Feb. 18, 1936. F. A. KOLSTER 2,031,490

HIGH FREQUENCY CIRCUIT

Filed Oct. 31, 1934

Fig. 1.

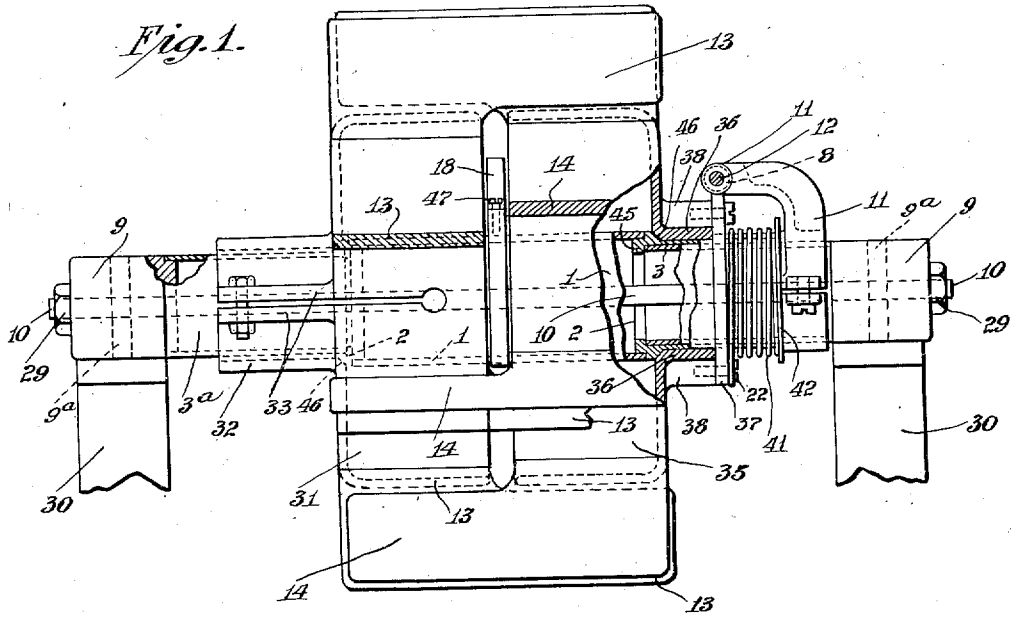


Fig. 2.

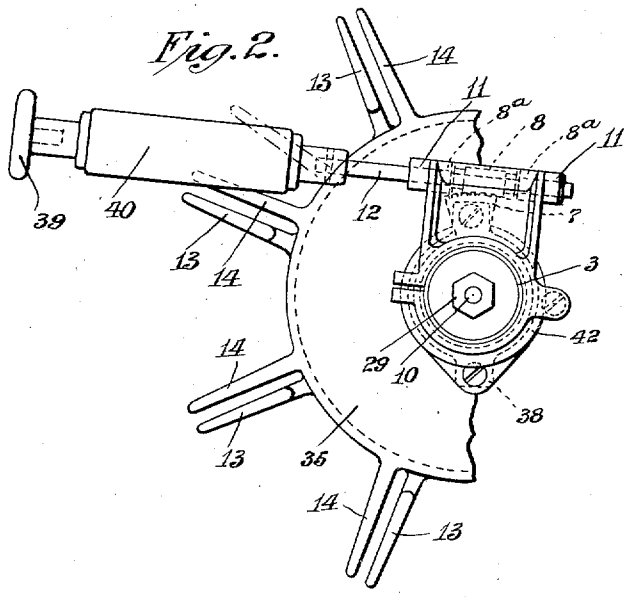
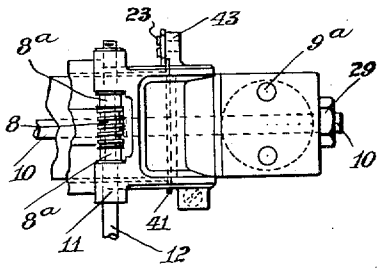


Fig. 3.



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HIGH FREQUENCY CIRCUIT

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6 Claims. (Cl. 250—40)

This invention relates to high frequency circuits, and particularly to tank flywheel frequency determining circuits especially useful in connection with vacuum tubes employed as oscillation generators.

An object of the invention is the production of such a tank circuit, the frequency characteristic of which is substantially constant for wide variations in temperature of the elements thereof.

Another object of the invention is the provision of such a tank circuit formed as a simple, compact unit, easily mounted and adjustable over a fairly wide range of operating frequencies.

In one of its aspects the invention is an improvement over my co-pending application Ser. No. 637,564, filed October 12, 1932, and particularly as disclosed in Figures 1 to 3 thereof.

A tank circuit embodying the invention is particularly useful in high frequency radio systems employing frequencies of 60,000 kilocycles, that is, for wavelengths of five meters and below.

Other objects of the invention will appear from the description and claims.

An embodiment of the invention is illustrated in the accompanying drawing, wherein:

Figure 1 is a front elevation, partly in section, of the unitary tank circuit;

Figure 2 is a broken right end elevation of the device of Figure 1; and

Figure 3 is a top plan of the mechanism for adjusting the tank circuit.

The tank circuit according to the invention comprises a closed oscillatory circuit containing inductance and capacity elements. The principal inductance element is formed as a tube 1 of high conductivity copper. This tube 1 is connected at each end by coupling rings 2 to extension tubular members or end tubes 3 and 3a, which are also of high conductivity copper. The tubular member 1 with the end tubes and coupling rings are held together as a unit by means of supporting metallic blocks 9 and co-operating tie rod 10 which extends through said members and is provided with nuts 29 which hold the assembly firmly together. The supporting blocks 9 are each provided with two openings 9a for the passage of bolts employed to fasten the structure to supporting insulator pillars 30.

Supported upon the left end tube 3a is a cup-shaped member 31 having radially projecting flanges 13 which serve as condenser plates. The cup-shaped member 31 has a split tubular extension 32 surrounding the end tube 3a and provided with a pair of flanges 33 on opposite sides thereof, through which bolts extend for clamping the cup-shaped member 31 in proper position on the end tube 3.

A second cup-shaped member 35 is rotatably supported on the right end tube 3 by a tubular extension 36 fitting over tube 3. This cup-shaped member 35 has radially extending flanges 14 similar to flanges 13 on the other cup-shaped member. These flanges 14 are the same in number as the flanges 13 and serve as condenser plates. Flanges 13 form condenser plates of the stator of the condenser, while flanges 14 form the condenser plates of the rotor of the condenser.

As shown, the rotor and stator condenser plates are staggered and there are eight of each. This number may be increased or decreased, but with eight, the tuning angle of the condenser is about 15 degrees.

The rotor 35 of the tank circuit condenser may be rotated to vary the distance between the rotor and stator plates by means of a worm drive. This worm drive comprises a worm gear 8 carried by a worm shaft 12 rotatably supported in a drive bracket 11, the worm 8 being fixed to shaft 12 and spaced from the arms of the bracket by means of spacing sleeves 8a. The bracket 11 is formed at its lower end so as to surround end tube 3 and is split so as to be held firmly in clamped adjusted position thereon. The worm 8 engages a worm gear segment 7 formed on an annular plate 37 which surrounds the end tube 3 and is held in spaced relation thereto by being bolted or otherwise fastened to lugs 38 provided on the rotor 35.

For operating the worm 8 a hand-wheel 39 is connected to the shaft 12, an elongated insulator 40 being interposed between the hand-wheel 39, which may be of metal, and the worm shaft 12. The tank circuit ordinarily will be mounted back of a panel, with the operating hand-wheel in front thereof.

The condenser rotor 35 is held yieldingly in its extreme left position by means of a coil spring 41 surrounding end tube 3. This spring is interposed between the annular member 37 carried by the rotor and a thrust ring 42 also surrounding the end tube 3 and positioned adjacent the bracket 11. One end of this spring is fixed to the rotor by being fastened under the head of the screw 22, while the other end is fastened to an extending lug 43 on the bracket 11 by being fastened under the head of the screw 23.

The spring also assists in holding the rotor in adjusted position, and prevents any backlash in

the operating mechanism from affecting the adjusted position of the rotor.

The cup-shaped stator **31** and rotor **35** with the condenser plates may be cast of bronze, and then copper-plated. To prevent corrosion the stator and rotor may be lacquered.

It will be noted that the coupling rings **2** are formed at one end as plugs **45** inserted in the ends of the central tubular inductance member **1**. The opposite side of each of the rings **2** is formed to receive end tubes **3** and **3a**. Each coupling ring **2** is also formed with a conical surface **46** against which a like conical surface on the stator and the rotor is held in firm electrical contacting engagement. This electrical engagement between the mating conical surfaces on the stator **31** and the coupling ring **2** is maintained by the stator being held in clamped position, while such contact between the mating conical surfaces of the rotor and the other coupling ring is maintained due to the action of the coil spring **41**, so that as the rotor is adjusted the said contact is maintained.

The particular construction of employing a central tubular inductance **1** and end tubes **3** with coupling rings **2** permits the use of inductance tubes **1** of different diameter, so that the operating frequency range of the circuit may be altered. To make such alteration it is merely necessary to provide central tubes of other diameters and other coupling rings with the plug ends thereof of appropriate diameters. A tubular inductance element of sufficient length may be employed thereby eliminating the coupling rings and end tubes.

The stator and rotor are, of course, maintained with their open faces in spaced relation. For making electrical connection to the electrical midpoint of the inductance element of the tank circuit, the tubular inductance element **1** is provided with a clamp **18** surrounding the tube. This clamp **18** may be held in adjusted position by means of a set screw **47**.

The length of the rotor and stator condenser plates **13** and **14** is such that as the structure expands and contracts slightly under varying temperature conditions the area of opposed plate surfaces will remain constant. Thus, the varying conditions of expansion and contraction will have no effect upon the capacity of the tank circuit insofar as the plates of the condenser element are concerned because the spacing and opposed area thereof remain constant. The expansion and contraction, under varying heat conditions, will, however, cause some slight changes in capacity due to the varying of the distance between the opposite open ends of the stator and rotor. The capacity between the opposite edges of these cup-shaped members is very small and forms only a very small part of the capacity in the tank circuit. The variations in such capacity between the opposing edges of these cup-shaped members may be reduced still further by reducing the thickness of the wall of the cup-shaped members at the opposing edges, and/or by increasing the distance between them.

The inductance of a tank circuit is formed by the central tube **1** together with the cup-shaped members **31** and **35**. The inductance path of the tank circuit is, therefore, toroidal.

The resistance of the tank circuit is extremely low, being of the order of less than one-hundredth of an ohm.

Tank circuits embodying this invention have been constructed in which for wavelengths of three meters, the capacity is approximately 60 micro-micro-farads, the inductance approximately .05 micro-henries, and the resistance approximately .009 ohms, which gives a Q of upwards of 3000, the value of Q being determined from the formula

$$Q=\sqrt{\frac{L}{R^2C}},$$

where L is the inductance, R the ohmic resistance, and C the capacity of the tank circuit. Such a tank circuit has been found to be very useful in connection with vacuum tubes for the production of high frequency oscillations.

In another practical embodiment of the invention, the tank circuit constructed was capable of use in oscillation generator systems in the production of wavelengths varying between three and five meters. By increasing the diameters of the central inductance tube **1**, the oscillations of shorter wavelengths are produced.

In tank circuits embodying the invention, which have been constructed, the frequency stability has been remarkably good. Thus, for temperature changes of 30° centigrade, there has been a change in frequency of less than 2,000 cycles in 60,000,000.

Although the tank cicrcuit has been illustrated as being mounted with the inductance tube **1** in horizontal position, the mounting may be such as to have the tube **1** extend vertically. When so mounted, insulating pillars **30** will not be required for the cup-shaped stator **31** will rest upon and be fixed directly to supporting insulators.

What is claimed is:

1. An electrical circuit comprising a metallic tube forming an inductance element of said circuit, a pair of dome-shaped metallic devices mounted in spaced relation at opposite ends of said tube in electrical contact therewith, one device being fixed and the other rotatable relative to said tube, flanges on both devices positioned to form a variable capacity element of the said circuit and so that the separation thereof is variable by rotation, and means for rotating said rotatable device to vary the distance between the flanges of said devices.

2. An electrical circuit comprising a metallic tube forming an inductance element of said circuit, a pair of dome-shaped metallic devices mounted in spaced relation at opposite ends of said tube in electrical contact therewith, one of said devices being rotatable relative to the other, and radially extending flanges on both devices positioned to form a variable capacity element of the said circuit and so that separation thereof is variable by rotation.

3. An electrical circuit comprising a metallic tube forming an inductance element of said circuit, a pair of dome-shaped metallic devices mounted in spaced relation on said tube in electrical contact therewith, one of said devices being rotatable relative to the other, radially extending flanges on said devices positioned to form a variable capacity element of said circuit and so that the separation thereof is variable by rotation, and means for rotating said rotatable device to vary the capacity between the said flanges.

4. An electrical device comprising, as a composite unit, a conducting rod constituting an inductance element of an electrical circuit, a pair of spaced conducting members electrically connected to said rod, one being rotatable relative to the other, said members forming a variable

capacity element co-operating with said inductance element to provide a closed oscillatory circuit and being so positioned that the distance therebetween is variable by rotation, and means for rotating said rotatable member to vary the distance between said members.

5. An electrical circuit comprising, as a composite unit, a metallic tube forming an inductance element of said circuit, a pair of dome-shaped metallic members mounted in spaced relation along said tube in electrical contact therewith and co-operating with said element to provide a toroidal inductance path, and a plurality of equally spaced radially extending flanges on each member, the flanges of one member being staggered with respect to the flanges of the other and positioned to present opposing faces thereby to form multiply connected capacity elements of said circuit.

6. An electrical circuit comprising, as a composite unit, a metallic tube forming an inductance element of said circuit, a pair of dome-shaped metallic members mounted in spaced relation along said tube and in electrical contact therewith whereby under varying operating temperatures said spacing varies due to expansion and contraction of said tube, and radially extending flanges on said members positioned in opposing relation to form a capacity element of said circuit the capacity of which is unaffected by variation in said spacing.

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