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SEARCH ROOM

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RADIO FREQUENCY OSCILLATION SYSTEM

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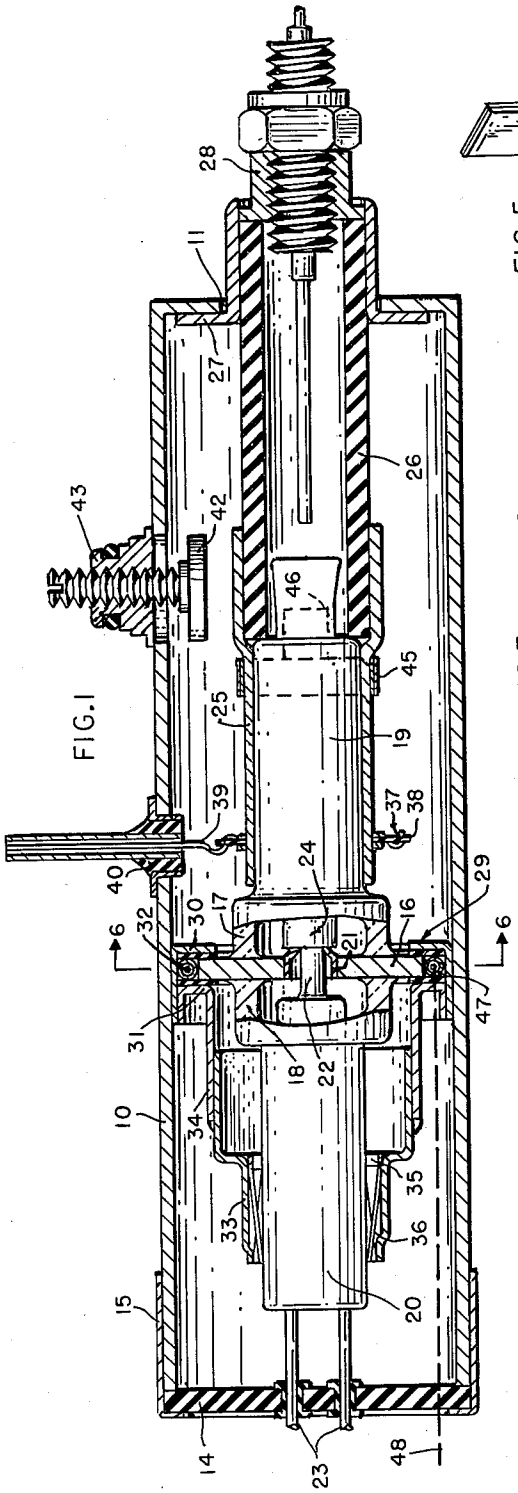


FIG. 1

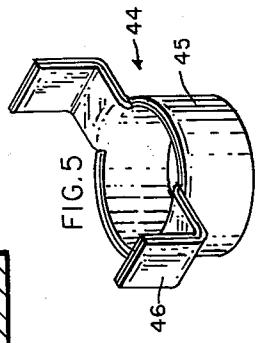


FIG. 5

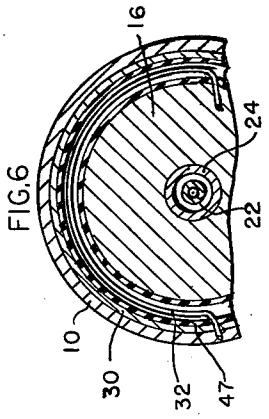


FIG. 6

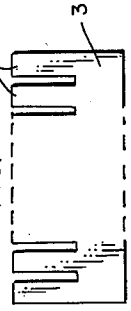


FIG. 3

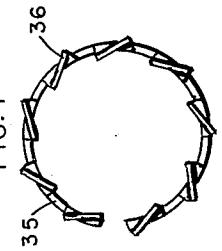


FIG. 4

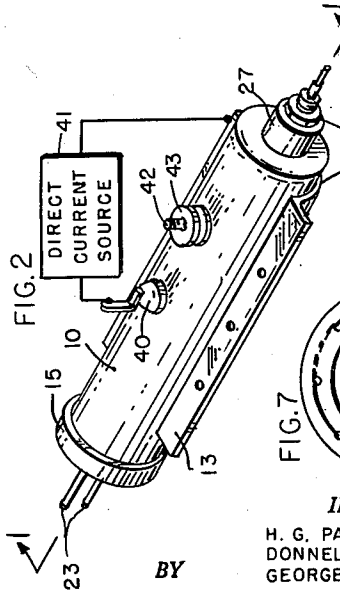


FIG. 2

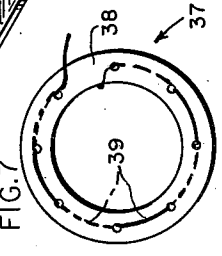


FIG. 7

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RADIO FREQUENCY OSCILLATION SYSTEM

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This invention relates to radio frequency oscillating systems and particularly to such systems which oscillate at ultra high frequencies and which are dimensionally compact and highly resistant to intense mechanical shock and vibration and in which certain circuit elements thereof are adjustable to achieve maximum operating efficiency over a wide frequency band.

The structure of the device of the invention provides an extremely rigid inclosure which functions as an electrical component as well as providing complete protection for the inclosed elements. The system may be roughly divided into two main sections one of which includes the above mentioned casing having certain structural and circuit elements secured thereto and a three element thermionic tube of the pencil type received within and protected by the casing.

The invention has many applications not the least important of which is in the operation of and tracking of missiles. In such service electrical stability and maximum reliability is of utmost importance. An important feature of the invention resides in the ingenious design and arrangement of elements to supply maximum resistance to the intense shock and vibration encountered in such severe service and thus maintain stability and reliability. The above characteristics are combined with an effective organization of components which provides a dimensionally compact and efficient device.

The thermionic tube is or may be of the type commonly known as a pencil tube whose structure is elongated and of small diameter. A tube of this type is readily adapted to incorporation in the device of the invention. Since the objectives of the invention are, among other things, to provide a high frequency oscillator of great physical strength and extreme compactness it was determined that the outer member of the assembly should best follow a hollow generally cylindrical contour thus to offer maximum protection for the inclosed inner components of the assembled apparatus.

Oscillator systems made in accordance with the invention are low in cost since they may be made of low cost materials and assembled by mass production techniques and moreover overall performance tests are readily made without certain critical tube tests which have heretofore been necessary in devices of a similar nature. The main body portion of the invention desirably may be made by an economical sheet metal drawing or forming operation and many of the other parts may be selected from standard items manufactured at low cost in large quantities.

Previous oscillators of similar type have consisted of relatively massive and expensive precision machined circuit elements of the cavity type into which tubes are inserted, each tube insertion requiring substantial and costly readjustment of the circuit elements. Oscillators made according to the invention are so constructed that they may be replaced in a system with very little or no adjustment and the operation may be done by an unskilled workman.

The basic structure of the device includes an elongated sheet metal cup or its equivalent which forms a casing within which the components of the system are received. A pencil type thermionic three element tube having at its ends anode and cathode terminals and a grid disc near its mid section. The tube is supported concentrically within the casing. Its anode end is supported by a tubular beryllia insulator of substantial size and mechanical strength. This insulator fits over and is soldered to the anode terminal of the tube. Its outer end is rigidly secured to the end closure of the casing which includes a feed thru coaxial radio frequency output terminal the inner member of which projects inward to establish capacitive coupling to the anode terminal.

The tube is further supported in the casing by its grid disc which is slightly smaller in diameter than the inner diameter of the casing. An annular metallic generally ring shaped support is inserted between the periphery of the grid disc and the casing and is insulated from the grid disc. Feed back energy for the system is provided by the capacitive relationship between the grid disc and the support ring which is electrically connected to the casing which itself is part of the oscillating circuit.

The cathode end terminal is provided with a plunger type connection which has good electrical contact with and is slidable along the terminal axially. This slidable member has telescoping connection with the grid disc support ring. Cathode heater connection is made thru an insulating disc fixed in the cathode end of the casing.

Direct current input energy is fed to the anode terminal by a wire extending thru an insulator in the casing wall. The wire makes substantially one turn around the anode terminal and is then soldered thereto. The turn of wire constitutes a radio frequency choke to prevent feed back to the direct current source. Other features are an adjustable capacitor between the casing and the high voltage end of the anode terminal which controls the oscillator frequency in connection with adjustment on the cathode terminal. A bimetallic member at the high voltage end of the anode automatically compensates for frequency drift due to thermal dimensional variations. A more detailed description of the system will be presented hereinafter.

A primary object of the invention is to provide a radio frequency oscillator which may be manufactured at low cost thru the use of inexpensive materials and mass production techniques.

A further object of the invention is to provide a radio frequency oscillator having compact dimensions coupled with rugged mechanical and electrical stability.

A still further object is to provide a radio frequency oscillator including a special type of insulator between its high voltage anode and its lower voltage components to serve the multiple purpose of a rigid support for a thermionic tube of the oscillation system and to constitute a channel for the rapid dissipation of heat.

A further object of the invention is to provide a radio frequency oscillator which may be manufactured with great facility and without variation in operating characteristics from unit to unit.

A further object of the invention is to provide a radio frequency oscillator having pre-adjustment facilities of circuit variables to achieve maximum efficiency over a relatively wide frequency band.

A further object of the invention is to provide a radio frequency oscillator having maximum resistance to shocks and vibration.

A further object of the invention is to provide a combination of elements which perform multiple functions, such combination consisting of a grid feed back assembly combined with a cathode adjusting means which coact to provide efficient grid feed back, to provide the main cathode circuit and to constitute a firm mechanical support for the thermionic tube.

Other objects and features will more fully appear from the following description and will be particularly pointed out in the claims.

To present a better understanding of the invention a particular embodiment thereof will be described and illustrated in the accompanying drawings wherein—

FIG. 1 is a longitudinal partial cross section of the device.

FIG. 2 is a perspective view illustrating the external appearance of the invention.

FIG. 3 is a developmental view of a spring type connecting member in the cathode circuit of the device.

FIG. 4 is an end view of the completed connection shown in FIG. 3.

FIG. 5 illustrates a frequency stabilizing member.

FIG. 6 is a cross section on line 6—6 of FIG. 1.

FIG. 7 is a detail view of a radio frequency choke coil for feeding high voltage current to the device.

The oscillator system of the invention is so constructed that its component parts are contained within a casing **10** which constitutes a cavity which electrically influences operation of the device. The casing **10** also provides a high degree of mechanical protection for the parts contained therein and serves as a rigid frame within which the parts are supported. The casing **10** may be economically made by a metal forming or drawing operation from sheet steel or other metal which should be of sufficient thickness to provide a rigid structure. The casing is an elongated hollow cylindrical cup having an aperture **11** in its closed end. If desired the casing may be further reinforced by the member **12** which has the shape of the casing extending partially around its outer surface and is provided with flanges **13** as shown in FIG. 2. The member **12** is soldered or otherwise secured to the casing **10** and its flanges provide rigid securing means for installing the oscillator. The open end of the casing is closed by a disc of insulation **14** thru which electrical connections extend as will appear hereinafter. The disc desirably is held in place by an inwardly flanged metallic retaining ring **15** soldered to the casing. The term soldered is used in its broad sense and is intended to include soldering, brazing or other similar techniques.

The oscillating system may desirably be considered to consist of two main assemblies combined in such a manner that the function of the one complements the function of the other to produce a high efficiency system. The inner assembly is a three element thermionic device of the type commonly referred to as a pencil tube which is elongated and of relatively small diameter. Its elements are proportioned to provide oscillations at very high frequency such as in the 2800 to 2900 mc. band. Its elements are also constructed to withstand intense shock and vibration. In the particular pencil tube incorporated in the oscillator of the invention the overall length of the tube has been decreased by shortening its internal elements and the length of the envelope glass. A core rod has been added to the cathode heater for added support and the grid disc is of substantial thickness for added strength and has been reduced in diameter from that which is used in the more conventional tubes of this type.

As illustrated in FIG. 1 of the drawing the pencil tube is provided with a grid disc **16** at its mid section to which are fused glass envelope sections **17** and **18** to which are fused respectively anode and cathode terminals **19** and **20** which are elongated metallic tubes. The disc **16** has a central aperture within which the cylindrically shaped grid **21** is secured in electrical contact therewith. The emissive end of the cathode **22** which is connected to the cathode terminal **20** extends into the grid and is held in spaced operative relation therewith. The cathode heater not shown is received within the hollow cathode and is provided with leads which extend thru the main cathode terminal **20** and insulated therefrom. The leads terminate in pins **23** which extend thru the insulation disc **14** for connection to a suitable source of current not shown. The anode **24** surrounds the grid **21** and is connected to the anode terminal **19**. The envelope formed by the above described elements is evacuated.

Special means are provided for rigidly securing the tube within the casing **10** such means constituting not only supports but also serving as electrical components for the oscillation system. The anode end of the tube is provided with a metallic sleeve **25** which constitutes the anode line desiredly maintained at one half operating wavelength. The sleeve fits over and is soldered to the anode terminal **19**. The sleeve **25** extends beyond the anode terminal and has received therein one end of a tubular insulator **26** which in turn extends outward axially from the tube and is received at its outer end in an eyelet structure **27** which is soldered or otherwise secured in the aperture **11** of the casing **10**. The insulator **26** desirably is of specialized material. The particular material used is beryllia which is a good conductor of heat thus providing a path for the rapid dissipation of heat from the inner assembly to the casing **10** which itself is a substantial heat sink and presents a large radiating area. The beryllia insulator may also be readily soldered and is a good high frequency insulator. For a short distance each end of the outer surface of the insulator is metalized by the well known tungsten-iron process. To rigidly fix the insulator in position its inner end is soldered to the extension of the anode sleeve **25** and at its other end to the eyelet **27**. By so doing the anode end of the tube is rigidly held in the casing.

The eyelet structure **27** serves to support a conventional coaxial radio frequency output terminal **28** to the center conductor of which is soldered a length of metallic tubing or wire which extends inward toward the outer end of the anode terminal sleeve to a point at which it has the correct value of coupling with the anode to function as the radio frequency output conductor of the system.

The cathode end of the tube is supported at two positions by devices which not only act as supports but also are component parts of the oscillating system. The peripheral edge of the grid disc **16** is encased in but insulated from a metallic annular structure **29** composed of two sections **30** and **31**. The section **30** is L-shaped in cross section and fits closely against the inner surface of the casing **10** and is soldered therein during assembly of the device. The section **31** has a tubular portion extending parallel to and spaced from the cathode terminal **20** while its other end is flanged outward at right angles to the tube axis lying parallel to the side face of the grid disc in the same manner as the inwardly turned portion of the section **30**. The outwardly flanged portion of the section **31** is bent back for a short distance parallel to the tube axis and fits closely within and is soldered to the section **30**. A tube **47** of Teflon or other insulation is placed between the peripheral edge of the grid disc and casing and serves to centrally locate the disc and insulate it from the casing. Also Teflon or equivalent washers are inserted between the two sections of the grid disc support structure **29** and the disc to complete the insulation of the grid disc from the casing. Teflon is the registered trademark of E. I. du Pont de Nemours and Co. Inc., for fluorocarbon resin insulating material.

A radio frequency choke wire **32** is inserted in the Teflon tube surrounding the grid disc, one end of this wire is connected to the grid disc and extends approximately three quarters of a turn around the disc and its other end is extended thru the tubing and connected to the grid disc support structure **29**. The wire **32** thus provides a radio frequency choke in parallel with the feed back capacitor formed by the spacing between the grid disc and the structure **29** and also provides the direct current grid return.

The cathode circuit includes an adjustable plunger type coaxial structure the inner member of which is the cathode terminal while the outer concentric member is a two section telescoping tube. To provide for adjustment the outer section **33** has a small portion slidable along the cathode terminal and an enlarged portion which fits closely within the cylindrical extension **34** of the

structure 29. A plurality of spring contact fingers are placed between the terminal 20 and the smaller end of the plunger 33. The fingers may be provided in any suitable manner. As shown in FIGS. 3 and 4, a strip of spring metal 35 such as beryllium copper has a series of fingers 36 formed therein each finger being given a permanent twist of about 30 degrees. The strip is shaped into a ring and soldered into the small end of the plunger 33. The dimensions of the inner and outer members of this coaxial construction are such that the fingers tend to be flattened thus providing spring contact between the two conductors. The spring of the fingers also permits of some excentricity of the whole assembly without imposing excessive force on the tube cathode terminal. This coaxial cathode circuit is electrically approximately one quarter wavelength of the operating frequency in length and may be adjusted to a given frequency during manufacture by moving the plunger 33 after which the telescoping surfaces between the plunger and the portion 34 of the assembly 29 are soldered. The tuning of the completed oscillator will be described more in detail hereinafter.

Direct current power is supplied to the system thru a radio frequency choke 37 surrounding the anode sleeve 25. The choke winding is supported by an annular insulating disc 38 provided with a series of holes thru which the wire 39 is threaded as shown in FIG. 6. The input end of the wire extends thru an insulator 40 secured in the casing 10 and is connected to a high voltage direct current source 41. The wire makes substantially one complete turn. Its inner end is connected to the anode terminal near the inner end thereof. The choke serves the usual purpose of preventing radio frequency energy from flowing to the direct current source.

Accurate frequency adjustment is provided by a capacitive adjusting member 42 situated at the high energy outer end of the anode sleeve 25. The member 42 has a flat surface inner end and is provided with a screw threaded shank portion which has threaded engagement with metallic bushing 43 soldered or otherwise rigidly electrically secured to the casing 10. By rotating the member 42 its capacity relationship to the anode is varied thus varying the resonant frequency of the oscillator output.

The above described oscillator is designed as a plate modulated device although it may also be operated as a continuous wave unit. As a plate modulated unit the device has produced 250 watts output with a 1000 volt pulse applied to its anode. The maximum pulse duration used was one microsecond.

The device may also be operated as a grid modulated unit in which case it has produced a peak power output of 2.5 watts with 250 volts direct current on the anode. In this latter case a grid choke wire 48 shown in dotted lines in FIG. 1 instead of being returned to the casing is brought out thru holes in the Teflon washer and the adjacent grid disc support structure, suitable insulation being supplied to isolate the wire from the support structure and the casing. This wire is extended to and thru the insulating disc 14 where it may be connected to a direct current bias and a grid pulsing means. In this form of the device the cathode circuit is adjusted to a shorter length. All of the metal parts within the casing are desirably silver plated to reduce corrosion and radio frequency losses.

Means are also provided for automatically stabilizing the operating frequency of the oscillator thruout a wide range of temperatures. Thermal changes cause changes in physical dimensions which in turn cause frequency drift. To counteract this effect a bimetallic member 44 is secured to the outer end of the anode line. This member comprises a band portion 45 and a pair of ears 46 which extend outwardly from the band and occupy a position between the anode line and the casing 10. As temperature changes occur the ears 46 are designed to shift their position to the correct extent to produce a change in capacitive coupling sufficient to counteract the shift in frequency which the change in temperature has caused.

Both types of the device are tunable thru the member 42 from 2850 mcs. to 2950 mcs. and operate into a load of 50 ohms with a standing wave voltage ratio of 1.1 or less. The same pencil tube is used in both types. It should be pointed out that the devices may be designed to function thruout frequency bands other than that specified and at different power input voltages. Oscillation is automatic when the input pulse is applied due to the feed back energy which is present.

To better point out the great economic benefit of the device of the invention a fabrication procedure will be outlined. Heretofore such procedures were not possible. Oscillators previously used for the same service as that of the invention have consisted of relatively massive and expensive machined circuit elements of the cavity type into which thermionic tubes were inserted. When it was necessary to provide for different circuit requirements with this type of system substantial and time consuming skilled readjustment of the circuit elements was required each time a tube was inserted.

In the present invention the tube may be preadjusted during assembly to function efficiently in a specified frequency band by a simple procedure and since the cost of manufacture is very low compared to previous oscillators in this class the savings in cost of supplying oscillators for a particular use is found to be very important and moreover replacements are readily made by unskilled labor and a high degree of uniformity in performance is obtainable from one unit to another.

To further indicate the economy of manufacture an assembly procedure which lends itself to mass production will be outlined. First a subassembly consisting of the casing 10, the reinforcing and supporting member 12 and the eyelet structure 27 are brazed together. The retaining ring 15 is also soldered in place.

Secondly the grid disc support structure 29 and the cathode plunger 33 are assembled to the tube. Thirdly the anode line sleeve 25 and insulator 26 which have been soldered together are soldered to the tube terminal 19. The anode choke 37 and the bimetallic member 46 are soldered to the anode line at this time.

Fourth the above parts assembled to the tube are now put in position in the casing 10. To hold these two main subassemblies together the metalized insulator 26 is soldered into the eyelet structure 27 and the grid disc support structure 29 is soldered to the inside surface of the casing.

Fifth the frequency adjusting member 42 and the input wire insulator 40 are fixed in position in the casing 10.

Sixth the insulation disc 14 and the coaxial output member 28 are secured in position at which time the completed device is ready for test.

The devices thus made are capable of withstanding five blows of 500 gravities in each of three directions without deterioration of power output or a frequency deviation of ± 1 mc. out of 2900 mc. They will also withstand close to 10,000 gravities longitudinally in the direction to throw the load against the insulator 26 and the output end of the casing without damage.

There are many uses for oscillators of the type herein presented. An important use and one in which the oscillators have been found to perform exceptionally well is in the tracking of missiles for telemetering signals or for other functions concerned with missile operations.

What is claimed is:

1. A radio frequency oscillator system of the coaxial type comprising a three element thermionic tube, a metal casing acting as the outer member of the coaxial structure, said tube presenting anode and cathode terminals an extension of said anode terminal to form an anode line and a grid disc connected to the tube grid having its periphery

extending outside the envelope of said tube, a rigid elongated tubular insulator in axial alignment with said tube and soldered to said casing and to said anode terminal to form a rigid support for said tube, said tubular insulator extending outward away from said anode terminal, an elongated probe type output electrode in said tubular insulator having capacitive coupling with said anode terminal line and insulated from and extending thru said casing, an annular capacitor element inserted between the inner wall of said casing and the peripheral edge of said grid disc, electrically connected to said casing but insulated from said disc, said capacitor element serving as a rigid support for the tube within the casing, a coaxial cathode circuit including said cathode terminal having its outer member connected between said grid capacitor and said cathode terminal and means to supply operating energy to said system.

2. An oscillator system according to claim 1 and means to adjust the length of said coaxial cathode circuit.

3. An oscillator system according to claim 2 and an adjustable capacitor connected in shunt between said anode output terminal and said casing.

4. A radio frequency oscillator comprising a rigid metallic generally cylindrical casing for inclosing the components thereof and to act as an electronic cavity, a thermionic tube of small diameter presenting elongated cylindrical cathode and anode terminals and a thick grid disc connected to the tube grid having its periphery projecting outside the tube envelope, a metallic tube soldered concentrically to said anode terminal and forming therewith a one half wavelength anode line, a tubular insulator of substantial length positioned axially in said casing and soldered at its ends respectively to the end of said casing and to the end of said anode line, a probe type output conductor insulated from and extending outward thru the end of said casing said conductor extending inward into capacitor coupling relation with said anode line, an annular tube support between the periphery of said grid disc and the wall of said casing, said support being insulated from but having capacitive coupling with said grid disc, a coaxial cathode circuit the outer member of which is adjustable in length and connected between said annular support and said cathode terminal and energy supplying means to supply operating energy to said system.

5. A radio frequency oscillating system according to claim 4 and wherein the said tubular insulator is made of beryllia.

6. A radio frequency oscillation system according to claim 4 and an annular resilient fingered electrical contactor received between the two members of the said coaxial cathode circuit.

7. A radio frequency oscillation system according to claim 1 and a bimetallic element connected to said anode line and extending into the space between the anode and said casing to act as a shunt condenser automatically to counteract shifts in operating frequency due to changes in the temperature of the oscillator.

8. A radio frequency oscillator system comprising a three element thermionic tube having endwise extending elongated anode and cathode terminals and a peripherally exposed grid disc connected to its grid, a casing of generally cylindrical form to axially receive said tube, an elongated tubular mechanically rigid insulator having solderable surfaces at its ends, means to extend said anode terminal to a wavelength dimension determined by the operating frequency of the oscillator, said insulator being soldered at one end to said anode terminal and at its other end to said casing, an electrically conductive annular structure surrounding and embracing the outer edge of but insulated from said grid disc and soldered to the inner surface of said casing whereby capacitive coupling is set up between said grid disc and annular structure, a tubular extension from said annular structure surrounding said cathode terminal and composed of two metallic solderable telescoping sections, spring tension electrical connecting means between said tubular extension and said cathode terminal, means to supply operating energy to said system and an output conductor insulated from said casing extending axially into said insulator adjacent to said anode terminal.

9. A radio frequency oscillating system according to claim 8 and adjustable capacity means connected in shunt between said anode and said casing.

10. A radio frequency oscillating system according to claim 9 and automatic thermally actuated means to counteract changes in output frequency caused by temperature changes in the oscillating system.

11. A radio frequency oscillator system according to claim 1, and a radio frequency choke connected between said grid disc and said metal casing.

12. A radio frequency oscillator system according to claim 4 and a radio frequency choke connected between said grid disc and said casing.

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