The 1-Tube "Oscillodyne" in actual operation. This is the set shown on our front cover.

The "OSCILLODYNE" 1-Tube WONDER SET

By J. A. WORCESTER, Jr.

This is the first of a series of articles on the "Oscillodyne" prepared by the inventor of the circuit, Mr. Worcester. The second article will appear in the next issue.

Part I.

● THE short-wave receiver which is described in this article depends for its operation on a principle which the writer believes is presented for the first time herewith. This receiver, while not presented as destined to replace existing methods of reception, is, nevertheless, in many respects the ideal receiver; particularly for the short-wave beginner or would-be beginner who is interested in obtaining the maximum "results per dollar" obtainable.

The fundamental circuit is shown in Fig. 1. A cursory examination will indicate that it is nothing more nor less than a simple oscillatory circuit. The feedback, however, is considerably greater than that required for the mere production of sustained oscillations, being of sufficient magnitude to produce *irregular oscillation.* This means that the oscillatory circuit is periodically rendered inoperative at a frequency dependent on the amount of feedback and on the value of the grid condenser and leak employed. In this receiver the oscillations are stopped and started at a super-audible frequency by proper selection of these three constants as explained later.

The manner in which such a circuit can be employed for the reception of radio frequency signals can be described as follows. In Fig. 1 is represented a high frequency disturbance of amplitude "A". If such a signal is present on the grid of the oscillator, this signal will build up as in Fig. 2B. In an ordinary oscillator, oscillations would build up to a value "B" (determined by the tube characteristics), as shown by the dotted lines of Fig. 2B. In this circuit, however, the feedback is too great to allow the electrons on the grid to leak off sufficiently fast to maintain a constant mean grid potential. The result is that the mean potential of the grid decreases, causing a corresponding decrease in the plate current as in Fig. 2C. As the plate current decreases the plate resistance increases, causing a decrease in the mutual conductance of the tube. Finally the plate current is reduced to a value "C" at which the mutual conductance is no longer sufficient to maintain oscillations and they die out as shown in Fig. 2B. The negative charge accumulated on the grid of the tube then leaks off at a rate determined by the time constant of the grid con-

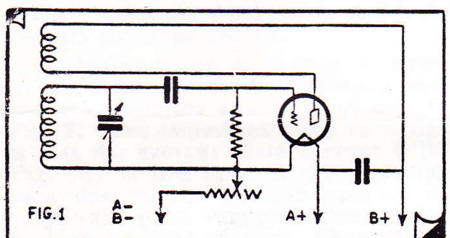


FIG. 1

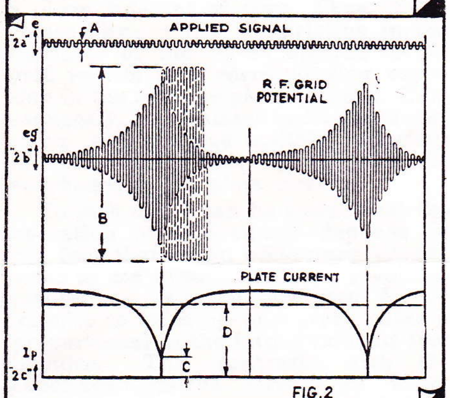


FIG. 2

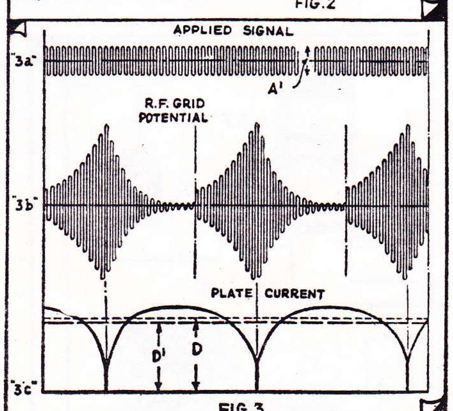
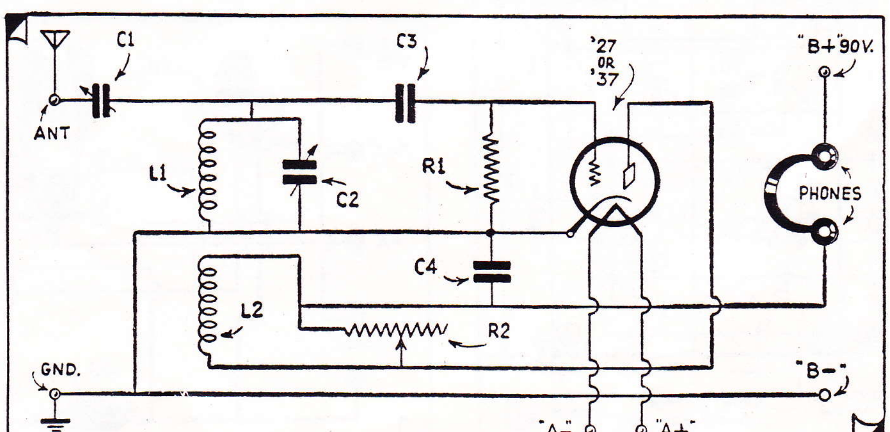


FIG. 3

Graphic diagrams employed by the author in connection with the text to explain the interesting action taking place in the "Oscillodyne."



Schematic wiring diagram showing how to connect the few simple parts composing the "Oscillodyne."

A REALLY NEW CIRCUIT

WE are pleased to present to our readers an entirely new development in radio circuits.

Under the name of "The Oscillodyne," Mr. J. A. Worcester, Jr., has developed a fundamentally new circuit, and he describes the theory as well as the practical application in this article. This circuit, which is of the regenerative variety, acts like a super-regenerative set, although it does not belong in this class. Its sensitivity is tremendous.

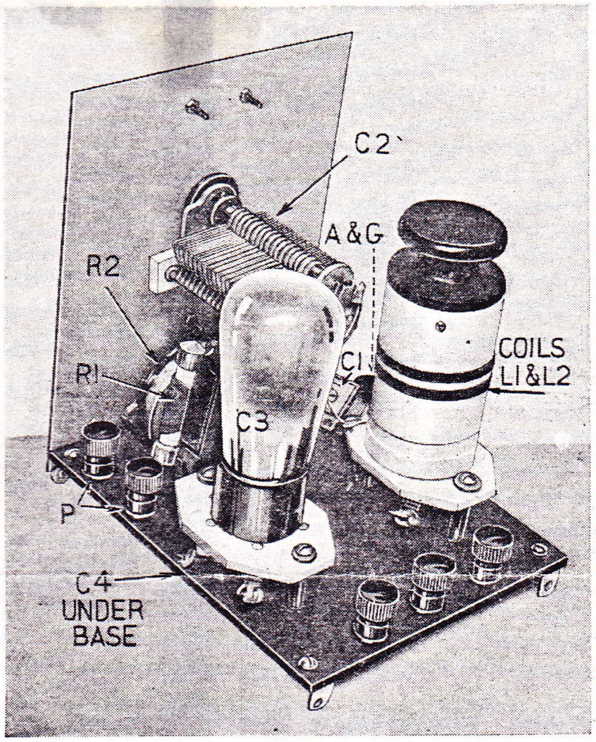
The editor, in his home on Riverside Drive, New York, in a steel apartment building, was able to listen to amateurs in the Midwest on this simple one tube set, *using no aerial and no ground!*

With a ground alone, a number of Canadian stations were brought in, and with a short aerial of 40 feet length, many foreign stations were pulled in easily.

This circuit is certainly an epoch-making one which should find immediate acceptance by the entire radio fraternity. The circuit has the advantage that it is not tricky if good material and common sense are used.

The set was tested in different parts of the East, and it has been found that the results are satisfactory in practically every location.

In our own estimation, the Oscillodyne is one of the greatest recent developments in radio circuits, and the editors recommend it warmly to all readers.



Rear view of the "oscillodyne," with parts labeled to correspond with those in the diagram.

denser and leak, whereupon the cycle repeats itself as shown.

A similar group of curves is shown in Fig. 3 for an initial disturbance having five times the amplitude of that in Fig. 2. The important thing to notice is that the average plate current ("D" Fig. 3C) is less than in the preceding case due to the greater number of "dips" the plate current makes during a given interval of time. Thus, it becomes obvious that a variation in the intensity of the signal applied to the grid results in a corresponding variation in the average plate current. Consequently, a modulated radio frequency signal will produce audible variations in the current flowing through the earphones in the plate circuit.

To sum up, it can be stated that the operation of this circuit depends on the fact that in an oscillatory circuit, prior to the establishment of sustained oscillations, *the time required* for an impulse to build up to a *given value* is proportional to the initial value of that impulse. This contrasts with the super-regenerative circuit in which use is made of the fact that *the value* to which an impulse will build during a *given interval of time* is dependent on the initial value of that impulse.

Before leaving the theoretical side of the subject it might be advisable to point out that for proper operation of the circuit it is necessary that the oscillations in the grid circuit entirely die out during the period in which the charge is leaking off the grid. This is to enable the next train of oscillations to build up from the amplitude of the signal present on the grid at that time and not from the amplitude of the preceding train of oscillations which would otherwise be present. Thus it will be found that for satisfactory reception of broadcast frequencies the damping constant of the coil and condenser combination ($\varepsilon^{\frac{Rt}{2L}}$) is not large enough without adding considerable external resistance, which necessitates a corresponding increase in the feedback employed. The feedback cannot be increased indefinitely, however,

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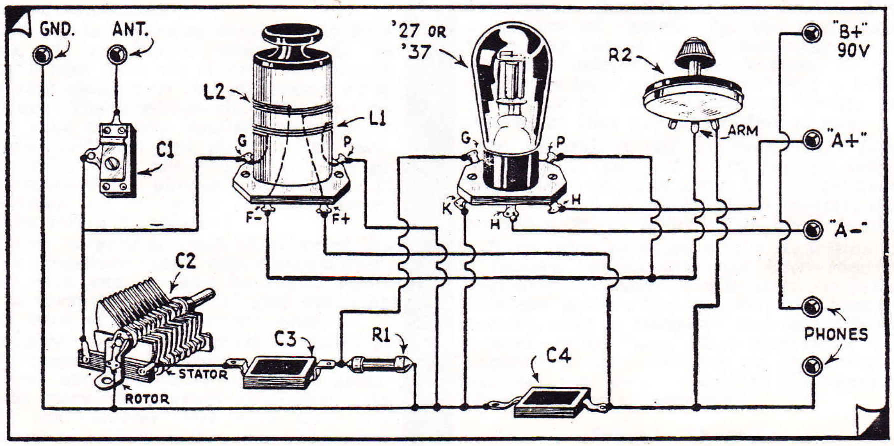
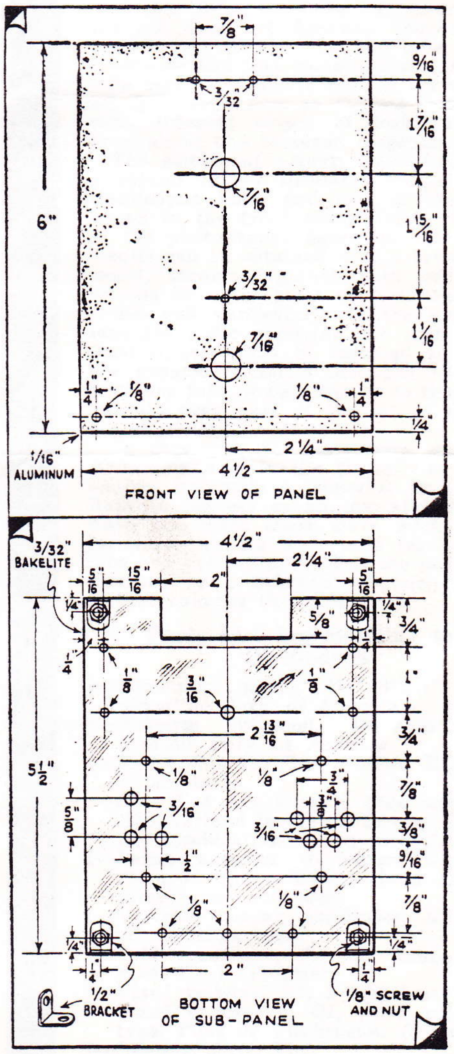


Picture wiring diagram for building the "Oscillodyne"; an "A-B-C" analysis of the set.



Layout for the "Oscillodyne" receiver panel and subpanel.

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as it will be found that as soon as the natural frequency of the tickler coil becomes less than that of the tuned grid circuit, the plate load becomes capacitative and phase relations are no longer correct for oscillation.

It becomes evident, then, that as the frequency of the signals received is increased, enabling the use of smaller inductance coils, the damping constant, $(\varepsilon^{-\frac{Rt}{2L}})$ increases, and operations of the circuit becomes more satisfactory. Henc it will be found that this circuit is particularly well adapted to short-wave reception (which is also true of the super-regenerative circuit and for the same reason.

How to Make the Simplest One-Tube Oscillodyne Set

In this article is described a simple one tube receiver employing the *oscillodyne* principle.

The schematic diagram for this receiver is shown in Fig. 4. The tube employed is a type 27 employing 2½ volts A.C., or a 37 using 6.3 volts D.C., on the heater and 90 volts plate potential supplied by a "B-eliminator," or battery. Other tubes such as the type 30, 56, 01A, 12A, etc., may be used if desired. The only change necessary is to supply the appropriate filament voltage for the tube selected. In general, screen grid tubes are not satisfactory in a one tube receiver due to the difficulty of matching the extremely high plate impedance of the tube to that of the earphone.

The plug-in coils employed are wound on tube bases. The specifications for the windings are given in the table accompanying this article. The turns of both windings are wound without spacing. It is essential that the two windings be wound in the same direction. This means that if the two inside terminals of the windings are connected together, the coil will appear like a continuous winding tapped near the center.

In regard to coil specifications, the following table is furnished for tube base coils wound with No. 36 D.S.C. wire and tuned with a 100 mmf. (.0001mf.) condenser. The first two coils may need a half turn adjustment one way or the other.

Approximate Wavelength (meters)	Sec.	Tickler
14- 25	4	6
23- 41	7	9
40- 85	14	12
83-125	23	23
120-200	36	36

About ⅛" separation between windings. It will obviously be necessary to extend the tube base forms if coils for the "broadcast band" are used. However, grid and plate windings of about 67 turns will tune from 200-360 meters and 105 turn windings will tune from 350-550 meters with the above condenser.

After the leads are soldered in the tube prongs, all superfluous solder should be carefully filed from the sides of the prongs to prevent damage to the coil socket when inserting. The windings should be so connected that the two outside leads go to the grid condenser and plate of the tube, respectively, while the two inner leads go to the cathode and phones respectively. If connections are not made in this manner *the tube will not oscillate!*

In order to provide exact coverage of the various frequency bands with suitable overlap at each end, it may be found desirable to vary the number of grid turns by a half turn or so for certain coils.

A suggested layout of parts is shown in the photographs. If other parts than the ones used are substituted it may be necessary to vary this layout somewhat. In wiring the receiver only nine leads are necessary and if these are carefully made

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no difficulty should be experienced from improper wiring. In preparing a lead to which several connections have to be made, such as the ground connections, a much more convenient method of removing wax impregnated insulation than by scraping off with a knife, is to mash the insulation at the desired points with a pair of long-nosed pliers. The insulation can then be readily removed with the fingers. Soldered connections are not essential but should be made if possible.

The 50,000 ohm variable resistance should have an insulated shaft and bushing so that it can be directly mounted to the aluminum panel. Otherwise, it will be necessary to first mount the instrument to a strip of bakelite, which in turn is mounted to the panel. If this is done, the shaft hole should be large enough for proper clearance. A potentiometer can obviously be used for this purpose by employing only one of the two outside terminals.

In making connections to the variable condenser, the ungrounded terminal should be connected to the grid condenser so that the panel will be at ground potential.

Operating Notes

When ready to operate the receiver, the first thing to do, of course, is to make the various connections to the antenna, ground, "A" and "B" supply, and phones. The antenna compensating condenser, C1, should be set at close to its minimum value. The variable condenser should be set so that its plates are within about 15° of "all-in"; and coil No. 3 inserted in the coil socket. The variable resistance R_3 should be set so that its maximum resistance is in the circuit.

The circuit is now tuned somewhere near the 80 meter amateur phone band. If the set is now turned on, a fairly loud high-pitched note should be heard in the earphones. The resistance R_2 should now be decreased until this note becomes inaudible and a "hissing sound" is heard. If the variable condenser is now rotated slightly it should be possible to tune in an amateur phone transmitter. *When this is done the resistance R_2 should be varied for best reception.* The antenna compensating condenser should now be set for maximum volume.

When using the 20 meter and 40 meter coils it will generally be found necessary to increase the resistance R_2 to a greater value than required for the 80 meter coil. While this control is not nearly as critical as the regeneration control in a regenerative receiver, it is, nevertheless, necessary to exercise some skill in its manipulation before maximum results can be obtained.

It will generally be found that when foreign stations are to be received they will come in with nearly the same ease as locals; while when they are not to be received all the coaxing in the world will not bring them in. The absence of foreign stations on the dials can be attributed to a number of causes. In the first place, there may not be any broadcasting at the time the listening is being done; or the frequency band on which listening is being done may not be suitable for foreign reception at that particular time of day.

In general, it will be found that from daybreak to about 2 p. m. foreign reception is best on 14 to about 20 meters; from 2 p. m. to 9 p. m. on 20-35 meters, and from 9 p. m. to daybreak on 35-75 meters.

Even when listening at the right time to a foreign station that had been received regularly for days, it will often be found that the station has suddenly disappeared entirely only to reappear, just as suddenly, a week or so later. Experiences of this nature are very common on short waves and can only be attributed to the vagaries of short wave transmission.

Trouble Shooting

Difficulties encountered in getting the set functioning properly can be grouped

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in three classifications as follows:

1. Set refuses to operate.
2. Set oscillates but will not break into irregular oscillation.
3. Set oscillates irregularly but does not function properly.

To determine whether the set is oscillating or not touch the terminal of the grid condenser that is *not* connected to the grid. If this results in a click in the phones the set is oscillating, and vice versa. If the set is not oscillating the first thing to determine is whether plate current is flowing. This can be determined by disconnecting one of the phone leads and making and breaking this connection by hand. If this results in corresponding loud clicks in the phones, plate current is flowing and the difficulty is elsewhere. If plate current is not flowing there is probably an "open circuit" in the plate or heater circuit. Make sure that the plate potential is not reversed; also that the coil is making contact with the socket and that the B— (minus) terminal is connected to the cathode. Also re-examine the plug-in coil to make certain that the connections have been made properly. Also make certain that the tube is not defective.

If the tube oscillates but does not break into irregular oscillation (high pitched note in earphones with R_2 at maximum) make certain that the plate and filament voltages are correct. Also make sure that the tube is not faulty. Reduce the antenna compensating condenser to its minimum value or temporarily disconnect the antenna. If this procedure rectifies the trouble, the antenna condenser has too large a minimum capacity and a smaller one should be substituted. Rock the plug-in coil slightly to make sure there is not a *high-resistance* contact.

If the tube oscillates irregularly, but the set does not function properly, the trouble is probably with the tube or grid condenser and leak combination. If a new tube does not improve results, try a .00005 mf. grid condenser at C_3 and experiment with different values of leak resistance from about one to seven megohms.

The editors of SHORT WAVE CRAFT had a special highly insulated model of the Oscillodyne built and this is the model shown in the front cover illustration and in the photographs herewith. Of course, results can be obtained with a bread-board model, thrown together with odd parts, but, as in every piece of electrical apparatus—and particularly in the case of a sensitive radio receiving set such as the Oscillodyne, which is designed to realize the greatest possible strength of signal from one tube, it behooves us to thoroughly insulate evey part of the set to the best of our ability.

To that end, the coils were wound on Hammarlund *Isolantite* forms. As is well known, Isolantite is superior to ordinary Bakelite for use as an insulator in short wave and ultra short wave work. Next, Isolantite sockets were used for both the tube and the coil and all of the parts were mounted on a bakelite subpanel, to still further enhance the insulation.

Parts List For Building the Oscillodyne

1—Aluminum panel, 4½"x6"x$\frac{1}{16}$". Blan (Insuline Corp. of America.)
1—Bakelite subpanel, 4½"x5½"x3/32". Insuline Corp. of America.
1—50,000 ohm variable resistor, R2, Frost, (Clarostat).
1—Set of 4 pin plug-in coils wound on Hammarlund Isolantite forms 1½" dia., per specifications given in article.
1—Series antenna condenser, Cl, about 25 mmf. max., Hammarlund Compensator type condenser.
1—Variable tuning condenser, C2, .0001 mf., Hammarlund.
1—Grid condenser, C3, 100 mmf., or 50 mmf. Illini (Polymet)
1—Fixed resistor, R1, 3 megohms, Lynch,
1—Fixed condenser, C4, .0005 mf., mica type, Pilot or Flechtheim. (Polymet)
7—Binding posts, Eby.
1—3" midget National Velvet Vernier Dial, type BM.

Original Circuit