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RADIO APPARATUS EMPLOYING SLOT ANTENNA

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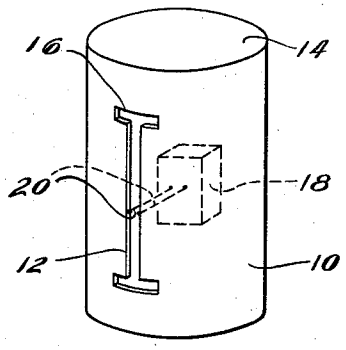


FIG 1

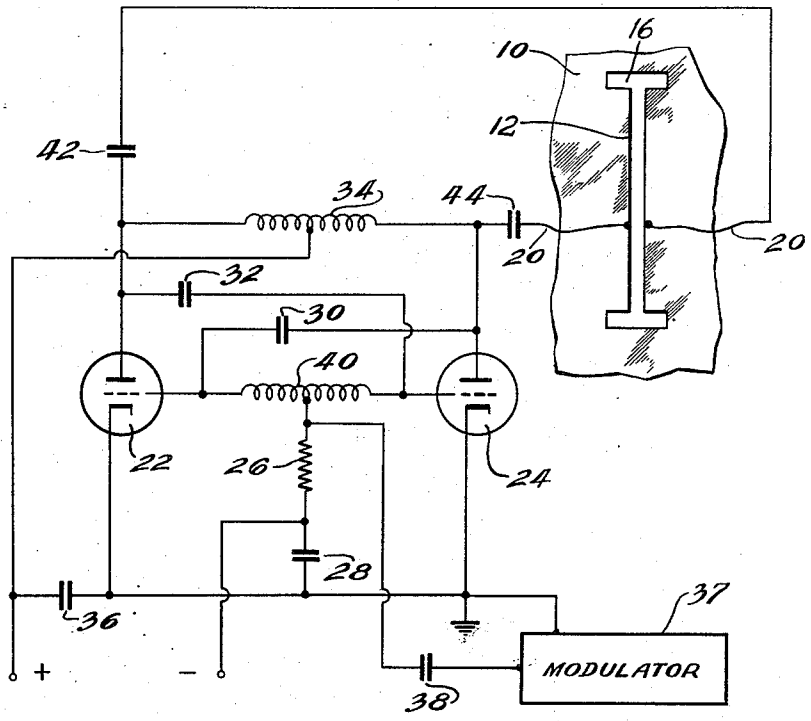


FIG-2

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RADIO APPARATUS EMPLOYING SLOT ANTENNA

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10 Claims. (Cl. 250—17)

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This invention relates to high-frequency radio apparatus, employing an antenna.

Slot antennas have been widely used in recent years, in which the antenna takes the form of a sheet having a long and narrow slot, with the slot coupled to a radio signal generator or a receiver. The slot antenna is notable for its effectiveness over a broad frequency range, making it well-suited to transmitters operating over a broad band of frequencies such as pulse transmitters, frequency-modulation transmitters, and for broad-band receivers as well. Where the antenna is of sheet-metal, generally cylindrical in form and having a single half-wavelength longitudinal slot, a broad radiation pattern is obtained. This is useful particularly for maintaining communication between airborne and ground units, where the relative orientation of the units is subject to continuous change. Directional cylindrical slot antennas can also be constructed by attention to length and number of slots.

Radio units incorporating a slot antenna, including both receivers and transmitters of various forms, commonly employ an impedance in the stage coupled to the antenna which is required to be high over the operating frequency range while the antenna is required to have a radiation impedance of only a few hundred ohms. I have succeeded in eliminating that stage impedance as a distinct structure by utilizing the edges of the slot in the antenna as the impedance. This has the further effect of imparting to the directly coupled portion of the radio unit the same broad frequency characteristic for which the slot antenna is noted. The desired matching of impedances of the antenna and the coupled stage is effected by correct proportioning of the slot and by coupling the stage at the proper point between one end and center of the slot. There is the further result that the matching network ordinarily used between the antenna and the unit is also eliminated. In particular, where the slot is utilized in an anode circuit as the principal frequency-determining unit of an oscillator, the resulting transmitter is especially well-suited to forms of radio signalling requiring broad frequency bands, as to pulse-communication and to frequency modulation about the center frequency of the slot edges which then act somewhat as Lecher wires having shorted terminals.

The usual transmission line between an antenna and the coupled radio unit involves troublesome problems of shielding and design. These I have overcome pursuant to another aspect of the invention by enclosing the radio unit bodily

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within the hollow of a cylindrical antenna and eliminating the transmission line. The several aspects of the invention, together with further features of novelty, will be better appreciated from the following detailed disclosure of a specific, illustrative embodiment of the invention, shown in the accompanying drawings in which:

Fig. 1 is a somewhat diagrammatic view of one form of slot antenna enclosing a radio unit to which the slot is connected; and

Fig. 2 is the wiring diagram of an amplitude-modulated oscillator coupled to the slot antenna of Fig. 1.

In Fig. 1 cylinder 10 is provided with a longitudinal slot 12 to constitute a cylindrical slot antenna. Cylinder 10 is closed by metal ends 14, although this is not entirely necessary. In the embodiment of Fig. 1 slot 12 is provided with transverse end portions 16 which have the effect of adapting the slot to lower-frequency operation than a similar slot 12 without such extensions. Translator 18 that may be a receiver or a signal generator is enclosed within cylindrical antenna 10 and is coupled to that antenna by short leads 20 that are joined to opposite edges of the slot. Unit 18 advantageously is battery-operated and in this respect is entirely enclosed within antenna 10. This eliminates the need for a transmission line that would ordinarily be used between unit 18 and its antenna, and avoids the shielding and matching difficulties connected with transmission lines in uses of that kind.

The foregoing apparatus represents a compact and lightweight radio complete in itself, which is well suited to airborne communication because of its broad radiation pattern and its wide-band frequency characteristic. Unit 18 of Fig. 1 advantageously takes the form of a modulated oscillator, particularly an amplitude-modulated oscillator as shown in Fig. 2. This illustrative oscillator has a push-pull pair of triodes 22 and 24, the grids of which are biased by grid-leak resistor 26 and capacitor 28, which are cross-coupled to the anodes of the opposite triodes by capacitors 30 and 32. The anodes of triodes 22 and 24 are energized through a center-tapped high-frequency choke 34 by the positive terminal of the direct-current supply that is bypassed by capacitor 36. Modulator 37, which injects varying voltage into the grid circuit, is coupled to the grids in parallel through coupling capacitor 38 and center-tapped radio frequency choke 40.

The principal element of the oscillator that determines its center frequency would usually be a coil-and-capacitor combination or comparable

resonator forming an integral part of the oscillator and coupled to the antenna through a carefully designed transmission line. In the present apparatus the oscillator utilizes the slotted antenna itself as the principal tuned impedance for determination of the center operating frequency. The anodes of tubes 22 and 24 are coupled through capacitors 42 and 44 through leads 20 to the opposite edges of slot 12 of antenna 10. Antenna 10 has the proper low impedance, of the order of a few hundred ohms, for effective radiation. The edges of the slot are effective, somewhat as the parallel wires of a Lecher system, to present to the oscillator the high impedance required by vacuum tubes 22, 24 for their efficient operation. The exact impedance presented by the slot to the oscillator depends on various factors, such as the separation of the edges of the slot and the point along the slot (measured from the center toward one of the ends 16) at which leads 20 are connected.

It will thus be apparent that the anode tuned impedance or "tank" circuit as a distinct element has been eliminated together with the usual matching line between the oscillator and the antenna. Where the slot is utilized both as the means for exciting the antenna and as the primary frequency control of the oscillator, that oscillator can be very effectively modulated to yield frequency components that requires the broad-band characteristic of the antenna. Furthermore, because the oscillator utilizes the slot as its tank circuit, it can be mounted adjacent, and within, the cylindrical antenna. With this arrangement a compact, lightweight, and aerodynamically suitable transmitter is provided, with improved characteristics as already stated. By filling the slot with insulating material such as polystyrene, smoothed flush with the external surface of the antenna, the aerodynamic characteristics of the antenna can be improved.

Varied modifications and applications of the novel aspects of the foregoing disclosure will occur to those skilled in the art; and it is therefore fitting that the appended claims be given broad interpretation, consistent with the spirit and scope of the invention.

What is claimed is:

1. An oscillator capable of operation over a broad frequency range comprising an electron-discharge device having a grid, a cathode and an anode, and a metal sheet having a slot one of the edges of which is connected to said anode to serve both as a tank circuit and for propagation of the oscillations generated.

2. Radio apparatus comprising electron-discharge means, a hollow slot antenna enclosing said electron-discharge means, and a direct connection between electrodes of said electron-discharge means and said slot antenna such that the edges of the slot constitute the principal tuned impedance between said device and said antenna.

3. A radio transmitter comprising a signal generator including an electron-discharge device having an anode, a slotted antenna, the slot edges of said antenna being directly connected to said device in a manner to function as the anode tuned impedance of said device.

4. Radio apparatus comprising a cylindrical antenna having a longitudinal slot, electron-discharge means enclosed within said cylindrical antenna, and direct connections between electrodes of said electron-discharge means and opposite edges of said slot.

5. A radio transmitter comprising a cylindrical antenna having a longitudinal slot, a signal generator enclosed in said cylindrical antenna and including electron-discharge means, and direct connections between electrodes of said electron-discharge means and opposite edges of said slot.

6. A radio transmitter comprising an oscillator, a cylindrical antenna having a longitudinal slot, said oscillator including electron-discharge means having electrodes directly connected to the edges of said slot.

7. Radio apparatus comprising a cylindrical slot antenna, an oscillator enclosed in said antenna, and a modulator for producing a range of frequency components in the output of said oscillator, said oscillator including electron-discharge means having electrodes directly connected to the edges of said slot.

8. Radio apparatus comprising electron-discharge means, a slot antenna, and direct connections between electrodes of said electron-discharge means and the edges of the slot of said antenna such that said edges constitute a coupling to the antenna and such that said edges also constitute a parallel-line resonator that tunes said electron-discharge means.

9. A radio transmitter comprising an oscillator including an electron-discharge means, a cylindrical antenna having longitudinal slot, and direct connections between electrodes of said electron-discharge means and edges of said slot, the slot edges thereby constituting not only the coupling to the antenna, but additionally the tuned output impedance of said oscillator.

10. A radio transmitter comprising a signal generator including electron-discharge means, a cylindrical antenna enclosing said means, said antenna having a longitudinal slot, and direct connections between electrodes of said device and the edges of said slot, which slot edges thereby couple said signal generator to said antenna and tune said electron-discharge means.

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