

Oct. 24, 1939.

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2,177,272

SHORT WAVE ELECTRON DISCHARGE SYSTEM

Filed April 22, 1936

3 Sheets-Sheet 1

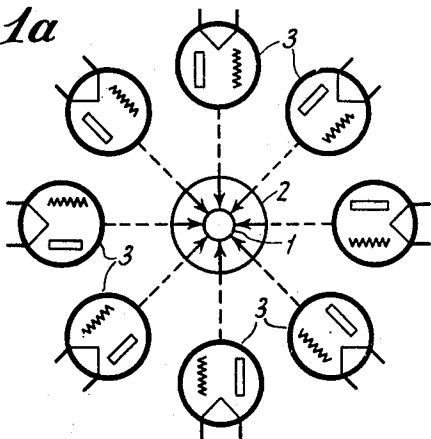
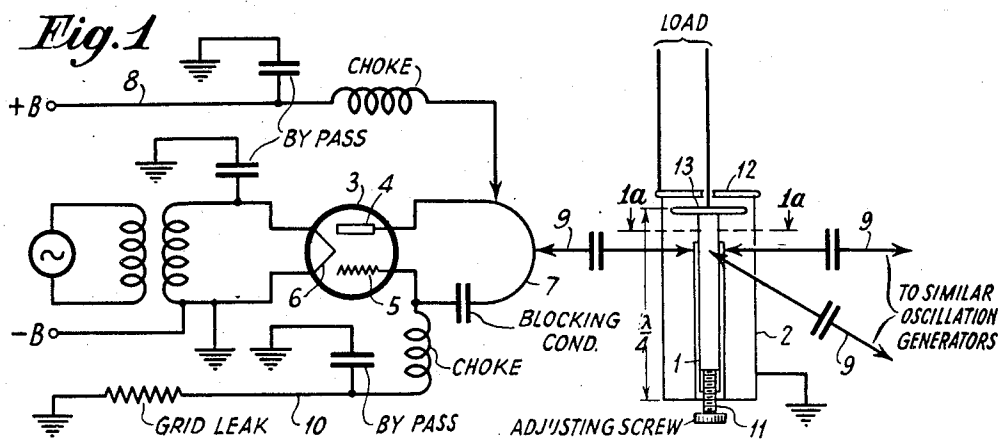
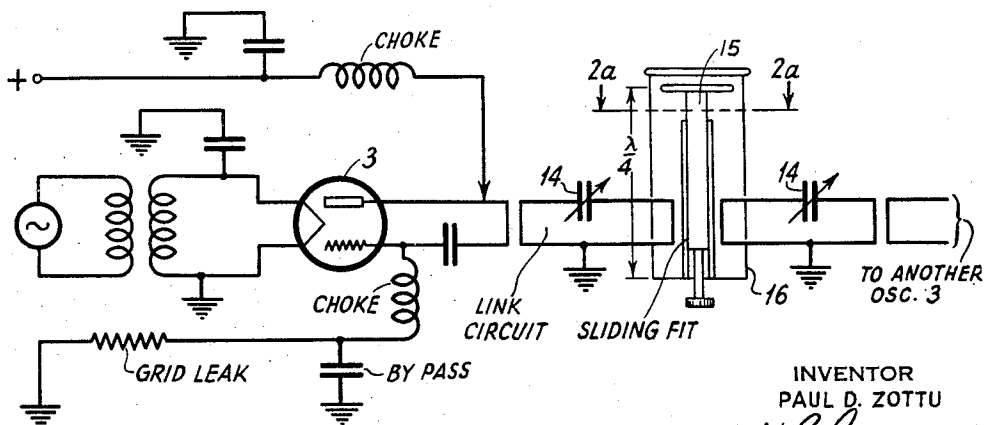


Fig. 2



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Fig. 3

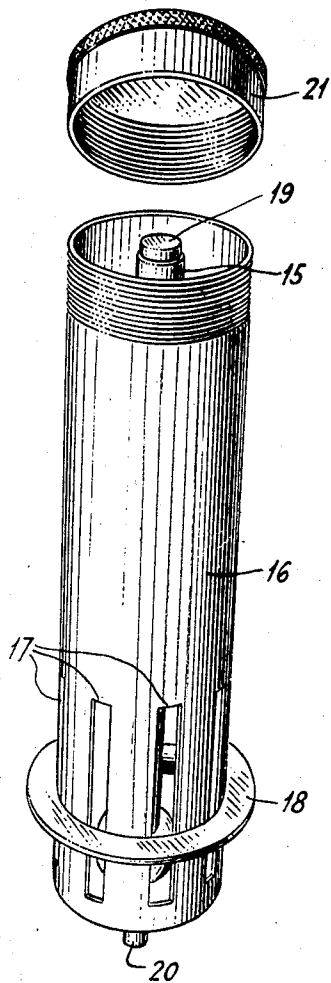


Fig. 2a

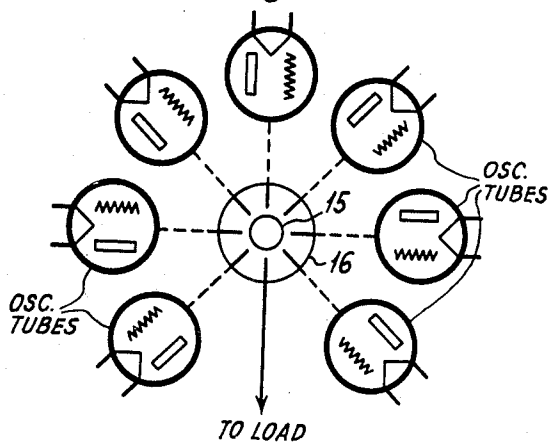


Fig. 4

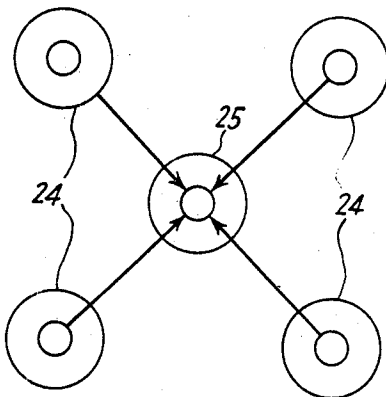
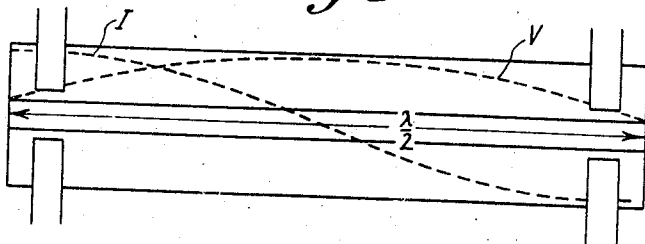


Fig. 5



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Fig. 6

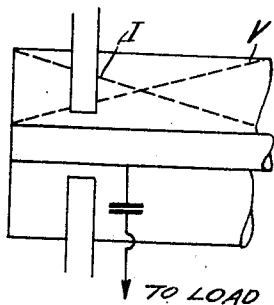
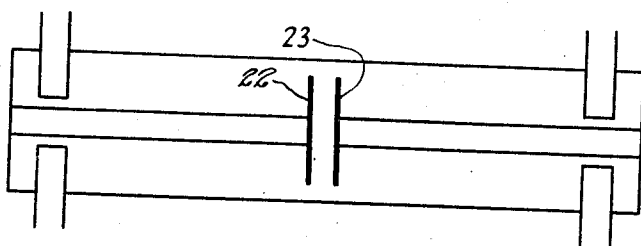
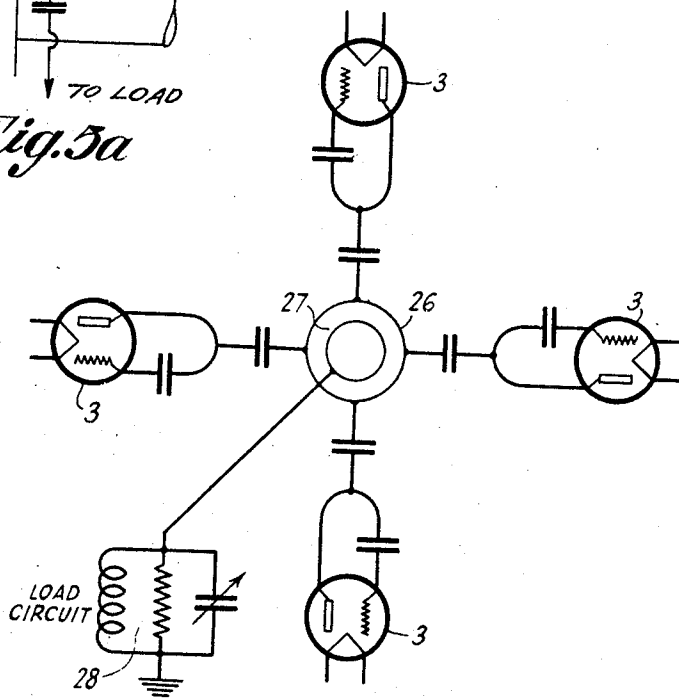


Fig. 5a

Fig. 7



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SHORT WAVE ELECTRON DISCHARGE
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26 Claims. (Cl. 250—36)

This invention relates to a short wave electron discharge device oscillation generator arrangement, and particularly to such an arrangement for efficiently obtaining an output whose magnitude is larger than that obtainable from a single electron discharge device short wave generator.

Heretofore, in the range of wavelengths below ten meters, it has been proposed to connect a plurality of electron discharge device generators in direct parallel relationship in order to obtain a desired output. It has been found, however, that the addition or subtraction of an electron discharge device generator at these wavelengths to an arrangement comprising a plurality of devices connected in parallel, affects appreciably the generated frequency available in the output circuit. A further disadvantage of the direct paralleling of short wave generators, particularly at wavelengths of the order of one meter, is that as the electron discharge devices are paralleled, the interelectrode capacities of the devices are also paralleled, and since the resultant capacity is increased, the required associated inductance of the output oscillatory circuit must be decreased in order to maintain the frequency essentially fixed. Since the lengths of the leads located externally of the electron discharge devices, as available for connection to the associated circuit elements such as the voltage supply leads and the utilization circuits, are very small, it will thus become evident that with direct paralleling it becomes increasingly difficult with a still smaller length of lead to couple the oscillation generator circuit properly to the associated elements. As a direct result of this last disadvantage, direct paralleling of the devices can only be employed for a comparatively few units before the available lengths of external circuit connections are reduced to such an extent that the leads, for a desired frequency, must be included within the envelopes of the devices. Consequently, at the short wavelengths in question, it is frequently impossible to obtain the desired magnitude of output.

One of the objects of the present invention is to overcome the foregoing difficulties and to provide an oscillation generator arrangement which will give outputs greater than heretofore obtainable.

A further object is to provide an arrangement employing a plurality of electron discharge device oscillation generators wherein the output increases substantially linearly with the number of electron discharge generating devices employed.

In brief, the preferred form of the invention

comprises the use of a plurality of electron discharge device oscillation generator units whose outputs are coupled to a common low loss tank circuit which preferably comprises a tuned oscillatory circuit in the form of a concentric line resonator having inner and outer conductors. Coaxial line resonators of this general type are known in the art and adequately described in the article by Clarence W. Hansell, published in the A. I. E. E. Transactions of August, 1935, pages 852 to 857.

Generally speaking, the invention utilizes a number of independent short wave oscillators which are coupled to a common resonator whose effect on each individual oscillator unit is the same. That is, the generated frequency of each unit is made to vary, with variation in load, in much the same manner as if the other units were not present, despite the fact that the units may differ in frequency slightly from each other.

A feature of the invention comprises a concentric line resonator circuit arrangement which functions both as a frequency stabilizing resonator and as an output tank circuit for a plurality of oscillation generators.

Another feature of the present invention lies in the use of a plurality of electron discharge devices coupled to the inner conductor of a concentric line resonator in such manner that the current in the inner conductor of the line affects all of the units substantially the same way, or in a predetermined manner.

A further feature resides in employing a plurality of short wave oscillators whose outputs are coupled in common to one electrode of a condenser, while the other electrode of the condenser is coupled to a load circuit.

An advantage of the present invention, wherein a plurality of short wave oscillators are effectively coupled in parallel as regards the load, resides in the fact that any one oscillation generator unit or more can be taken out of the circuit without affecting appreciably the generated frequency as available for utilization purposes.

A more detailed description of the invention follows, accompanied by drawings, wherein:

Fig. 1 illustrates schematically a preferred embodiment of the present invention;

Fig. 2 illustrates a modification of the circuit of Fig. 1;

Figs. 1a and 2a are schematic detail views of the line resonator circuits of Figs. 1 and 2, respectively, along the lines 1a—1a and 2a—2a;

Fig. 3 illustrates a concentric line resonator of the type shown in Fig. 2 for inductively coupling

a plurality of short wave oscillation generator units to the inner conductor of the line;

Fig. 4 schematically illustrates the manner in which a plurality of oscillation generator output units, each fed by a plurality of short wave generators, can be still further coupled effectively in parallel to a tank circuit in common with all of the units;

Figs. 5 and 6 illustrate other ways by which short wave oscillation generator units can be coupled to a line resonator;

Fig. 5a is an arrangement similar to Fig. 5 with the exception that the load is here shown capacitively coupled to the inner conductor of the tank circuit; and

Fig. 7 shows a modification employing a pair of capacitively coupled elements for coupling the load to the parallel connected oscillators, instead of a line resonator as shown in the other figures.

Referring to Fig. 1 in more detail, there is shown a low loss concentric line resonator comprising an inner conductor 1 and an outer conductor 2 to which are coupled, through leads 9, 9, a plurality of individual short wave oscillation generator electron discharge devices 3, 3. Note Fig. 1a. Each oscillation generator, only one of which is shown in Fig. 1 by way of example, comprises an electron discharge device having an anode 4, a control electrode 5, and a cathode 6; to the anode and grid of which is connected a U-shaped conductor 7. Since U-shaped conductor 7 is connected between the anode and grid, it may be considered to be either an input or an output circuit. The manner in which the electrodes are suitably energized will be apparent from an inspection of the drawings. Connected to conductor 7 are the anode supply lead 8, the control electrode supply lead 10, and the output lead 9 which tap on the conductor 7 at points which are suitable for optimum operation of the oscillator. In practice these tapping points are determined experimentally by measuring the output of the oscillator with movement of the leads over the conductor 7. The output leads 9 from the various individual units 3 are coupled, each through a blocking condenser, to suitable points on the periphery of the inner conductor 1 of the line resonator which give maximum output or which provide adequate impedance match for the load. These points on the inner conductor 1 are also selected to give a desired impedance match between the individual units 3 and the line resonator. With maximum output it will be found that these points on the line resonator provide the proper impedance match between the resonator and the individual units 3. It is preferred, although the invention is not necessarily limited thereto, that the leads 9 connect to the line resonator 1 at points on the periphery of the conductor 1 which are in a single plane transverse to the length of the resonator. These points will be in a single plane if the individual oscillator units 3 are all made in identically the same way so as to have approximately the same characteristics. It will be appreciated, of course, that for oscillator units having different characteristics there are different points on the conductor 1, not necessarily in the same plane, which will provide the desired maximum output.

Fig. 1a is a cross section of the line resonator 1, 2 along the lines 1a—1a looking down from the upper end and shows how a plurality of oscillator units, herein eight by number, couple to the inner conductor 1 around its periphery. It should be understood that these points, although shown

symmetrically coupled to the line resonator at its periphery, need not necessarily be symmetrically arranged around the surface of inner conductor 1. It is also to be understood that with a different number of individual oscillators 3 connected to the line resonator there may be other points along the length of the line 1 to which these units will connect, and by so doing the same output per individual oscillator unit may be obtained despite the fact that a fewer number of units are employed.

Concentric line resonator 1, 2 is shown conductively connected together at one end, the lower end, and capacitively terminated at its other end, the upper end. This capacitive termination is obtained by means of a plate 12 connected to the outer conductor and a plate 13 connected to the inner conductor and spaced away from the plate 12 a desired amount. An adjusting screw 11 enables variation of the capacity between the outer conductor 2 and the inner conductor 1 by varying the length of the inner conductor 1 with respect to the length of the conductor 2, and thus varying the spacing between plates 12 and 13. In the particular embodiment employed, the physical length of line 1 was much shorter than a quarter wavelength due mainly to the capacity effect between the inner and outer conductors as determined not only by the capacity termination between plates 12 and 13, but also slightly by the capacity effect of the various units 3 upon the line resonator. In one embodiment wherein an output at 1.2 meters was obtained, the length of line 1 was about four centimeters, whereas a quarter wavelength line at this wavelength would be about thirty centimeters.

It should be noted, at this time, that the outer conductor 2 of the resonator is grounded. In practice, however, the grounding of all connections is obtained by providing a substantially circular metallic plate upon which both the line resonator and all the individual oscillator units 3 are mounted, the oscillator units being located around the circumference of the metallic plate and connected to the line resonator which is located in the center. Variations from such an arrangement may, of course, be employed. An advantage of such an arrangement lies in the facility with which the individual oscillator unit devices may be connected into and taken from the circuit.

Although Fig. 1 illustrates an arrangement for capacitively coupling the individual oscillator units 3 to the line resonator, it should be understood that the invention is not limited to such manner of coupling since practically any of the well known means of coupling an oscillator unit to the line resonator may be employed.

Fig. 2 illustrates, by way of example only, an arrangement for inductively coupling the individual oscillator units to the inner conductor 1. For this purpose, there is employed between each oscillator 3 and the inner conductor 15 a tuned link circuit comprising an inductance in the form shown and a variable condenser 14. It should here be noted that the line resonator comprising inner conductor 15 and outer conductor 16 has no lead now connected to its upper end and has a length substantially equal electrically to a quarter of the length of the operating wave, the oscillators 3 now being inductively coupled to the lower portion of the inner conductor 15 of the line resonator where maximum current exists. In practice it is advisable to be able to adjust the distance between the inner conductor 15 and the

link circuit and/or the distance of the link circuit from the lower end of the line resonator in order to vary the coupling between the link circuit and the line resonator. The manner in which this may be accomplished is more clearly shown in connection with Fig. 3, to be described later.

Fig. 2a is a cross section plan view of the line resonator along the lines 2a—2a and shows, in a manner somewhat similar to Fig. 1a, how the individual oscillator devices 3 are coupled to the inner conductor of the resonator. In this case the load circuit may also be coupled to the line resonator in the same manner as the individual outputs of the units 3 are coupled to the inner conductor 15. If desired, by suitably coupling with the inner conductor 1 the link circuit may be dispensed with entirely and the oscillator coupled to the line resonator 15, 16 either capacitively or conductively, and also inductively at the short wavelengths with certain types of electron discharge devices. At wavelengths longer than one meter, the coupling difficulties between the line resonator and the individual oscillator units are minimized and the effects of stray capacities become negligible.

In the arrangement of Fig. 2, it is preferred also to employ a metallic plate upon which the individual oscillator units 3 and the line resonator may be mounted. This metallic plate will then serve not only as a support for the individual oscillator unit and resonator but also as an equipotential surface essentially at ground or zero radio frequency potential.

Fig. 3 illustrates a line resonator of the type disclosed in Fig. 2 comprising an inner conductor 15 and an outer conductor 16 having slits 17 through which the link circuits, or any other suitable coupling circuit for the oscillator extends for inductively coupling with the inner conductor 15. Where such inductive coupling is employed, both wires or rods of the coupling circuit which extend through slots 17, are arranged to be located above the ring 18 which is suitably fastened to the outer conductor 16. In practice, the portion below the ring 18 is connected to the metallic plate or equipotential surface, and by loosening the ring 18 from the outer conductor 16, the conductor 16 together with the inner conductor 15 of the resonator may be moved up or down to vary the distance between the coupling link and the lower or conductively connected end of the line resonator. In this manner the entire resonator may be moved relative to the coupling link. For obtaining a fine adjustment of the length of the inner conductor, there is provided within and in close contact with the inner conductor 15 a rod which extends throughout its length and terminates at its upper end in a metallic plug 19 and at the other end in an adjustable screw 20, adjacent the length of the end 19, for effectively varying the length of the inner conductor. A metallic cap 21 may, if desired, be employed for the dual purpose of providing an end capacity between the inner conductor and the outer conductor and for preventing undesired radiation from the inner conductor.

Fig. 4 illustrates very diagrammatically how a plurality of multiple unit generators of the type disclosed in Figs. 1 and 2 may, in turn, be coupled with another tank circuit in common with all of the oscillation generators for obtaining outputs greater than those which could be obtained with one multiple oscillator unit. In this Fig. 4, the numerals 24 designate four complete multiple unit generators, each of which can be the com-

plete circuit either of Fig. 1 or Fig. 2, while numeral 25 designates the common tank circuit for these multiple unit generators. If the line resonator to which the various units couple has sufficient length, a plurality of units of the type disclosed in Fig. 4 can be mounted one above the other in the plane of the drawings and coupled to the line resonator in the same manner shown. This mode of coupling may be more apparent by referring to the resonator of Fig. 5 which shows a line whose length is equal to half the length of the operating wave and wherein a plurality of individual units may be coupled at each end of the line resonator to the inner conductor. The load may be coupled to the inner conductor of Fig. 5 in any desired fashion, either capacitively, inductively or conductively. The current and the voltage distribution of the energy along the resonator are shown by the I and V curves respectively. Fig. 5a shows how the load can be capacitively coupled to the inner conductor of the tank circuit. In Fig. 5a there are shown a plurality of looped link circuits coupled to the inner conductor of the line resonator at the left hand end, while the load, appropriately labeled as such, is capacitively coupled to the inner conductor through a condenser.

Fig. 6 illustrates how the resonator of Fig. 5 can be shortened by inserting a condenser comprising a pair of spaced plates 22, 23 in series with the inner conductor. In this way an appreciable shortening of the line can be obtained, depending upon the value of the capacity between the plates 22, 23 and the line constants. In the line resonator shown in Figs. 1, 5 and 6, the outer conductor may comprise either a cylindrical container or else, as was successfully tried in practice, merely a plurality of rods or linear conductors, such as let us say three rods, although the invention is not limited to this number, for forming the return circuits between both ends of the inner conductor. These rods or conductors may either be straight or curved in the form of loops, and if the latter, may be used to couple the outer conductor with the oscillators instead of the hereinabove described method of coupling the oscillators to the inner conductor.

Where it is desired to dispense with a tank circuit in the common outputs of the individual oscillators, one may employ a circuit as shown in Fig. 7 where a plurality of short wave oscillators 3 have their outputs connected in common to a metallic plate electrode 26 which is spaced from and capacitively coupled to another plate electrode 27 forming a condenser therewith, and the load circuit 28 coupled to element 27. It will be evident that electrodes 26 and 27 may comprise single loops of wire, instead of plates, to effect the capacitive coupling. A disadvantage of this last arrangement is that there is not the same degree of frequency stabilization as is had with the circuits of Figs. 1 and 2.

It is to be distinctly understood that the invention is not limited to the precise arrangement of parts shown in the drawings and described herein since various modifications may be made without departing from the spirit and scope of the invention. For example, if desired, each individual oscillator unit 3, shown in Figs. 1 and 2, may be replaced by a push-pull type of circuit employing two electron discharge device oscillators. The feature of coupling the line resonator to a multiplicity of electron discharge devices is not necessarily limited to the output circuits, since it may also be employed where it is desired

to couple a plurality of independent oscillator grid circuits to a common stabilizing resonator, in which case, if desired, one line resonator may control the individual grid circuits of a plurality of oscillators whereas another line resonator may be connected to the common outputs of the same oscillators. Similarly, a plurality of electron discharge device amplifiers may also have their outputs coupled to a single line resonator in common with all the amplifiers in the same manner described above in connection with the oscillators.

What is claimed is:

1. A short wave system comprising, in combination, a plurality of electron discharge device oscillators each having a tuned output circuit, an oscillatory circuit effectively coupled in parallel to the tuned output circuits of said oscillators, said oscillatory circuit comprising concentric inner and outer substantially straight conductors coupled together at both ends, said tuned output circuits being coupled to one of said conductors intermediate its ends at points which are substantially similarly positioned with respect to said ends of said one conductor, and a load also coupled to said one conductor.

2. In a short wave system comprising, in combination, a plurality of electron discharge device oscillators each having a tuned input circuit, a frequency stabilizing oscillatory circuit connected in common to all of said tuned input circuits of said oscillators, said oscillatory circuit comprising a straight metallic member and a cylinder of metal about said member, said cylinder and member being arranged coaxially and parallel to one another, a capacitor having a plate connected to one end of said member and a plate cooperating with said first plate and connected to the adjacent end of said cylinder, the other ends of said member and cylinder being coupled together, said input circuits being coupled to one of said metallic elements of said oscillatory circuit intermediate its ends at points substantially similarly positioned with respect to said ends of said one element, and a load also coupled to said one metallic element.

3. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively connected together at one end and capacitively coupled together at the other end of the resonator, and a connection from each tuned circuit of said plurality of electron discharge devices to a point on said inner conductor of said line resonator, said points of connection being all substantially the same distance from the terminals of said line resonator.

4. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes and a tuned circuit coupling said anode and control electrodes together, a resonator comprising inner and outer conductors conductively connected together at one end and capacitively coupled together at the other end of the resonator, and a connection from each tuned circuit of said plurality of electron discharge devices to a point on said inner conductor of said resonator.

5. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes and a tuned circuit coupling two of said electrodes together, a resonator comprising inner and outer conductors conductively connected together at one end and capacitively

coupled together at the other end of the resonator, and a connection including a serially connected condenser from each tuned circuit of said plurality of electron discharge devices to a point on said inner conductor of said resonator, said last connections engaging said inner conductor at points on the surface thereof near the capacitive termination of said resonator.

6. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator whose length, physically, is appreciably less than one-quarter of the length of the operating wave and comprises inner and outer conductors conductively connected together at one end and capacitively coupled together at the other end of the resonator, and a connection from each tuned circuit of said plurality of electron discharge devices to a point on said inner conductor intermediate the ends thereof, said points being appreciably removed from nodal points on said line resonator, means for varying the capacity between said inner and outer conductors, and a utilization circuit coupled to both said inner and outer conductors.

7. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors, and means for coupling each of said tuned circuits to said inner conductor of said line resonator, the coupling points of said inner conductor with said means being substantially similarly positioned with respect to the ends of said inner conductor.

8. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer concentric conductors conductively coupled together at one end, and means for inductively coupling each of said tuned circuits to said inner conductor, the parts of said inner conductor to which said tuned circuits are coupled being substantially the same distance from the ends of said resonator.

9. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at one end, and means for inductively coupling each of said tuned circuits to said inner conductor of said line resonator, said means including a tunable link circuit inductively coupled to each tuned circuit of said devices and inductively coupled to said inner conductor of said resonator, said link circuits being coupled to said inner conductor around the periphery thereof near said one end.

10. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at one end, and means for inductively coupling each of said tuned circuits to said inner conductor of said line resonator, said means including a tunable link circuit inductively coupled to each tuned circuit of said devices and inductively coupled to said inner conductor of said resonator, said link circuits being coupled to said inner conductor around the periphery thereof near said one end, and an ele-

ment for varying the distance of said link circuits from said one end with a consequent variation in coupling between said resonator and said link circuits.

11. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer concentric conductors, means for inductively coupling said tuned circuits of said devices to said inner conductor around the periphery thereof, and a utilization circuit also coupled to said inner conductor.

12. In combination, a plurality of electron discharge device oscillation generators each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a resonator comprising inner and outer coaxial conductors conductively coupled together at one end, and means for inductively coupling each of said tuned circuits to said inner conductor of said line resonator.

13. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at both their ends, and a coupling path extending between each of said tuned circuits of said devices and points on said inner conductor intermediate the ends thereof, said points being substantially similarly positioned with respect to the ends of said inner conductor.

14. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at both their ends, and means for inductively coupling individually some of said tuned circuits of said devices to said inner conductor near one of its ends and others of said tuned circuits of said devices to said inner conductor near its other end.

15. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial resonator equal to substantially half the length of the operating wave comprising inner and outer conductors conductively coupled together at both their ends, and means for inductively coupling individually some of said tuned circuits of said devices to said inner conductor near one of its ends and others of said tuned circuits of said devices to said inner conductor near its other end.

16. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at both their ends, and means for inductively coupling individually some of said tuned circuits of said devices to said inner conductor near one of its ends and others of said tuned circuits of said devices to said inner conductor near its other end, said inner conductor having a condenser serially connected in its length.

17. In combination, a plurality of electron discharge devices each having anode, cathode and control electrodes, and a tuned circuit coupling

two of said electrodes together, a coaxial line resonator comprising inner and outer conductors conductively coupled together at one end and capacitively coupled together at the other end of the resonator, and a connection from each tuned circuit of said plurality of electron discharge devices to a point on said inner conductor of said line resonator, said outer conductor comprising a plurality of separated conductors in the form of rods.

18. In a high frequency system, an oscillatory circuit comprising inner and outer concentric conductors conductively coupled together at one of their adjacent ends, said outer conductor having near said one end a plurality of apertures around the periphery thereof, a plurality of electron discharge devices located externally of said outer conductor, each of said devices having electrodes and feed-back means between certain of said electrodes to constitute a regenerative oscillator, and coupling connections extending from said inner conductor through said apertures to said devices.

19. In a high frequency system, an oscillatory circuit comprising inner and outer concentric conductors conductively coupled together at one of their ends, said outer conductor having near said one end a plurality of apertures in the form of slits of appreciable length for enabling external circuit connections to couple to said inner conductor, and a ring-like element movable relative to said outer conductor for varying the positions of said external circuit connections relative to said one end.

20. A short wave system comprising, in combination, a plurality of electron discharge device oscillators each having an output circuit, a load, a condenser having a pair of plates, a connection from each output circuit to one plate of said condenser and a connection from said load to the other plate of said condenser.

21. A multi-stage, ultra-high, radio frequency system comprising a plurality of electron discharge device stages, a centrally located concentric transmission line coupling unit connected in common to the outputs of said stages, said devices being substantially equidistant from said coupling unit, said stages and concentric line coupling unit being mounted on a conductive plate which is maintained at substantially zero radio frequency potential, whereby there is obtained a compact assembly.

22. An ultra-high frequency system comprising a plurality of tuned concentric line resonators located substantially in a circle around a central point, with the longest axis of each line resonator parallel to the longest axis of the other line resonators, there being at least one electron discharge device individual to each line resonator and having electrodes coupled thereto, there being another tuned concentric line resonator at said central point having its longest axis parallel to the longest axes of the other tuned line resonators, said centrally located line resonator being coupled in common to the other line resonators.

23. A short wave system comprising, in combination, a plurality of electron discharge devices each having an output electrode and an input electrode with feed-back means between said electrodes, a low loss tank circuit capacitively coupled in parallel to the output electrodes of said devices, and a load coupled to said tank circuit.

24. A short wave system comprising, in combination, a plurality of electron discharge devices each having an output electrode and an input

electrode with feed-back means between said electrodes, a low loss tank circuit inductively coupled in parallel to the output electrodes of said devices, and a load coupled to said tank circuit.

5 25. A short wave system comprising, in combination, a plurality of electron discharge devices each having electrodes and a tuned circuit connected between certain of said electrodes, a low
10 loss tank circuit effectively coupled in parallel to the tuned circuits of said devices from points on said tank circuit over which flow appreciable
radio frequency voltage, and a load coupled to said tank circuit, whereby interaction between elec-
tron discharge devices is substantially overcome,

said points on said tank being substantially similarly positioned with respect to the terminals of said tank circuit.

26. In combination, a plurality of electron discharge devices each having an input and output
5 electrode, and a tuned circuit coupling said electrodes together, a low loss tank circuit, means for coupling each of said tuned circuits to said tank circuit, said tuned circuits being coupled to points
10 on said low loss tank circuit which are substantially similarly positioned with respect to the terminals of said tank, and a load coupled to said tank circuit.

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