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TUNED ULTRA HIGH FREQUENCY TRANSFORMER

Filed June 24, 1943

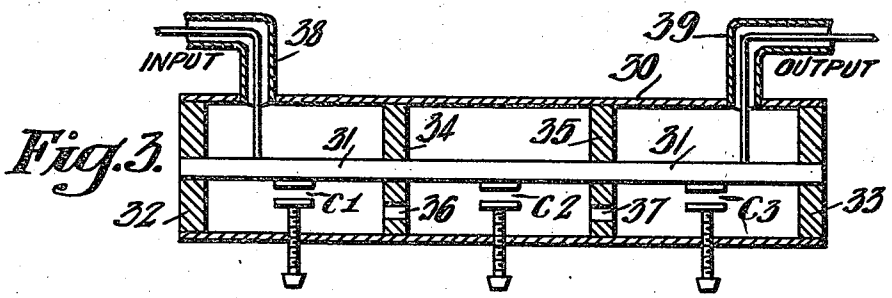


Fig. 3.

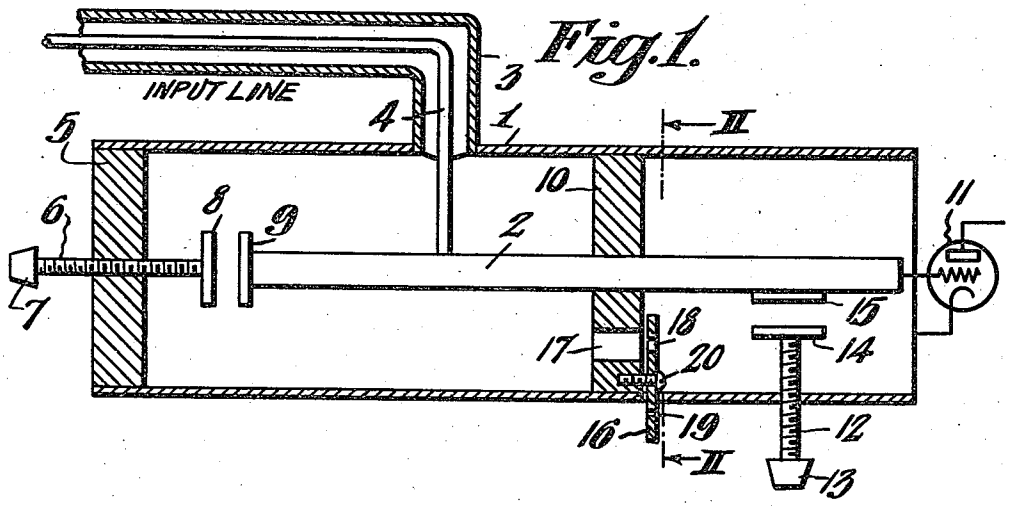
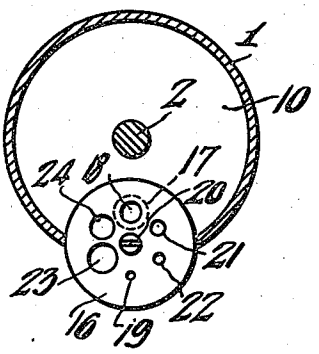


Fig. 1.

Fig. 2.



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TUNED ULTRA HIGH FREQUENCY TRANSFORMER

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7 Claims. (Cl. 178—44)

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This invention relates generally to ultra-high frequency apparatus and more particularly to a tuned transformer for ultra-high-frequency energy wherein both primary and secondary portions may be separately tuned to resonate at the operating frequency and wherein the coupling between the primary and the secondary portions may be adjusted to any predetermined coupling factor.

Ultra-high frequency receivers and transmitters often require that interstage or antenna coupling circuits be tunable to the operating frequency, and that the response of the coupling transformer have predetermined band width characteristics. Transformation of the type required may be accomplished by employing a concentric line transformer of the type to be described in detail hereinafter.

The primary portion of the transformer may be tuned by inserting a variable series capacitor in the center conductor of the primary portion of the transmission line. Such a capacitor may be adjusted by a control shaft extending through a shorting plug interposed at the adjacent end of the concentric line transformer unit. Input to the primary portion of the transformer unit may be provided by tapping an input transmission line to a predetermined point along the primary portion of the concentric line transformer.

The secondary portion of the transformer unit is separated from the primary portion thereof by means of an apertured shorting plug disposed transversely of the concentric line transformer at a predetermined distance from the connection of the input transmission line. The remaining end of the secondary portion of the transformer unit is left open. The center conductor of the secondary portion may, for example, be connected to the control electrode of a high frequency thermionic tube, while the outer concentric conductor thereof may be connected to the cathode or grounded circuit of the tube.

The secondary portion of the transformer unit also may be tuned capacitively. The secondary tuning may be accomplished by securing a flat capacitive plate to the center conductor, and adjustably positioning a second capacitive plate at a predetermined distance therefrom, which may be varied through the side of the outer conductor. It will be seen that the adjustment will provide a shunt capacity between the inner and outer conductors of the secondary portion.

Coupling between the primary and secondary portions of the transformer unit may be accomplished by providing one or more apertures of

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predetermined cross-sectional area in the shorting plug separating the primary and secondary portions. The size or number of the apertures, or both, may be adjusted externally by means of an annular apertured plate pivoted parallel to the apertured shorting plug. Coincidence of the apertures of the shorting plug and the annular apertured plate will provide coupling between the primary and secondary portions of the transformer. The coupling factor will be proportional to a function of the coinciding aperture areas of the apertured plates.

Among the objects of the invention are to provide an improved ultra-high-frequency tuned transformer. Another object of the invention is to provide an improved ultra-high-frequency, tuned, concentric-line transformer including means for tuning separately the primary and secondary portions thereof, means for providing predetermined coupling to the primary portion from an external circuit, and means for providing predetermined coupling between the primary and secondary portions of the transformer. A further object of the invention is to provide an improved ultra-high frequency concentric line transformer having capacitive tuning of the primary separate capacitive tuning of the secondary portion, and an adjustable coupling between the primary and secondary portions. An additional object of the invention is to provide an improved ultra-high-frequency, concentric-line transformer including an externally adjustable series capacitively tuned primary portion, an externally adjustable parallel capacitively tuned secondary portion and adjustable apertured means for controlling the coupling factor between the primary and secondary portions thereof. A further object is to provide an improved high-frequency filter comprising a plurality of tuned sections of coaxial line which are mutually coupled through apertures in conductive means interposed between the line conductors to form said sections.

The invention will be described in further detail by reference to the accompanying drawing of which Figure 1 is a cross-sectional view of a first embodiment thereof, Figure 2 is an elevational sectional view, taken along the section line II—II, of the adjustable coupling elements of Figure 1, and Figure 3 is a cross-sectional view of a second embodiment thereof. Similar reference numerals are applied to similar elements throughout the drawing.

Referring to Figure 1, the coupling transformer comprises a concentric line including an outer conductor 1 and a coaxially disposed inner con-

ductor 2. An input transmission line including an outer conductor 3 and coaxially disposed inner conductor 4 is tapped to the corresponding conductors 1, 2 of the transformer concentric line at predetermined points thereon. A shorting plug is disposed within one end of the outer conductor 1 of the transformer concentric line. An adjusting shaft 6, having an externally adjustable control knob 7, extends through an aperture in the shorting plug 5, and terminates in a capacitive conductive plate 8. A similar capacitive conductive plate 9 terminates the adjacent end of the inner conductor 2 of the transformer concentric line. The spacing between the capacitive plates 8 and 9 may be varied by adjusting the external control knob 7. As a matter of convenience, the control shaft 6 may be threaded to the shorting plug 5.

An apertured shorting plug 10 is interposed in the transformer concentric line between the outer and inner conductors 1, 2 thereof at a point intermediate the connection of the input line to the transformer line and the remaining open end of the transformer line. The second shorting plug 10 includes an aperture for the center conductor 2 of the transformer line and one or more additional apertures to provide coupling between the primary and secondary portions of the transformer line. The open ended portions of the transformer secondary may be connected, for example, to the control electrode and cathode of a thermionic tube 11, or to any other type of load device. As illustrated, the center conductor 2 is connected to the control electrode of the tube 11, and the outer concentric conductor is connected to the cathode.

Tuning of the secondary portion of the transformer line is accomplished by means of a second threaded control shaft 12 which extends, and is threaded, normally through the outer concentric conductor 1. The external end of the second control shaft 12 is terminated in a second control knob 13 while the internal end thereof is terminated in a third capacitive conductive plate 14. A fourth capacitive conductive plate 15 is secured to the adjacent side of the inner conductor 2 of the secondary portion of the transformer line. External adjustment of the second control knob 13 may thereby provide adjustable spacing between the third and fourth capacitive plates 14, 15 to provide adjustable parallel capacitive tuning between the inner and outer conductors of the transformer secondary portion. It should be understood that both tuned sections may be tuned similarly, and both sections may be either open or closed at the extremities thereof.

The coupling factor between the primary and secondary portions of the transformer line may be adjusted externally by means of a conductive adjusting plate 16, a portion of which extends through the outer concentric conductor 1. The adjusting plate 16 may be pivoted to the shorting plug 10 adjacent the aperture 17 therein. The adjusting plate 16 is provided with a plurality of apertures 18, 19, which may be made to coincide with the larger aperture 17 in the shorting plug 10, by rotating the adjusting plate 16 about its pivot 20. It should be understood that if the shorting plug 10 includes a plurality of apertures, similar to the aperture 17 illustrated herein, a plurality of such adjusting plates might be employed or other known mechanical means might be utilized to control simultaneously the effective aperture of each of the apertured portions of the shorting plug 10.

Figure 2 shows the second shorting plug 10 and the adjusting plate 16 pivoted thereto. It will be seen that various sized apertures 18, 19, 21, 22, 23, 24 may be rotated about the axis 20 to coincide with the larger aperture 17 in the second shorting plug 10. If desired, some type of locking device, not shown, may be provided for fixing the position of the adjusting plate 16 when the desired aperture has been selected to provide the desired coupling factor.

Figure 3 is a modification of the invention providing a tuned multi-stage filter network comprising a coaxial line having an outer conductor 30 and an inner conductor 31. The ends of the coaxial line are terminated by shorting plugs 32, 33. A plurality of apertured conductive means 34, 35 are interposed between the line conductors 30, 31 to provide the separate filler stages which are coupled through fixed or adjustable apertures 36, 37 therein. Adjustable capacitors C_1, C_2 and C_3 are employed to tune separately each of the filter stages. An input coaxial line 38 is connected, as shown in Fig. 1, to the input filter stage, and an output coaxial line 39 is connected similarly to the output filter stage. The shorting plugs 32, 33 may be omitted if desired, or the stages may be tuned by series capacitors in the center conductor 31, as shown in Fig. 1.

Thus the invention described comprises an improved ultra-high frequency concentric line transformer or filter network having capacitive means for tuning separately the input and output or intermediate portions thereof and additional means for adjusting the coupling between the several portions of the transformer or network. It should be understood that the devices may be employed similarly as a tuned coupling unit between any other input and load devices customarily utilized in ultra-high frequency circuits.

I claim as my invention:

1. A tuned high-frequency circuit comprising a coaxial-line section having an inner and an outer conductor, apertured conductive means joining said conductors intermediate the ends thereof so as to form separately resonant portions, at least one aperture in said conductive means being disposed intermediate said inner and outer conductors whereby said resonant portions are electrically coupled through said aperture and separate capacitive means interposed between said conductors for separately tuning each of said portions.

2. A tuned high-frequency circuit comprising a coaxial-line section having an inner and an outer conductor, a plurality of apertured conductive means joining said conductors at points intermediate their ends so as to form a plurality of separately resonant portions, at least one aperture in each of said conductive means being disposed intermediate said inner and outer conductors whereby adjacent ones of said resonant portions are electrically coupled through said apertures, and separate capacitive means interposed between said line conductors for tuning each of said resonant portions.

3. A tuned high frequency transformer comprising a coaxial line section including a pair of concentric conductors, conductive means terminating one end of said line, apertured conductive means terminating said conductors at a point intermediate the ends thereof to provide primary and secondary transformer portions, at least one aperture in said conductive means being disposed intermediate said inner and outer conductors whereby said resonant portions have a coupling

factor which is a function of the aperture area, capacitive means interposed in series with the center one of said concentric conductors for tuning said primary transformer portion and capacitive means interposed between said concentric conductors for tuning said secondary transformer portion.

4. A tuned high frequency transformer comprising a coaxial line section including a pair of concentric conductors, conductive means terminating one end of said line, apertured conductive means terminating said conductors at a point intermediate the ends thereof to provide primary and secondary transformer portions, at least one aperture in said conductive means being disposed intermediate said inner and outer conductors whereby said resonant portions have a coupling factor which is a function of the aperture area, capacitive means interposed in series with the center one of said concentric conductors and adjustable externally of said line section for tuning said primary transformer portion and capacitive means interposed between said concentric conductors and adjustable externally of said line section for tuning said secondary transformer portion.

5. Apparatus of the type described in claim 4

including means adjustable externally of said concentric conductors for adjusting the effective aperture area of said apertured conductive means for controlling the coupling factor between said primary and said secondary transformer portions.

6. A tuned high frequency transformer comprising a coaxial line section, apertured conductive means terminating said conductors at a point intermediate the ends thereof to provide primary and secondary transformer portions, at least one aperture in said conductive means being disposed intermediate said inner and outer conductors whereby said resonant portions have a coupling factor which is a function of the aperture area, means for tuning said primary transformer portion and means for tuning said secondary transformer portion, means for coupling said primary transformer portion to an input circuit, and means for coupling said secondary transformer portion to a load circuit.

7. Apparatus of the type described in claim 4 including means for coupling said primary transformer portion to an input circuit, and means for coupling said secondary transformer portion to a load circuit.

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