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Sept. 18, 1956 | H. O. LORENZEN | 2,763,783

HIGH FREQUENCY OSCILLATOR

Filed April 5, 1946 | 3 Sheets-Sheet 1

Tunable osc. using "lighthouse" tube (tunable) having long line connected to cathode and anode. Adjust feedback coupling provided by aperture 15 between lines

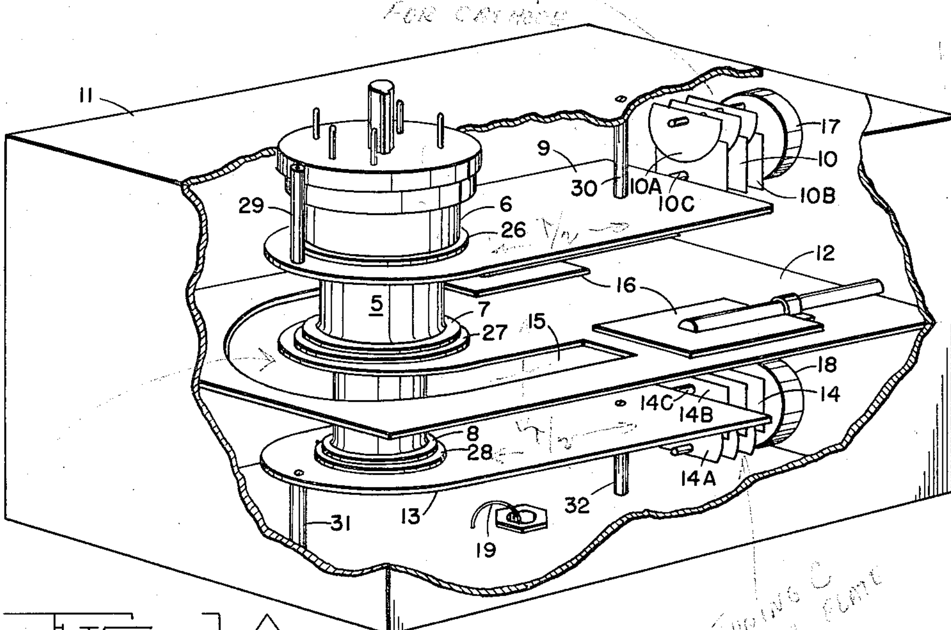

FIG. 1A

Provides electromagnetic coupling between anode & cathode (feedback). Coupling varied by varying size of aperture 15 with movable shutters 16

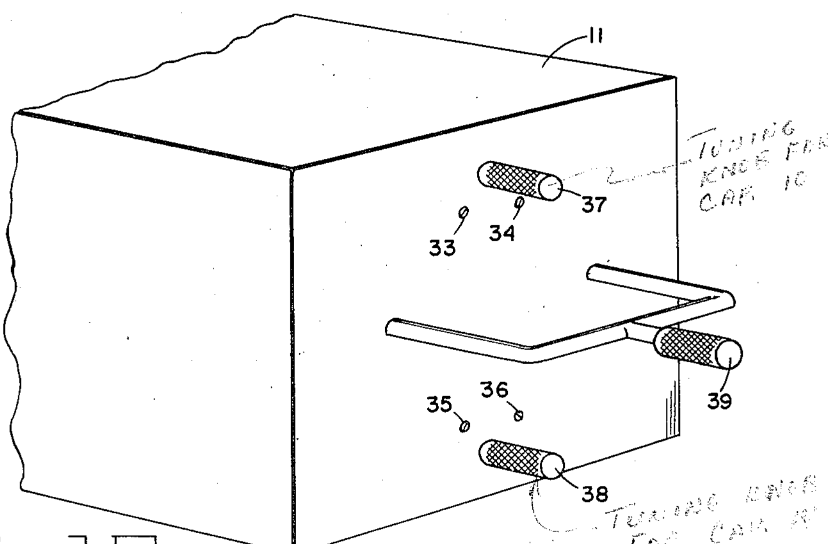

FIG. 1B

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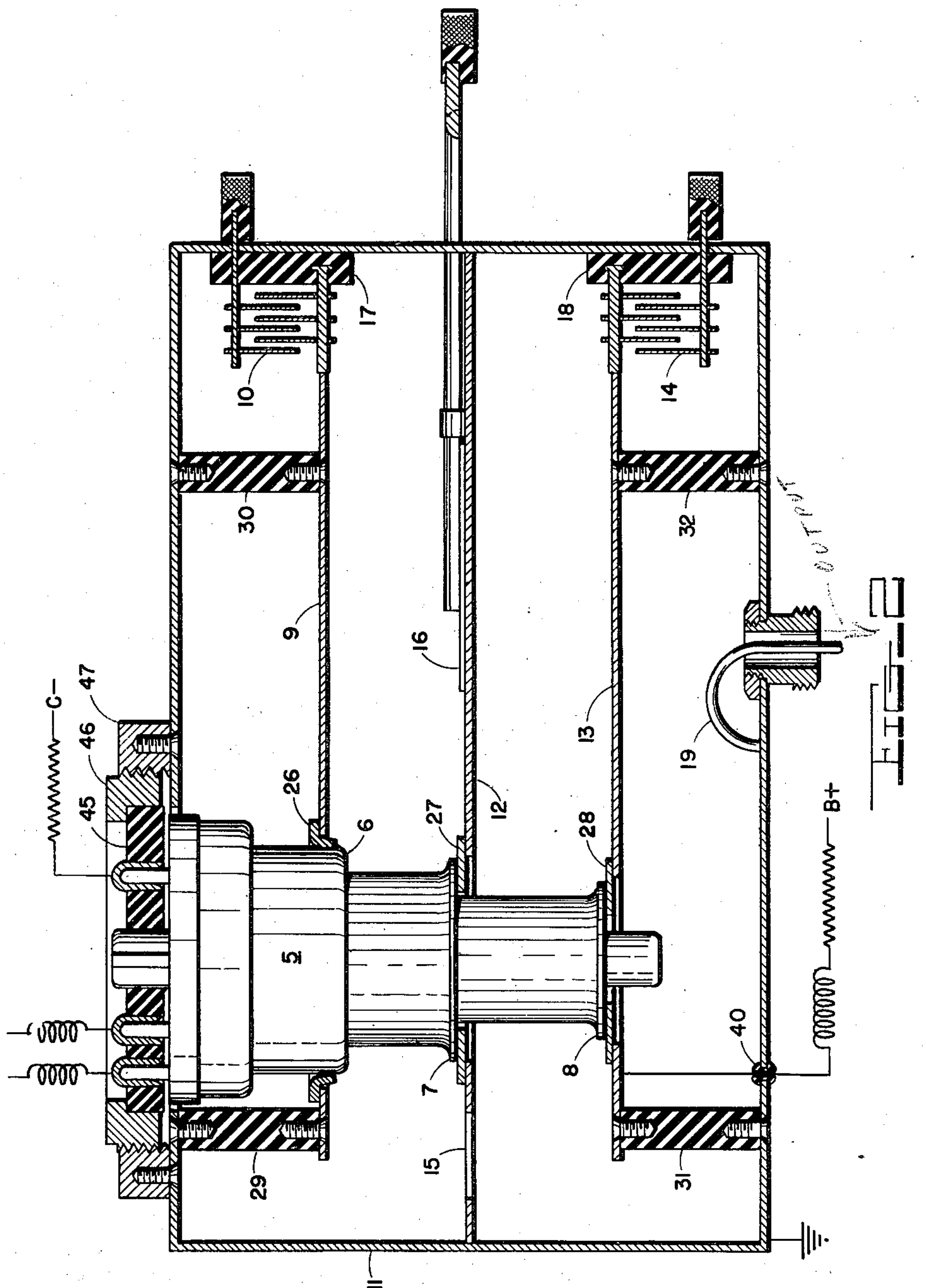

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HIGH FREQUENCY OSCILLATOR

Filed April 5, 1946 3 Sheets-Sheet 3

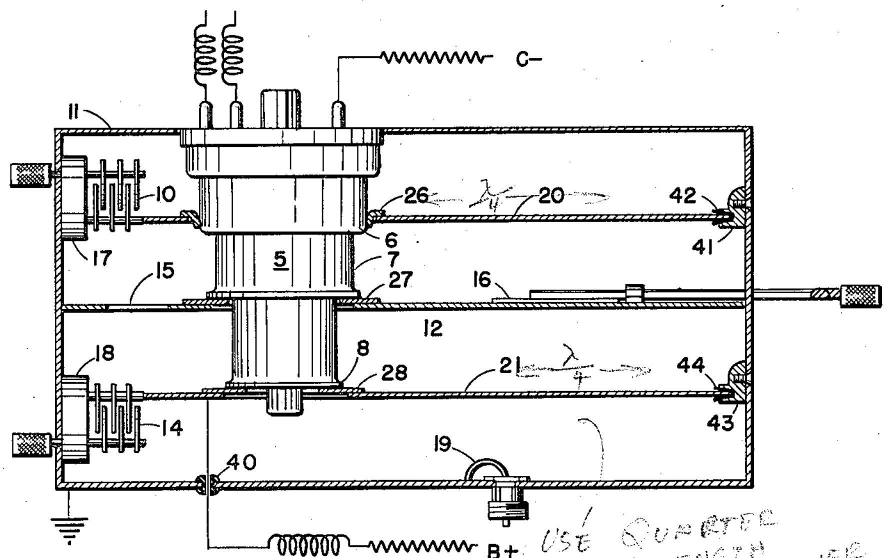
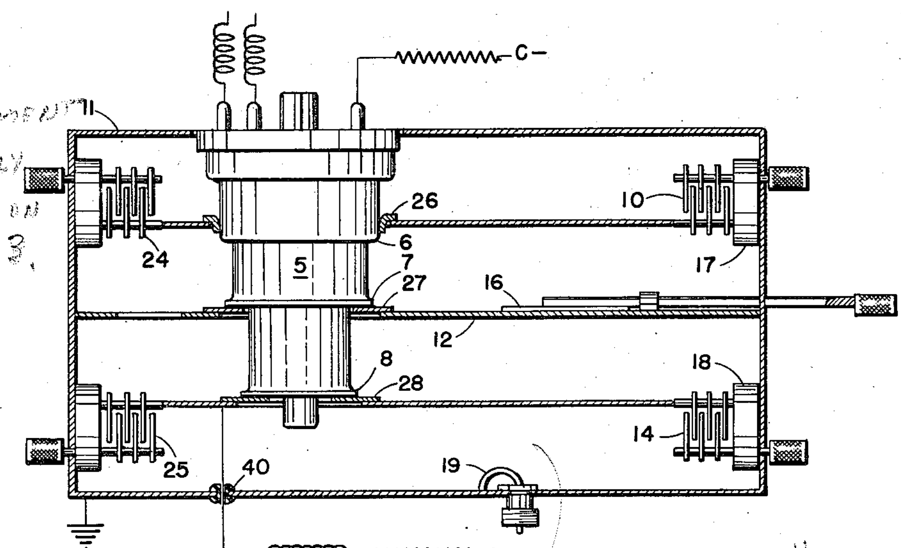


FIG. 3

USE QUARTER WAVE-LENGTH LINES (FOR LOWER FREQ OF OSC.)



THIS EMBODIMENT IS ESSENTIALLY A COMBINATION OF FIGS. 2 & 3.

FIG. 4

FOR USE WITH WIDE RANGE OF FREQUENCIES

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HIGH FREQUENCY OSCILLATOR

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2 Claims. (Cl. 250—36)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The present invention relates in general to a high frequency oscillator and in particular to a line controlled type of high frequency oscillator.

A recent product of the development of line controlled oscillators is a vacuum tube which is especially designed to be axially inserted in a concentric line assembly. The line assembly, for one modification of this tube, commonly referred to as a "lighthouse tube," comprises three cylindrical line sections, each of a different diameter, concentrically disposed one within another. For the purpose of making contact with the cylinders of the assembly, the tube has its electrical terminals projected from its envelope in the form of annular rings. These rings are each of a different diameter and lie in parallel planes normal to the axis of the tube. The cathode ring is made the largest in diameter and is located at the base of the tube; the anode ring is made the smallest in diameter and is located at the top of the tube; and the grid is in diameter intermediate to that of the anode and cathode rings and is located at the middle of the tube. Supporting the ring terminals of the tube in their chosen position is a pair of concentric glass insulating shells; one interposed between the cathode and the grid ring terminals and the other between the grid and anode ring terminals. The purpose of the disposition of the electrical ring terminals and their variation in diameter is to facilitate contact between the cathode, anode and grid ring terminals of the tube and the cylindrical section comprising the line assembly.

In oscillator circuits of the foregoing type and particularly where the diameter of the tubes is small, construction of these line assemblies becomes a very difficult problem. By means of the present invention this problem is circumvented in that it is contemplated herein to employ ordinary sheets of metal for the line sections. Such sheets being easily stamped out.

It is an object of this invention to provide an oscillator which is compact and yet the construction of which is simple, economical and rugged.

It is another object of this invention to provide an oscillator the frequency of which may be readily changed over a wide tuning range.

Still another object of this invention is to provide an oscillator which may be adjusted to give optimum performance for any frequency desired.

Fig. 1A is a cutaway illustration of one embodiment of the invention.

Fig. 1B is a cut away perspective of the embodiment in Fig. 1A.

Fig. 2 is a view, partly in cross-section, of the embodiment shown in Fig. 1A.

Fig. 3 is a view similar to that of Fig. 2 of a variant embodiment of the invention.

Fig. 4 is a view similar to that of Figs. 2 and 3 of still another embodiment of the invention.

Referring to Fig. 1A the fundamental principles of the invention may be observed. It will be noted that the oscillator as represented is designed around a tube **5** of

the foregoing type having a cathode ring terminal **6**, a grid ring terminal **7**, and an anode ring terminal **8**. To the cathode terminal is connected a metallic plate **9** which may be approximately a half-wave or a full-wave length long and of a width generally not more than one quarter its length, and which may be tuned, as hereinafter described in detail, by a capacitor **10**, located at one end of the cathode plate **9**. Plate **9** should be made from a metal sheet of high conductivity in which is cut a circular opening of a diameter suitable to receive the annular cathode ring terminal **6**. Electrical connection is obtained by a slotted annular contact ring **26** fluted and bent downward at its inner periphery so as to assume a cylindrical form which tightly grasps the cathode ring terminal **6**. This fluted ring **26** may be brazed to the metallic plate **9** assuring positive contact between the plate **9** and terminal **6**. The grid of the tube is connected to a metallic plate member **12** which is conductively secured to the inner periphery of the grounded box-like enclosing member **11**. Thus plate **12** provides grounded grid operation for tube **5**. Plate **12** should also be made from a metal sheet of high conductivity similar to the cathode plate **9**. A circular opening like that in the aforementioned plate **9** and concentric therewith will also be necessary, but of a diameter suited to the annular ring terminal **7** of the grid of the tube. Electrical connection between the grid terminal **7** and plate **12** is provided by an annular contact ring **27** which is fluted at its inner periphery to afford a flexible pressure contact against the lower face of terminal **7**. Contact ring **27** may also be brazed to plate **12**. The anode terminal **8** of the tube is connected to a plate **13** similar to plate **9** but with a circular opening of a diameter suited to receive the anode ring terminal **8**. This plate may likewise be a half-wave or a full-wave length long and of a width generally not more than one quarter its length, and may be tuned, as hereinafter described in detail, by a capacitor **14**, located at one end thereof. The anode ring terminal **8** makes electrical connection with plate **13** via ring contact member **28** in a manner similar to that provided to establish contact between the grid annular ring terminal **7** and plate **12**.

Plate **12** is rigidly attached to the enclosing case **11**, acquiring thereby the required electrical connection and physical support. The electrical connection to plates **9** and **13**, however, do not provide adequate physical support. Therefore stand off insulators **29** through **32** are used for this purpose. Insulator **29** is fastened by screws between the free end of the plate **9** and the portion of the enclosing case **11** directly above. In the same way insulator **30** is mounted, for example, in the center of plate **9** near the capacitor **10**. Plate **13** is rigidly secured in a similar way by insulators **31** and **32**.

It may thus be seen that in essence the oscillator has an oscillatory circuit consisting of two juxaposed half-wave length lines, open at one end and connected through the tube anode-cathode circuit at the other end. The capacitors **10** and **14** make it possible to electrically lengthen the lines if it is desired to have the oscillator operate at a lower frequency than that determined by the electrical length corresponding to the actual physical length of plates **9** and **13**. These capacitors **10** and **14** are similar. The upper capacitor **10** consists of a rotor **10A** and a stator **10B**. The stator **10B** is attached to a conducting rod **10C** connected at one end to the cathode plate **9**, the other end of the rod **10C** being connected to an insulating bracket **17** which in turn is attached by screws **33** and **34** as seen in Fig. 1B to the enclosing case **11**. The rotor **10A** is attached to a shaft which passes through the insulating bracket **17** and enclosing case **11**, while contacting electrically the enclosing case, and terminates in knurled knob **37** or similar device which will permit ease of controlling the position of the rotor

10A. The lower capacitor 14 consists of a rotor 14A and a stator 14B. The stator 14B is attached to a conducting rod 14C connected at one end to the anode plate 13, the other end of the rod 14C being connected to an insulating bracket 18 which in turn is attached by screws 35 and 36 as seen in Fig. 1B to the enclosing case 11. The rotor 14A is attached to a shaft which passes through the insulating bracket 18 and enclosing case 11, while contacting electrically the enclosing case, and terminates in a knurled knob 38 or a similar device which will permit ease of controlling the position of the rotor 14A. With appropriate voltages applied to the cathode and the anode, voltage oscillations will result between plates 9 and 13 provided feedback from the anode to the cathode is present. A simple aperture 15, cut in the grid plate 12, provides this feedback by allowing the cathode plate 9 to see electrically the anode plate 13, thereby providing an electromagnetic coupling. This aperture 15 may have any convenient shape but should be located reasonably in symmetry with other elements of the oscillator and should be so located as to be directly between the cathode plate and the anode plate. As shown in Fig. 1A this aperture is U-shaped around the tube with the legs of the U paralleling the lengthwise direction of the oscillator. Since the amount of feedback for optimum performance at various frequencies may differ, it may be desirable to have an adjustable feedback. The feedback depends on the degree of electromagnetic coupling between plates 9 and 13 which in turn depends on the size of the aperture 15. The opening of aperture 15 may be made adjustable by the addition of a shutter 16. This shutter should be so designed as to allow a simple and convenient means of covering part of aperture 15 with a grounded metallic plate, thereby essentially reducing the size of the aperture. A strip of metal in moving contact with plate 12 and to which a shaft extending through the enclosing case is attached, is suitable. The shaft should terminate in a knurled knob 39, Fig. 1B or other device for convenient control and should be guided between pins or other convenient means mounted on plate 12 so that it may be moved to cover more or less of the aperture easily. An example of such a shutter has been shown on Fig. 1A as element 16.

Fig. 2 is a cross sectional view of the embodiment shown in Fig. 1A. This view shows more clearly the electrical connection to the lighthouse tube. In this diagram the cathode and anode plates 9 and 13 are approximately half-wave or full-wave lengths long and of widths generally not more than one-quarter their length. The particular wave-length used being that for the highest frequency at which it is desired to operate the oscillator. These plates are insulated from the grounded case by the variable capacitor support brackets 17 and 18. These support brackets may be made of porcelain or other suitable material and should be firmly attached to the enclosing case by means such as screws. (See Fig. 1B). By the use of capacitors 10 and 14 the effective electrical lengths of plates 9 and 13 may be changed so that said plates, in conjunction with the cathode-anode circuit in the tube 5, may constitute a resonant circuit for any of several frequencies, the frequency range being limited only by the limits of the capacitors 10 and 14 and the above mentioned higher limit. The high anode voltage may be applied directly to the anode cap. It may, as noted before, be applied at any other convenient point along plate 13, such as shown in Fig. 2. Since the high voltage supply source lies outside the enclosing case 11, an insulated path must be provided for entering a supply line through the case 11 which is at ground potential. The supply line may be passed through a rubber grommet 40 inserted in case 11. When the high voltage is applied, oscillations will result in the resonant circuit at the frequency determined by the electrical lengths of plates 9 and 13. Since, owing to the unique construction, wherein both the anode plate and the cathode plate will carry pulsating potentials within grounded compartments, almost the entire space within the enclosing case 11 will be energized, the output may be taken at any convenient point. In Fig. 2, a simple magnetic pick up loop 19 has been inserted at a point of high magnetic field into the space between the anode plate 13 and the case 11 as the means of obtaining the output energy.

The disposition of the annular contact rings 26, 27, and 28, may be more readily understood from the cross-sectional view. Contact rings 27 and 28 are flat and springy. The grid and anode terminals are held tight against their respective contact rings by a downward pressure. The fluted contact points of the cathode contact ring 26 are tapered inward so that their smallest dimension is less than the diameter of the cathode terminal 6. Thus, secure contact is established by forcing the cathode terminal into said contact ring. Support for the tube 5 and the downward pressure required at the anode and grid terminals are provided by the socket assembly 45, 46, and 47 on top of the case. The socket 45 is of non-conducting material supporting conventional contact lugs suitable to receive the base prong contacts of the tube. Said socket is held in place by a flanged annular ring 46 threaded on its outer periphery so as to screw into another annular ring 47 similarly threaded on its inner periphery. Said latter ring 47 is affixed to the case 11 by screws. The downward pressure is adjustable by turning said ring 46 in said ring 47.

If it should be desired to use this type of oscillator for a lower frequency whereby a half-wave length would be inconveniently long, the embodiment illustrated by Fig. 3 would be used to keep the overall size of the oscillator small. In this diagram quarter wave length plates 20 and 21 have been used as the cathode and anode plates, if desired these plates could be made three-quarter wave length, the width of these plates should again generally be not more than one quarter their length. They are mounted at the end away from the tube by insertion into suitable slots as shown at 41 and 43 in Fig. 3. The members containing said slots are securely fastened to the enclosing case 11 by screws. The slots are lined with insulating strips such as mica, 42 and 44. Such mountings at the frequencies used are essentially capacitors providing a R. F. path between the plates through the grounded enclosing case. Hence, somewhat analogous to Fig. 1, it may be seen that this oscillator has an oscillatory circuit consisting of two parallel quarter wave lines, closed at one end and connected through the tube anode-cathode circuit at the other end. The capacitors 10 and 14 may then be mounted as shown at the tube end of plates 20 and 21 and may be used as before to tune the oscillator to the exact frequency desired.

For uses where a very wide range of operating frequencies is desired the oscillator could be designed as illustrated by Fig. 4. As can be seen this is a combination of Figs. 2 and 3. By setting capacitors 24 and 25 to a minimum capacitance and using capacitors 10 and 14 for tuning the operation will be the same as that of Fig. 2. If capacitors 10 and 14 are set for maximum capacity, however, they will essentially short the plates at radio frequencies to the enclosing case and capacitors 24 and 25 may be used for tuning to provide operation like that illustrated in Fig. 3.

Although I have shown and described only limited and specific embodiments of the present invention, it is to be understood that I am fully aware of the many modifications possible thereof. Therefore this invention is not to be limited except insofar as is necessitated by the spirit of the prior art and the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A high frequency oscillator comprising a thermionic vacuum tube having at least three electrodes including a cathode, an anode, and a grid, said electrodes being provided with annular ring terminals located in parallel planes normal to the axis of the tube, a first metallic plate attached to the cathode of said tube and extending laterally from the tube axis, a second metallic plate attached to the anode and also extending laterally from the axis of said tube, a metallic rectangular box-like member enclosing said tube and said metallic plates, a third metallic plate attached to said grid and interposed between said first and second plates, said third plate extending beyond the edges of said first and second plate to contact the inner periphery of said box-like member, four variable capacitors connected between said box-like member and said first and second metallic plates, each being connected at a different longitudinal end of said plates, and feed-back means for providing a regenerative exchange of energy between the anode and cathode plate members, and means inserted within the enclosing peripheral structure from which the output of the oscillator may be obtained.

2. A high frequency oscillator comprising a thermionic vacuum tube having at least three electrodes including a cathode, an anode, and a grid, said electrodes being provided with annular ring terminals located in parallel planes normal to the axis of the tube, a first metallic plate attached to the cathode of said tube and extending laterally from the tube axis, a second metallic plate attached to the anode and also extending laterally from the axis of said tube, a metallic rectangular box-like member enclosing said tube and said metallic plates, a third metallic plate attached to said grid and interposed between said first and second plates, said third plate extending beyond the edges of said first and second plate to contact the inner periphery of said box-like member, and feed-back means comprising an aperture cut in said third plate whereby said first plate may be electrically visible to said second plate, a shutter so mounted on said third plate as to allow the aperture to be effectively controlled in size, and means inserted within the enclosing peripheral structure from which the output of the oscillator may be obtained.

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