April 8, 1947.

H. W. KLINE

2,418,472

MICROWAVE TRANSMISSION SYSTEM

Original Filed May 28, 1943

Fig. 1.

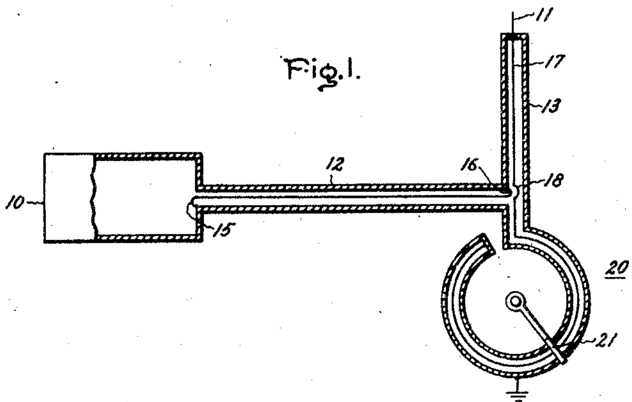


Fig. 2.

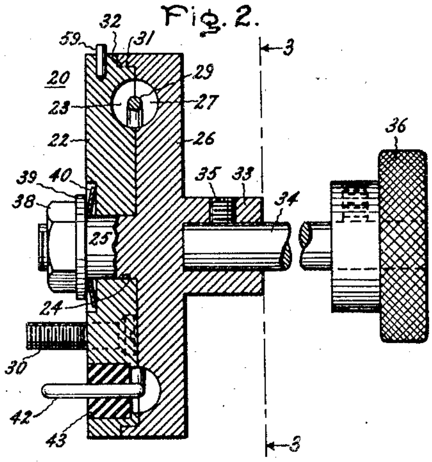


Fig. 3

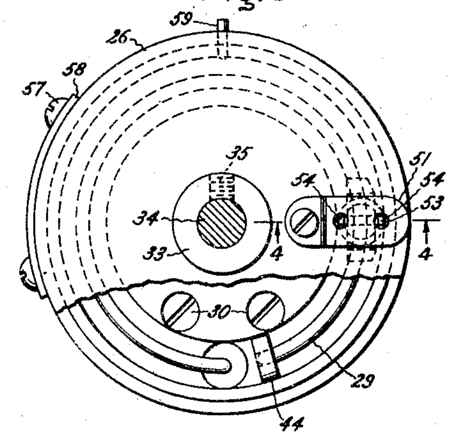


Fig. 4.

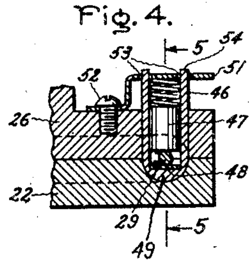
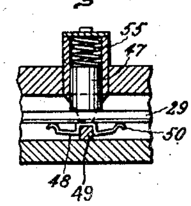


Fig. 5.



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Patented Apr. 8, 1947 **2,418,472**

UNITED STATES PATENT OFFICE

2,418,472

MICROWAVE TRANSMISSION SYSTEM

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Original application May 28, 1943, Serial No. 488,824. Divided and this application August 17, 1944, Serial No. 549,819

3 Claims. (Cl. 178—44)

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My present invention is a division of my copending application, Serial No. 488,824, filed May 28, 1943, and it has for its object to provide a new and improved tuning arrangement for a microwave transmission system.

My invention relates more particularly to a system for transmitting microwave energy from a resonating body to an output circuit. For transmitting high frequency energy from an oscillator of the resonant cavity type to an output circuit, such as an antenna or the radiating stub of a wave guide, it is desirable to employ a transmission line of the concentric conductor type both for flexibility and ease of tuning over a wide band of frequencies and for simplicity of connection and impedance matching.

A further object of my invention is to provide an improved means for easily and rapidly adjusting the length of a concentric transmission line.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 shows a high frequency transmission system according to my invention; Fig. 2 is a view, partly in section, of a rotary tuning device used in the system of Fig. 1; Fig. 3 is a side view, partly in section, of the device of Fig. 2 along the lines 3—3; Fig. 4 is an enlarged view of the contacting means employed in the tuning device of Fig. 3 taken along the lines 4—4; and Fig. 5 is a side view along the lines 5—5 of Fig. 4.

Referring to Fig. 1, I have shown a high frequency transmission system in which high frequency energy within the cavity resonator 10 is supplied to an output radiating element 11 over a pair of transmission lines 12, 13. The cavity resonator 10 may be associated with any desirable high frequency oscillator operating to produce oscillations having a very small wave length, for example, of the order of 10 centimeters. The transmission line 12 is of the concentric type having a tubular outer conductor and a centrally disposed inner conductor. The line 12 at its point of connection with the cavity resonator 10 is provided with a coupling loop 15 extending within the resonator 10 and is provided at its junction with transmission line 13 with a similar coupling loop 16.

The output radiator 11, which may be for example an antenna element or a radiating stub projecting into a wave guide, is formed by an extension of the inner conductor 17 of concentric transmission line 13. Conductor 17 is provided with a loop portion 18 adjacent the coupling loop 16 at the end of line 12. The loops 16, 18 preferably are one-turn coils and are tightly coupled together. The lower end of line 13 is connected to a rotary tuning device 20 which provides means for adjustably connecting a short-circuiting element 21 between the inner and outer conductors of a substantially circular extension of the transmission line 13. The slider 21 shorts the inner conductor of this extension of line 13 to the grounded outer conductor and provides means for allowing the electrical length of the entire antenna output circuit to be adjusted to resonate at the frequency of the cavity resonator. When the output circuit of the system is adjusted to resonate at the frequency of the cavity resonator, the coupling loops 16, 18 enable optimum loading of the high frequency source or resonant cavity 10.

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Referring to Fig. 2, I have shown the tuning device 20 in a preferred form. As shown, the device 20 comprises a stationary body member 22 in the form of a circular piece of metal having a substantially circular groove 23 on its right hand face. The body member 22 has a centrally located bearing surface 24 for rotatably supporting a cooperating bearing surface 25 on a rotatable body member 26. The body member 26 similarly is shown as a circular metallic plate having a circular groove 27 formed on its left hand surface in such a manner that the groove 27 lies adjacent the groove 23 to form therewith, when the members 22 and 26 are pressed together, a circular passage through the composite tuning device 20. This passage, moreover, is circular in cross section and a substantially complete loop of rigid wire 29 is supported in the center of the circular passageway formed in the device 20. As thus described, the wire 29 and grooves 23 and 27 in body members 22 and 26 form a section of concentric transmission line. The body member 22 is provided with a shoulder 31 and rotatable body member 26 is provided with a flanged portion 32 which fits about the shoulder 31. Member 26 is provided with a hub portion 33 in which one end of a shaft 34 is secured by means of a set screw 35. The shaft 34 carries at its other end a knurled adjusting knob 36. An extension of the cooperating bearing surface 25 is threaded and a nut 38 threaded thereon bears against a washer 39 and a spring member 40 to hold the body members 22 and 26 pressed together with sufficient force that good contact between adjacent surfaces of the body members is secured, but that movable member 26 may be easily rotated with respect to the stationary member 22 by turning the knurled knob 36. Screws 30 provide means for affixing stationary body member 22 to a supporting object.

The wire 29 is provided with a connecting portion 42 which extends at right angles to the plane of the loop of wire lying in the grooves 23 and

27. A plug 43 of any suitable insulating material, such as polystyrene, both insulates the wire 42 and the loop 29 from the member 22 and supports one end of the loop in a fixed position such that the loop lies substantially in the plane of adjacent surfaces of members 22 and 26. The opposite end of the loop of wire is electrically conducted, as by soldering, to a circular metal connection ring 44 (as shown in Fig. 3). The diameter of the circular ring 44 is the same as the diameter of the circular passageway formed by the grooves 23 and 27 and this ring 44 is soldered to member 22 so that one end of the loop of wire 29 is grounded to the body member 22.

The sliding contact for adjusting the length of the transmission line between the connection portion 42 and the base member 22 is shown in Figs. 4 and 5. This sliding contact comprises a cylinder 46, a piston 47 and a contact member 48. The cylinder 46 is located in a hole drilled in the movable member 26 and is formed with a semi-circular bearing portion 49 at its lower end, the bearing portion 49 sliding in the groove 23 formed in the body member 22. The spring member 48 which lies between the bearing surface 49 and conductor 29, carries a plurality of arms 50 for contacting the conductor 29. A retaining member 51 which is fastened to the rotatable member 26 by means of screw 52 has a pair of openings 53 for engaging fingers 54 at the upper end of cylinder 46. Spring 55 of any suitable material compressed between retaining member 51 and the piston 46 provides means for assuring contact between conductor 29 and the grounded member 26.

Secured to the rotatable member 26 along its outer periphery by means of screw 57 is a stop member 58. A stop pin 59, secured to the stationary body member 22 operates in conjunction with stop member 58 to limit the rotation of movable member 26 with respect to fixed member 22.

In the operation of the tuning device 20, as the knurled knob 36 is turned to adjust the position of contact 50 on conductor 29, the length of line 13 may be adjusted to a desired value. The piston 47, biased against conductor 29 by means of spring 55, assures positive contact of spring 50 against conductor 29 to ground the conductor at this point. In this way the device 20 provides a compact, variable-length concentric line turning device which may be used to vary the length of line 13 in Fig. 1 and to adjust the tuning of the output circuit. Since the coiled conductor 29 and the walls of the grooves 23 and 27 cooperate to form an extension of transmission line 13 which has the same impedance characteristics of line 13, all difficulty of terminating line 13 is eliminated. The construction is such that all backlash is avoided and adjustment of the length of line 13 may be made easily and rapidly. Moreover, when used in conjunction with the link coupling line 12, adjustments of the length of line 13 by means of tuning device 20 have substantially optimum loading effect on the cavity resonator 10. The link coupling line 12 to a large extent is independent of frequency and provides not only improved coupling between resonator 10 and the radiating element 11, but also permits optimum tuning of the output circuit of the system.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An adjustable terminating means for a transmission line of the type having an inner conductor and a tubular outer conductor concentric therewith comprising, a pair of plate members having contacting plane surfaces, each of said surfaces having corresponding circular grooves therein, each of said grooves being substantially semi-circular in cross section and said grooves uniting to form a circular passageway between said members, a loop of wire centrally supported in said passageway, one end of said loop being connected to said inner conductor and said members being conductively connected to said tubular outer conductor, said loop cooperating with the walls of said passageway to form a section of concentric transmission line, a shaft concentric with said grooves for rotatably supporting one of said members with respect to the other of said members; and a contact member carried by said one member and slidable along said loop to vary the amount of said section connected in series with said transmission line as said one member is rotated with respect to said other member.

2. A rotary tuning device for a concentric transmission line comprising a stationary body member having a plane surface, a movable member rotatably supported by said body member, said movable member having a plane surface, means to secure said members together with said plane surfaces in engagement, each of said surfaces having corresponding circular grooves cut therein, said grooves being semi-circular in cross section and uniting to form a circular passageway between said members, a substantially circular loop of conductive material centrally supported in said passageway to form with the walls of said passageway a section of concentric transmission line, said loop being conductively connected to said members at one of its ends and being insulated from said members throughout the remainder if its length, a contact member supported by said movable member, and resilient means for causing said contact member to slide along said loop as said movable member is rotated to adjust the length of said section of transmission line.

3. An adjustable terminating means for a transmission line of the type having an inner conductor and a tubular outer conductor concentric therewith comprising a pair of circular plate members having contacting plane surfaces, one of said members being supported for concentric rotation with respect to the other of said members, each of said surfaces having corresponding circular grooves therein, each of said grooves being substantially semi-circular in cross section and said grooves uniting to form a circular passageway between said members, a loop of wire centrally supported in said passageway, one end of said loop being connected to said inner conductor and said members being conductively connected to said tubular outer conductor, said loop cooperating with the walls of said passageway to form a section of concentric transmission line, and a contact member carried by said one member and slidable along said loop to vary the amount of said section connected in series with said transmission line as said one member is rotated with respect to said other member.

HALSEY W. KLINE.