May 8, 1928. 1,669,103

W. SCHAFFER

COUPLING ARRANGEMENT

Filed Dec. 28, 1926 2 Sheets-Sheet 1

Fig. 1

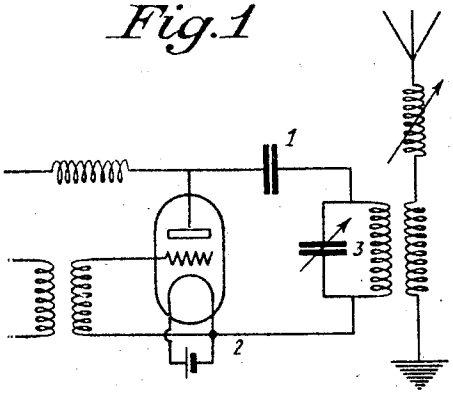


Fig. 2

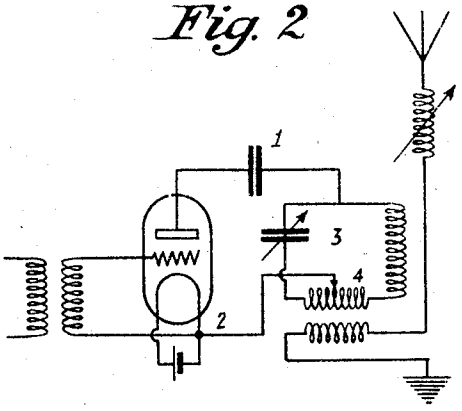


Fig. 3

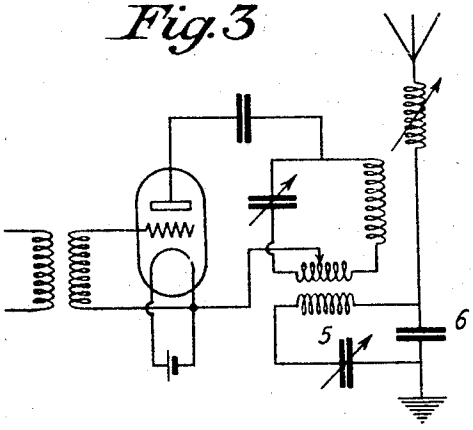


Fig. 4

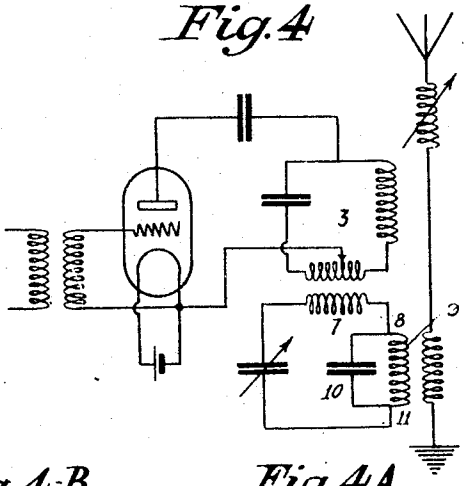


Fig. 4-B

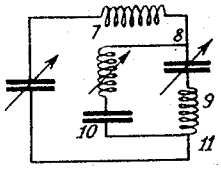
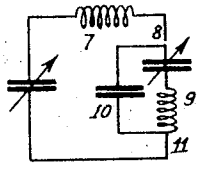


Fig. 4A



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Fig. 5

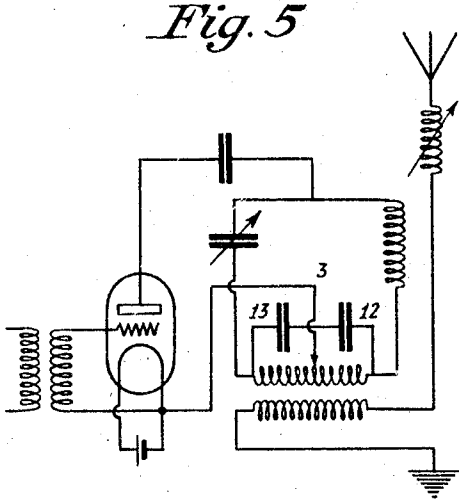


Fig. 6

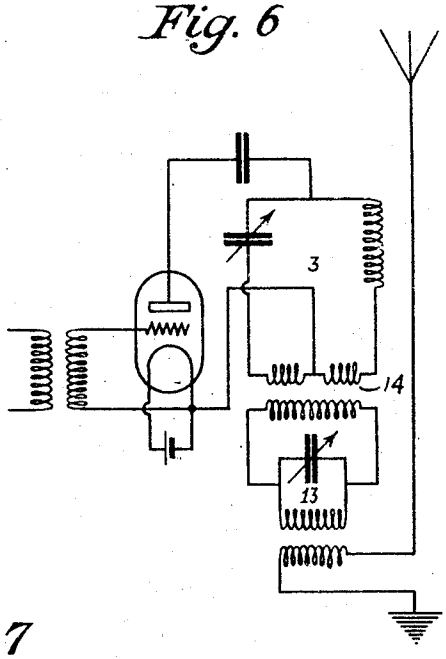
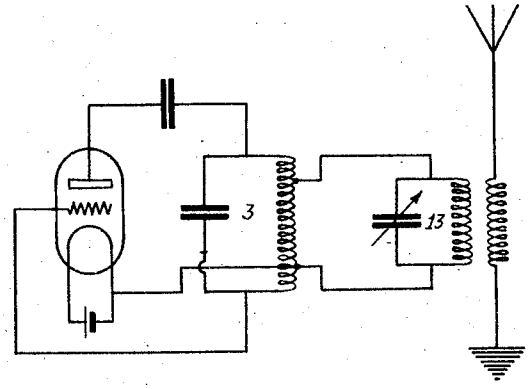


Fig. 7



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UNITED STATES PATENT OFFICE.

WALTER SCHAFFER, OF BERLIN, GERMANY, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE.

COUPLING ARRANGEMENT.

Application filed December 28, 1926, Serial No. 157,453, and in Germany September 26, 1925.

This invention relates to coupling arrangements, and more particularly to the coupling of a vacuum tube transmitter to an antenna.

An object of my invention is to so couple an oscillator to an antenna that a minimum of harmonics will be transferred to the antenna.

This I prefer to do by a symmetrical coupling which interposes equal resistance in each branch of the oscillation circuit, which incidentally tends to decrease detuning, and accordingly a more specific object of my invention is to provide such a coupling for non-transfer of harmonics which is symmetrically arranged.

The specification is accompanied by drawings, in which,

Figure 1 represents the prior art;

Figure 2 is a suggested improvement thereover;

Figure 3 is a further improvement using an intermediate circuit;

Figure 4 utilizes an intermediate circuit having divided paths;

Figure 4^A shows tuning of one of the paths;

Figure 4^B employs tuning in both paths;

Figure 5 is an improvement upon Figure 2 by the addition of a capacity by-pass;

Figure 6 is a modification of Figure 4 wherein the divided paths themselves form a resonant circuit; and

Figure 7 is a variation in which the coupling of the intermediate circuit is direct.

With the end in view of reducing harmonics in antenna circuits, circuit arrangements comprising intermediate circuits are used in connection with tube-type transmitters as shown in Fig. 1. The plate current flowing from the filament and plate of the tube by way of the leads 1 and 2 into the so-called intermediate circuit S is not sinusoidal, on the contrary, it contains harmonics. These pass predominantly by way of the capacitive branch because its impedance for the harmonics is considerably lower than that of the inductive branch. However, it is by means of the latter that coupling to the antenna is produced. For this reason the harmonics reaching the antenna are comparatively limited; in addition, of course, the intermediate circuit 3 inherently causes a resonant rise or gradual amplification of the fundamental wave, with the result that the intensity of the harmonics is small compared with the fundamental.

However, the arrangement is faulty because detuning of the intermediate circuit 3 occurs upon coupling the antenna inasmuch as the resistance transferred from the antenna to the intermediate circuit acts mostly upon the inductive branch. To obviate this draw-back, an arrangement as shown in Fig. 2 is suggested. The feeding of the plate current is by way of lead 2 which is connected to the middle of a separate antenna coupling coil 4, with the result that the resistance transferred from the antenna to the intermediate circuit 3 is distributed over both the capacitive and the inductive branches of the intermediate circuit. No detuning of the intermediate circuit upon coupling the antenna takes place. As regards avoiding the arising of harmonics in the antenna, however, this circuit arrangement is less favorable. The antenna, as will be noted, is now coupled with the capacitive branch through which the major part of the harmonics in the intermediate circuit are flowing. Even the use of a special "counter-coupling" for the harmonics has brought no basic and thorough cure of the undesirable condition because such a coupling can be effective and accurate for only one harmonic.

Now, an attempt may be made to preclude the harmonics from the antenna by means of an additional intermediate circuit 5 as shown in Figure 3. With this circuit 5, the antenna is coupled capacitively by means of the comparatively large condenser 6. Although the potential difference of the harmonics across the terminals of this condenser is relatively low, it nevertheless still exists; and it is impossible to diminish it at will because the size of the condenser 6 is conditioned by the requisite degree of coupling for the fundamental wave.

Whenever an oscillation circuit contains harmonics in addition to the fundamental wave, a circuit path may be created comprising a capacitive and an inductive branch. By suitable dimensions of the reactance there is caused to flow in one of said branches primarily the wave to be coupled, and in the

other branch, the undesirable waves. Coupling with the next following circuit is effected at that branch through which the current of the desired wave is passing. Figure 4 shows a convenient circuit arrangement of this kind. The distinct intermediate circuit 7 is split at 8 so that paths are created by way of inductive branch 9 and capacitive branch 10, the two branches being united at 11. The structure between 8 and 11, for the tuning wave of circuit 7, combinedly represents either a capacitive or an inductive resistance under the condition and presupposition that it is not in itself tuned to the fundamental wave or a harmonic. Coupled with the inductive branch 9 is the third circuit, for instance, the antenna, and it is possible in this manner that, by virtue of the ratios between the impedances of the two branches 9 and 10, for the current of the fundamental wave to flow predominantly by way of 9, and the currents contained in the harmonics by way of 10 primarily. It will be noted, by the way, that different modifications are conceivable, for instance, by that the inductive branch 9 is made of the series circuit type by the addition of a condenser, shown in Figure 4^A, and tuning the said structure to the fundamental wave. On the other hand, branch 10 can be made a circuit similar to branch 9 by the addition of self-inductance, shown in Figure 4^B, and by tuning the same to a definite harmonic which it is particularly desirable to shut off from the antenna. Another final scheme would be to provide the arrangement with rejector or stopper means.

The arrangement illustrated in Figure 4 has the disadvantage that, besides the usual intermediate circuit 3 and antenna, the supplementary intermediate circuit 7 must be tuned. A simpler plan of precluding harmonics from the antenna is attainable in a circuit arrangement as shown in Fig. 5 without having recourse to a special intermediate circuit by that, in parallel relation to the two coupler coils of the usual intermediate circuit 3, condensers 12 and 13, respectively, are provided. Fundamentally speaking, this results in conditions as described in connection with Figure 4 as regards the intermediate circuit 7 and the paths 9 and 10 there used. All of the combinations there suggested as regards the separate tuning of the two branches, of course, are applicable to the arrangement in Figure 5.

Two special kinds of coupling in which fundamentally two means are operative to the end of suppressing harmonics are shown in figures 6 and 7. In Figure 6, an intermediate circuit 13 is coupled by the agency of coil 14 with the intermediate circuit 3. The feeding of circuit 13 is effected in such a manner that the harmonics still coupled on by way of coil 14, upon entering circuit 13, find two paths, i. e., the capacitive and the inductive branch, it being evident that they will in major part flow by way of the capacitive branch, while to the inductive path, which is more or less free from harmonics, the antenna is coupled. Circuit 13, which is tuned to the fundamental or useful wave, is subject to resonant rise or gradual building up of intensity, so that for this reason the amplitude of the current of the useful wave is proportionately large. The same result is attained in the arrangement Figure 7; but in this case, the intermediate circuit 13 is coupled by galvanic means with the circuit 3. In this case, the resultant conditions are the same as in Figure 6, the sole distinction residing in that the coil 12 is omitted, while in its stead galvanic coupling means are provided.

What I claim is:

1. In combination, an oscillation generator having an output circuit comprising capacitive and inductive branches arranged in parallel and a coupling impedance portions of which are connected in each of said branches, an intermediate tuned oscillating circuit coupled to said coupling impedance, and a utilization circuit coupled to said intermediate circuit.

2. In combination, a tuned output circuit comprising capacitive and inductive branches arranged in parallel and a coupling impedance portions of which are connected in each of said branches, a utilization circuit, an intermediate circuit coupled to the coupling impedance and to the utilization circuit, and a by-pass for harmonics connected in parallel with one of the coupling coils of said intermediate circuit.

3. In combination, a tuned output circuit comprising inductive and capacitive branches and a coupling coil located symmetrically with respect to said branches, an intermediate circuit coupled to said coupling coil and having a plurality of parallel paths of relatively different admittances to harmonics, and a utilization circuit coupled to the path of least admittance to harmonics.

4. In combination, an output circuit comprising inductive and capacitive branches and a coupling coil located symmetrically with respect to said branches, an intermediate circuit containing a resonant circuit and a coupling coil coupled to the symmetrically located coupling coil, and a utilization circuit coupled to the resonant circuit.

5. In combination, a tuned output circuit comprising inductive and capacitive branches and a coupling impedance located symmetrically with respect to said branches, an intermediate circuit coupled to said coupling coil and having a plurality of parallel paths each including inductance and capacitance tuned respectively to the fundamental and to a harmonic frequency, and a utilization cir-

cuit coupled to the path which is resonant to the fundamental frequency.

6. In combination, a tuned output circuit comprising inductive and capacitive branches and a coupling impedance arranged symmetrically with respect to said branches so that equal load resistances are transferred thereto, a utilization circuit, means coupling said output and utilization circuits, and paths arranged in parallel with said coupling means to cause only currents of desired frequency to flow through said utilization circuit.

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