June 11, 1929. G. C. DE COUTOULY 1,717,011

REACTANCE DEVICE

Filed Jan. 2, 1926

Fig. 3.

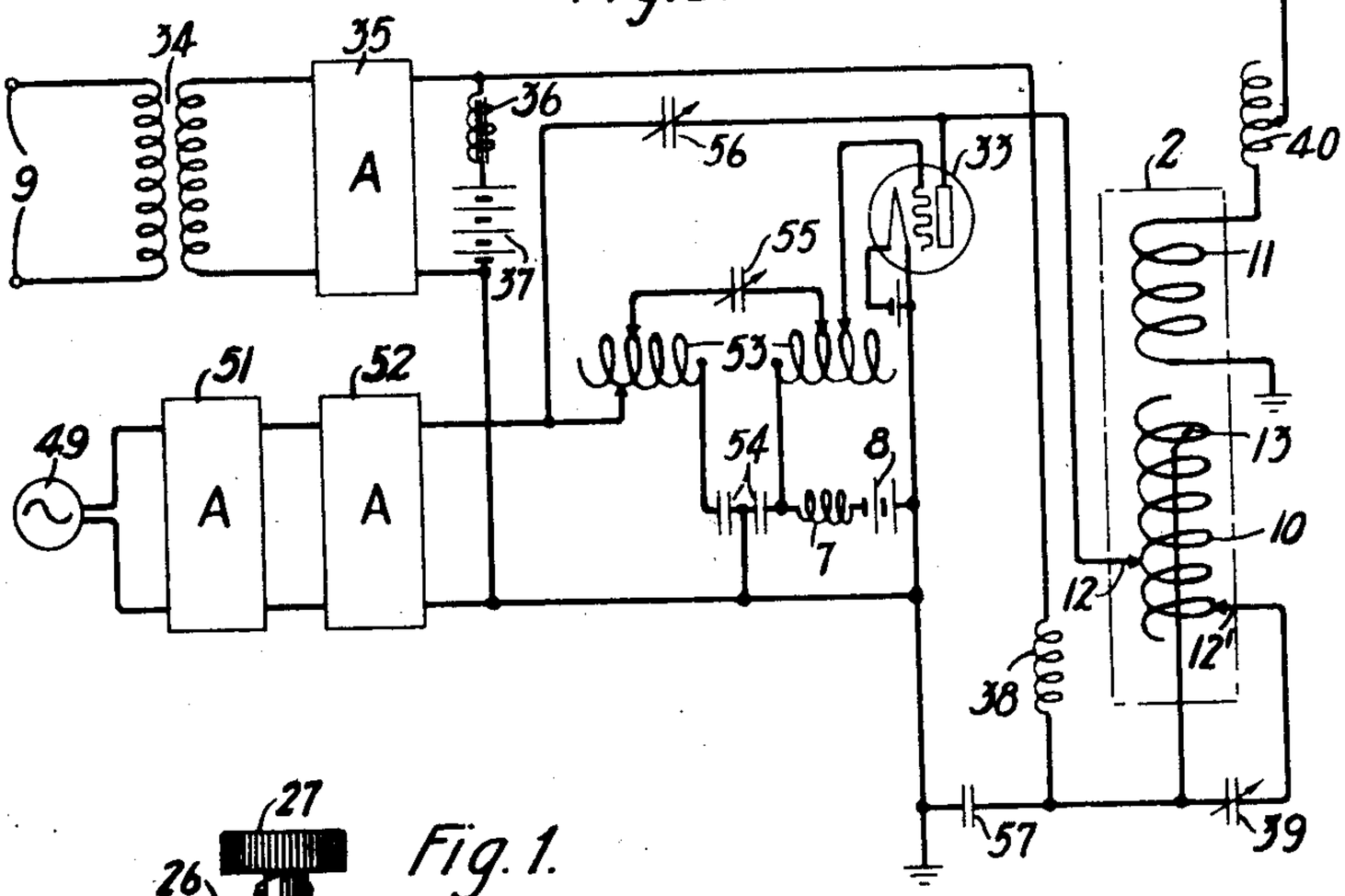


Fig. 1.

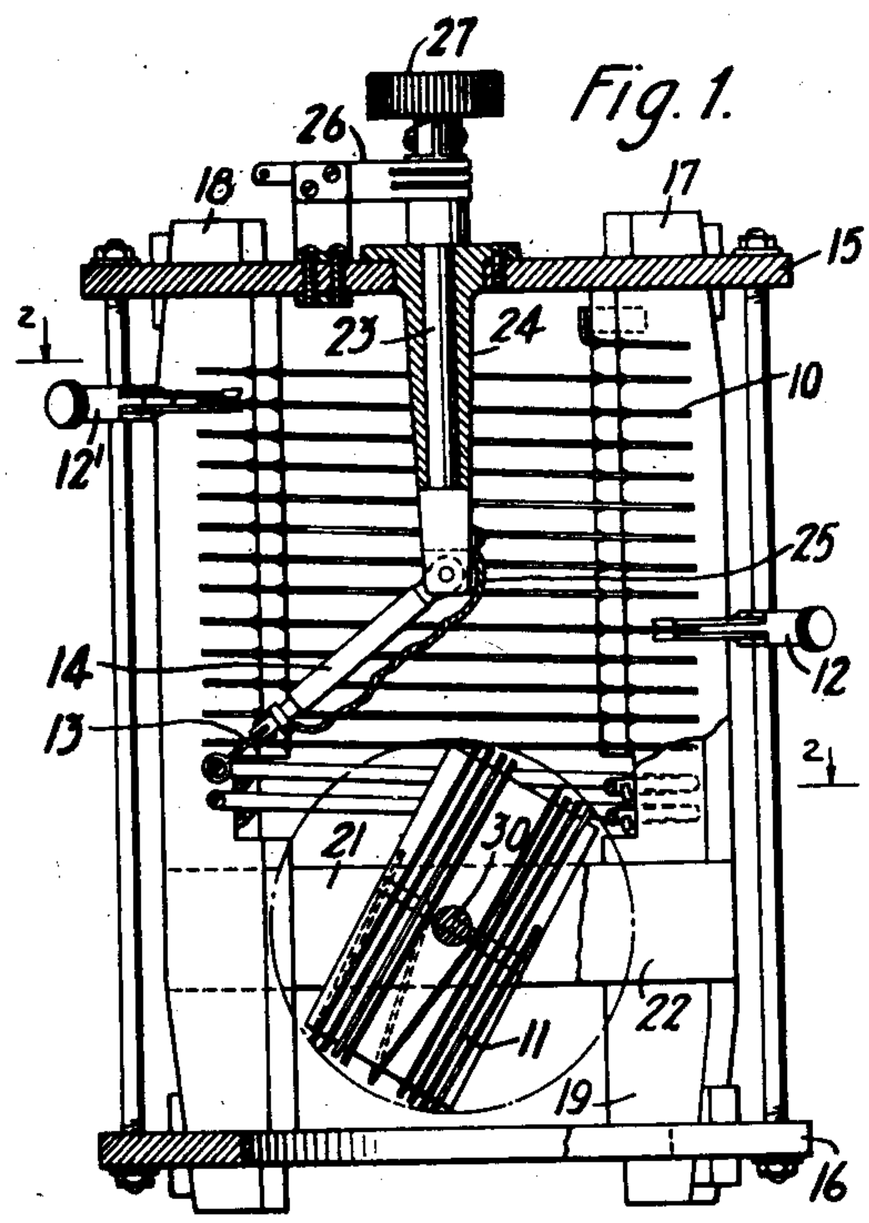
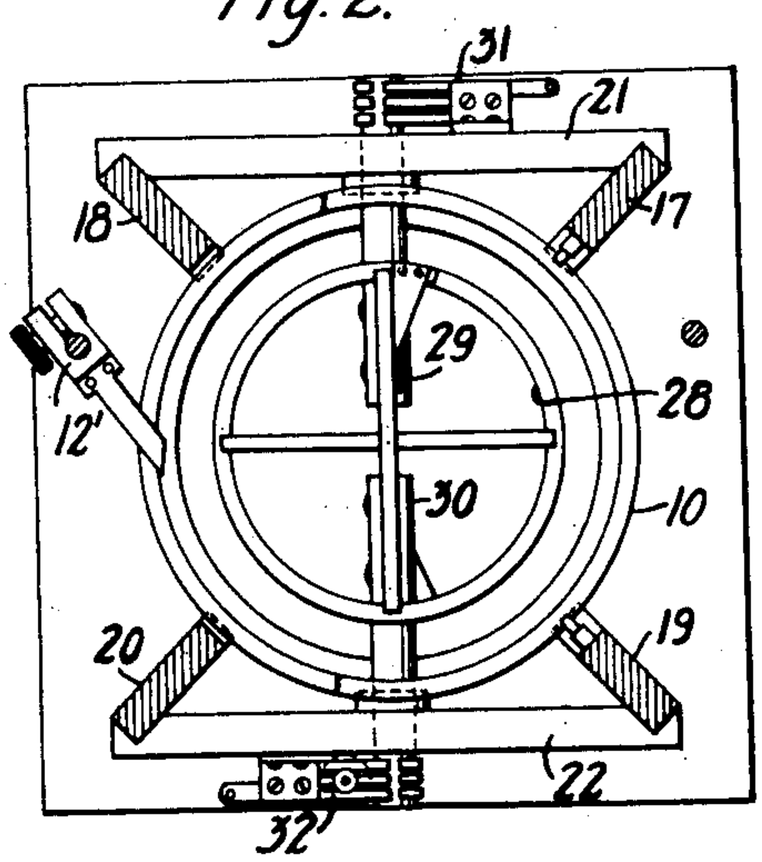


Fig. 2.



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by J. G. Roberts Atty.

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UNITED STATES PATENT OFFICE.

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REACTANCE DEVICE.

Application filed January 2, 1926. Serial No. 78,902.

This invention relates to reactance devices and more particularly to adjustable coupling inductances.

The use of coupling devices of various kinds, in electric circuits, is exceedingly common. In radio signaling systems, especially, it is customary to couple space discharge tube circuits to one another by means of transformers or inductance coils and likewise to couple space discharge tube circuits to antennæ or other resonant circuits by such means. Coupling devices, such as variometers, two winding transformers, or auto transformers, very frequently constitute an element or elements of one or more resonant circuits. When used for the purposes mentioned a difficulty is encountered when it is sought to make adjustment of the coupling elements for tuning or other purposes, because such adjustments cause variation in the coupling between the circuits in which the adjustable elements are included.

One instance may be cited as an example of when it is desirable to be able to adjust the inductance elements used for coupling two resonant circuits without making substantial change in the coupling of the circuits. In a radio transmitting circuit wherein a transformer is used to couple an amplifier to an antenna circuit, and the transformer constitutes an element of the antenna circuit as well as of the tuned circuit of the amplifier, it is desirable to maintain the coupling substantially fixed at a predetermined value. This is required in order that, as the circuits are tuned, the power output will remain constant. A change of output power during tuning is undesirable in any radio transmitter, but, in a transmitter used in making field surveys, such power variations are extremely serious, because they render field strength readings taken during the period of variation of little or no value.

It is an object of this invention to enable variation of the value of an element used for coupling electric circuits without materially affecting the value of the coupling.

A further object is to enable tuning of coupled circuits without substantial change in the coupling of the circuits.

A feature of the invention is a coupling transformer including a winding having means for fine and coarse adjustments and a second winding coupled to the first in such manner that the coupling is substantially unaffected by either fine or coarse adjustments.

The invention itself lies in the construction and arrangement of adjustable reactance elements so that they may be adjusted without varying the coupling therebetween. The reactance elements may be the two windings of a two winding transformer or the coils of a variometer. One of the coils or windings is provided at one end with means for securing coarse adjustments along the winding and at the other end with means for making fine adjustments over a limited number of turns. The second coil which is coupled to the first is positioned adjacent to the end of the first coil at which the fine adjustment is effected. By this arrangement the coupling of the two coils is substantially unaffected by either fine or coarse adjustments made upon the first coil.

In practice the reactance device of the invention may be included in the circuit of a radio transmitter, for example, as a means of coupling a power amplifier to an antenna circuit. The coil with adjustment means may be connected so as to form an element of a resonant circuit whereby tuning of the circuit may be effected. The second coil may be included in the antenna circuit. By virtue of the constant coupling between the two coils the power transmitted to the antenna will be unaffected by the tuning adjustments.

The invention is shown in the drawings, wherein

Fig. 1 is a plan view partly in section of the adjustable inductance element of this invention.

Fig. 2 is an end view partly in section of the coil illustrated in Fig. 1.

Fig. 3 illustrates a radio transmitting circuit which includes a coil like that illustrated in Figs. 1 and 2.

The coil illustrated in Fig. 1 comprises a primary winding 10 and a secondary winding 11. The primary winding includes contact members 12 and 12′ for making coarse adjustments from turn to turn. By means of a wiper 13 carried by an arm 14, fine adjustment may be made over a number of end turns of coil 10 which are adjacent to the coil 11. Coil 11 is rotatable about an axis which intersects the axis of coil 10 at right angles.

An insulating framework comprising end plates 15 and 16 and longitudinal bars 17, 18, 19 and 20, is provided for supporting the coil 10. The coil 11 is supported by bearings pro-

vided in the cross pieces 21 and 22 attached to the longitudinal bars. The coils 10 and 11 are so positioned that by rotation of coil 11 close coupling between the coils may be secured.

The arm 14 is attached to a shaft 23 journaled in a bearing 24 on the end plate 15. The shaft 23 is preferably of conducting material and is connected to the wiper 13 by flexible conductor 25. By means of a brush 26 in contact with the shaft 23 suitable external connections may be made to the wiper 13 and thence to the coil 10. The shaft arm and wiper are rotatable by means of an insulating knob or hand wheel 27.

The coil 11 is mounted upon a cylindrical core 28 attached to the electrically independent conductive shafts 29 and 30 to which the respective terminals of the winding of coil 11 are electrically connected. Brushes 31 and 32 suitable for making external connections to the coil 11 are positioned in electrical contact with the respective shafts 29 and 30 and are mounted upon the respective cross bars 21 and 22.

The end turns of the coil 10 along which the wiper 13 is adapted to move are preferably of circular bare conductor whereas the remaining turns of the coil 10 are preferably constructed of a bare conductor having a rectangular cross section. Coarse adjustments of the inductance of coil 10 are made by the movement of the contact members 12 and 12′ along one portion of the coil. The fine adjustment of the inductance of coil 10 is limited to the adjustment of the position of the wiper 13 along two or three turns of the coil at the end thereof remote from the portion of the coil engaged by the contacts 12 and 12′.

The coefficient of coupling between the closely coupled coils 10 and 11 depends in part upon their spacing. Therefore, if the coil 11 were mounted at the upper end of the coil 10 any major change in the position of the contact member 12′ would produce a substantial change in the spacing of the coil 11 with respect to the effective portion of the coil 10 and consequently would cause a material variation in the coupling between the coils.

However, with the coil 11 associated with the end of the coil 10 remote from that engaged by the contacts 12 and 12′, these contacts may be adjusted without affecting the coupling between the coils. Also, since the fine inductance adjustment is limited to the movement of the wiper 13 along only two or three turns of the coil 10, such an adjustment will not produce a material change in the spacing of the coils. Thus, with the arrangement of this invention, either coarse or fine adjustments of the inductance of the coil 10 may be made without any material effect upon the coupling between the coils 10 and 11.

The arm 14 is positioned at an angle with the axis of coil 10 and the shaft 23 is made of such length that the coil 11 may be rotated and fine adjustment may be made without mutual interference between the coil 11 and the arm 14.

In Fig. 3 the coil illustrated in Figs. 1 and 2 is shown incorporated in a radio transmitter circuit at the position illustrated by the broken line square 2. This radio transmitter comprises a source of carrier waves 49 connected, through the tandem amplifiers 51 and 52 designed to amplify high frequency waves, to the input circuit of space discharge modulator 33.

The output circuit of amplifier 52 is coupled to the input circuit of the modulator tube 33 through a coupling circuit of the type disclosed and claimed in the application of P. H. Betts, Serial No. 755,612, filed December 13, 1924. This coupling circuit comprises a closed loop including in series a condenser 55 and an inductance coil 53, the two halves of which are connected together through the blocking condensers 54. The anode of the modulator tube 33 is connected to the coil 53 through a condenser 56 which is adjusted to balance the interelectrode capacity of the modulator tube 33 to prevent singing.

A source of signal waves is represented by the transformer 34, the primary winding of which is connected to terminals 9 which may be in turn connected to a wire line, a microphone circuit or other circuit including a signaling device. The secondary winding of this transformer is connected to the input terminals of an amplifier 35 designed to amplify signal frequency waves. The output terminals of amplifier 35 are connected to a signaling frequency choke coil 36 in series with a space current battery 37. The choke coil and battery are also included in circuit with the anode and cathode of tube 33 in series with a high frequency choke coil 38 and the portion of coil 10 included between the fine adjustment wiper 13 and the coarse adjustment wiper 12.

The coil 10 has connected to its wipers 13 and 12′ the adjustable capacity 39. The circuit formed by coil 10 and condenser 39 may be tuned either by adjustment of the capacity 39 or by movement of the wipers 13 or 12′ or both. In practice the condenser serves only as a supplementary tuning device. The tuning adjustments provided on the coil 10 enable the condenser 39 to comprise fixed elements of convenient size which may be adjustably connected into the circuit.

The coil 11 has one terminal connected to ground and is included in series with a loading coil 40, a condenser 41, and the antenna 50.

In operation, the source 49 supplies carrier waves through amplifiers 51 and 52 to the input circuit of modulator 33 and the source 34 supplies amplified signal waves to the anode

circuit of modulator 33, whereby the carrier waves are modulated in accordance with signals in the anode circuit in a manner which is now well understood.

The resonant circuit 10—39, which is normally tuned to the mean of the frequencies resulting from modulation, selectively transmits the modulated waves to the antenna 50 by virtue of the coupling between coils 10 and 11. The power supply to the antenna circuit depends upon the degree of coupling between the coils 10 and 11. Hence it is desirable that no change in the coupling of these coils should result when the wipers 12, 12′ or 13 are adjusted for tuning the circuit 10—39. The device illustrated in Figs. 1 and 2 enables a constant coupling between the coils 10 and 11 during adjustments of the tuning in a manner already set forth. If it is desired to vary the power transmitted to the antenna 50, this may be accomplished by adjustment of the wiper 12 which varies the transformation ratio of the transformer constituted by windings 10 and 11.

What is claimed is:

1. In a transformer a fixed winding of bare conductor, a second winding of smaller diameter than said first winding and adapted to rotate at least partly within said first winding for adjusting the coupling therebetween, a rotatable arm, a wiper carried thereby and engaging the end of said fixed winding adjacent to said rotatable winding, said wiper arm being positioned at an angle so as to prevent mutual interference between itself and the rotatable coil.

2. A transformer comprising a fixed high voltage winding, a rotatable high voltage winding, said rotatable winding of substantially smaller diameter than said fixed winding and adapted to rotate at least partly within said fixed winding, means for making a connection to any of a relatively large number of turns of said fixed winding at the end thereof remote from said rotatable winding to provide for coarse adjustments in the inductance of said fixed winding, a wiper adapted to move over a limited number of turns of said fixed winding at the end thereof adjacent said rotatable winding to provide for fine adjustments in the inductance of said fixed winding and an arm carrying said wiper and positioned at an angle to permit the movement of said wiper without mutual interference between said arm and said rotatable winding, said movement being so limited as to negligibly affect the coupling between said windings whereby the coupling between the windings is substantially independent of coarse and fine adjustments of the inductance of said fixed winding.

In witness whereof, I hereunto subscribe my name this 30th day of December, A. D., 1925.

GUSTAVE CHARLES DE COUTOULY.