

# Experimental Wireless Telegraphy and Telephony—IV\*

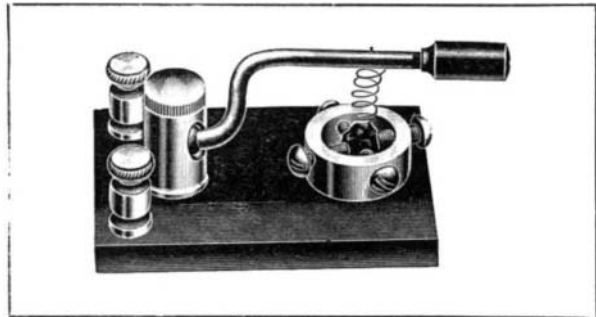
## Crystal Detectors, Telephone Receivers, Receiving Coils and Condensers

By Louis Gerard Pacent and Austin C. Lescarbours

(CONTINUED FROM SCIENTIFIC AMERICAN SUPPLEMENT, AUGUST 9, 1919, No. 2275, PAGE 85)

### CRYSTAL DETECTORS.

A very simple and convenient form of detector is obtained by the contact of two dissimilar solid substances properly chosen. The number of substances which have been found suitable for use in such detectors is large. This type of detector is inexpensive and easily portable, but requires frequent adjustment and is less sensitive than the average vacuum tube. For field sets where a compact and easily portable form of detector is required, the crystal detector is very



Typical detector of the rectifying crystal class, which is still widely employed

convenient. The use of crystal detectors is largely confined to such work now, and even in the portable military sets is rapidly giving way to the vacuum tube detector. For beginners, however, it represents the logical detector because of the simplicity of its attendant apparatus.

Among the combinations of solid substances which have been used as contact detectors may be mentioned silicon with steel, carbon with steel, and tellurium with aluminum. The most important contact detectors, however, consist of crystals, natural or artificial in contact with a metallic point. Examples of such minerals are galena, iron pyrites, molybdenite, bornite, chalcopryite, carborundum, silicon, lenzite and zincite. The first three are, respectively, lead sulphide, iron sulphide, and molybdenum sulphide. Bornite and chalcopryite are combinations of the sulphides of copper and iron. Carborundum is silicon carbide, formed in the electric furnace. The fused metallic silicon commonly used is also an electric furnace product. Zincite is a natural red oxide of zinc.

In order to test the sensitiveness of a detector at any time, a buzzer and battery are employed. The buzzer sets up oscillations which affect the receiving set the same as would the wireless waves.

Probably the three most widely used crystals are galena, silicon and iron pyrites. Sensitive specimens of iron pyrites are more difficult to find than sensitive galena, but they usually retain their sensitiveness for a longer time than galena. These sensitive pyrite detectors are often sold under the trade name of "Feron." The detector sold under the name of "Perikon" consists of a bornite point in contact with a mass of zincite. Another popular combination is silicon-antimony. Most crystal detectors operate without battery, particularly galena, silicon, and iron pyrites.

Various mechanical arrangements are used in different types of detectors. In the case of two dissimilar crystals, each crystal is held in a cup or jaw and brought in contact with its companion by spring pres-

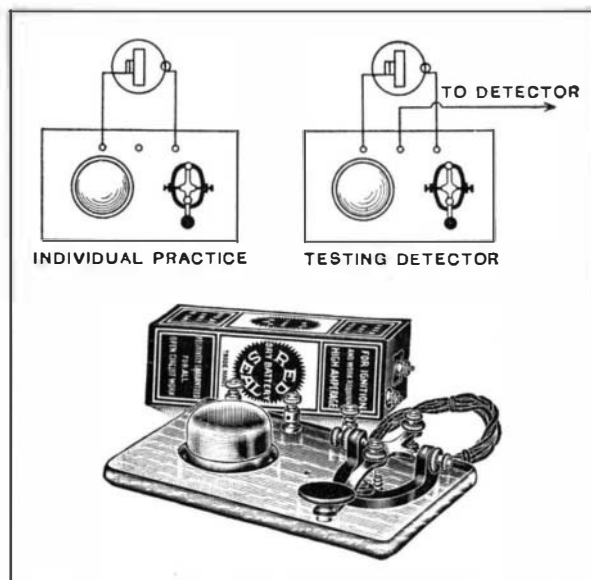
\*This series dealing with wireless telegraphy and telephony for the beginner in the art. Began with I in SCIENTIFIC AMERICAN SUPPLEMENT No. 2270, dated July 5, 1919; II in No. 2273, dated July 26, 1919 and III in No. 2275, dated Aug. 9, 1919. Every phase of amateur radio is being covered in this series, in a simple, clear and thorough manner, together with the latest commercial practices. (Copyright, 1919, Scientific American Publishing Co.)

sure. Single crystal detectors use a sharp point which presses against the crystal by spring pressure, or a fine wire whose tip presses lightly on the crystal surface.

### TELEPHONE RECEIVERS.

The distinctive features of telephone receivers for radio work are lightness of the moving parts and the employment of a great many turns of wire around the magnet poles. The lightness of the moving parts enables them to follow and respond to rapid pulsations of current. The large number of turns of wire causes a relatively large magnetic field to be produced by a feeble current. The combined effect is to give a very sensitive receiving device. Inasmuch as the size of wire used is always about the same (around A. W. G. No. 40 copper), the amount of wire and therefore the number of turns is usually specified indirectly by stating the number of ohms of resistance in the coils. Telephone receivers of fair sensitiveness for radio work have 1,000 ohms in each receiver (measured on direct current), while the better ones usually have 1,500 to 2,000 ohms per receiver.

The most common type, called the magnetic diaphragm type, has a U-shaped permanent magnet with soft iron poles, and a thin soft diaphragm very close to the poles so that it vibrates when the attraction is rapidly varied, producing sounds to correspond with the frequency of the pulsations of current.



Combination practice buzzer and test set, with wiring diagram

The only other important type is called a mica diaphragm receiver. The regular diaphragm is of mica, and is put in the usual place in the receiver, but of course is not attracted upon directly by the magnets. Between the magnet poles a soft iron armature is pivoted, inside of a solenoidal telephone winding. It is arranged so that as it moves in response to changes of magnetism a small stiff wire attachment transmits the motion to the mica diaphragm. The armature is so arranged that there is no pull upon it at all, except when pulsations of current are passing through the coil. This is contrary to the ordinary magnetic telephone receiver where the magnet poles are always exerting a pull on the diaphragm. If there is no strain in the diaphragm between pulsations the vibratory movements due to incoming signals are much greater than if a strain were already existing in the diaphragm or armature. In the mica telephone this unrestrained vi-

bration is communicated to the mica diaphragm near the ear.

### RECEIVING COILS AND CONDENSERS.

The coils used in receiving apparatus are very simple, being usually wound in a single layer of wire on bakelite, pasteboard, or other insulating tube. The wire is usually stranded and covered with an insulation of



Typical fixed condenser used for receiving purposes

silk or cotton. In some types one or two sliders make contact with any desired turn of wire, the insulation being scraped off on top of the wires along a narrow path lengthwise of the coil. Some tuning coils make use of bare wire wound in such a fashion as to maintain an even space between turns.

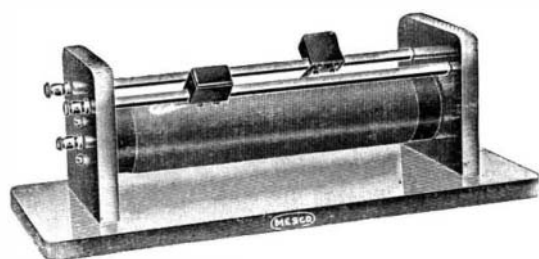
Tuning coils, however, are fast passing out of date, except as equipment for the beginner in radio. Most sets today use no slider but have switches whose points are connected by tap wires to the turns of wire in the coil. One switch takes care of single turns, and the other switch makes contact to groups of, say, ten turns each. To cover 100 turns, for instance, one switch should have 9 points of ten turns each, and a zero point, making ten points in all, and the units switch should have 9 points and a zero point. Then any number from 0 to 100 turns could be used. If a coil had 400 turns the first switch in groups of 20 turns could have 20 points including zero, and the unit switch could also have 20 points for nineteen unit turns and zero.

Such an arrangement is followed out in most loose-couplers or receiving transformers of the more modern kind, although some still cling to a sliding contact on the primary and a switch on the secondary. The finer tuning in this and other apparatus is done with variable condensers.

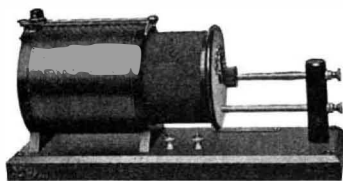
Loading coils are merely large coils used to increase the inductance of the circuit when the inductance of the receiving transformer is not great enough to be tuned to the wave-length received. Ordinary tuning coils and the coils of receiving transformers of the inductively coupled types are usually 6 to 10 inches long and 4 to 6 inches in diameter, with single layer windings, while some of the common loading coils for long waves are 25 inches or more in length.

The variable condenser generally used today is of the rotary plate type, such as that shown in the accompanying illustration. A set of semi-circular plates is rotated between a corresponding set of fixed plates, forming alternate layers of air dielectric with adjacent conductors of opposite polarity.

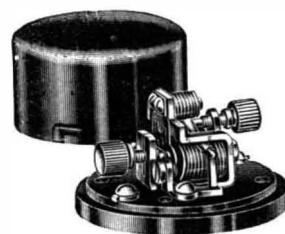
For most of the foregoing data the authors are indebted to Radio Pamphlet No. 40 of the Signal Corps, U. S. A., which deals with the principles of radio communication as applied to military wireless telegraphy and telephony. In the next section the advanced receiving apparatus and arrangements are covered, particularly the amateur equipment that has come into use since the ending of the great war.



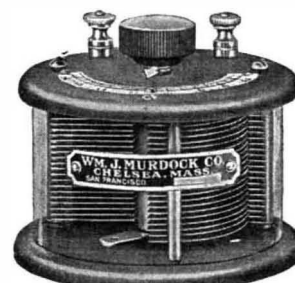
Two-slide tuning coil



Conventional loose-coupler



Improved buzzer



Variable plate condenser

Various pieces of receiving equipment—the buzzer excepted—which are now considered suitable for the beginner in the art