April 2, 1946. S. GUBIN 2,397,787

ULTRA HIGH FREQUENCY COUPLING DEVICE

Filed Dec. 31, 1940

Fig. 1.

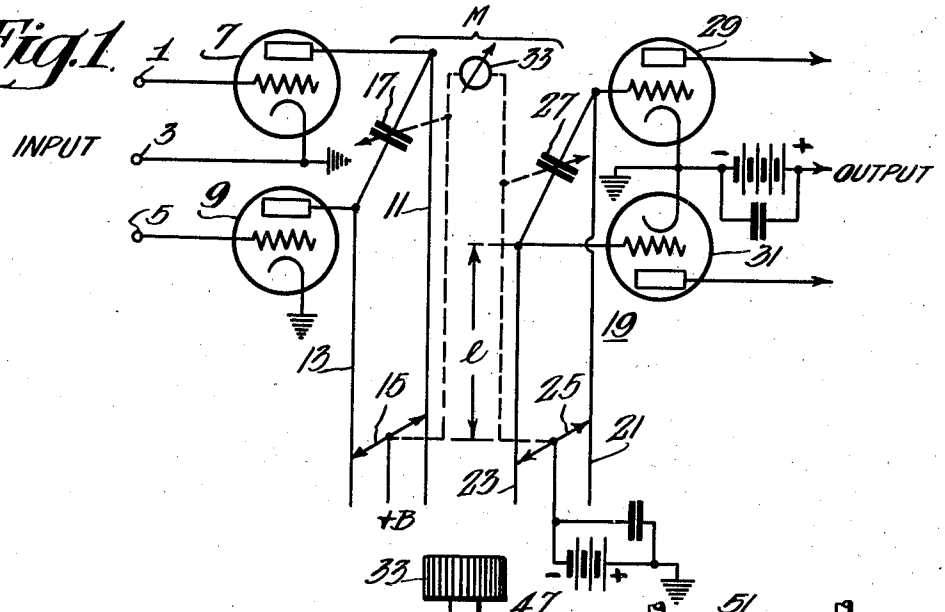
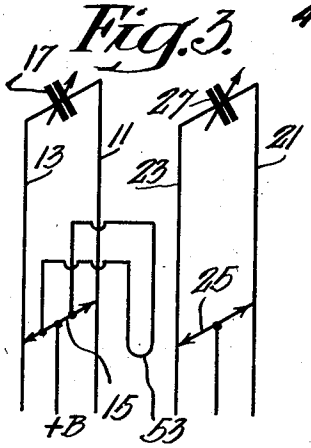


Fig. 3.



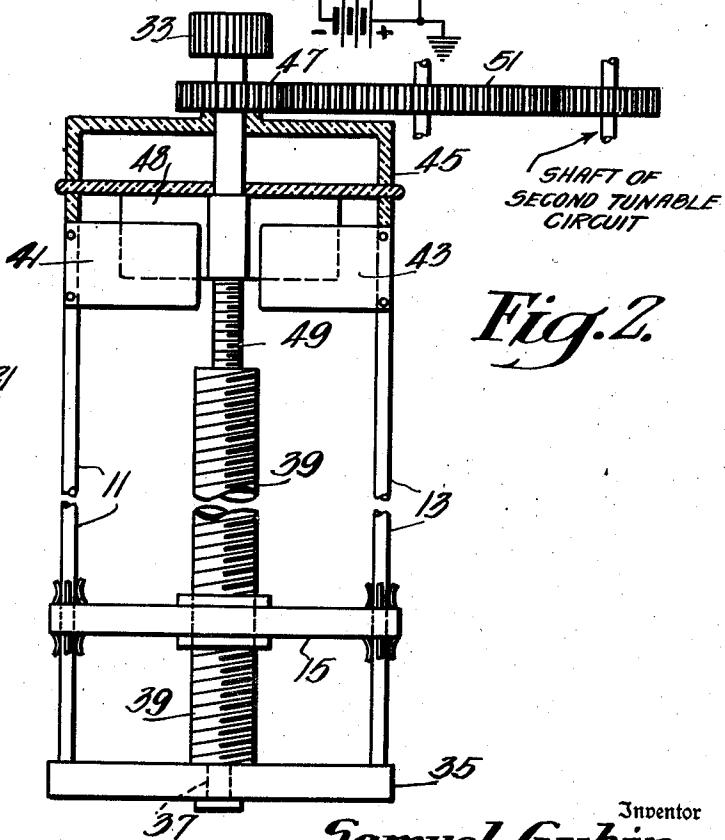


Fig. 2.

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ULTRA HIGH FREQUENCY COUPLING DEVICE

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10 Claims. (Cl. 178—44)

This invention relates to ultra high frequency coupling devices and particularly to means for coupling two tunable ultra high frequency circuits so that the transfer through the coupling is constant over a wide frequency band.

The problem of transferring ultra high frequency energy through coupling systems is not difficult at any specific frequency. If the transfer is made at any frequency within a wide band, it is difficult to obtain constant transfer. Inductive and capacitive couplings which have complementary frequency characteristics have been used to obtain automatically the desired frequency response. Various mechanical expedients have been employed. For example, an inductive coupling may be varied as the frequency is varied by connecting mechanically the coupling and frequency controlling elements. Such mechanical coupling has not been obtained without designs which are involved and expensive.

It is an object of the present invention to provide simple, inexpensive means for transferring ultra high frequency energy at a substantially constant level over a wide range of frequencies. Another object is to provide means for tuning a pair of resonant coupled circuits to effect a constant energy transfer between them. Another object is to provide means for tuning a pair of resonant coupled circuits so that the energy transferred between follows a predetermined frequency characteristic.

The invention will be described by referring to the accompanying drawing in which Figure 1 is a schematic circuit diagram of one embodiment of the invention; Figure 2 is an elevation view, partly in section of one mechanical embodiment of the invention; and Figure 3 is a schematic diagram of a modification of the invention. Similar numerals indicate similar elements in the drawing.

Referring to Fig. 1, terminals 1, 3, 5 represent the input circuit to a pair of tubes 7, 9 which are connected in push-pull. The anodes of these tubes are connected respectively to conductors 11, 13 which are arranged parallel to each other to form a tunable transmission line. The lower end of the line is connected to an adjustable shorting bar 15; the upper end of the line terminates in an adjustable capacitor 17. The line including elements 11, 13, 15, 17 forms the output circuit for the push-pull tubes.

The transmission line 11, 13 is mutually coupled to a second tunable line 19. The second line, like the first, consists of parallel conductors 21, 23, a short bar 25 and an adjustable capacitor 27. The second line is connected to the inputs of a second pair of push-pull tubes 29, 31. The output of these tubes 29, 31 may be connected to a load circuit or to another push-pull stage. The adjustable elements of the two transmission lines may be linked mechanically so that a uni-control 33 may be used to tune the lines through their frequency range.

If the length l of the transmission lines is varied, so that it is always a constant fraction of the wave length at the operating frequency, then the capacity terminating the line should preferably increase linearly with the operating wave length to store a constant amount of energy in the magnetic field at the different operating frequencies. If a constant amount of energy is thus stored, the magnetic coupling will establish a constant voltage in the secondary circuit. If C=capacity, λ=wave length, l=transmission line length, and K1 and K2 are constants, then

$$C=K1\lambda \text{ and } \frac{l}{\lambda}=K2$$

The constants are determined by the spacing of the transmission line conductors and by the surge impedance of the lines.

One suitable practical embodiment of the invention is shown in Fig. 2. The transmission line conductors 11, 13 are mounted on a base 35 which includes a bearing 37 for the threaded shaft or tuning member 39. The shorting bar 15 is threaded. The shaft engages the shorting bar so that the bar advances or recedes with the shaft to vary the effective length of the line. The upper ends of the conductors include a pair of members 41, 43 whose surfaces form the fixed rectangular plates of the capacitor 17. The members 41, 43 are further supported by an insulated bridge 45 which includes a bearing 47 for the upper end of the shaft 39. The upper end of the shaft is threaded differently from the lower end. The upper thread 49 engages a thread in a portion of a grounded conductor plate 48 which spaced from the fixed members and adjustable with respect thereto to vary the capacity between them. The movable plate, as it moves along the threaded member 49, increases and decreases the capacity between the several capacitor members. It should be understood that each capacitor may include a plurality of fixed and movable plates. The pitches of the upper and lower threads are made to correspond respectively to the constants K1 and K2. The second tunable circuit is preferably constructed similar to the first so that their

tuning shafts may be connected together through an idler gear 51.

Thus the invention has been described as an ultra high frequency coupling device in which the tunable elements are mutually coupled. The tuning is accomplished by varying simultaneously the length of an open transmission line and a capacitor at its termination. The rates of variation are predetermined so that a constant amount of energy is stored in the magnetic field throughout the tunable range and hence a constant voltage is induced in the secondary circuit which is similarly tuned. In some arrangements auxiliary coupling may be provided to increase the energy transfer, particularly in the high frequency region of the device. The arrangement for the auxiliary coupling loop 53 is shown in Fig. 3. The auxiliary loop is preferably placed close to the circuit elements to which it is coupled. Thus placed, the auxiliary loop slightly increases the coupling at low frequencies but greatly increases the coupling at the higher frequencies.

I claim as my invention:

1. An ultra high frequency device including a tunable transmission line, adjustable means shorting one end of said line, a variable capacitor terminating the other end of said line, and means for coupling mechanically said shorting means and said capacitor so that the rates of variation of said shorting means and said capacitor correspond to predetermined constants.

2. An ultra high frequency device including a tunable transmission line, adjustable means shorting one end of said line, a variable capacitor terminating the other end of said line, and a single adjustable tuning means for coupling mechanically said shorting means and said capacitor so that the rates of variation of said shorting means and said capacitor correspond to predetermined constants.

3. An ultra high frequency device including a tunable transmission line, an adjustable shorting bar for varying the length of said line, a tuning member having a predetermined rate of change for varying the position of said bar, a capacitor connected to the open end of said line, and means connecting said capacitor, a portion of said tuning member having a rate of change different from said predetermined rate so that said capacitor and said line length vary according to different constants.

4. An ultra high frequency device including in combination a transmission line, an adjustable shorting bar connected to said line, an adjustable capacitor connected to the open end of said line, a tuning member having sections with threads of two different pitches, means connecting said shorting bar to one of said threaded sections and means connecting said capacitor to the other of said sections so that said tuning member varies said length and said capacitor at different rates.

5. An ultra high frequency device including a transmission line having parallel conductors, an adjustable shorting bar connected to said conductors, a pair of capacitor members connected respectively to the open ends of said conductors an adjustable element movable with respect to said capacitor members to vary their capacity, a tuning member having a coarse thread section and a fine thread section, means including said shorting bar engaging one of said threads and means including said adjustable element engaging the other of said threads so that said bar and said adjustable element move at different rates.

6. An ultra high frequency device including a pair of tunable transmission lines, a pair of adjustable shorting bars engaging said lines respectively, a pair of capacitors connected respectively to the open ends of said lines, means mutually coupling said lines, and adjustable tuning means common to said shorting bars and said capacitors for varying simultaneously said shorting bar positions according to one predetermined rate and said capacitors at another rate so that the coupling of said lines is constant over the tunable range.

7. An ultra high frequency device including a pair of tunable transmission lines, a pair of adjustable shorting bars engaging said lines respectively, a pair of variable capacitors connected respectively to the open ends of said lines, means mutually coupling said lines, and adjustable tuning means common to said shorting bars and said capacitors for varying simultaneously said shorting bar positions according to

$$\frac{l}{\lambda}=K2$$

where l=length of line, λ=wave length and K2=a constant and for varying said capacitors according to C=K1λ where C=capacity, K1=a constant and λ=wave length so that said mutual coupling is constant over said tunable range.

8. An ultra high frequency device including a pair of tunable transmission lines, a pair of adjustable shorting bars engaging said lines respectively, a pair of variable capacitors connected respectively to the open ends of said lines, means mutually coupling said lines, and a pair of adjustable tuning means respectively common to said shorting bars and said capacitors for varying simultaneously said shorting bar positions according to

$$\frac{l}{\lambda}=K2$$

where l=length of line, λ=wave length and K2=a constant and for varying said capacitors according to C=K1λ where C=capacity, K1=a constant and λ=wave length so that said mutual coupling is constant over said tunable range.

9. An ultra high frequency device including a pair of tunable transmission lines, a pair of adjustable shorting bars engaging said lines respectively, a pair of variable capacitors connected respectively to the open ends of said lines, means mutually coupling said lines, a pair of adjustable tuning means respectively common to said shorting bars and said capacitors for varying simultaneously said shorting bar positions according to

$$\frac{l}{\lambda}=K2$$

where l=length of line, λ=wave length and K2=a constant and for varying said capacitors according to C=K1λ where C=capacity, K1=a constant and λ=wave length so that said mutual coupling is constant over said tunable range, and means common to said pair of adjustable tuning means for tuning simultaneously said transmission lines.

10. A device of the character of claim 6 including auxiliary means for coupling said pairs of lines.

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