

June 9, 1936.

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2,043,774

COUPLING ARRANGEMENT FOR AMPLIFIERS AND REPEATERS

Original Filed Sept. 2, 1926

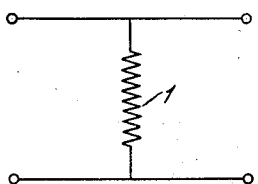


Fig. 1

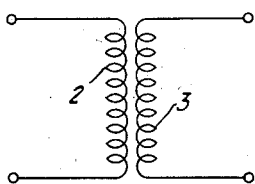


Fig. 2

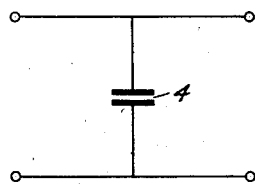


Fig. 3

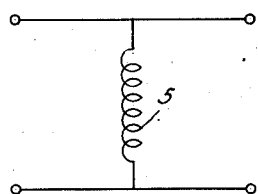


Fig. 4

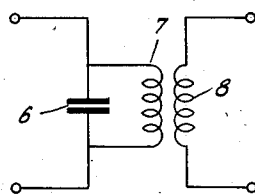


Fig. 5

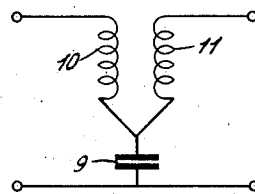


Fig. 6

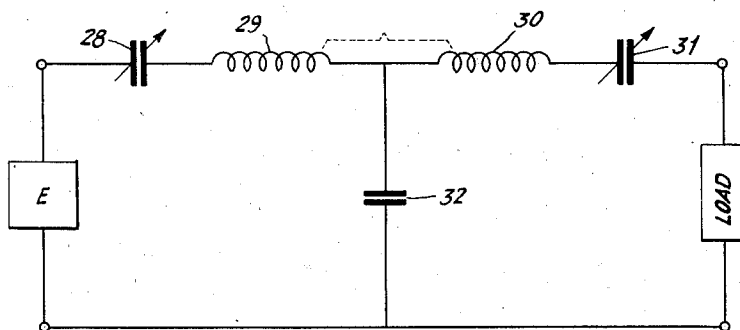


Fig. 7

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2,043,774

COUPLING ARRANGEMENT FOR AMPLIFIERS AND REPEATERS

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Original application September 2, 1926, Serial No.
133,283. Divided and this application September 9, 1932, Serial No. 632,318

9 Claims. (Cl. 178—44)

The invention which is a division of application Serial No. 133,283, filed September 2nd, 1926, relates to couplings through which a large range of frequencies are ordinarily used. It relates more particularly to radio frequency amplifiers, but is not limited to the exact range of frequencies which are ordinarily understood to be included in the radio frequency range. It might be also applicable to audio frequencies or even lower.

It has been known in connection with ordinary coupling arrangements heretofore used which intercouple different elements of energy changing arrangements such as amplifiers, detectors, etc., used with oscillatory currents, that the particular couplings were always susceptible and responsive to one particular frequency which predominated over all of the others. This was due to the inherent characteristics of the coupling elements, particularly the relation between the capacity and the inductance of the circuits.

In a great many cases throughout the radio and electrical art there is a necessity for coupling between two or more circuits. These circuits are said to be coupled when an alternating current flowing in one produces an electromotive force in the other. The number of volts of electromotive force produced in either circuit per ampere in the other circuit is called the mutual impedance between the two circuits. This mutual impedance may be obtained in several different ways.

If the two circuits are coupled by means of a mutual inductance, sometimes called a transformer, the mutual impedance increases directly with the frequency. In many cases it is desirable that the mutual impedance between the circuits be independent of frequency or that it vary with frequency less rapidly than with the ordinary case of the mutual inductances.

The objects of this invention are to obtain means for controlling the variation of mutual impedance. It may be controlled in such a way that it will be made to vary in any desired manner with the frequency. The manner for doing this and other objects, some of which will be found to be obvious from, and are explained more precisely in connection with the annexed drawing and the specification.

In this drawing,

Fig. 1 shows a resistance coupling;
Fig. 2 shows the mutual inductance coupling;
Fig. 3 shows a capacitance coupling;
Fig. 4 shows a self-inductance coupling;
Fig. 5 shows modification of Fig. 3 and
Figs. 6 and 7 show modifications and adaptations of the improved coupling means.

In connection with Fig. 1, element 1 shows a resistance where the mutual impedance is simply equal to the resistance and hence is practically independent of frequency. In other words, the coupling values are constant regardless of the change in frequency.

2 and 3 of Fig. 2 show intercoupled inductance coils. The terminals at the left may be connected to one circuit and the terminals at the right are connected to another circuit in a similar way as Fig. 1 may be connected. In this type of coupling, as explained before, the mutual impedance between these two circuits varies directly with the frequency so that with an increase of frequency an increase of coupling exists. Also difficulties arise from the fact that there are other elements entering into the system, such as distributed capacity which causes the curve defining a mutual inductance throughout a given range of frequencies to deviate from a straight line.

4 in Fig. 3 is a condenser used for coupling between two circuits. This type of coupling works just the opposite from the type shown in Fig. 2; that is, the mutual impedance, due to a condenser common to both circuits, increases directly as the wavelength or varies as the reciprocal of the frequency.

5 in Fig. 4 shows a single inductance coil and is substantially the same type of coupling as is shown in Fig. 2, inasmuch as the magnitude of the mutual impedance varies directly as the frequency. This is what is commonly known as the auto-transformer arrangement.

6, 7 and 8 of Fig. 5 show respectively a capacity shunted by an inductance coil which is coupled to another inductance coil. This type of coupling can be made approximately equivalent to the type shown in Fig. 3 over moderate ranges of frequency, as the transformer is so designed with respect to the capacity as to make the mutual impedance vary inversely with the frequency over the desired range of frequencies.

Now, in many cases it is desirable that the mutual impedances between two circuits be independent of frequency, or that it vary with frequency less rapidly than in Figs. 2, 3, 4 and 5. It is usually impractical to use resistance coupling for this purpose as it introduces energy losses which are undesirable. My invention consists in the method of utilizing both inductive and capacitive coupling at the same time so that as the mutual impedance of one element decreases that of the other element increases and vice versa. By proper choice of the relative magnitudes of the two coupling means, the total

mutual impedance may be made to stay as nearly constant as there is any need for over a range of frequencies, such as is used in what is commonly known as the "broadcast range" or that
 5 range of frequencies commonly used between 200 and 600 meters.

If desired, the relative values of the two coupling means may be designed so that the total mutual impedance increases somewhat with the
 10 frequency, but not so rapidly as the mutual impedance due to the simple inductive coupling. Fig. 6 shows in the simplest form, this type of compound coupling in which 10 and 11 are mutual inductances connected through a common
 15 capacity 9. The intercoupled circuits may be connected to the right and left hand terminals respectively, as before. It is essential that the windings 10 and 11 be in opposite directions so that the voltages produced by the inductive and
 20 capacitive couplings add to each other rather than to subtract from each other, which would be the case if an attempt was made to combine the arrangements shown in Fig. 3 and Fig. 4, to make a coupling element consisting of a coil
 25 in series with a condenser. However, this last mentioned coupling combination is useful in wave traps and filters where it is desired that the mutual impedance vanish completely for some particular frequency.

Still another use for compound coupling is in connection with continuously tunable radio frequency filters. The width of the band of frequencies passed by a simple filter depends upon the mutual reactance between sections so that
 30 as it is desired to select a band of frequencies some ten kilocycles wide no matter what part of the spectrum of broadcast frequencies we are selecting from, it is desired to have a mutual impedance element whose value does not vary appreciably over the broadcast range. Fig. 7 shows
 35 a typical filter section using this type of coupling. This is an adaptation of the coupling arrangement shown in Fig. 6, where the transformer coils of the filter are coalesced with the rest of the inductances. Here 28 and 31 are adjustable
 40 condensers, one in each side of the two circuits. 29 and 30 are inductances associated as in Fig. 6 and 32 is the mutual capacity.

A source of radio frequency voltage E is conventionally shown connected across the input
 50 terminals of the filter, the source being a signal energy collecting means, or a preceding amplifier of collected signal energy, as is well known to those skilled in the prior art. Across the output
 55 terminals of the filter is connected a load conventionally represented equal to the value of terminating resistances. This load has a resistance value correct for ensuring the proper uniform band pass selecting characteristic of the filter. The selected currents flowing through
 60 the load may be utilized to operate translating devices in any of the usual ways well known to those skilled in the art of radio reception. The term filter, as used heretofore, is understood
 65 to imply to those skilled in the art, the mathematical relations between the filter element and, additionally, the inclusion and nature of the voltage source, as well as the output load or terminating resistance.

It will be understood that if the resistances of the coils vary with frequency, as is usually the case, the compound coupling will not be designed for constant mutual impedance but will be so proportioned that the total mutual impedance increases with frequency to the extent desirable to
 75

keep pace with the increase of resistance. The values of resistances in two coupled circuits always determine the optimum values of the mutual impedance between the circuits. Care should
 5 therefore be taken to prevent unnecessary effective resistances at any particular frequency.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. The method of radio reception, which comprises effecting selection of modulated radio frequency energy by cascaded tuned circuits, and utilizing combined condensive and inductive coupling reactions in aiding phase between the circuits to effect transfer of radio frequency energy modulated at audio frequencies with high uniformity and selectivity of the modulated radio frequency energy through a frequency range corresponding substantially to the range of audio frequencies.

2. The method of radio reception, which comprises effecting selection of modulated radio frequency energy by adjusting cascaded tunable circuits to individual resonance at the carrier frequency of said energy, and utilizing combined capacitative and magnetic coupling reactions in aiding phase between the circuits to effect substantially uniform transfer of the selected modulated radio frequency energy through a range of frequencies substantially co-extensive with the limits of modulation of said energy.

3. In an electrical wave transmission system, an exciting circuit, a load circuit, an adjustable means in each of said circuits for selecting any of a plurality of waves in the broadcast frequency range, and means having capacity and inductive reactance for coupling said circuits, said means comprising mutual inductance between said circuits and a condenser common to both said circuits, said mutual inductance and condenser providing inductive and capacity couplings which are additive in effect and cooperate to transmit all waves in said frequency range with a width of substantially ten kilocycles.

4. A band selective transmission network comprising a pair of syntonous tuned circuits, means for varying the resonance of said circuits, coupling means therefor adapted to produce an increase in the width of the selected band as the frequency of tuning is increased, and additional coupling means adapted to produce a band width variation complementary to that due to said first mentioned coupling means, whereby the band width is substantially constant for a wide range of tuning frequencies.

5. A band selective transmission network comprising a pair of syntonous tuned circuits, means for varying the resonance of said circuits, coupling means therefor adapted to produce an increase in the width of the selected band as the frequency of tuning is increased, and additional coupling means adapted to produce a band width variation complementary to that due to said first mentioned coupling means, whereby the band width is substantially constant for a wide range of tuning frequencies, and one of the said coupling means comprises an impedance connected in shunt between the tuned circuits and the other

of said coupling means comprises an impedance connecting the tuned circuits serially.

5 6. A band selective transmission network comprising a pair of syntonous tuned circuits, means for varying the resonance of said circuits, coupling means therefor adapted to produce an increase in the width of the selected band as the frequency of tuning is increased, and additional coupling means adapted to produce a band width
10 variation complementary to that due to said first mentioned coupling means, whereby the band width is substantially constant for a wide range of tuning frequencies, and one of the said coupling means comprises an impedance common to
15 each of the said tuned circuits and the other of said coupling means comprises an impedance connecting said tuned circuits serially.

7. A band selective transmission network comprising a pair of syntonous tuned circuits including variable tuning condensers of equal capacity,
20 coupling means for said circuits comprising an impedance common to both circuits which is capacitive throughout the tuning range of the network and additional inductive coupling means comprising coupled windings phased to aid the
25 capacitive coupling throughout the tuning range, said capacitive coupling and said inductive coupling being proportioned to provide a substantially constant width transmission band through-

out the range of frequencies to which the network can be tuned.

8. A band selective transmission network comprising a pair of syntonous tuned circuits including variable tuning condensers, coupling means
5 for said circuits comprising an impedance common to both circuits which is capacitive throughout the tuning range of the network and additional inductive coupling means comprising coupled windings phased to aid the capacitive coupling
10 throughout the tuning range, said capacitive coupling and said inductive coupling being proportioned to provide a substantially constant width transmission band throughout the range of frequencies to which the network can be tuned.
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9. A signal selective network, comprising a plurality of resonant non-amplifying circuits, each of said circuits simultaneously tunable to substantially the same desired frequencies, said circuits coupled both inductively and capacitatively,
20 the coupling inductances being fixed, and the capacitive and inductive values adjusted so that the coupling co-efficient decreases as frequency increases without a mechanical adjustment of the coupling instrumentalities, in such a
25 way that selectivity remains substantially uniform over the tuning range.

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