Nov. 6, 1928. 1,690,228

R. A. HEISING

HIGH FREQUENCY TRANSFORMER

Original Filed Dec. 31, 1923

Fig. 1.

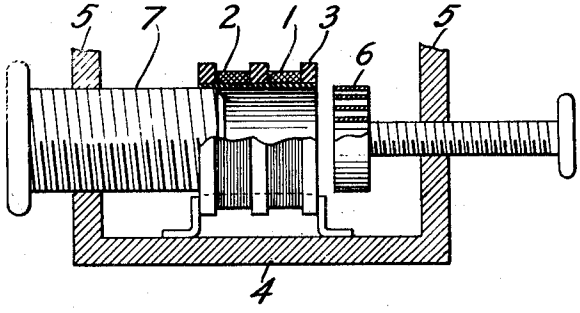
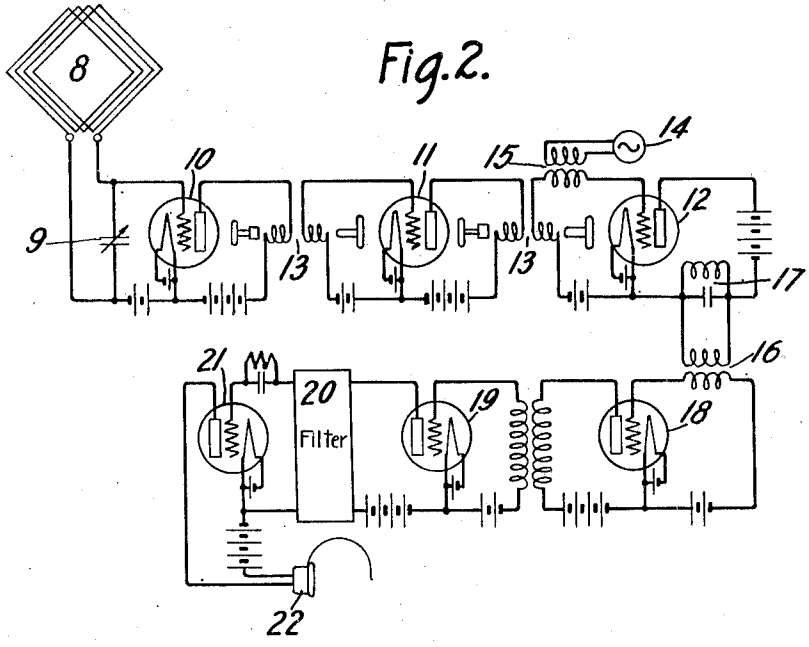


Fig. 2.



Inventor:
Raymond A. Heising

by Edwards Atty

Patented Nov. 6, 1928. 1,690,228

UNITED STATES PATENT OFFICE.

RAYMOND A. HEISING, OF MILLBURN, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

HIGH-FREQUENCY TRANSFORMER.

Original application filed December 31, 1923, Serial No. 683,629. Divided and this application filed August 20, 1925. Serial No. 51,305.

This invention relates to radio signaling systems and more particularly to a transformer for coupling high frequency circuits.

This application is a division of an application of R. A. Heising, Serial No. 683,629, filed December 31, 1923.

In radio receiving circuits employing high frequency amplification it is desirable to intercouple the amplifying devices by means of circuits tuned to the incoming signal waves. Thus the coupled circuit between the amplifiers and between the high frequency amplifiers and the detector should be selective of the frequency of the signal waves received by the antenna. The input and output circuits of the amplifiers being both tuned to the same frequency, considerable difficulty has been encountered due to the production of undesired oscillations or "singing" in the amplifier circuits. This "singing" is largely due to a coupling effect between the input and output circuits of the amplifier.

The usual method for preventing "singing" in amplifier circuits is to include a resistance at some point in the coupled circuits or else to construct the primary winding of the transformers of resistance wire. In accordance with this invention a transformer, provided with adjustable means for controlling the electrical characteristics of its primary and secondary circuits, is used to intercouple the high frequency amplifiers and to couple the amplifiers to a detector.

It is an object of this invention to provide for intercoupling high frequency circuits in such manner that singing is prevented.

A feature of the invention is an adjustable high frequency transformer.

The above object and others, which will be apparent as the nature of the invention is disclosed, are accomplished by employing an air core transformer having primary and secondary windings. Effective resistance is introduced by the hysteresis effect of a magnetic ribbon adjustably associated with the primary winding. The effective inductance of the secondary winding is varied by means of a conductive core adjustably associated therewith.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the claims appended hereto, the invention itself, its objects and advantages, the manner of its organization and the mode of its operation will be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which Fig. 1 shows an adjustable high frequency transformer constructed in accordance with this invention, and Fig. 2 shows a circuit arrangement in which this transformer may be used.

The coupling transformer shown in detail in Fig. 1 comprises an air core transformer having primary and secondary windings 1 and 2, respectively wound on an insulating core 3 secured to a supporting frame 4. The supporting frame is shown as of insulating material and may be of any material and of any form. Arms 5 of frame 4 are adapted to support elements 6 and 7 axially of the core 3. Windings 1 and 2, when used with discharge devices as herein described, are each wound to cooperate with the internal capacity of the associated discharge device to constitute a tuned circuit. When used with other forms of high impedance amplifiers and detectors, such windings should be designed to have the necessary inductance and distributed capacity to determine its tuning. The element 6 consists of the spirally wound laminated strip or ribbon with its convolutions spaced apart. This element is carried by a threaded shank engaging a screw threaded opening in one of the arms 5 and is associated with the primary winding 1.

A conductive element 7, which may be a copper or brass rod, is provided with a screw thread to engage a screw threaded opening in the other arm 5. The area of the rod 7 should be as large as possible and preferably its diameter should be only slightly less than the internal diameter of the secondary winding 2. The transformer should preferably be mounted so that the only coupling between the windings 1 and 2 is that due to their mutual inductance. In other words, the supporting means for the windings should introduce substantially no coupling effect between the primary and secondary circuits of the transformer.

High frequency current flowing through

the primary winding 1 will produce a magnetic field in the space surrounding it. With the element 6 lying in this magnetic field losses will be introduced into the primary circuit due to eddy currents traversing the ribbon winding and the hysteresis of the iron. These losses appear as an effective resistance load in the primary circuit. Because of the high frequencies involved the iron does not function to decrease the reluctance of the magnetic circuit. Hence the reactance of the primary circuit and the mutual inductance between the transformer windings remain substantially constant.

By varying the position of the element 6 relatively to the winding 1 the value of the losses in the ribbon winding, and hence the amount of the resistance load introduced in the primary circuit, may be regulated.

In a similar manner high frequency current flowing through the secondary winding 2 will generate a magnetic field. The rod 7, being of conductive material, functions as a short-circuited winding in which eddy currents will be produced when this element lies within the magnetic field of winding 2. Because of the transformer action between the winding 2 and element 7 the magnetic field due to the flow of eddy currents in the element 7 will be opposed to the magnetic field resulting from current flow in the winding 2, and consequently the effective inductance of the winding 2 will be decreased by adjusting the element 7 relatively to the winding 2. The coupling therebetween can be varied to control the amplitude of the eddy currents and hence the value of the inductance introduced into the secondary circuit. In this manner the tuning of the circuit including the winding 2 may be accurately adjusted.

Fig. 2 shows a circuit arrangement particularly adapted for point-to-point radio communication in which the above described transformer may be advantageously employed as a coupling means. This particular system is given by way of illustration only and not as a limitation upon the uses to which the transformer may be applied. Obviously, the transformer is of general application in circuits involving the use of a high frequency coupling means.

The radio receiver shown in Fig. 2 is adapted to operate on the basis of the well-known successive detection system in which the incoming signal waves are combined with other oscillations to produce an auxiliary intermediate frequency signal modulated wave which is then detected to yield the signal current. The receiver includes a rotatable loop antenna 8 adapted to be sharply tuned to the incoming signal wave by an adjustable condenser 9. The received high frequency waves are amplified by the amplifiers 10 and 11 and impressed upon the input circuit of the detector 12. The devices 10, 11 and 12 are intercoupled by transformers 13, the construction of which was described in connection with Fig. 1.

Heterodyne oscillations are impressed upon the input circuit of detector 12 from source 14 coupled to the input circuit of the detector by transformer 15. The output circuit of the detector 12 includes a coupling inductance 16 shunted by an anti-resonant circuit 17 which is of high impedance for the auxiliary intermediate frequency, but provides a low impedance path for other frequencies.

The resultant intermediate frequency wave is amplified by the amplifiers 18 and 19, transmitted through the selective means 20, and detected by the device 21. The selective means 20 may be either a tuned circuit resonant to the intermediate frequency or a filter adapted to freely pass a frequency band including the intermediate frequency wave while suppressing frequencies outside this band. The low frequency currents resulting from the second stage of detection are supplied to the indicating device 22 which may be of any well-known design but is herein shown as a telephone receiver.

A system embodying certain apparatus and certain specific details has been described for the purpose of completely and clearly disclosing the principles of the invention. However, it is to be understood that this invention is not limited to the arrangement or specific features disclosed but only by the scope of the attached claims.

What is claimed is:

1. A coupling means for high frequency apparatus which comprises inductively associated coils, a resistance control element and an inductance control element respectively included in the magnetic fields of said coils.

2. A coupling means for high frequency apparatus which comprises inductively associated coils, an adjustable resistance control element and an adjustable inductance control element respectively included in the magnetic fields of said coils.

3. A transformer for coupling high frequency apparatus which includes a resistance control element in the magnetic field of one of said windings and an inductance control element in the magnetic field of the other of said windings.

4. A transformer for coupling high frequency apparatus which includes an adjustable resistance control element in the magnetic field of one of said windings and an adjustable inductance control element in the magnetic field of the other of said windings.

5. A coupling means for high frequency apparatus comprising inductively coupled coils and a variable resistance control element included in the magnetic field of one of said coils.

6. A coupling means for high frequency amplifiers comprising inductively coupled

coils and a control element comprising a spirally wound ribbon of high resistance material included in the magnetic field of one of said coils.

7. A coupling means for high frequency amplifiers comprising inductively coupled coils and a spirally wound iron ribbon included in the magnetic field of one of said coils.

8. A coupling means for high frequency amplifiers comprising inductively coupled coils and a control element comprising a spirally wound ribbon of high resistance material included in the magnetic field of one of said coils, and means for adjusting said control element relatively to said coil.

9. A tuned coupling means for high frequency apparatus comprising inductively coupled coils, and a conductive element included in the magnetic field of only one of said coils.

10. A transformer including inductively coupled coils and an adjustable conductive element included in the magnetic field of the secondary, and to a negligible extent in that of the primary.

11. A transformer including inductively coupled coils one of which is included in a circuit tuned to a wave of definite frequency, and means for varying the tuning of said circuit comprising an adjustable conductive element in the magnetic field of the coil included in said circuit, and to a negligible extent in the field of the other coil.

In witness whereof, I hereunto subscribe my name this 17th day of August A. D., 1925.

RAYMOND A. HEISING.