

July 23, 1946.

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2,404,640

ULTRA-HIGH-FREQUENCY SIGNAL-TRANSLATING APPARATUS

Filed Oct. 29, 1941

2 Sheets-Sheet 2

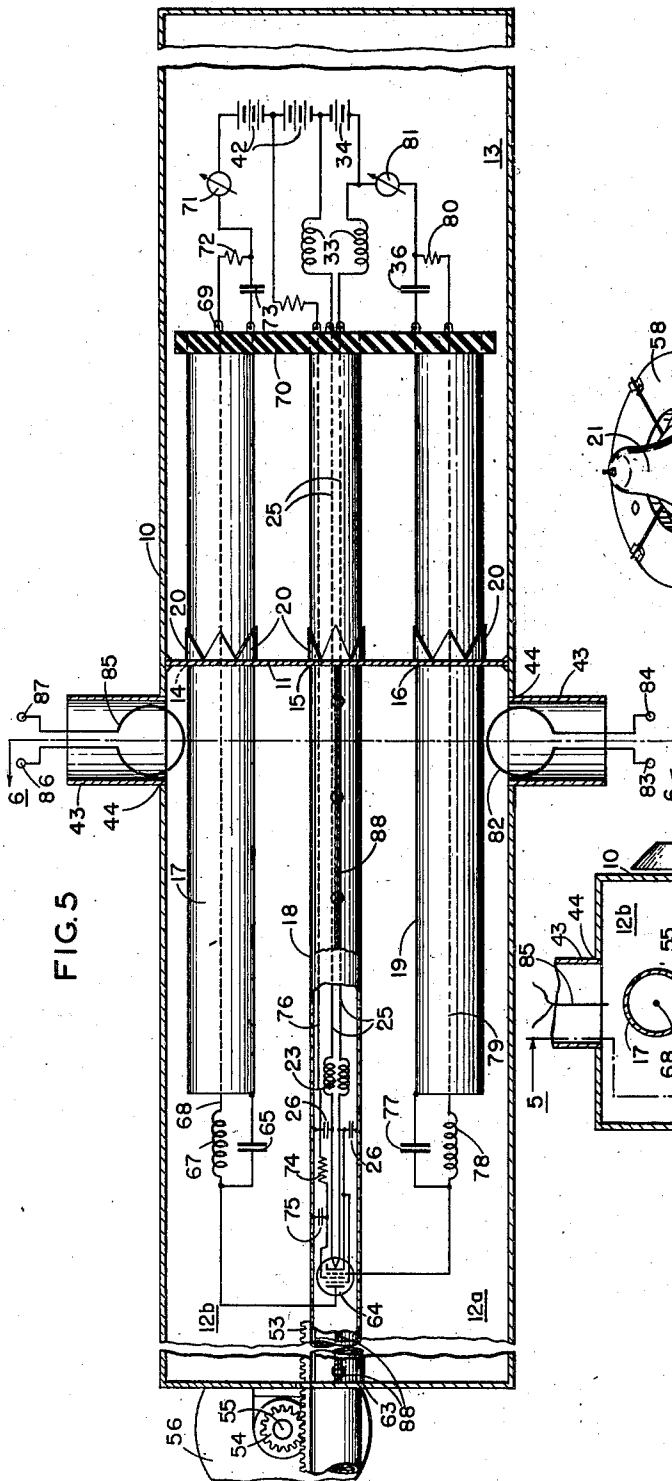


FIG. 5

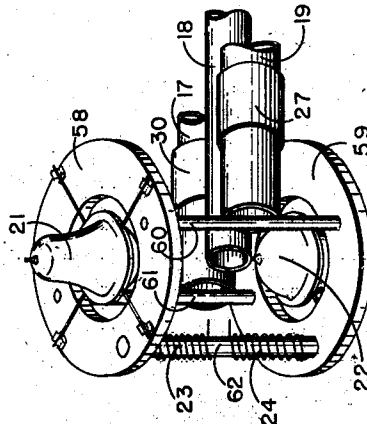


FIG. 3

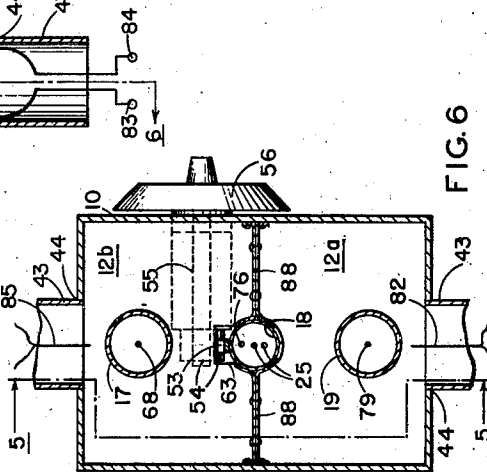


FIG. 6

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2,404,640

ULTRA HIGH FREQUENCY SIGNAL-TRANSLATING APPARATUS

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Application October 29, 1941, Serial No. 416,986

14 Claims. (Cl. 250—36)

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The present invention relates to ultra-high-frequency signal-translating apparatus and, particularly, to such apparatus of the type adapted to be tuned over a wide range of operating frequencies.

Certain ultra-high-frequency signal-translating apparatus of the prior art has included a pair of parallel stationary conductors arranged as a two-wire transmission line and tunable over a range of operating frequencies by a short-circuiting bar slidable along the conductors. The arrangement thus provided is effectively a two-terminal resonant circuit and has generally been used as a single-tuned stage between tandem stages of amplification or as a single-tuned stage of an oscillator. In the prior art arrangements of this nature, the coupling of any signal-translating channels or associated vacuum tubes with the two-wire transmission line has been accomplished by coupling such channel or tubes directly or capacitively with the open end of the line, or an intermediate tap. It would be desirable, however, to couple to the two-wire transmission line by the use of an inductive coupling arrangement which has the advantage that it can be arranged to avoid ground return currents. Such inductive coupling systems, however, must be positioned in the vicinity of the shorting bar since this is the region of maximum magnetic field intensity and flux density about the conductors. Inductive coupling arrangements of this nature have heretofore been used only where the signal-translating apparatus is designed to operate at or near one frequency. No attempt has been made to use such coupling arrangements where the apparatus is designed to operate over a wide range of frequencies since the region of maximum magnetic field intensity about the conductors would move with the short-circuiting tuning bar.

It is an object of the present invention, therefore, to provide a new and improved ultra-high-frequency signal-translating apparatus which avoids one or more of the disadvantages and limitations of the prior art arrangements of this nature.

It is a further object of the invention to provide an ultra-high-frequency signal-translating apparatus of the type including a tuned transmission line and in which the region of maximum magnetic field intensity of the tuned transmission line remains stationary at a predetermined fixed location over a wide range of tuning frequencies, whereby the transfer of signal energy to and from the apparatus by a fixed inductive coupling system remains maximum throughout the wide

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range of frequencies over which the apparatus is adapted to operate.

In accordance with the invention, an ultra-high-frequency signal-translating apparatus comprises an elongated rigid conductor and a fixed conductive member slidably supporting the conductor and providing an electrical ground connection thereto. There is provided means including the conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of the conductor extending from one side of the aforesaid member. The apparatus includes means movable in unison with the conductor for supporting vacuum-tube apparatus and associated circuit elements at the end of the conductor on the aforesaid one side of the member. The apparatus also includes means for moving the conductor through the member to tune the resonant circuit to a predetermined operating frequency in the aforesaid frequency range.

In accordance with a preferred form of the invention, a signal-translating apparatus of the type described comprises a pair of elongated rigid conductors and a fixed member slidably supporting the conductors in parallel spaced relation and providing an electrical connection therebetween, the conductors forming a resonant circuit tunable over a range of frequencies by adjustment of the lengths of the conductors extending from one side of the member. The region of maximum field intensity about the conductors remains stationary in the vicinity of the one side of the member over the aforesaid range of frequencies. The apparatus also includes means for moving the conductors in unison through the member to tune the resonant circuit to a predetermined operating frequency in the aforesaid frequency range.

In accordance with a particular form of the invention, the apparatus of the type described includes means movable in unison with the conductor for supporting vacuum-tube apparatus and associated circuit elements at the end of the conductor on the aforesaid one side of the supporting member. The apparatus may also include an elongated metallic housing in which case the supporting member takes the form of a partition wall fixedly supported transversely within the housing to divide the interior thereof into two chambers, the partition wall having an aperture through which the conductor extends. Means is provided for supporting the conductor in the aperture and for completing an electrical

ground connection thereto at a fixed location near the partition wall.

For a better understanding of the present invention together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

Referring now to the drawings, Fig. 1 represents a top view, partly schematic, of a complete ultra-high-frequency signal-translating apparatus embodying the invention; Fig. 2 is a cross-sectional view of the Fig. 1 arrangement taken along the plane 2—2; Fig. 3 is a perspective detail view of an arrangement for supporting vacuum-tube apparatus and associated circuit elements on one end of the parallel movable conductors of the Fig. 1 embodiment of the invention; Fig. 4 is a cross-sectional view of a modified construction of ultra-high-frequency signal-translating apparatus embodying the invention; Fig. 5 represents a complete ultra-high-frequency signal-translating apparatus embodying the invention in a modified form; and Fig. 6 is a cross-sectional view of the Fig. 5 arrangement taken along the plane 6—6.

Referring more particularly to Fig. 1, there is represented a complete ultra-high-frequency signal-translating apparatus embodying the present invention in the form of an ultra-high-frequency oscillator. The oscillator includes an elongated metallic housing 10 with a conductive member or partition wall 11 fixedly supported transversely within the housing 10 to divide the interior thereof into two chambers 12 and 13. The partition wall 11 has a plurality of apertures 14, 15, 16 through which extend a plurality of elongated rigid tubular conductors 17, 18, and 19, respectively. The apparatus includes means for supporting the conductors 17, 18, and 19 in parallel spaced relation and for completing a conductive connection therebetween at a fixed point near the partition wall 11 comprising a plurality of longitudinally-slotted sleeves 20, 20 fixedly secured to the partition wall 11 in registry with individual ones of the apertures 14, 15, 16. The partition wall 11 and sleeves 20 thus comprise a unitary fixed member slidably supporting individual ones of the conductors 17, 18, and 19 and providing an electrical connection therebetween and to the casing 10, usually at ground potential, at a fixed location near the partition wall. The conductors 17 and 19 as thus arranged and supported form a resonant circuit balanced to ground. This resonant circuit may, in one view of the matter, be considered two resonant circuits each unbalanced to ground and simultaneously tuned by movement of the conductors 17 and 19 through the partition wall 11. This type of resonant circuit is comparable to that formed by an inductor having two equal-valued series condensers connected across its terminals, ground connections being made to the center point of the inductor and the junction of the condensers. This resonant circuit is tunable over a range of frequencies in accordance with the lengths of the conductors extending from that side of the partition wall 11 which closes the chamber 12. The central conductor 18 is neutral.

Vacuum-tube apparatus comprising vacuum tubes 21 and 22 and associated circuit elements are supported, in a manner presently to be considered in greater detail, on those ends of the conductors 17, 18, and 19 which extend into the

chamber 12 and thus are movable in unison with the conductors. The cathodes of vacuum tubes 21 and 22 are energized through respective pairs of radio-frequency choke coils 23, 24 from an energizing circuit 25 which extends through the tubular conductor 18 but is insulated therefrom. By-pass condensers 26, 26 connected between the circuit 25 and neutral conductor 18 maintain the energizing circuit 25 at ground potential for currents of ultra-high frequency. The grid of tube 21 is coupled through a condenser 27 to an optimum point near the end of conductor 19 and is connected to the cathode-energizing circuit 25 through a grid-leak resistor 28 and a conductor 29 which extends through, but is insulated from, the tubular conductor 19. The grid of tube 22 is similarly coupled through a condenser 30 to an optimum point near the end of conductor 17 and is connected to the cathode-energizing circuit 25 through a grid-leak resistor 31 and a conductor 32 which extends through, but is insulated from, the tubular conductor 17. The anodes of tubes 21 and 22 are directly connected to the ends of the respective conductors 17 and 19.

The energizing circuit 25 emerges from the tubular conductor 18 in the chamber 13 and is connected through a pair of radio-frequency choke coils 33 to a source of energizing potential, such as a battery 34. Resonance-damping networks comprising series condensers 8, 8 and series resistors, 9, 9 are connected between a point of zero radio-frequency potential and the conductors of the energizing circuit 25 in proximity to the point at which the latter emerges into chamber 13. The grid-circuit conductor 29 likewise emerges from the tubular conductor 19 in the chamber 13 and is connected to one side of the energizing circuit 25 through a radio-frequency filter comprising a series resistor 35 and shunt condenser 36 and through a microammeter 37. The other grid-circuit conductor 32 similarly emerges into the chamber 13 and is connected to the same side of the energizing circuit 25 through a similar radio-frequency filter comprising a series resistor 38 and shunt condenser 39 and through a microammeter 40. The ends of the conductors 17, 18, and 19 which extend into the chamber 13 are mechanically and electrically connected together by a conductive yoke 41. A source of space current, such as a battery 42, is connected between the cathode-energizing circuit 25 and the yoke 41, whereby space current is supplied to tubes 21 and 22 directly through the respective tubular conductors 17 and 19.

The batteries 34 and 42 may be supported to move with the yoke 41 though in practice these batteries are preferably fixedly positioned in the metallic housing 10 and are electrically connected to the energizing circuit 25 and the yoke 41 through flexible conductors. Alternatively, the batteries 34 and 42 may be positioned externally of the housing 10 and, in either event, the batteries may be replaced by any of the well-known forms of cathode and anode supply systems.

The oscillator is provided with an output circuit including a loop or winding 45 disposed in the region of maximum magnetic field intensity developed about the conductor 19 in the vicinity of the partition wall 11 and on the side thereof which closes the chamber 12. The loop or winding 45 forms a component of the mutual-inductance type of piston attenuator including an open-ended metallic cylindrical member 43 fixedly se-

cured in an aperture 44 in one wall of the chamber 12 near the partition wall 11. The loop or winding 45 is movably positioned in the cylindrical member 43, whereby it is movable into and out of the region of maximum magnetic field intensity developed about the conductor 19, which remains stationary in the vicinity of the partition wall 11 over the range of operating frequencies of the oscillator. The loop winding 45 is coupled to a pair of output terminals 46, 47 and there is connected across these terminals a center-tapped impedance 48. A third output terminal 49 is connected to the center tap of the impedance 48 to provide a balanced output circuit for the oscillator. The inductance piston attenuator comprising the cylinder 43 and loop or winding 45 is described in detail in a paper by Daniel E. Harnett and Nelson P. Case entitled "The design and testing of multirange receivers," which appears in the Proceedings of the Institute of Radio Engineers, June, 1935, pages 578-593, inclusive.

In order to preserve substantial symmetry and electrical balance of the tuned circuit formed by the conductors 17 and 19, a dummy attenuator cylinder 50 is secured in an aperture 51 provided in the wall of the housing 10 at a point diametrically opposite the cylinder 43. The cylinder 50 is closed at its outer end 52.

Movement of the tubular conductors 17, 18, and 19 in unison through the partition wall 11 is effected by a rack 53 provided on the center conductor 18, the rack 53 being driven by a pinion gear 54 which is fixedly secured to one end of a shaft 55. The other end of the shaft 55 extends outside of the housing 10 and has secured thereon a suitable calibrated dial and operating knob 56. A dummy rack 57 is provided on the center conductor 18 diametrically opposite the rack 53 to preserve symmetry and electrical balance.

Considering now the operation of the oscillator arrangement just described, vacuum tubes 21 and 22, connected in push-pull to the resonant circuit comprising conductors 17 and 19, generate ultra-high-frequency signal oscillations which develop standing waves of potential and current on the conductors 17 and 19, the potential waves having a maximum value near the ends of the conductors 17, 19 and the current waves having a maximum value in the vicinity of the partition wall 11. Sustained oscillations are maintained by feeding back to the grids of tubes 21 and 22 through the respective condensers 27 and 30 the high-frequency potentials developed at optimum points near the ends of the respective conductors 19 and 17. Suitable operating biases for the grid of tubes 21 and 22 are produced in well-known manner by grid rectification of the generated oscillations and appear across the respective resistors 28 and 31, a state of sustained oscillation being indicated by the microammeters 37 and 40. The conductors 17 and 19 thus operate as a balanced transmission line and form a balanced resonant circuit tunable to the operating frequency, the latter varying with the lengths of the conductors 17 and 19 which extend from the partition wall 11 into the chamber 12.

Thus, the balanced resonant circuit formed by the conductors 17 and 19 is tunable over a range of frequencies. The dial 56, the pinion gear 54, and the rack 53 comprise means for moving the conductors 17, 18, and 19 through the partition wall 11 to tune the resonant circuit over the operating frequency range. The standing waves of current developed along the conductors 17 and 19 always have maximum values in the vicinity of

the partition wall 11 regardless of the lengths of the conductors 17, 18, and 19 which extend into the chamber 12. The regions of maximum magnetic field intensity about the conductors 17 and 19, therefore, remain stationary in the vicinity of the partition wall 11 throughout the range of frequencies over which the balanced resonant circuit formed by the conductors 17 and 19 is tunable. With the loop 45 positioned near the conductor 19, the ultra-high-frequency signal energy induced in the loop 45 and applied to the output terminals 46, 47 consequently remains maximum over the entire range of operating frequencies. The amplitude of the signal output applied to terminals 46, 47 may be varied, as is well known, by adjustment of the loop 45 along the axis of the cylinder 43. A balanced output may be obtained between the terminals 46, 47.

The purpose of the by-pass condensers and radio-frequency choke coils associated with the conductors 29 and 32 and the cathode-energizing circuit 25 is to reduce the tendency of the conductors 29, 32 and the conductors of the energizing circuit 25 to act as parasitic resonant transmission lines, thereby to impair the operation of the oscillator arrangement.

Fig. 3 illustrates in greater detail the construction by which the vacuum tubes 21 and 22 and their associated circuit elements are fixedly supported on the ends of the conductors 17 and 19 to move therewith. Tube sockets 58, 59 are provided for the respective vacuum tubes 21 and 22 and are fixedly supported in spaced relation by spacing members 60, 61, 62. Two of the spacing members, for example, the members 60 and 61, are fixedly secured to the ends of individual ones of the conductors 17 and 19 by any suitable means, as soldering, welding or the like. The third supporting member, for example, the member 62, is used as a winding form for the pairs of radio-frequency chokes 23 and 24. The by-pass condensers 27 and 30 are conveniently formed by wrapping a ribbon of conductive material of suitable width over a layer of insulating material provided near the ends of the respective conductors 19 and 17. The optimum position of these condensers varies both with the characteristics of the balanced resonant circuit formed by the conductors 17 and 19 and with the constants of the vacuum-tube apparatus and circuit elements associated therewith and can best be determined by experiment. By-pass condensers 26, 26, Fig. 1, are conveniently formed in similar manner on the center conductor 18.

The region of greatest magnetic field intensity in the Fig. 1 arrangement occurs at the position occupied by the central conductor 18 and is produced by the combined fields of the conductors 17 and 19. Where the maximum possible output is desired, it is therefore necessary that the inductance piston attenuator 43, 45 be positioned at this point. The cross-sectional view illustrated in Fig. 4 represents a modified construction by which this may be accomplished. The arrangement of Fig. 4 is essentially similar to that of Fig. 1, similar elements being designated by similar reference numerals, except that an additional conductor 18' permits the conductor 18 to be moved to one side of the position which it occupies in the Fig. 1 arrangement while preserving symmetry and electrical balance of the resonant circuit provided by the conductors 17 and 19. Symmetry and electrical balance is further preserved by the provision of dummy racks 53' and 57' on the dummy conductor 18'. The

cylindrical member 43 of the piston attenuator is now fixedly positioned in an aperture provided in the partition wall 11 at a point aligned with and midway between the conductors 17 and 19. The operation of this modified form of high-frequency oscillator is essentially similar to that of the Fig. 1 arrangement and will not be repeated.

Fig. 5 illustrates a modified form of the invention comprising an ultra-high-frequency amplifier arrangement which is essentially similar to the oscillator arrangement of Fig. 1, similar elements being designated by similar reference numerals, except that the conductors 17 and 19 in the amplifier arrangement operate as unbalanced transmission lines forming respective output and input tuned circuits of the amplifier. The central neutral conductor 18 in this arrangement is longer than in Fig. 1 and extends through an aperture 63 in the end wall of the housing 10. A vacuum-tube amplifier device 64 and associated circuit elements therefor are enclosed within the conductor 18. The anode of tube 64 is coupled to the conductor 17 through a condenser 65, which may be formed on the conductor 17 in the manner of the condenser 30 of Figs. 1 and 3, and is connected through a radio-frequency choke 67 and conductor 68, which extends through the tubular conductor 17, to a terminal 69 on a yoke 70, preferably of insulating material, which mechanically connects the conductors 17, 18, and 19 for simultaneous movement through the partition wall 11. The source of space current 42 is connected through a milliammeter 71 and a filter network comprising a series resistor 72 and a shunt condenser 73 to the terminal 69. The screen grid of tube 64 is energized from the battery 42 through a filter network comprising a series resistor 74 and shunt condenser 75 and a conductor 76, which extends through the hollow conductor 18. Additional filter networks of well-known form may be included in the energizing circuits of the anode and screen grid if desired. The control electrode of tube 64 is coupled through a condenser 77 to the end of the conductor 19 and is connected through a radio-frequency choke 78, conductor 79, a grid resistor 80, and a microammeter 81 to the cathode-energizing circuit 25.

The conductors 18 and 19 form the input resonant circuit of the amplifier and there is consequently coupled to the conductor 19 in a region of its maximum magnetic field intensity, which is in the vicinity of the partition wall 11, an input loop or winding 82 having input circuit terminals 83, 84. Similarly, the conductors 17 and 18 form the output resonant circuit of the amplifier and there is coupled to this conductor 17 an output loop or winding 85 having output circuit terminals 86, 87, the winding 85 being positioned in the vicinity of the partition wall 11 where there is developed the region of maximum magnetic field intensity about the conductor 17.

A cross-sectional view of the apparatus of Fig. 5 is shown in Fig. 6. This view illustrates more clearly the arrangement of a second partition wall 88, 88 which is fixedly secured longitudinally of the housing 10 at the elevation of the center conductor 18 and extends from the partition wall 11 to the opposite end of the housing 10 to form an input circuit chamber 12a and an output circuit chamber 12b, thus isolating the input and output circuits of the amplifier.

The operation of the Fig. 5 amplifier arrangement is essentially similar to that of the Fig. 1

oscillator arrangement except that each of the conductors 17 and 19 operates as a resonant transmission line comprising a single conductor unbalanced to ground as distinguished from the balanced pair of conductors 17 and 19 which form the tuned circuit of the Fig. 1 arrangement. Input ultra-high-frequency signal currents applied to the input terminals 83, 84 produce along the conductor 19, when the latter is tuned to the frequency of the input signal by suitably proportioning the extended length of this conductor from the partition wall 11, a standing wave of potential having maximum value near the end of the conductor. This potential is applied through the condenser 77 to the vacuum-tube amplifier 64 where it is amplified and applied through the condenser 65 to the output circuit conductor 17. Since the conductors 17 and 19 are mechanically connected by the yoke 70 and, therefore, move in unison through the partition wall 11, the output circuit conductor 17 is tuned to the same operating frequency as the input circuit conductor 19. Consequently, there is developed along the conductor 17 a standing wave of current having maximum value in the region of the partition wall 11, and, therefore, in proximity to the output loop or winding 85. The maximum value of amplified high-frequency signal current is thus induced in the loop 85 and applied to the output terminals 86, 87. The meter 81, in this operation, provides an indication of the input-signal level at the control grid of tube 64.

While the amplifier construction of Figs. 5 and 6 is of the unbalanced or single-ended type, a push-pull or balanced amplifier may be provided using the balanced construction disclosed in the oscillator arrangement of Figs. 1 and 2. Also several stages can be cascaded by connecting the output terminals 86, 87 of one stage to the input terminals 83, 84 of the next stage.

From the above description of the invention, it will be evident that an ultra-high-frequency signal-translating apparatus embodying the invention has the advantage that the region of maximum magnetic field intensity of its tuned input and output circuits remains stationary at a predetermined fixed location over a wide range of tuning frequencies, thus ensuring that the transfer of signal energy to and from the apparatus by fixed inductive coupling means remains maximum over a wide range of frequencies over which the apparatus is adapted to operate. The invention has the additional advantage, where the apparatus includes at least two tuned circuits of the resonant transmission line type, that both circuits are simultaneously and accurately tuned to the same operating frequency, thus greatly simplifying the adjustment of the apparatus for operation over the operating frequency range.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid conductor, a fixed conductive member slidably supporting said conductor, means including said con-

ductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said member, means movable in unison with said conductor for supporting vacuum-tube apparatus and associated circuit elements at the end of said conductor on said one side of said member, and means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

2. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid conductor, a fixed conductive member having an aperture in which said conductor is slidably supported, means including said member for completing an electrical ground connection to said conductor substantially at the point of support thereof by said member, means including said conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said member, means movable in unison with said conductor for supporting vacuum-tube apparatus and associated circuit elements at the end of said conductor on said one side of said member, and means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

3. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid conductor, a fixed conductive member slidably supporting said conductor, means including said conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said member, means for supporting vacuum-tube apparatus and associated circuit elements on that end of said conductor which is on said one side of said member, and means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

4. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid conductor, a fixed member slidably supporting said conductor and providing an electrical connection thereto, means including said conductor for forming a resonant circuit tunable over a range of frequencies in accordance with the length of said conductor extending from one side of said member, the region of maximum magnetic field intensity about said conductor remaining stationary in the vicinity of said one side of said member over said range of frequencies, means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range, and an output circuit including a loop disposed in said region of maximum magnetic field intensity.

5. An ultra-high-frequency signal-translating apparatus comprising, an elongated metallic housing, a conductive apertured partition disposed transversely within said housing to divide the interior thereof into two chambers, an elongated rigid conductor, means for slidably supporting said conductor in an aperture of said partition and for making an electrical connection between said conductor and said partition at a fixed point near said partition, means including said conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said partition, the re-

gion of maximum magnetic field intensity about said conductor remaining stationary in the vicinity of said one side of said partition over said range of frequencies, means for moving said conductor through said partition to tune said resonant circuit to a predetermined operating frequency in said frequency range, and an output circuit including a loop disposed in said region of maximum magnetic field intensity.

6. An ultra-high-frequency signal-translating apparatus comprising, a pair of elongated rigid conductors, a fixed member slidably supporting said conductors in parallel spaced relation and providing an electrical connection therebetween, said conductors forming at least one resonant circuit tunable over a range of frequencies by adjustment of the lengths of said conductors extending from one side of said member, means movable in unison with said conductors for supporting vacuum-tube apparatus and associated circuit elements at the end of said conductors on said one side of said member, and means for moving said conductors in unison through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

7. An ultra-high-frequency signal-translating apparatus comprising, a pair of elongated rigid conductors, means including a fixed member for slidably supporting said conductors in parallel spaced relation and for completing an electrical connection between said conductors substantially at the point of support thereof, said conductors forming at least one resonant circuit tunable over a range of frequencies by adjustment of the lengths of said conductors extending from one side of said member, means movable in unison with said conductors for supporting vacuum-tube apparatus and associated circuit elements at the end of said conductors on said one side of said member, and means for moving said conductors in unison through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

8. An ultra-high-frequency signal-translating apparatus comprising, three elongated rigid conductors, a fixed member slidably supporting said conductors in parallel spaced relation and providing an electrical connection therebetween, said conductors forming two resonant circuits having one conductor common to each and tunable over a range of frequencies by adjustment of the lengths of the other two of said conductors extending from one side of said member, means movable in unison with said conductors for supporting vacuum-tube apparatus and associated circuit elements at the end of said other two conductors on said one side of said member, and means for moving said conductors in unison through said member simultaneously to tune both of said resonant circuits over the same frequency range.

9. An ultra-high-frequency signal-translating apparatus comprising, three elongated rigid conductors, a fixed member slidably supporting said conductors in parallel spaced relation and providing an electrical connection therebetween, said conductors forming two resonant circuits having one conductor common to each and tunable over a range of frequencies by adjustment of the lengths of the other two of said conductors extending from one side of said member, each of said other two of said conductors having a maximum magnetic field intensity thereabout which remains stationary in the vicinity of said one side of said

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member over said range of frequencies, means for moving said conductors in unison through said member simultaneously to tune both of said resonant circuits over the same frequency range, and input and output circuits including input and output loops disposed in individual ones of said regions of maximum magnetic field intensity.

10. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid tubular conductor, a fixed member slidably supporting said conductor and providing an electrical connection thereto, means including said conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said member, means for fixedly supporting vacuum-tube apparatus and associated circuit elements on that end of said conductor which is on said one side of said member, an electric circuit extending through said conductor and electrically insulated therefrom for energizing said vacuum-tube apparatus, and means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range.

11. An ultra-high-frequency signal-translating apparatus comprising, an elongated metallic housing, a conductive apertured partition disposed transversely within said housing to divide the interior thereof into two chambers, a plurality of elongated rigid tubular conductors, means for slidably supporting said conductors in individual apertures of said partition and for making an electrical connection between said conductors and said partition at a fixed point near said partition, means including said conductors for forming at least one resonant circuit tunable over a range of frequencies by adjustment of the lengths of said conductors extending from one side of said partition, the region of maximum magnetic field intensity about said conductors remaining stationary in the vicinity of said one side of said partition over said range of frequencies, means for moving said conductors through said partition to tune said resonant circuit to a predetermined operating frequency in said frequency range, means movable in unison with said conductors for supporting vacuum-tube apparatus and associated circuit elements in one of said chambers, current supply means in the other of said chambers, current supply leads extending through said conductors and electrically insulated therefrom for energizing said vacuum-tube apparatus from said current supply means, and an output circuit including a loop disposed in said region of maximum magnetic field intensity.

12. An ultra-high-frequency signal-translating apparatus comprising, a pair of elongated rigid conductors, a fixed member slidably supporting said conductors in parallel spaced relation and providing an electrical connection therebe-

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tween, said conductors forming at least one resonant circuit tunable over a range of frequencies by adjustment of the lengths of said conductors extending from one side of said member and the region of maximum magnetic field intensity about said conductors remaining stationary in the vicinity of said one side of said member over said range of frequencies, means for moving said conductors in unison through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range, and an output circuit including a loop disposed in said region of maximum magnetic field intensity.

13. An ultra-high-frequency signal-translating apparatus comprising, an elongated rigid conductor, a fixed conductive member slidably supporting said conductor, means including said conductor for forming a resonant circuit tunable over a range of frequencies by adjustment of the length of said conductor extending from one side of said member, the region of maximum magnetic field intensity about said conductor remaining stationary in the vicinity of said one side of said member over said range of frequencies, means for moving said conductor through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range, and an inductance type of piston attenuator fixedly positioned with respect to said conductive member and including a loop movable into and out of said region of maximum field intensity.

14. In an ultra-high-frequency signal-translating apparatus, a push-pull oscillator comprising, a plurality of elongated rigid conductors, a fixed conductive member slidably supporting said conductors, means including said conductors for forming at least one resonant circuit tunable over a range of frequencies by adjustment of the lengths of said conductors extending from one side of said member, the region of maximum magnetic field intensity about said conductors remaining stationary in the vicinity of said one side of said member over said range of frequencies, means for moving said conductors through said member to tune said resonant circuit to a predetermined operating frequency in said frequency range, means movable in unison with said conductors for supporting a pair of vacuum tubes and associated circuit elements at the end of said conductors on said one side of said member, means for connecting the output electrodes of said vacuum tubes to individual ones of said conductors, and for coupling the input electrodes of said vacuum tubes to individual other ones of said conductors to provide a balanced push-pull oscillator, and an output circuit including a loop disposed in the region of maximum magnetic field intensity of at least one of said conductors.

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