THE MAKING AND THE USING OF A WIRELESS TELEGRAPH TUNING DEVICE.—IV.*

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ONE of the difficulties usually encountered by the amateur wireless telegraphist who has constructed or is using a syntonizer apparatus is that of bringing the receiving circuits of the receptor into sharp resonance with the oscillation circuits of the transmitter.

The tuning device, or more appropriately the "syntonizer" here described and illustrated, is an instrument that any operator can easily make and, by following the suggestions offered, the resultant product will be found to be at once simple, cheap, and efficient, admirably fulfilling the requirements for which it is designed and permitting even a beginner to adjust the high potential and high frequency circuits of both stations to a predetermined wave length and so effect syntonization between them.

The tuning device is primarily a closed circuit having an inductance and capacity equal to the closed resonating circuit of the receiver, but unlike the Slaby ondrometer and Fleming cymometer it is not intended to measure the lengths of the emitted and received waves but rather to provide an adjustable standard for producing them, and again, different from those very useful and ingenious instruments, it is connected directly to the closed circuit of the oscillator, instead of inductively with it.

The principle upon which it operates is that by setting sliding contacts, of which there are two, on a number on the scale the wave length in meters is indicated, and then the closed circuit of the transmitter can be tuned to the tuning device, and thus not only the length of the electric waves emitted can be predetermined, but if the lengths of the sending and receiving aeri-als are the same it is easy to put the aerial wire system in tune with the closed circuits as well as to know when syntonization prevails between the sending circuits and the receiving circuits.

The closed circuit device is shown perspective-ly in Fig. 1 and diagrammatically in Fig. 2. By referring to the latter it will be observed to consist of three parts, namely, a variable inductance coil, an adjustable spark-gap and a small condenser, the first two in series, the last shunted around the spark-gap. The inductance coil is made by using tinned copper wire

Fig. 1.—The Tuning Device Complete.

No. 16 B. W. G. and winding this on a light cylindrical wooden frame having a circumference of 90 centimeters. Each turn of wire represents a wave length of four meters, but since the turns are wound about 2 millimeters apart the actual length of each turn needs only to be 90 centimeters owing to the increased inductance due to the proximity of the turns of wire. There may be as many turns of wire as desired but the number should be the same as on the tuning coil of the receiver; at least 100 turns are essential so that the instruments may be tuned for any wave length up to 400 meters.

Mounted on top of the coil is a small spark-gap; this is formed of pointed wires, the opposite ends of which are connected to the tuning coil, one terminal leading to the upper end of the inductance coil and the other and opposite end to a flexible conductor to which is attached the lower sliding contact. The spark-gap terminals may be formed of two binding posts screwed to a hard rubber base and set about 4 centimeters apart and through the orifices of the posts darning needles or wires of any other metal having sharpened points are inserted; for the sake of convenience in adjusting it is well to have these fitted with handles.

The condenser shunted around the spark-gap should have as nearly the same capacity as the coherer used in the receptor; this condenser may be made of two sheets of tin-foil 2 x 3 inches separated by a thin sheet of glass or mica and protected on either side by similar sheets of glass, when it can be mounted on top of the frame of the inductance coil by the side of the needle point spark-gap. The photograph shows the inductance coil incased in a hard rubber covering but this is not at all essential to insure success but rather to give the device a finished aspect. It is well, however, to inclose the needle point spark-gap in a small case made of wood and having a glass front, since this will serve to exclude currents of air which might affect the spark length, yet at the same time permits the spark to be observed.

The scale may be of brass, hard rubber, or wood and a rule divided into millimeters will serve admirably. Brass is the most durable but if used care must be taken to insulate the contact points and connections from the slides. The scale may have 100 or more divisions, each division representing one turn of the inductance coil. Where the coil is left exposed spring clips may be used instead of the sliding contacts, or small metal wedges that can be forced between the successive turns of wire can be employed; such an arrangement is much easier to make but not quite as convenient to use.

Fig. 2.—The Tuning Coil.

Having the device the next thing is to utilize it. Instead of trying to adjust the receiving station to the wave length of the sending station the process is reversed, since the closed circuit of the tuning device represents very closely the electrical dimensions of the resonating system of the receptor; in fact the tuning inductance coil of the receptor is exactly duplicated in the syntonizer, both electrically and physically. The difference in the two circuits is due to one having a coherer and the other a condenser and it is difficult to make these correspond in their capacity values.

Now an electric wave emitted by any plain open oscillating circuit is four times the length of the aerial so that if the aerial is 50 meters in length it will emit a wave 200 meters in length. Similarly a wave 200 meters in length will set up oscillations in a 50-meter receiving aerial that will surge naturally through it and hence the tuning coil of the closed circuit resonator which is coupled to the open-circuit aerial should be set on the fiftieth turn of the inductance coil which is a fourth of the wave length emitted, when the open and closed circuit of the receiver should now be in tune.

The contacts of the tuning device connected to the closed circuit of the transmitter are likewise set on the fiftieth turn of inductance coil since this is the same as the receiver is tuned for. The aerial wire of the transmitter is now disconnected from the closed oscillation circuit, and the spark-gap of the sending inductance coil is made very small, all of which is shown in the diagram Fig. 3.

When these preliminaries have been satisfactorily attended to the contacts of the large sending inductance coil 1 and 2 are brought together on the middle turn, the starting resistance of the primary circuit is thrown in and the key held down. The resistance is now gradually cut out until a bright spark is produced in the sending spark-gap; when this is obtained, the operator should open the needle-point spark-gap of the tuning device to about one centimeter and then the inductance of the sending tuning coil should be varied by moving the contacts 1 and 2 until sparking begins between the needle-points of the tuning device. When the sparking becomes brightest separate the spark-gap points a little farther and again adjust the positions of the contacts 1 and 2 and continue this process until the sparks have reached their greatest length and brilliancy, which shows that the sending closed circuit and closed circuit of the tuning device are in resonance, when the wave length of the former will be of course that of the latter and equal to the receiving station.

Fig. 3.—How the Tuning Device is Connected with the Closed Circuit of the Transmitter.

If the sending aerial wire is of a length exactly equivalent to that represented by the tuning device it will be very closely in tune with the closed circuit of the transmitter, but to tune the aerial wire to the closed oscillation circuit more accurately a hot wire ammeter must be resorted to, as described in SUPPLEMENT 1623. Assuming the condenser of the tuning device to have the same capacity as that of the coherer, then the sending and receiving apparatus will be fairly well in resonance, i. e., syntonized. But the capacities of coherers vary considerably and hence the capacity

of the condenser in the tuning device may be too great or too small.

There are two methods by which this difficulty may be obviated. The best and simplest is to insert in the closed circuit of the receptor a condenser having a capacity of say 1/10 of one microfarad, which is large compared with that of the average coherer. A condenser of like capacity may then be used in the tuning device when the capacity of the coherer may be ignored. Another means to ascertain if the sending and receiving circuits are in syntonization is by actual testing, which as a matter of fact should be done anyway whether the condensers have a capacity approximating that of the coherer or whether these are large in comparison.

To make tests of this kind the stations must not be too far apart, that is, not over 25 miles at most. Then the sending operator transmits a letter—say the letter "S," represented by three dots—and keeps repeating this at intervals of several minutes, at the same time he reduces the amount of the initial energy. In the meantime the receiving operator keeps adjusting the inductance of his coil until the receiving circuits are in sharp resonance with the sending instruments, when the stations are ready for actual operation.

SOME REQUIREMENTS OF CARBURETER DESIGN.

In a paper read before the Society of Automobile Engineers, and reported in The Journal of Electricity, Mr. E. T. Birdsall, M.L., said that ever since the idea of using a vaporized or gasified liquid fuel in the internal combustion engine was suggested, the device for preparing the fuel for use in the engine has been a subject for much thought and study. Numberless designers more or less insufficiently armed with the proper experience, knowledge, and data for the task, have undertaken to solve the problem with varying results. As long as the principal requirement was to furnish fuel to engines working under a practically constant load and speed, and fuel was cheap, the defects of the early carbureters were not such as to interfere seriously with the operation of the engine. Other troubles, such, for example, as ignition, occupied so much of the operator's time, that the carbureter, so long as it worked at all, was neglected.

In the following remarks it is assumed that the engine used has a sufficient number of cylinders to produce a steady flow of mixture and that the carbureter is of the modern float-feed type, with a fuel jet and main and auxiliary air inlets. The fuel is assumed to be gasoline, although in the main alcohol or heavier oils require the same general conditions. The object to be attained is a mixture that will develop a maximum of power from a given size of motor with a minimum of fuel, not an average or "good enough" result.

With the use of the internal-combustion engine under extreme variations of load and speed, as demanded by the modern automobile, with the perfection of the ignition and other features, and with the rapid rise in price of the lighter oils, the subject of carbureter design becomes one of great interest and importance. Again, in a few years, when the commercial wagon will demand a low fuel cost combined with great certainty and flexibility of engine operation, the carbureter will probably determine the extent of the development of this, the most important branch of the automobile industry.

The function of a carbureter is to supply the proper mixture of air and fuel to the engine, under all conditions of speed and power. The four essential conditions under which carbureters must work are:

First—Wide-open throttle and high engine speed, as when climbing hills or running fast on the level.

Second—Wide-open throttle and slow engine speed, as when traveling slowly on the high gear or picking up from standstill.

Third—Partly closed throttle and high engine speed, as when running fast down grade or on a low gear.

Fourth—Nearly closed throttle and low engine speed, as with engine running idle when car is standing.

For some time it was thought that the best carbureter was one that gave a constant mixture under all conditions. But we now know that a constant mixture is not the best from either the standpoint of best operation or full economy. It was also thought that the best mixture contained just sufficient oxygen to entirely consume the carbon and hydrogen. It was found, however, that a mixture with a slight excess of fuel gave the best results. These facts being demon-

* Specially prepared for SCIENTIFIC AMERICAN SUPPLEMENT. This article should be read in connection with the following articles by the same author: "The Design and Construction of a 100-Mile Wireless Telegraph Set" (SCIENTIFIC AMERICAN SUPPLEMENT 1605); "The Location and Erection of a 100-Mile Wireless Telegraph Station" (SCIENTIFIC AMERICAN SUPPLEMENT 1622); "The Installation and Adjustment of a 100-Mile Wireless Telegraph Set" (SCIENTIFIC AMERICAN SUPPLEMENT 1623).