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HIGH-FREQUENCY COUPLING CONDENSER

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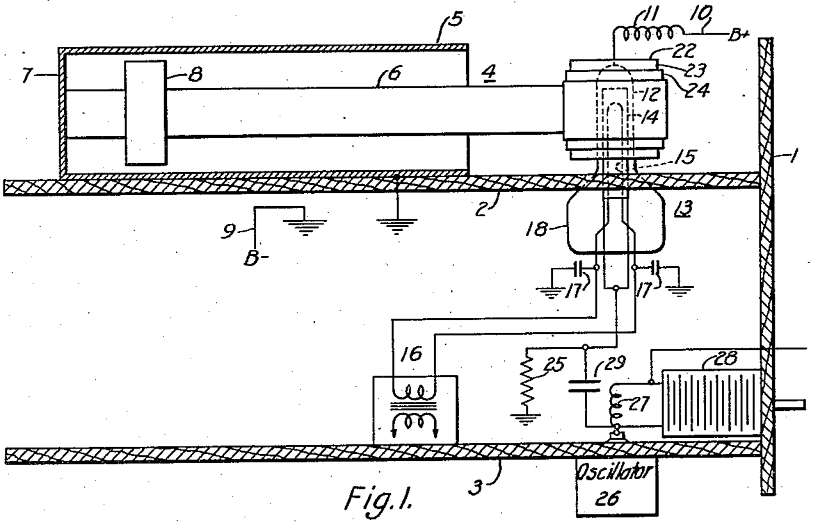

Fig. 1.

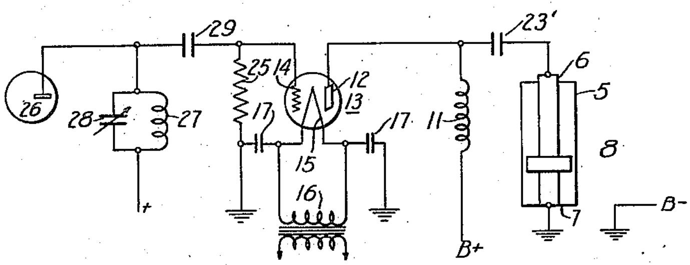

Fig. 2.

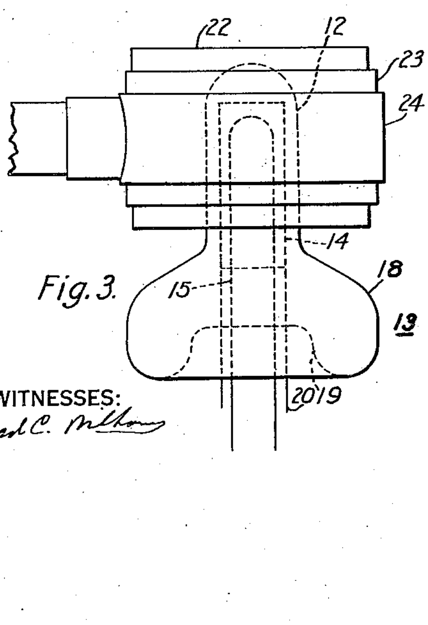

Fig. 3.

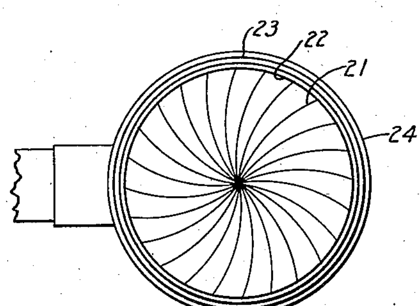

Fig. 4

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HIGH-FREQUENCY COUPLING CONDENSER

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4 Claims. (Cl. 179—171)

My invention relates to ultra-high-frequency electrical system and, in particular, to structures for circuit elements and supports for electrical discharge tubes in such systems.

One object of my invention is to provide a structure for capacitatively coupling the output circuit of an electrical discharge tube in an ultra-high-frequency electrical system with elements of a tuned network to be used in said system.

Another object of my invention is to form as a compact structure a coupling condenser in the output circuit of an ultra-high-frequency electrical discharge tube.

Still another object of my invention is to provide a compact arrangement which embodies in a single unit a coupling capacitor and a support for an ultra-high-frequency electrical discharge tube.

A further object of my invention is to provide for coupling the output circuit of an ultra-high-frequency electrical discharge tube to a tuned reactor of the transmission line type; that is to say, a tuned element making use of distributed inductance and capacity inherent in a pair of concentric conductors.

Still other objects of my invention will become apparent upon reading the following specification, taken in connection with the drawing in which:

Figure 1 is an elevation, partly in section, showing an ultra-high-frequency triode supported and coupled to a tuned reactor of the transmission line type in accordance with my invention;

Fig. 2 is a diagram of the pertinent portion of the electrical circuit embodying the elements illustrated in Fig. 1;

Fig. 3 is a side view in detail of the coupling capacitor and anode of the triode; and

Fig. 4 is a top view at right angles to Fig. 3 of the same coupling capacitor and anode.

In ultra-high-frequency electrical circuits, it is necessary to condense into extremely small dimensions the lead-wires interconnecting various impedances and other circuit elements in order that the distributed inductance and capacity of such lead-wires and connections shall be minimized to the greatest possible degree. This is by reason of the fact that even the distributed capacity and inductance of interconnecting leads may form a very large part of the total inductance and capacity of such ultra-high-frequency oscillation circuits, and may even make it impossible to reduce the frequency-determining constants sufficiently to permit the attainment of the desired frequencies. As a result of the foregoing facts, it becomes necessary to carefully arrange the positions of the various elements traversed by the radio frequency currents of such ultra-high-frequency triodes, and to so design the tube structure, its supports and the structure of the oscillating circuit as to minimize the length of the paths traversed by the high-frequency currents. The foregoing forms a marked contrast to the situation in the case of ordinary radio circuits which employ lumped capacity and inductance as frequency determining elements, and in which the distributed inductance and capacity of the lead-wires may often be ignored.

In accordance with my invention, I have devised a tube and circuit structure in which a coupling capacitor in the output circuit of an ultra-high-frequency triode, said capacitor constituting a coupling of the triode to a variable reactance, is compactly formed by employing the sheet of dielectric enclosed between the periphery of a metallic cooling cylinder on the anode of the triode and a ring-shaped clamp directly connected to one element of a reactance of the transmission line type, said clamp also acting as substantially the sole support of the triode.

In this arrangement, the fairly extensive surface which is inherent in the cooling cylinder forms one plate of the capacitor and the clamp forms the other plate, thus consolidating in a single unit the extended surface necessary for cooling purposes and the extended surface necessary for capacitor purposes and eliminating the use of any lead-wire for connecting the capacitor surface to the anode. The unit similarly makes a double use of the surface area of the clamp so that it performs in addition to its normal function that of providing the cooperating extensive surface required by the capacitor. By thus causing single surfaces to perform a pair of functions which in the prior art have required separate extensive surfaces as well as interconnecting conductors, the total distributed capacity of the ultra-high-frequency circuit is materially reduced and an arrangement produced which has been found to function most effectively in the ultra-high-frequency field.

With the foregoing principles in mind, Fig. 1 of the drawing shows a supporting structure 1 which may be of any suitable material, for example, wood, having shelves 2, 3 for supporting elements of an ultra-high-frequency electrical circuit. The latter comprises a variable reactor 4 consisting of an outer cylinder 5 of metal and an inner concentric cylinder 6 which may be of the same metal and which is supported from the closed end 7 of the cylinder 5. A movable cylindrical collar 8 is arranged to be displaced to any desired position along the inner cylinder 6. The outer rim of the collar 8 extends into close proximity to the interior surface of cylinder 5 and capacitatively couples the inner cylinder 6 and the outer cylinder at the point where the collar is positioned at any time. Cylinder 5 may, as by grounding, be connected to the negative terminal 9 of a source of direct current, the positive terminal 10 of which is connected through a choke coil 11 to the anode 12 of an ordinary hot cathode triode 13 suitable for generating high-frequency electrical oscillations. The triode 13 has a control electrode 14 and an electron-emissive cathode 15 which is supplied with current from an alternating-current source 16 in the usual way. Each end of the cathode 15 is connected by a condenser 17 to the cylinder 5, this being conveniently done by grounding the outer terminals of the condenser 17 if the cylinder 5 is grounded.

The structure of the anode of the triode 13 will be more readily apparent from Figs. 3 and 4 which show the anode 12 as comprising a metallic thimble sealed to a glass tube mamber 18 having a reentrant press 19 through which are sealed the leads to cathode 15 and a lead 20 for the grid 14.

In order to effectively cool the anode 12, the latter is provided with a set of radiating metallic vanes 21 which may conveniently be welded to anode 12. The periphery of the vanes 21 is surrounded by a sheet-metal covering 22, and a sheet 23 of dielectric material of suitable thickness which may be mica is wrapped around the metallic cylinder 22. Surrounding the mica layer 23 is a sheet-metal band 24, the ends of which are connected directly to the inner cyinder 6. In order to minimize the length of the high-frequency circuit, the end of the outer cylinder 5 may be very closely spaced from the band 24.

The grid 14 may be connected to the condensers 17 by a resistor 25, and this may conveniently be done by grounding the end of the resistor 25 in cases where a plate of condenser 17 is grounded.

I have chosen to illustrate the tube 13 as being employed as an ultra-high-frequency amplifier, input current being fed to the grid 14 from an oscillator 26 of the required frequency, said oscillator 26 being provided with a resonant circuit comprising an inductor 27 and a capacitor 28 which are linked to the grid 14 through a coupling capacitor 29.

The foregoing relation of the circuit elements just described is schematically illustrated by Fig. 2 in which the reference numerals indicate the same structural elements as do the same numerals in Fig. 1. It will be seen that the elements 22, 23, 24 in Fig. 1 constitute the coupling capacitor marked 23′ in Fig. 2.

By displacing the movable collar 8 lengthwise of cylinder 6, it will be found possible to tune the output circuit of triode 13 very effectively, and the energy in this output circuit may be drawn off for any desired purpose by means too well known in the art to require separate description.

To illustrate one specific embodiment of my invention which will work satisfactorily in practice, the cylinder 5 may be of sheet copper about 3½ inches in diameter and about 12 inches long. The cylinder 6 may be of copper metal $\frac{1}{32}$ inch thick, 1¼ inches in external diameter and about 13 inches long. The movable collar 8 may be of copper metal 3¼ inches in external diameter and 1 inch long. The band 24 may be of sheet copper approximately $\frac{1}{16}$ inch thick, 1¼ inches wide and having an internal diameter of approximately 2¾ inches. The dielectric 23 may be of mica approximately 0.002 inch thick and may extend at each end ⅜ inch beyond the edge of the band 24. The cooling cylinder 22 may be of copper metal about 2½ inches in internal diameter, $\frac{1}{16}$ inch thick and 2½ inches long. The triode 13 may be of the type known as the WX3005 having an anode 12 about ½ inch in outside diameter and 2½ inches long. The tube portion 13 may be of glass about 2¾ inches in diameter and about 2 inches long. The grid 14 may be of tungsten wire about .020 inch in diameter having eight parallel conductors arranged in the form of a cage of .22″ diameter. The cathode 15 may be of the thoriated type requiring 11.5 amperes at 4 volts to maintain it at a suitable operating temperature. The source of electromotive force 9, 10 may be of 1000 volts furnishing .25 ampere. The condensers 17 may each be of about 0.001 microfarad capacity, and the shelves 2, 3 may be spaced about 8 inches apart. The resistor 25 may be of about 5000 ohms; the condenser 29 of about 0.0005 microfarad; the condenser 28 of about 0.00005 microfarad; and the inductor 27 of about .001 millihenry. The oscillator 26 may be of any desired type producing a frequency of about 100,000 kilocycles with power output of 30 watts. For example, it may comprise a tube of the 304-A type.

While I have described one particular embodiment of my invention in order to comply with the patent statutes, it will be recognized by those skilled in the art that its principles are of broader application in ways that will be evident to those versed in the radio art.

I claim as my invention:

1. In combination with an electrical discharge device having a cathode, a control electrode and an anode forming a portion of its wall, a layer of dielectric material upon said wall portion and a metallic covering in contact with the outer surface of said dielectric material to form a capacitor, a tuned output circuit coupled to said device by said capacitor, and means to supply alternating current between said control electrode and said cathode, said dielectric material constituting the main mechanical support for said discharge device.

2. In combination with an electrical discharge device having a cathode, a control electrode and an anode forming a portion of its wall, a layer of dielectric material upon said wall portion and a metallic covering in contact with the outer surface of said dielectric material to form a capacitor, a tuned output circuit comprising a pair of cylindrical surfaces and a movable member forming a capacitative coupling between them to constitute a variable reactance of the transmission line type, said output circuit being coupled to said device by said capacitor, and means to supply ultra-high-frequency alternating current between said control electrode and said cathode, said dielectric material constituting the main mechanical support for said discharge device.

3. An electrical discharge device having a cathode, a control electrode and a cylindrical anode forming a wall portion thereof, a cylindrical conductor closely spaced away from said anode by insulating material to form a capacitor therewith, a tuned output circuit comprising a pair of cylindrical surfaces and a movable member forming a capacitative coupling between them to constitute a variable reactance of the transmission line type, said output circuit being coupled to said device by said capacitor, a structure supporting said output circuit, and means to supply ultra-high-frequency alternating current between said control electrode and said cathode, said insulating material mechanically supporting said discharge device relative to said supporting structure.

4. An electrical discharge device having a cathode, a control electrode and a cylindrical anode forming a wall portion thereof, means extending radially outward from said anode to provide cooling-means therefor, a cylindrical conductor closely spaced away from said means by dielectric sheet material to form a capacitor therewith, a tuned output circuit comprising a pair of cylindrical surfaces and a movable member forming a capacitative coupling between them to constitute a variable reactance of the transmission line type, said output circuit being coupled to said device by said capacitor, and means to supply ultra-high-frequency alternating current between said control electrode and said cathode, said dielectric material constituting the main mechanical support for said discharge device.

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