June 9, 1931. W. KUMMERER 1,809,630

VALVE TRANSMITTER ARRANGEMENT

Filed Dec. 15, 1928

Fig. 1

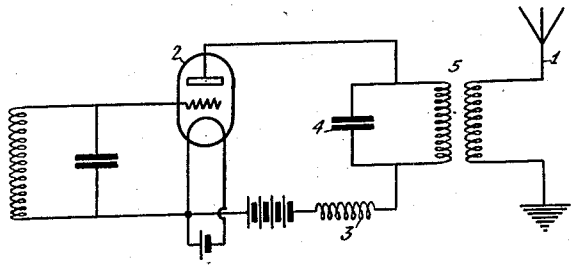


Fig. 2

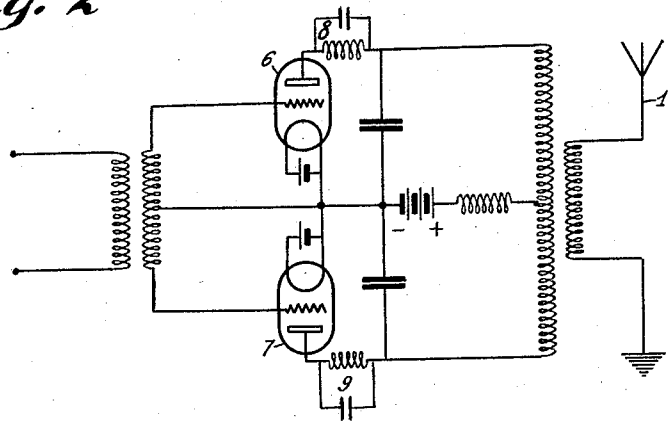


Fig. 4

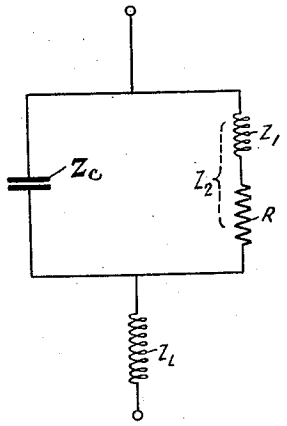
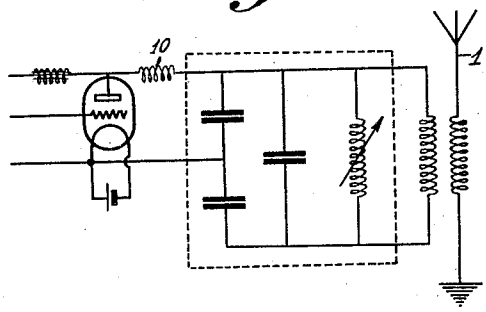


Fig. 3



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Patented June 9, 1931

1,809,630

UNITED STATES PATENT OFFICE

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VALVE TRANSMITTER ARRANGEMENT

Application filed December 15, 1928, Serial No. 326,277, and in Germany December 29, 1927.

In radio transmission work, it is known that detuning of a circuit in parallel resonance by unilaterally transferred reactive or non-reactive resistance takes place when any changes occur in the active resistance transferred from the load circuit.

It is the object of this invention to prevent this undesired occurrence regardless of the changes in the load circuit.

This and other objects of the invention will appear in the following specification when read in connection with the drawings in which:

Figure 1 shows diagrammatically one preferred embodiment of the invention applied to a tube transmitter arrangement;

Figure 2 diagrammatically illustrates the invention applied to a push-pull arrangement;

Figure 3 shows a modification of the invention as applied to different circuits; and,

Figure 4 illustrates diagrammatically an oscillation circuit for purposes of deriving certain formulæ in the annexed specification.

Referring to Figure 1, 2 represents the tube working upon a parallel circuit comprising a coil 5 and a condenser 4. In such a case should the coupling between the antenna 1 and the working circuit be altered, an alteration of the resistance thus transferred to the working circuit will occur. To insure optimum operation of a thermionic tube, it is necessary to cause the same to work upon an ohmic resistance. Hence, in order that these conditions may be fulfilled, the working circuit associated with the tube must be tuned to parallel or current resonance instead of to voltage or series resonance. These two forms of tuning differ from each other in that voltage or series resonance is not disturbed by a series resistance in the circuit, but by a resistance being connected in parallel either to the condenser or to the coil, while inversely, that is, in the case of parallel or current resonance, a resistance disposed in parallel relationship to the oscillation circuit will not disturb the resonance condition, whereas an additional resistance connected in one of the branches will lead to a detuned condition. Generally speaking, if in both branches the resistances are different, parallel resonance will be present whenever the wattless or reactive components of the currents in the inductive branch and the capacitive branch are equal and opposite. Now, inasmuch as under practical working condition, as shown in Figure 1, the useful resistance is mostly transferred by transformer action only into one of these two branches, it will be seen that in such case, even in the presence of tuned condition of the consumer circuit to the operating wave (that is, in the absence of transferred reactance), untuning of the transfer of non-reactive resistance, with the result that the oscillation circuit, considered as a whole, would represent a non-ohmic resistance, and this of necessity would be conducive to an impairment of efficiency of the outfit.

Now, in order to preclude this change in the character of the load resistance, a supplementary reactance is provided in series with the oscillation circuit having the same value as the reactance of that branch into which non-reactive resistance is not transferred and which is of opposite sense. In this way, as will be noted, the inductive or capacitive load represented by the oscillation circuit is just compensated. (If the non-reactive resistance is transferred to the inductive branch, then the oscillation circuit constitutes a capacitive load, while when it is transferred to the capacitive branch, the oscillation circuit represents an inductive load.)

In the circuit arrangement shown in Figure 1, this additional reactance consists of a choke-coil 3 whose inductance must be chosen so high that, for the working frequency, it represents an equally high, but opposite, resistance compared with the condenser. Calculation shows that this compensation method of the reactive resistances (reactances) is independent of the value of the non-reactive resistance in one branch of the oscillation circuit. This will become clear if it is kept in mind that by the change in the transferred non-reactive resistance, the current supplied from the generator must undergo an alteration, this change in the current supply taking place in such a way

that the wattless component of the potential set up across the reactance connected in the plate lead is always equal to and opposite the wattless component of the potential which originates from the untuning of the working circuit.

The feature of the invention may be proven mathematically as follows:

In Figure 4, R represents the resistance as applied from the outside, Z_2 is the sum of Z_1+R the remaining references being self-explanatory. In the figure, the total impedance of the circuit

$$=Z_L+\frac{Z_C Z_2}{Z_C+Z_2}$$

$$=\frac{Z_C Z_L+Z_2 Z_L+Z_C Z_2}{Z_C+Z_2}$$

But as described above, Z_L is made equal and opposite to Z_C, hence

$$Z_C+Z_L=0$$

therefore total impedance

$$=\frac{Z_C Z_L+Z_2(Z_L+Z_C)}{Z_C+Z_2}$$

substituting from above total impedance

$$=\frac{Z_C Z_L}{Z_C+Z_2}$$

But

$$Z_C=-\frac{j}{\omega C} \text{ and } Z_L=j\omega L$$

therefore substituting total impedance

$$=\frac{\frac{-j}{\omega C}\times j\omega L}{Z_C+Z_1+R}$$

$$=\frac{\frac{L}{C}}{Z_C+Z_1+R}$$

$$=\frac{L}{CR}$$

Since $Z_C + Z_1 = 0$ (tuned circuit)
Since

$$\frac{L}{CR}$$

is a pure resistance then for any value of R obviously it remains a pure resistance. Another suitable scheme is not to simply use a choke coil as shown in Figure 1 or a condenser to represent the reactance but rather a parallel arrangement of a capacity and a choke coil whose total reactance must then be chosen as described above. The use of such a parallel scheme offers the advantage that the chances of disturbing oscillations of higher frequency being formed are precluded since for these frequencies the condenser constitutes a short circuit. It is of advantage to so choose the proportions of the choke coil and the parallel condenser that the circuit formed by these two elements is tuned to a frequency located between the working frequency and the next harmonic. A circuit illustrating the above described parallel circuit is shown in Figure 2 which also illustrates another embodiment of the basic idea when tubes in push-pull are employed.

Figure 2 illustrates another embodiment of the basic idea by way of example. In said figure in which two tubes 6 and 7 connected in push-pull fashion are provided the reactance circuits 8, 9 comprising a parallel arrangement of inductance coil and condenser are inserted in the two plate leads of the two tubes 6 and 7 since in a circuit such as shown in Figure 2 the filament lead is not passed or bridged by the fundamental waves as is the case in Figure 1 where, of course, it is immaterial whether the choke coil is disposed at the plate or at the filament end.

The circuit schemes here illustrated and described represent the simplest instances in which the invention will be found useful. In the majority of cases, a complex system comprising several coils and condensers is associated with the electrodes of a transmitter tube. In this case, the compensation scheme here disclosed must, in an analogous way, be generalized, for instance, in an arrangement as shown in Figure 3 and as used, for example, for short-wave tube transmitters. Here the reactance which is connected in the plate circuit, in absolute value must be equal to the reactance of the equivalent inductance and equivalent capacity constituted by the coils and condensers as a whole and which are connected with the branch into which the non-reactive resistance is being transferred.

Hence, according to Figure 3 the value of the inductance 10 would be equal to the capacitive value of the reactance due to the elements boxed by the dash lines. In complicated cases, as will be noted, the arrangement must be reduced to terms of the simplest or fundamental case, and then the resultant capacity or the resultant inductance must be considered.

Having thus described by invention what I desire to protect by Letters Patent is as follows:

1. In a transmitting device, an oscillation circuit comprising an inductive branch and a capacitve branch n parallel, an antenna circuit coupled to one of said branches and a reactance in series with said oscillation circuit having a value equal and opposite to the reactance of the other branch.

2. In a device of the kind described, a parallel resonance circuit, a load circuit coupled thereto and means comprising a reactance circuit in series with said first named circuit for preserving the tuned state of said parallel resonance circuit regardless of the value of

any active resistance transferred from said load circuit to said parallel resonance circuit.

3. In an oscillation circuit comprising a space discharge device having an input and an output circuit, said output circuit comprising an inductive branch and a capacitive branch forming a parallel resonance circuit tuned to any desired frequency, a load circuit coupled to one of said branches, means for preserving the tuned state of said parallel resonance circuit comprising a circuit in series therewith in said output circuit having reactance elements therein the algebraic sum thereof being equal and opposite to the reactance of the other branch of said parallel resonance circuit.

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