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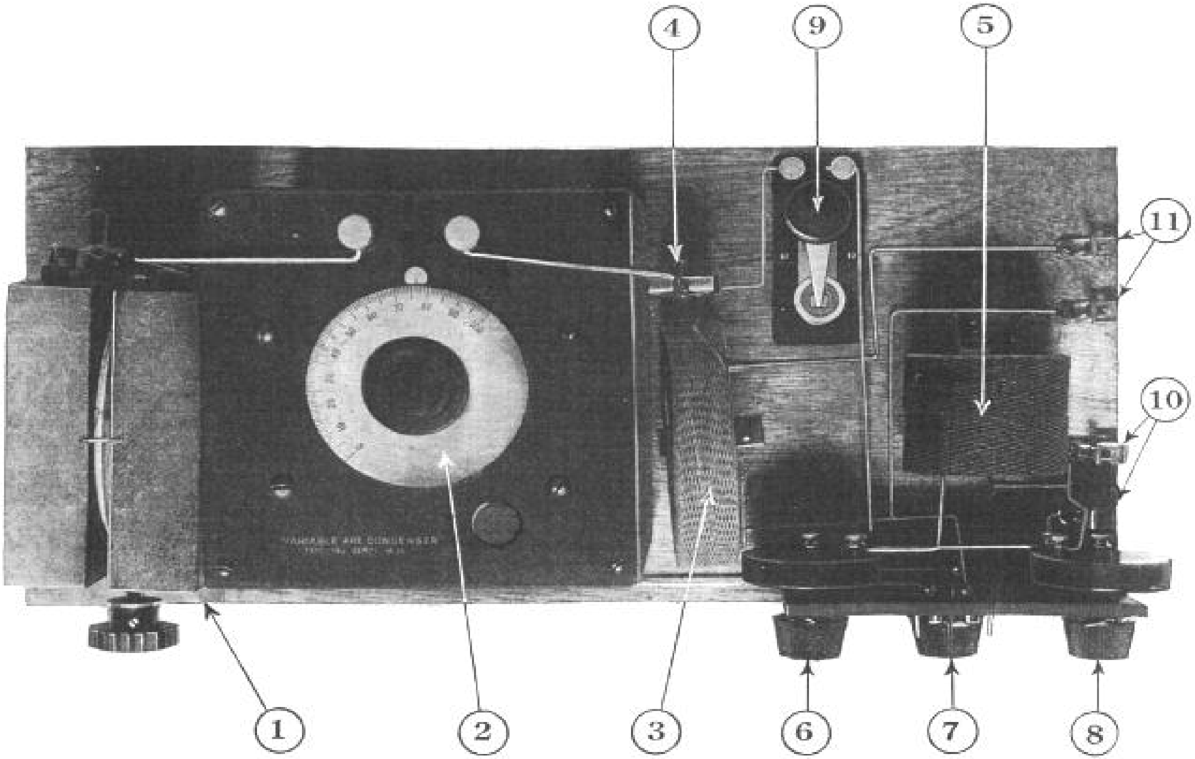
The Crystodyne Principle



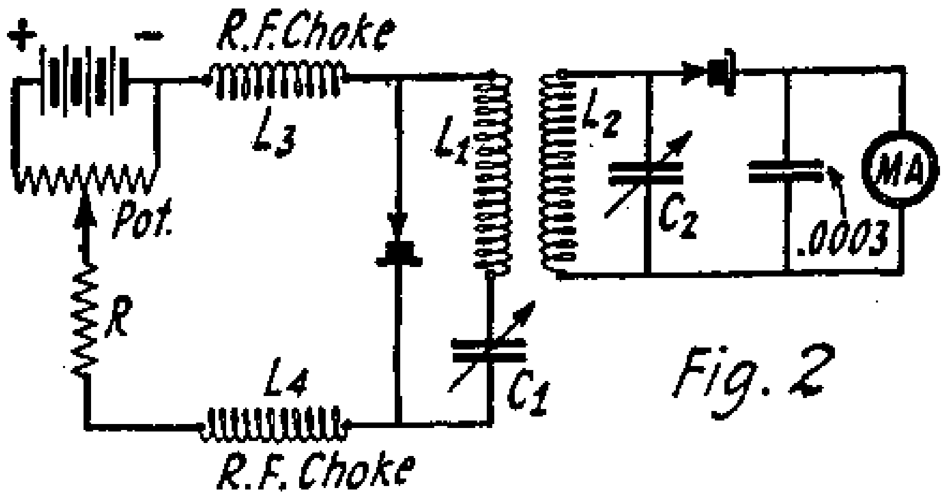
Top view of the experimental panel, built in the Radio News Laboratories, to produce oscillations with a crystal detector. In the picture the numbers refer to the following parts: No. 1, variometer; 2, variable condensor; 3, honeycomb coil; 4, .005 mfd. condensor; 5, choke coils; 6, potentimeter; 7, switch; 8, resistance; 9, zincite steel crystal detector; 10, phone clips; 11, battery clips.

SEVERAL experimenters have observed that some contacts, such as crystal and metal or crystal and carbon generally employed as detectors may produce undamped oscillations of any frequency, exactly as the vacuum tube oscillator. The same contact may also be utilized as an amplifier. Oscillating crystals are not new since they were investigated as far back as 1906 by well known engineers, but it was not until lately that a Russian engineer, Mr. O. V. Lossev, succeeded in finding some interesting uses for oscillating crystals. The construction of the apparatus by means of which oscillations may be produced with crystal as a generator seems quite simple and should be of great interest to our readers.

Among the numerous contacts studied are pyrite carbon, chalcopyrite-zinc, galena-carbon, or zincite-carbon. The zincite-carbon and zincite-steel contacts seem to be the best producers of strong oscillations. The construction of the contact is similar to an ordinary crystal detector in which a springy piece of wire rests on a crystal. One may use as the cat-whisker a piece of carbon taken from a broken incandescent lamp, the carbon being a piece of the filament; an ordinary piece of steel wire is also suitable.

The zincite crystals may be selected but it has been proved by experiment that even a poor crystal is made much better if it is fused in an arc and scraped to remove the outside black layer which is not a good conductor. One may also break the crystal and use the inside surface. It is necessary to fuse the crystal in binoxide or peroxide of manganese.

To find the best condition in which to use the crystal, one may trace its characteristic curves showing that when submitted to a certain voltage the contact acts as a negative resistance. This negative resistance explains why the crystal may be used to produce oscillations. These curves are generally similar to that of an arc or a dynatron tube. However, it is simpler to try the contact as in an ordinary detector until it functions as an audio frequency oscillator, furnishing a musical note which is heard directly in the phones. Once the crystal oscillates at audio frequency, it is easy to replace the audio frequency circuit by one of radio frequency so as to have the contact functioning in the ordinary heterodyne manner.



The amount of energy produced by the oscillating crystal may be measured with a microammeter connected as shown in this diagram.

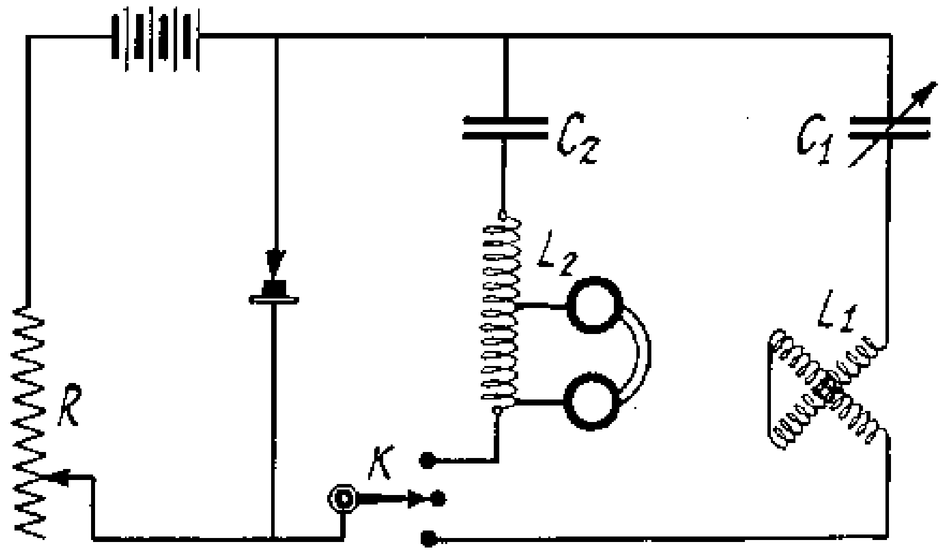


Fig. 1

Diagram of the oscillating crystal circuit. As may be seen, the hook-up is similar to that of an arc transmitter.

BATTERY FURNISHES POWER

Fig. 1 shows the connection of a circuit which is made to oscillate by the energy produced from a crystal connected to a battery. The battery may be composed of dry cells such as a "B" battery, provided its inside resistance is not too great. The voltage to apply on the contact is generally between 5 and 30 volts, depending upon the quality of the crystal. In the circuit of Fig. 1, the constants are as follows: R is a rheostat of about 3,000 ohms resistance with variable contact. L2C2 is the audio frequency oscillating circuit while L1C1 is the radio frequency circuit. By means of a switch K, either of these may be connected to the crystal. L2 may be a 1-henry inductance; C2, a 2-mfd. condenser; C1, a .01-mfd. condenser; and L1, a 5-millihenry variable inductance. It is preferable to use phones of about 300 ohms resistance in this circuit. By connecting the circuit L2C2, and by varying the tension of the battery and the value of the resistance R, audio frequency oscillations are produced in the circuit. In order to start the radio frequency oscillations in the circuit L1C1, it is necessary to have an extra switch-point not connected to the circuit between the two extreme ones. It is also necessary to have the high frequency resistance of the circuit L1C1 lower than that of L2C2; it is further necessary that the ratio of the co-efficients of self-inductance in the two circuits be equal to the ratio of their respective capacities. It is possible to keep the proper value of inductance and capacity at all times by using a variometer for the inductance L1, and by mounting on the same shaft the variable condenser C1 so that both are turned at the same time, making the ratio between L1 and C1 about constant for any setting.

With the circuit of Fig. 2, it has been found possible to produce oscillations of very high frequency, the shortest wave-length obtained being 25 meters. The resistance R has a value of 2,300 ohms. The coil L1 is 2¼ inches in diameter and is composed of seven turns of No. 12 copper wire. The variable condenser C1 has a value of .0003 mfd. and L3 and L4 are choke coils used to prevent the high frequency oscillations flowing through the battery circuit. To measure the wave-length, a special wave-meter was used, composed of a coil L2 which is 2¼ inches in diameter and consists of a single turn of No. 12 copper wire shunted by a variable air condenser C2 of .006 mfd. capacity. A galena crystal detector is connected in series with a micro-ammeter, with a scale of zero to 100, allowing the operator to find the resonance point.

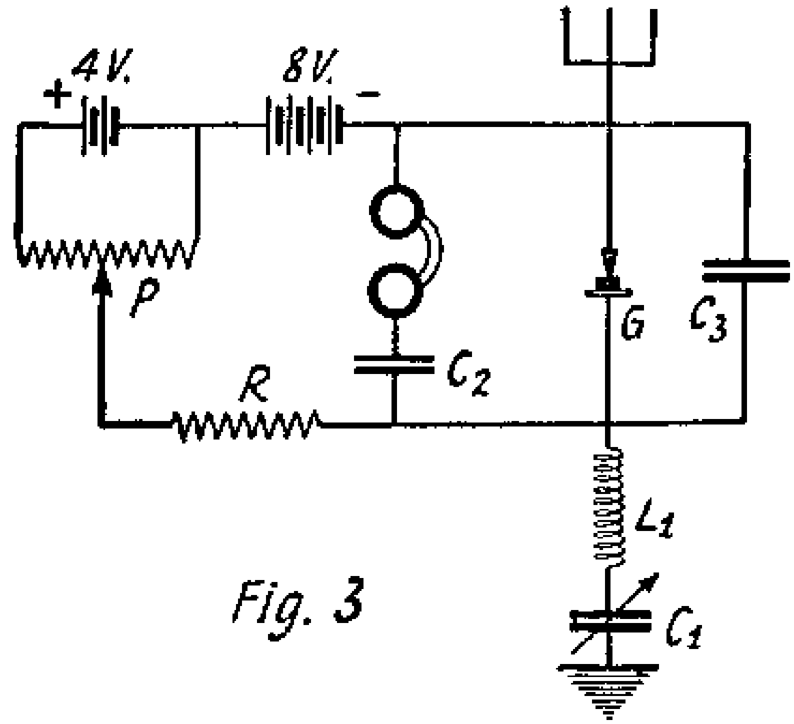
However, the production of short wave-lengths even with this arrangement is rather difficult although oscillations of lower frequency may readily be produced with the same circuit. We shall show in another article how the zincite crystal oscillator may be used for the reception of code signals and radio telephony, and how the same crystal may be utilized as an amplifier and detector.

GALENA WEAK OSCILLATOR

Some crystals, such as galena, do not produce strong oscillations, although they may sometimes oscillate sufficiently even without any battery in the circuit to produce a beat note when continuous wave signals or a carrier wave are received. This phenomenon, which has been observed several times, explains why some amateurs using only a crystal detector, are sometimes able to receive continuous waves without an outside oscillator. It also explains how it is sometimes possible to pick up very distant broadcast stations on a crystal set installed in such a location that no radiating receivers or re-radiating structures reinforce the signal. Fig. 3 shows a practical circuit for the reception of short wave C.W. signals with an oscillating crystal similar to the one described above. The crystal may be made to oscillate first by the method explained previously; that is, by listening in the phones when it oscillates at audio frequency, then by means of switches the circuit of Fig. 3 may be connected to the crystal. It should be noted that the potentiometer acts as a vernier when adjusted, because the natural period of the crystal depends upon the bend of the negative part of the characteristic curve; that is, the wave-length decreases if the negative resistance increases. For short wave-length, it is recommended to use a fixed condenser of .003 or .004 mfd. across the detector. This arrangement was used by Fuller who connected fixed condensers across his arcs to improve the efficiency and stability of the circuit.

It is possible to obtain regeneration with this system by adjusting the potentiometer until the detector starts to oscillate. It is found that a strong increase of the signal strength may be obtained just below the oscillating point exactly as in a regenerative circuit. Mr. Lossev also constructed a small transmitter with such crystal contacts and since he gave the information regarding the circuit to a few amateurs in Russia, they have been communicating over short distances by means of oscillating crystal transmitters. The reception is made by means of oscillating crystals connected as in Fig. 3. The circuits shown herewith are very simple ones which may, of course, be improved upon by experimenters interested in this subject, and we shall welcome any report of results obtained by our readers with oscillating crystals.

In closing, we wish to acknowledge our indebtedness to our French contemporaries *Radio EIectricité* and *Radio Revue* for the information contained in this article.



A practical receiving circuit for the reception of continuous waves with a crystal detector.

THE diagrams, as well as a good deal of the information printed in this article, are published in conjunction with *"Radio Revue"* of Paris. Arrangements have also been made with the inventor, Mr. O. V. Lossev, to furnish additional information on the *Crystodyne* principle.