction point (d) be-...en the vectors $a\text{-}d$ and $d\text{-}b$ moves ... the dotted circle, and the cath-...grid voltage takes on the differ-... values shown. Note that at no ... is $c\text{-}d$ at all in phase with the ...ed voltage, $a\text{-}b$. Remembering ... two reversals in phase take place ...een the grid of V_1 and the plate ... it will be realized that $c\text{-}d$ must ... a component in phase with $a\text{-}b$ ...tain oscillations. Since the feed-... is out of phase, and therefore de-...erative, oscillations will not take ... at any frequency.

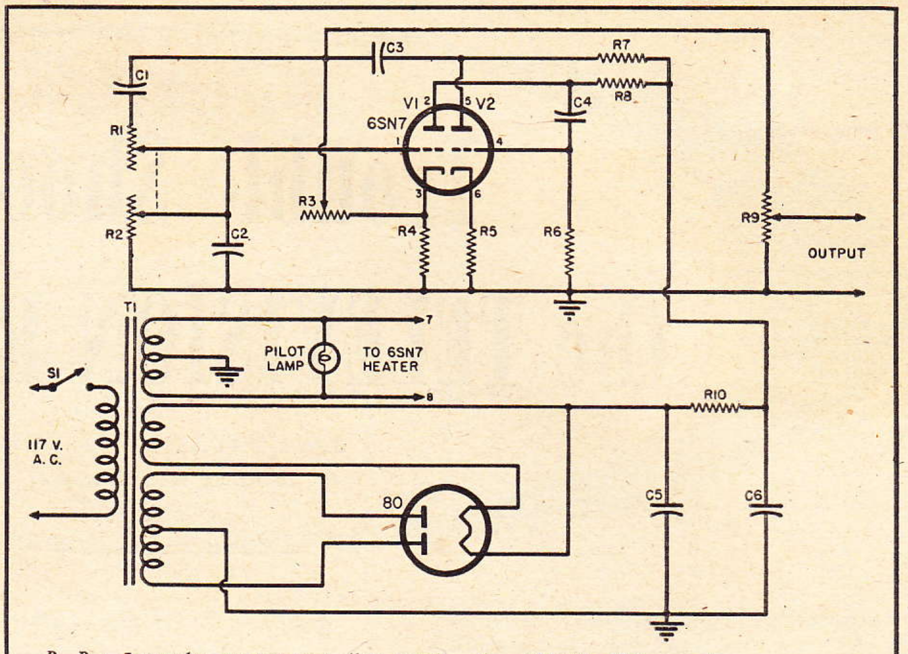
... Fig. 7C, resistor R_3 is slightly ...ler than the value required for ...ance. While there is now some ...back at the balance frequency as ... as at other frequencies, it is still ...enerative and no oscillations will ... place.

... Fig. 7D, resistor R_3 is slightly ...er than the value required for bal-... At frequencies close to the bal-... frequency (the top of the circle), ... vector $c\text{-}d$ swings around so that ... in phase with $a\text{-}b$. When resistor ... adjusted so that the voltage $c\text{-}d$, ...mplified by the two tubes, is just ... enough to equal voltage $a\text{-}b$, ... oscillations will take place.

...e preceding analysis shows two ...ficant features of the Wien Bridge ...it. One is that for any values of ... C_1 and C_2, it is possible to find ...ting of R_3 that will just cause ... circuit to break into oscillation. ... other is that oscillation is limited ...requencies very close to the bal-... frequency determined by R_1, R_2, ...and C_2, and no harmonics thereof; ... which result the inherent fre-...ency stability and pure waveform ...racteristics of this circuit.

...e actual circuit of the audio os-...ator is shown in Fig. 4. This is the ...me as the circuit of Fig. 3 with the ...dition of a power supply and the ...essary blocking capacitors for the ...ertion of the d.c. voltages to the ... sections. In designing the cir-...it, every effort was made to keep ... down. While a transformerless ...er supply might be used to shave ...penses a little further, it was felt ... an isolating transformer was ...essary in order to make it possible ... connect the oscillator to other ap-...ratus that may or may not be ...unded to the a.c. line.

...he chassis layout and placement of ...ts are adequately described in the ...ompanying pictures and diagrams, ... very little need be said. Most of ... impedances were purposely kept ... to avoid any problems of hum ...kup that might be encountered rel-... to parts placement.



R_1, R_2—.5 megohm, two-gang pot. (log. taper)
R_3—.1 megohm pot. (log. taper)
R_4, R_5—1500 ohm, 1 w. res.
R_6—.5 megohm, 1 w. res.
R_7, R_8—50,000 ohm, 1 w. res.
R_9—25,000 ohm pot. (log. taper)
R_{10}—5000 ohm, 1 w. res.
C_1—.002 μfd., 400 v. cond.
C_2—.005 μfd., 400 v. cond.
C_3—.1 μfd., 400 v. cond.
C_4—.05 μfd., 400 v. cond.
C_5, C_6—8x8 μfd., dual 450 v. elec. cond.
T_1—Power trans., 250-0-250 v., 40 ma., 6.3 v. @ 1.5 amp., 5.0 v. @ 2 amp.
S_1—S.p.s.t. toggle sw.

Fig. 4. Over-all circuit diagram and parts list for the audio oscillator.

Selection of parts to be used is also not very critical. It might be pointed out, however, that it is wise to use resistors and capacitors that are rated considerably higher than the wattages and voltages they will have to stand in order that stability of the unit will not be affected by overheating and breakdown of components.

In selection of potentiometers, it is important to note that they are all of the logarithmic-taper type. This taper is used in conventional volume control units, so it should not be difficult to find the correct parts. It is also important to observe the connections shown in Fig. 5 for the potentiometers. If they were connected incorrectly, calibrations on the main tuning potentiometer would be very crowded near one end, and the setting of the feedback control would be extremely critical. With correct connections, the frequency calibrations space out about equally for every octave (See Fig. 8), and adjustment of feedback can be accomplished smoothly and easily.

It is not so important to use a logarithmic taper for the output control, but it is more convenient. The total

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Fig. 5. Proper connections for potentiometers used in the test oscillator. All potentiometers are of the logarithmic-taper type.

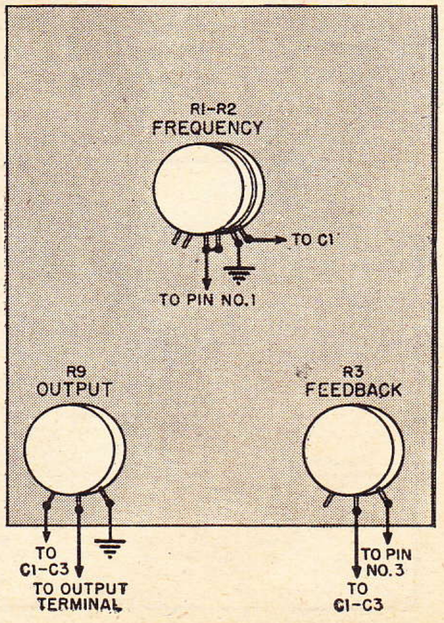
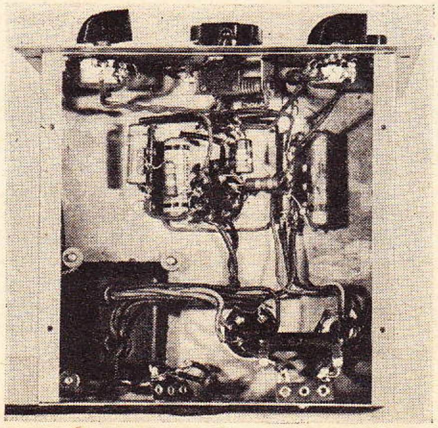


Fig. 6. Bottom view of chassis.



ested in making one—can be transmitted to forty-eight countries outside North America these days. Included are such far-off spots as Australia, Japan, Russia, Sweden and Switzerland.

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signal voltage across this control is approximately 15 volts, while most amplifiers require an input of only ½ volt or ¼ volt. A logarithmic-taper control, connected as shown in Fig. 5, spreads the low-output range over a wide arc and makes it easy to adjust for these outputs while still allowing for greater output if desired.

Placing the unit into operation is a relatively simple matter, and, wired correctly, it will work the first time it is turned on. As a rough performance check, connect a pair of high-impedance headphones to the output, set the output control to a fairly low value to avoid overloading the circuit, set the frequency dial about mid-scale, and adjust the feedback control until oscillations just take place as indicated by a tone in the headphones. Then swing the frequency dial back and forth over the entire range. Very little adjustment of feedback should be required to produce oscillations from the lowest frequency, where the dial is fully clockwise, up to a frequency which is above the range of audibility.

It will be noted that the unit will stop oscillating some distance away from the high-frequency end of the dial. This is normal, and is a result of loss in gain caused by lowered impedance of the potentiometer. Oscillations should not drop out, however, until the frequency is somewhat above the audible range. It is not advisable to try to force oscillations in this dead region at the high end of the dial through the use of the feedback control; because the audio frequency so obtained will be no higher than the upper limit observed with a normal setting of the feedback control, and a considerable adjustment of feedback will be required when returning to lower frequencies.

The over-all frequency range can be checked with the aid of an oscilloscope or a comparison oscillator whose frequency calibration is already established. If, for some reason, it is desired to shift the frequency range, this can be done by changing the values of C_1 and C_2. Making either capacitor smaller will raise the frequencies, and vice-versa. Changing these values will not extend the over-all frequency range but will simply shift the entire range of the instrument higher or lower as desired.

Some extension of the over-all range can be obtained through the substitution of a 1 megohm double potentiometer for the .5 megohm unit specified for R_1 and R_2, along with suitable readjustment of C_1 and C_2. This will