PROCEEDINGS

of the

RADIO CLUB *of* AMERICA

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R.C.A. SPECIAL NOTICES

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The recent Radio Exhibition and Convention of the Second Inspection District was a striking success from all angles. Many members of the Radio Club of America took an active part in the exhibition of new radio apparatus and in assisting in the extensive program of events which took place during the Convention.

The Resonant Converter

By Walter S. Lemmon

Presented at Meeting of Radio Club of America, Columbia University, Nov. 26, 1920

THE many advantages accruing from the use of high musical tones in radio transmitters of both spark and C.W. types has led to the development of a simple and effective means of producing them.

The Resonant Converter is applicable in its present development to both types of apparatus and therefore may be particularly interesting to amateurs at this time. Before describing the device in detail it may be well to state that it has been used by the writer for many years during its development, both at his own amateur station and at others'.

No attempt will be made in this paper to outline the complete development of the device but some of the fundamental features will be given of the practical apparatus already produced. Essentially the Resonant Converter was developed as a simple means of converting direct current into alternating current of any desired frequency. In practice this alternating current may be applied in the transformer of a spark set or to the plates of vacuum tubes.

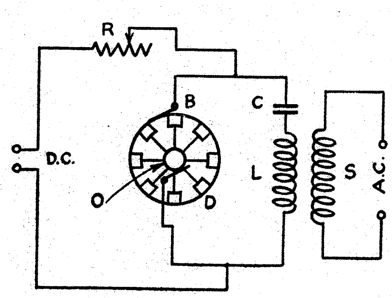

FIG. I

The component parts of the fundamental circuit are illustrated in Fig. 1. Here D represents a revolving disc or controller containing alternate conducting and insulating segments which for the purpose of illustration may be assumed of equal length. A brush B and a collector ring O lead the current through the disc. The disc controls the admission of energy from the D. C. source to the resonant circuit LC. The speed of the disc is adjusted so that the number of makes or breaks per second is equal to the natural frequency of LC. (a complete cycle being produced by a complete make or break.) In order to control the energy admitted to the device and also prevent short circuiting the line, a control resistance R is inserted in the supply lead. Inasmuch as R is non-inductive it does not alter the tuning conditions of the resonant circuit.

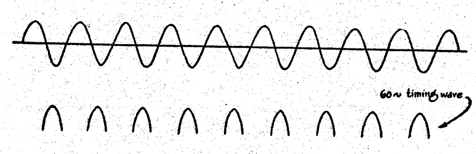

FIG. 2—RESONANT CONVERTER—OUTPUT CURRENT WAVE SHAPE OUTPUT AT RESONANT SPEED.

The wave shape of the current produced by the machine when operating at resonance is shown in the oscillogram, Fig 2. This oscillogram was taken with the machine adjusted to give 60 cycles and it will be noted that the wave shape is remarkably sinusoidal. With resonant adjustment any sparking at the controller practically disappears. This adjustment, moreover, is not critical but the driving motor speed can be varied over quite a range before sparking becomes objectionable. While not attempting to dwell too much on theory in this paper, the action of the Resonant Converter may be roughly described as follows: During the period of break, the resonant circuit is charged from the supply line and then during the closing of this contact the energy in LC is discharged at the same time period. The current upon discharge acts oppositely to the line current so that the break is accomplished at a point of minimum current flow

—hence no sparking. Due to the opposite direction of charge and discharge, and the regular repetition of this action, an alternating potential of pure wave shape is produced at the terminals of the transformer.

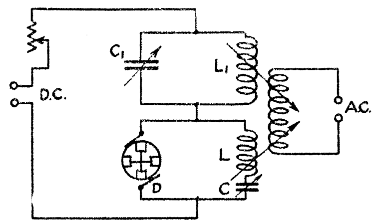

FIG. 3

If instead of supplying the resonant converter with direct current, an alternating current is employed, it is possible to multiply the frequency of the source. For instance, from 60 cycles a 500 cycle tone may be obtained. This effect will be treated more fully later in the paper.

Now instead of using the resistance, R of Fig. 1, to control the power supplied, an effective resistance may be composed of the parallel inductance and capacity L_1C_1 as in Fig. 3. When this circuit is tuned in a similar manner to LC it has the current limiting effect of a resistance,

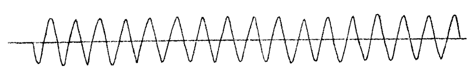

Fig 4 - Resonant Converter - Output Current Above Resonant Speed Range

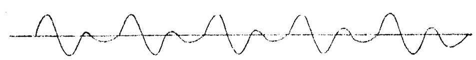

Fig 5 - Resonant Converter - Output Current Below Resonant Speed Range

without seriously altering the other operating qualities of the machine. As a further refinement it was found that there was a circulating current in the parallel circuit, L_1C_1. Therefore this circuit could be coupled to LC, thereby amplifying the output by a sort of regenerative action. In some experiments it was found that this amplification increased the output about 20%.

It may be interesting at this point to note that when the machine is operated above or below synchronous or resonant speed, we no longer have a sine wave output but the distorted waves of Fig. 4 and 5 respectively. When the Resonant Converter is operated from an A.C. source the resulting spark note is not exactly a pure tone but carries a 60 cycle undertone, which however gives a resultant tone readily distinguishable through static. By adjustment of the various circuits, however, the quality of the musical tone can be varied at will, and with certain refinements the lower frequency can be eliminated.

The Resonant Converter as a spark transmitter is shown in Fig. 6. Here the primary of the transformer is formed by the inductance L inserted in the resonant circuit. The condenser C is made variable in steps, which for low power transmitters may be several 2 mfd. telephone condensers (tested for 1000 volts.) The resonant control circuit L_1C_1 may be formed of a similar set of condensers, and L_1 made either a part of the primary winding or a separate inductance. A small resistance R is inserted in the supply lead to vary the power.

While the transmitter will operate very satisfactorily with a quenched gap, it is

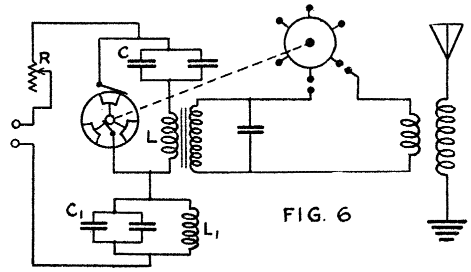

FIG. 6

ideally suited for the use of a synchronous gap. The synchronous gap is mounted directly on the driving motor shaft and since the position of maximum voltage is readily found the gap functions very smoothly. Inasmuch as the resonant converter gives one alternation at make and another at break, the gap should contain a number of studs equal to twice the number of conducting segments on the controller disc.

A photograph of a model transmitter

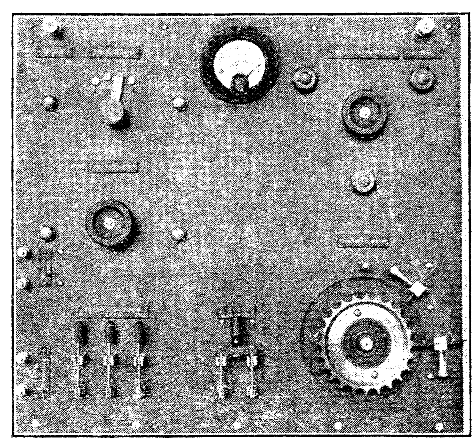

Fig. 7

built along these lines is shown in Fig. 7. The set is designed for 200 watts and is of the panel type. A pure musical spark tone can be obtained at any desired frequency from 300 to 500 cycles. The set operates from 110 volt D.C. and is simple and easy to operate, requiring but few adjustments.

Among the various applications of the Resonant Converter principle, perhaps the most interesting one at this time is that of a plate voltage generator for V.T. sets. Its inexpensive contruction and steady operation makes it particularly desirable for amateur low power work where a 500 cycle alternator or high voltage D.C. generator is not readily obtainable. Since the Resonant Converter gives a pure tone readily adjustable from 200 to 500 cycles it may be directly employed for modulated C.W. telegraphy or used with a suitable filter for telephony.

In Fig. 8 the use of the Resonant Converter is illustrated, together with a double self-rectifying circuit. The converter produces directly at its terminals 1000 volts at a frequency adjustable from 200 and 500 cycles. Taps may be provided on the transformer secondary to obtain other voltages for tube operation. In case only one tube is used the entire output of the transformer may be directly applied to its plate.

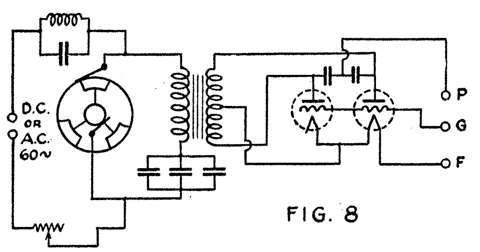

FIG. 8

Using the model shown in Fig. 9 a plate voltage of approximately 800 volts and a space current of 120 mils has been obtained from a 100 volt D.C. supply. This has been found sufficient to operate several 5 watt tubes in parallel. By using an A.C. supply and an A.C. driving motor (preferably synchronous) a clear tone closely resembling the old "Cape Cod" note can be produced. This tone has excellent carrying properties made famous by old "WCC" in the days of long distance spark press. When using the Resonant Converter on A.C. cycle supply, the tube filamaents may be lighted from the supply line by

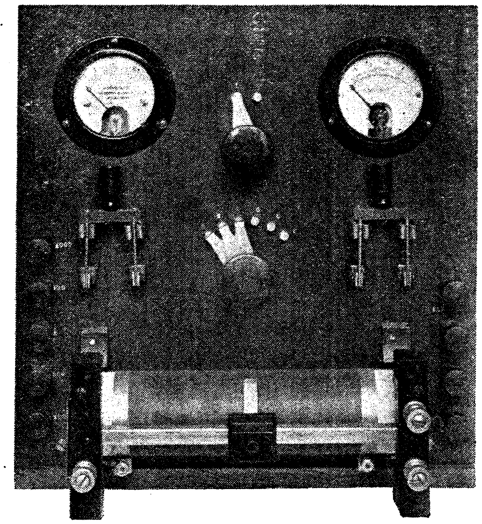

Fig. 9

a small transformer. There are of course many other arrangements of the Resonant Converter circuits of which space does not permit the description.

In conclusion, it is believed that the development of the Armstrong superheterodyne receiver will work hand in hand with a device such as the Resonant Converter for vacuum tube transmitters. This receiver of high amplification reproduces the exact tone of the distant transmitter and the great value of a distinctive tone is not lost by heterodyning. In traffic work over congested areas, which is the case with amateur or short range ship operation, constant and easily distinguishable tones are a great advantage. It is here that the adjustable frequency and waveshape of the Resonant Converter may be found of greatest value.