

March 25, 1941.

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ULTRA HIGH FREQUENCY SIGNALING SYSTEM

Filed July 30, 1938

3 Sheets-Sheet 1

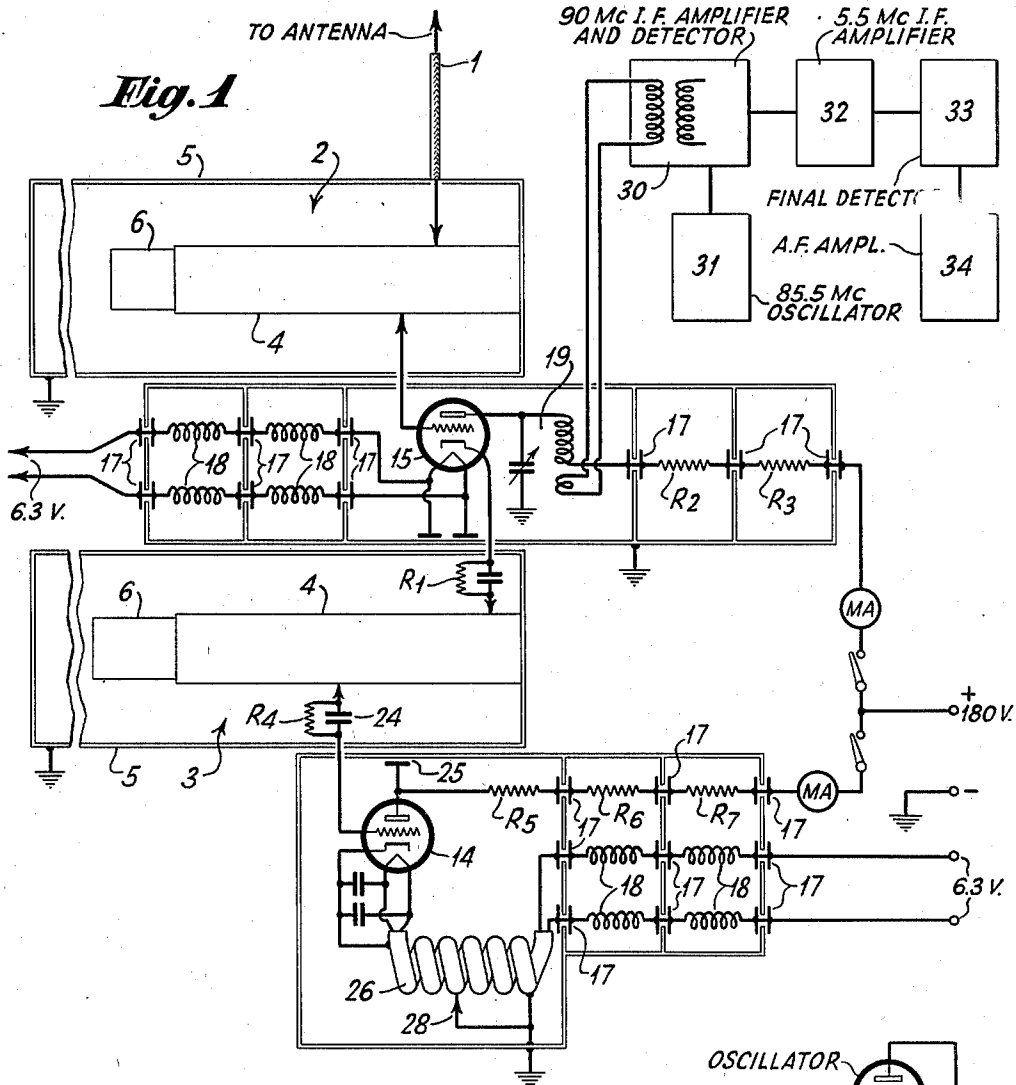


Fig. 4

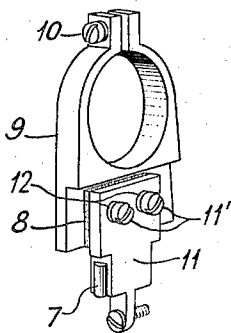


Fig. 4a

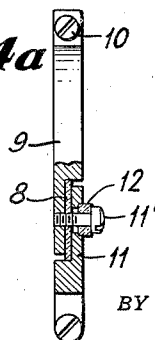
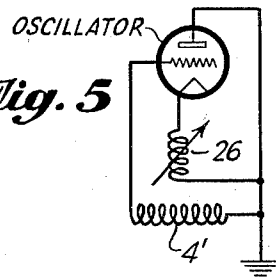


Fig. 5



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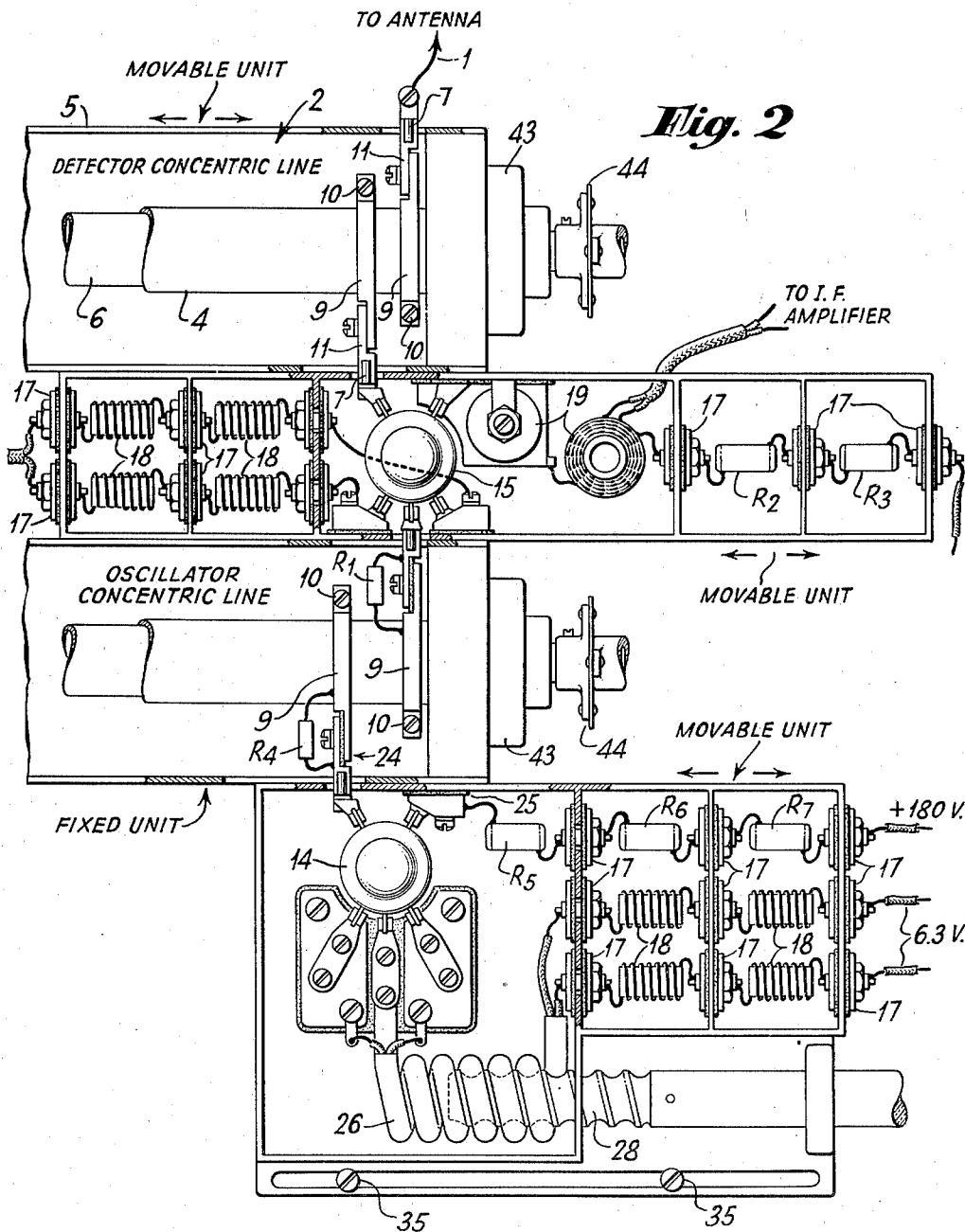
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ULTRA HIGH FREQUENCY SIGNALING SYSTEM

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3 Sheets-Sheet 2



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ULTRA HIGH FREQUENCY SIGNALING SYSTEM

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3 Sheets-Sheet 3

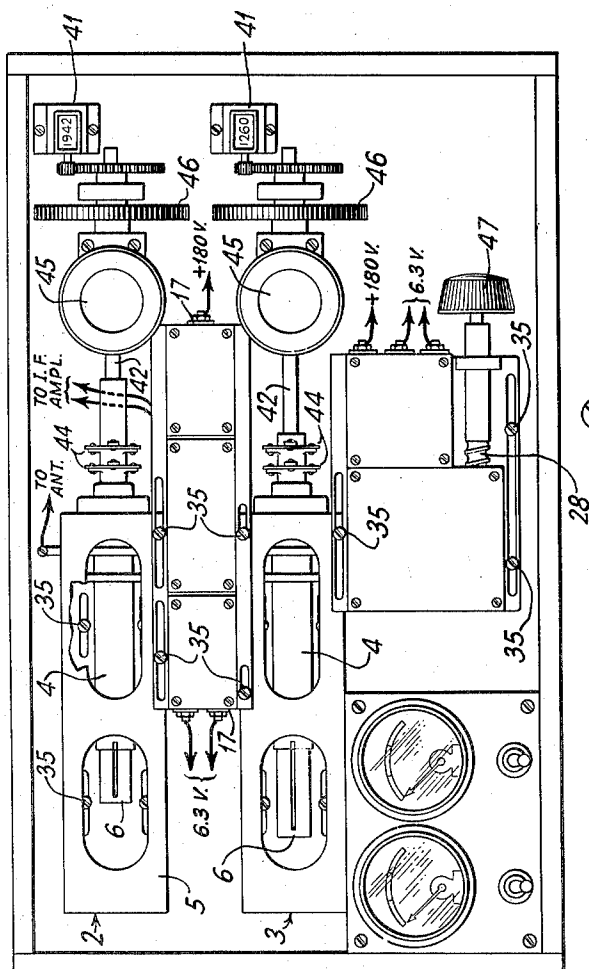


Fig. 2a

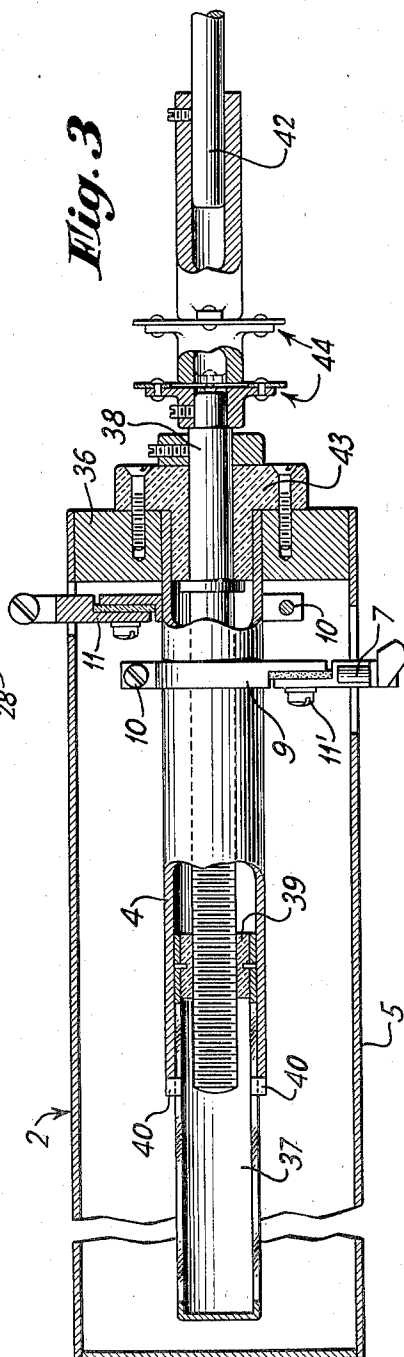


Fig. 3

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2,236,004

ULTRA HIGH FREQUENCY SIGNALING
SYSTEMKenneth G. MacLean, Riverhead, N. Y., assignor
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Application July 30, 1938, Serial No. 222,104

4 Claims. (Cl. 250—36)

This invention relates generally to receiving systems for the reception of ultra high frequency signals. More particularly, the invention relates to the high frequency unit of a superheterodyne receiver capable of receiving waves of the order of 60 centimeters in length.

One of the objects of the present invention is to provide a high frequency converter unit for an ultra short wave receiver capable of receiving signals in the range of 200 megacycles to 500 megacycles, wherein the tuning elements are adjustable and so arranged that the connections to the vacuum tube electrodes are reduced to a minimum length.

Various features of the present invention lie in the novel mechanical construction of the high frequency converter unit which enables the achievement of the foregoing object. This novel mechanical construction includes the use of square metallic tubing, novel condenser units which prevent leakage between shielded compartments, and concentric line resonators used as tuned oscillatory circuits, etc. Another feature resides in the use of a novel concentric resonant line controlled oscillator wherein the anode of a vacuum tube is grounded for radio frequency energy, and reactance in the cathode to ground circuit is employed to obtain the proper phase relations on the electrodes of the tube. This circuit differs from prior art filament tuning where the filament is so tuned as to effectively be at ground potential. In this new circuit the filament is at high radio frequency potential and the reactance of the tuning element to ground constitutes a phase adjustment of the cathode potential.

Other objects, features and their advantages will appear in the following description, which is accompanied by drawings, wherein like parts throughout the figures are represented by like reference characters. In the drawings:

Fig. 1 illustrates, schematically, the electrical features of a complete superheterodyne receiving system embodying the principles of the present invention;

Fig. 2 illustrates only certain essential details of the physical embodiment of the high frequency converter unit of Fig. 1, and shows in some detail the novel mechanical construction which goes to make up the various features of applicant's invention;

Fig. 2a shows the complete assembly of the high frequency converter unit of Fig. 2 with the front cover removed;

Fig. 3 is a detail cross-section view of the con-

centric line resonator used in the detector and oscillator circuits of the improved high frequency converter unit;

Fig. 4 and Fig. 4a are perspective and side views, respectively, of the collar type of connector used for coupling the inner conductor of the concentric line to its associated circuit; and

Fig. 5 illustrates, very schematically, the equivalent electrical circuit of the local oscillator of the high frequency converter unit, and is given for a better understanding of the principles involved.

Referring to Fig. 1 which indicates schematically the electrical circuit of a complete superheterodyne receiver employing my improved high frequency converter unit, there is shown conventionally a detector 15 to whose grid is fed the incoming signal energy arriving from an antenna and transmission line 1 and to whose cathode is supplied oscillatory energy from a local high frequency oscillator 14. Both the detector and the oscillator have associated therewith concentric line resonator circuits 2 and 3 respectively, each having an outer conductor 5 and an inner conductor 4, the inner conductor including as a portion thereof a tube 6 which slides therein for tuning purposes. The output 19 of the detector, which is tuned to the beat frequency of the incoming signal wave and the local oscillator frequency, is fed to an intermediate frequency amplifier and detector 30 from which energy of a lower intermediate frequency produced by beating with a second local oscillator 31, is fed to a second intermediate frequency amplifier 32. From amplifier 32 the energy is passed on to a final detector 33 from which there is obtained an audio frequency signal which is amplified in 34 before utilization.

An inspection of the detector unit 15 will show that there is included in each leg of the filament thereof a filter unit comprising choke coils 18 and low inductance filter condensers 17, of which more will be said later in connection with the description of Fig. 2. In the anode or output circuit 19 of detector 15 there are also included filter units comprising resistances R_2 and R_3 serially arranged in connection with low inductance filter condensers 17. The anode and filament circuits of oscillator unit 14 are also similarly provided with filter circuits, generally of the same type shown in connection with the detector unit. It should be noted, however, that in the anode circuit of the oscillator 14 there are provided three resistances R_5 , R_6 and R_7 , instead of two, as shown in the anode circuit of the de-

detector. The filter elements of the detector unit 15 and the oscillator unit 14 are divided into shielded compartments, and the vacuum tubes per se are also shielded, both from the shielded
5 elements of the filter units and from the associated concentric line tuned circuits. The cathode of the detector 15 is connected to the oscillator concentric line through a bias resistor R_1 and condenser combination.

10 The oscillator 14, it should be observed, comprises a vacuum tube whose anode is grounded to the outer conductor 5 of the concentric line oscillatory circuit through a by-pass condenser 25 and whose grid electrode is coupled through
15 a grid-leak R_4 and a coupling condenser 24 to the inner conductor 4 of its associated concentric line resonator 3, the latter functioning as a frequency controlling element. There is provided in circuit with the oscillator cathode a regenerative tuning coil 26. By varying the inductance
20 of coil 26, regeneration in the oscillator is obtained for optimum oscillation, while stability of oscillation is controlled by varying the connection from the oscillator grid to the inner conductor 4 of the concentric line 3. In practice,
25 as will be observed more fully from Fig. 2, the cathode regeneration control is a coil of copper tubing within which the filament heating leads are run to an external source of heating supply,
30 tuning of the coil being effected by inserting or withdrawing a solid metallic screw plug 28 within the spiral turns of the coil. It is obvious that the cathode to ground element may be any type
35 of circuit presenting a proper reactance to the oscillator frequency.

A better understanding of the operation of the oscillator 14 may be had by referring to Fig. 5, which shows very generally the electrical arrangement of the grid, cathode, and anode electrodes of the oscillator. It will be observed that
40 the anode is directly grounded for radio frequency energy. The by-pass condenser 25 of Fig. 1 has been shown omitted in Fig. 5 for the sake of simplicity. The cathode regeneration control is indicated by the variable regeneration
45 control coil 26, which connects with ground and provides the proper phase relations for oscillation. The coil 4' in Fig. 5, shown connected between the grid and anode, is equivalent to the inductance of the tuned concentric line circuit
50 3 of Fig. 1, particularly that portion between the tapping point on the inner conductor 4 which couples with the grid and the grounded outer conductor. It will be apparent that the circuit
55 simulates a Hartley type of oscillator.

This particular type of oscillator arrangement is highly advantageous and convenient, since it eliminates the necessity of a low inductance
60 cathode lead and is non-critical in permitting tuning of the oscillator over a wide range of frequencies without readjustments. Another advantage lies in the elimination of a tuned anode circuit, such as is customary in certain known
65 types of oscillators, thus simplifying the construction of the vacuum tube circuit and eliminating the necessity for running a low inductance lead from the anode or the cathode of the tube to the tuned circuit. A further advantage of
70 the improved oscillator circuit 14 is that the construction provides an easy method of filtering the anode supply, and only requires a single connection from the oscillator vacuum tube to the concentric line 3. It is obvious that a further modification of this circuit which would operate the
75 same would consist of grounding the grid and

connecting the plate only to the concentric line, the cathode reactance remaining the same. A still further advantage is that the amount of reactance between the grid and plate of the oscillator and ground is kept extremely small so as
5 to discourage parasitic oscillations at the higher frequencies.

The operation of the circuit of Fig. 1 will now be described briefly. The signal from the antenna is passed into the detector concentric line 10
2 by conductively coupled transmission line 1. The detector concentric resonant line 2 is then tuned to the resonant frequency of the received signal, let us say 500 megacycles, and the grid
15 of the detector 15 is adjusted on the inner conductor 4 of the resonant line 2 for optimum results. The cathode of the detector 15 which is connected through bias resistor R_1 and the condenser combination to the inner conductor 4 of
20 the oscillator resonant line 3 is adjusted for proper excitation of the detector, and the oscillator 14 is tuned say 90 megacycles higher or lower than the signal frequency to provide a suitable intermediate frequency of 90 megacycles
25 in the tuned output 19 of the detector. The two frequencies of 500 megacycles (the incoming signal frequency) and 410 megacycles (let us say the oscillator frequency) are mixed in the detector 14 and the resultant beat or converted
30 frequency of 90 megacycles is selected by the detector anode tuned circuit 19 and passed on to the first intermediate frequency amplifier 30 by means of a low impedance coupled circuit. From the first intermediate frequency detector
35 circuit 30 a lower beat note of 5.5 megacycles is passed on to the second intermediate frequency amplifier, and from this latter amplifier the signal is passed to a final detector 33 from which
40 audio frequency energy is supplied to the audio frequency amplifier 34. A second local oscillator 31 serves to supply oscillations to the first intermediate frequency detector circuit 30 to produce the second lower intermediate frequency of
45 5.5 megacycles. The elements 30, 31, 32, 33 and 34 have been shown conventionally in box form, since such circuits are well known in the art and of themselves form no part of the present invention, except that they couple, in the manner
50 shown, to the high frequency converter unit 14, 15 to form an advantageous combination of circuit elements.

Fig. 2 illustrates only certain essential details of the complete assembly of Fig. 2a. More specifically, Fig. 2 is a front view of the high frequency converter unit, with the front panel re-
55 moved, in order to show how all the equipment is readily accessible from the front. The outer conductors 5 of each of the concentric line tuned circuits 2 and 3, and the shielding for the oscillator 14, detector 15, and the associated filter elements are in the form of square tubing since from
60 a mechanical standpoint such square tubing makes it very convenient to mount the elements on one another and to screw the covers for each of the elements in place. This construction also
65 enables adjustment of the parts relative to one another. It should be noted that the concentric line elements are integral elements of themselves, which are adjustable and movable as a whole, relative to the oscillator unit 14 and the detector
70 unit 15, which also with their associated filters are integral units adjustable relative to one another and to the concentric lines.

The detector and oscillator electrodes and the antenna transmission line 1 all couple to the in-
75

ner conductors 4 of the concentric lines by means of collar type clamps 9 which surround the inner conductor and are movable over the outer surfaces thereof by adjustment of the screws 10, shown in the collars. Figs. 4 and 4a, respectively, show perspective and cross-sectional views of the construction of the collars. It will be observed from these figures that the collar comprises a circular clamping arrangement which is split at one end for clamping around the outer surface of the inner conductor. At the lower end of the clamp, there is provided a recessed or indented portion to which is secured another recessed or indented plate 11. Where it is required that there be a condenser serially included in the connection of the collar to the associated vacuum tube circuit, such as in the grid circuit of the oscillator 14, and in the cathode circuit of the detector 15, there is provided a mica spacer 8 between the elements 11 and 9 so as to provide a capacity effect therebetween. In this last case, it will be obvious, of course, that screws 11' will have bushings 12 provided for securing elements 9 and 11 together, in order to provide suitable insulation therebetween. Of course, where there is no necessity to provide a condenser in series with the collar 9, to its associated circuit, there will be no necessity for providing a mica spacer 8 between the elements 11 and 9, and for this reason the element 9 may be made integral with the element 11 so as to provide a direct conductive connection therebetween. Such an arrangement is used for the clamps coupling the antenna 1 and the grid of the detector 15 to the inner conductor 4 of the concentric resonant line 2. The connector 9 may be provided at its lower end, particularly in the portion 11, with an insulating bead 7, as shown in Figs. 2, 3, 4 and 4a, in order to prevent possible contact of the sides of the metallic tubing with the element 11 as the clamp 9 is adjusted over the inner conductor of the resonant line. This bead 7 may be made of Vicon or any other suitable insulating material. Where the collar 9 and element 11 have a dielectric spacer 8 in between for providing a condenser effect, it is a relatively simple matter to solder across both of these elements a small bias or grid leak resistor R_1 or R_4 , as shown in Fig. 2, for the cathode circuit of detector 15 and for the grid circuit of the oscillator 14 respectively.

The oscillator unit 14 with its associated filter elements R_5 , R_6 and R_7 and condensers 17 and inductors 18 are movable as an integral unit, in either direction longitudinally with respect to its associated concentric line 3, merely by loosening screws 25 (note Fig. 2a) which fasten the square metallic tubing shielding the oscillator unit 14 to the square metallic tubing constituting the outer conductor 5 of the resonant line 3, and by loosening the screws 10 on the clamps 9. Similarly, the detector unit 15 and its associated filter circuits are movable as an integral unit longitudinally in two directions with respect to the resonant lines 2 and 3. The screws 35 used for securely fastening the detector unit to the two resonant lines are also shown.

One of the novel features in the physical embodiment of the high frequency converter unit lies in the use of the low inductance filter condensers 17 which comprise, in effect, a pair of plates mounted on opposite sides of a dividing or partition wall. This partition wall separates the filter elements into different compartments. The wall is provided with a hole or aperture to enable the screw to pass through the partition and to

connect together the two plates on opposite sides of the hole. Since the partition wall and the square tubing in which the partition wall is mounted is grounded, there are provided mica or dielectric spacers between each plate of the condenser 17 and the immediately adjacent partition wall to effectively insulate the plates from the partition. The screw passing through the aperture or hole in the partition wall has a diameter smaller than the hole, and connects both plates of each condenser 17 together, thus forming terminals for the connecting wires. Such an arrangement eliminates the necessity of using separate leads between compartments in order to connect the condenser elements to associated circuits. Furthermore, each plate of the condenser 17 forms through the dielectric spacer a low impedance path to ground for the radio frequency energy. The screws connecting the plates together have extremely small reactances at the high frequencies and serve as the mechanical mounting for the condenser. Since the hole or aperture in the partition wall is plugged to some extent by the screw connecting the plates and condensers 17 together, and the plates are relatively large with respect to and cover both sides of the aperture in the partition, it will be apparent that there can be no leakage between compartments because of the hole in the partition, inasmuch as the hole is effectively shielded by the condenser plates.

Fig. 3 shows, in some detail, the features of the concentric resonant line employed in the present invention. The inner and outer conductors of the concentric line are conductively coupled together at one end by an end plate 36. The inner conductor 4 includes an adjustable extension piece 37 which is longitudinally movable in response to rotation of the shaft 38. The shaft 38 is mounted in an insulating bearing 43 and is threaded in the interior of the conductor 4 so as to cooperate with an insulated threaded sleeve 39. Threaded sleeve 39 is pinned to extension 37 while a split bronze sleeve 40 is used to produce good electrical contact between elements 37 and 4. Keyways cut in the edge of 37 allow longitudinal movement without rotation of the inner element 37. Shaft 38 is driven through flexible couplings 44 by a tuning control knob 45 for rapid tuning or by disc 46 for fine tuning (note Fig. 2a). A counter 41 is geared to the shafting for use as an indicator, and reads, in accordance with one actual embodiment constructed in accordance with the invention, $\frac{1}{100}$ of a turn and from zero to 30 turns. The purpose of the flexible coupling 44 and the insulated bearing 43 is to avoid unnecessary electrical noise from sliding metallic contacts. A long shaft, such as 42, may extend through coupling 44 so that the entire resonant control line can be moved readily without disturbing the dial driving mechanism. In Fig. 3 there is also shown the collar clamp device 9 and a slot in the outer conductor over the length of which the collar may be moved.

An inspection of Fig. 2 will show that the various electrodes of the oscillator and detector are suitably by-passed to ground where required, by means of their supporting metallic elements external of the vacuum tube, which in turn are mounted on suitable dielectric spacers, such as mica, in turn located adjacent the square tubing. For example, it will be observed that the filaments and anode terminals of both oscillator 14 and detector 15 are mounted on metallic plates which are spaced from the supporting square tubing by

means of insulating spacers so as to form by-pass condensers.

It should be noted that the metallic screw plug 28, which is employed for short circuiting the 5 turns of the cathode regeneration coil 26 of the oscillator unit 14, is movable by means of a suitable knob 47.

The term "ground" as used in the specification and the appended claims is deemed to include 10 any point of zero high frequency alternating current potential, as well as an actual earthed connection.

What is claimed is:

1. An ultra high frequency oscillation generator 15 comprising an indirectly heated vacuum tube oscillator having grid, anode and cathode electrodes, a heater for said cathode, a concentric line resonator for stabilizing the frequency of said oscillator, said resonator having an inner and an 20 outer conductor suitably coupled together, a connection from said outer conductor to ground, a capacitive connection from said anode to ground for the radio frequency energy, a connection from said grid to a point on said inner conductor, a regeneration control coil coupling said cathode to 25 ground, leads within said coil coupling said heater to an external source of energy, and means for tuning said coil.
2. An ultra high frequency oscillation generator 30 comprising a vacuum tube oscillator having grid, anode and cathode electrodes, a heater for said cathode, a metallic shielding box surrounding said vacuum tube, a connection from said shielding box to ground, a frequency stabilizing 35 element external of said box and coupled to the grid of said vacuum tube, a metallic plate mounted on the interior of said box and separated therefrom by a dielectric spacer to form a low impedance capacitive path to ground for radio 40 frequency energy, a connection from said metallic plate to said anode, a regeneration control coil for said oscillator located within said box, said coil being hollow and connected at one end to said cathode and at its other end to said box, 45 leads within said coil coupling said heater to an external source of heating supply, a lead extending from said anode to a source of polarizing potential located externally of said box, and means for by-passing said heater leads to ground 50 where they emerge from both ends of said coil.

3. An ultra high frequency oscillation generator comprising a vacuum tube oscillator having grid, anode and cathode electrodes, a metallic shielding box surrounding said vacuum tube, a 5 connection from said shielding box to ground, a concentric line resonator located externally of said box, said resonator having an inner and an outer conductor suitably coupled together, said outer conductor being in contact with said box and movable relative thereto, a connection from 10 a point on said inner conductor intermediate its ends to the grid of said vacuum tube oscillator, a capacitive connection from said anode to said box, and a regeneration control coil within said box coupling said cathode to ground, said coil 15 having means for tuning the same.

4. An ultra high frequency oscillation generator comprising a vacuum tube oscillator having grid, anode and cathode electrodes, a heater for said cathode, a metallic shielding box surrounding 20 said vacuum tube, a connection from said shielding box to ground, a frequency stabilizing element external of said box and coupled to the grid of said vacuum tube, a metallic plate mounted on the interior of said box and separated there- 25 from by a dielectric spacer to form a low impedance capacitive path to ground for radio frequency energy, a connection from said metallic plate to said anode, a regeneration control coil for said oscillator located within 30 said box, said coil being hollow and connected at one end to said cathode and at its other end to said box, leads within said coil coupling said heater to an external source of heating supply, a lead extending from said anode 35 to a source of polarizing potential located externally of said box, filter elements in circuit with each of said heater leads and with said anode lead and located externally of said box, and means in circuit with each lead to said box for 40 grounding said filter elements for radio frequency energy, said means comprising a metallic plate on each side of one wall of said box and separated from said wall by a dielectric spacer, and a screw electrically connecting said last plates together 45 through an aperture in said wall.

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