

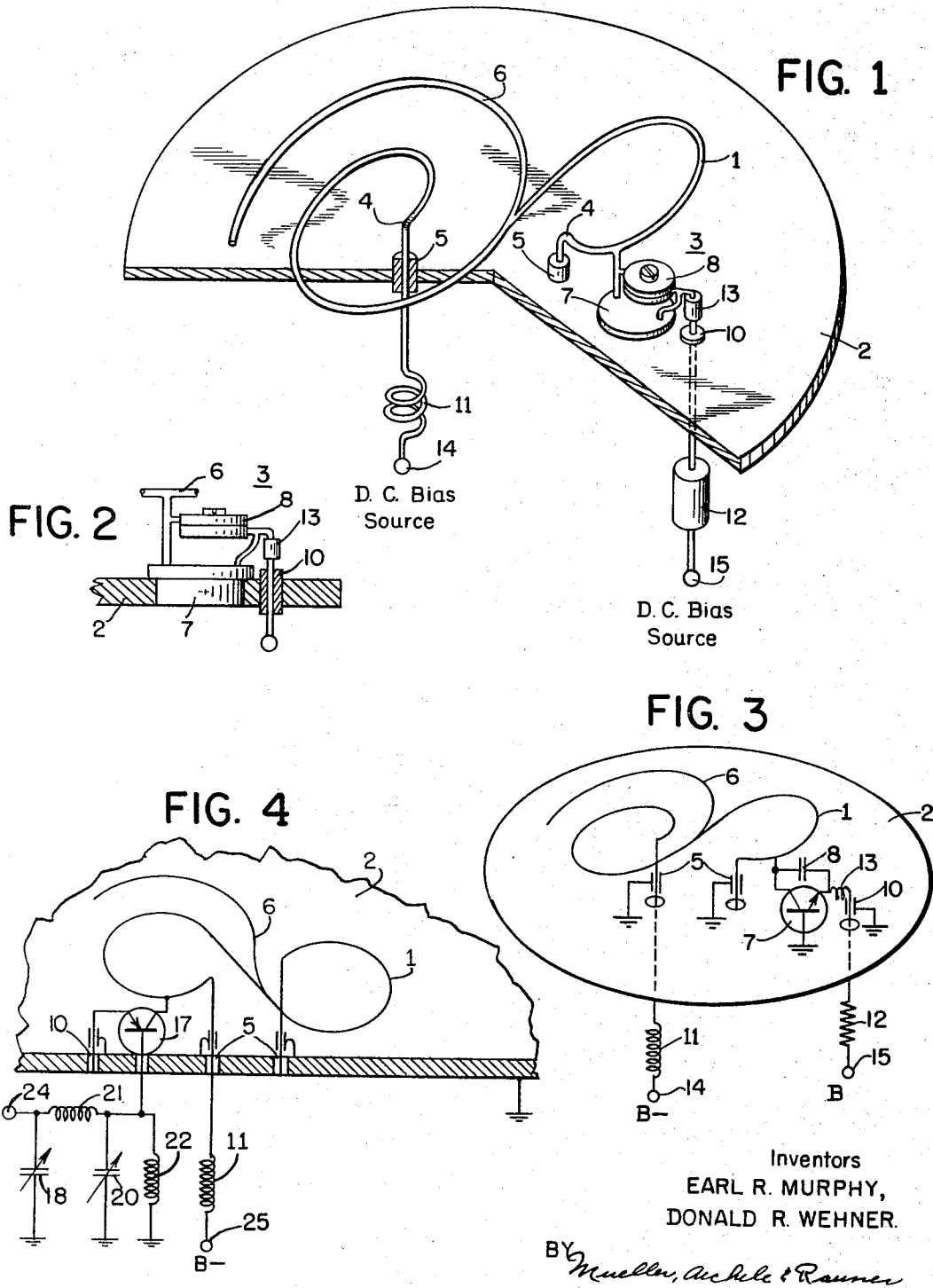
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3,343,089

QUARTER WAVE LOW PROFILE ANTENNA TUNED TO HALF WAVE RESONANCE
BY STUB; ALSO INCLUDING A TRANSISTOR DRIVING STAGE

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QUARTER WAVE LOW PROFILE ANTENNA TUNED TO HALF WAVE RESONANCE BY STUB; ALSO INCLUDING A TRANSISTOR DRIVING STAGE

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This invention relates to a low profile transmission line antenna which is directly integrated into the transmission frequency power device.

In known applications of low profile transmission line antennas, a quarter wave section of wire over a conducting ground plane is tuned by a capacitance connected between the wire and the ground plane at a point about half-way between the two end posts. The electrical power is applied by means of a further transmission line and an impedance-matching network which is connected near one end post to the antenna. This technique produces losses associated with the further transmission line and the coupling network especially for antennas with low radiation resistance.

Accordingly, it is an object of the present invention to provide an improved low profile transmission line antenna which avoids a coupling network between the signal frequency source and the antenna and which results in a structure with high reliability using fewer parts and interconnections.

Another object of the invention is to provide a signal frequency power amplifier which is integrated into the radiating antenna and which converts the signal directly into radiated energy without any external circuitry.

Another object of the invention is to provide a signal frequency power oscillator which uses a high Q antenna structure as the resonant circuit converting the signal directly into radiated energy.

A feature of the invention is the provision of a low profile antenna including a power transistor which is directly integrated with a high Q low profile transmission line antenna structure, with the antenna forming the resonant circuit for an amplifier or an oscillator.

Another feature of the invention is the provision of an integrated antenna structure having a transistor mounted on the ground plane conductor with its collector connected directly to the radiating element. This forms the active element and tuned circuit for an amplifier or an oscillator.

The invention is illustrated in the drawings in which:

FIG. 1 is an oscillator with a transistor being integrated into a figure 8 low profile transmission line antenna;

FIG. 2 shows the structure of the transistor and a feedback capacitor mounted onto the ground plane of the antenna of FIG. 1;

FIG. 3 is a schematic circuit of the oscillator integrated into the low profile antenna of FIG. 1; and

FIG. 4 is a schematic circuit of an amplifier integrated into the low profile antenna of FIG. 1.

In brief, the present invention may be utilized advantageously for a low profile transmission line antenna. A transmission line of low impedance is formed into a figure 8 and mounted parallel above a ground plane. For the signal frequency, the end posts of the transmission line are electrically coupled through bypass capacitor to the ground plane. The quarter wavelength transmission line is tuned to half wave resonance by means of the capacitive reactance of a transmission line stub connected to the midpoint of the antenna. In an oscillator

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the antenna becomes the oscillator tank circuit. The feedback is achieved by coupling the signal frequency back through a capacitor from the output into the input circuit of a transistor which is integrated directly into the antenna. For matching the output impedance of the transistor directly to the low impedance transmission line the output circuit is connected to a real impedance point of the antenna. The transistor is supplied with direct current (DC) power which is applied through the transmission line. For that purpose one end post is connected through an inductor on the opposite side of the ground plane to a DC bias source. The input circuit of the transistor is completed by a further bypass capacitor and series inductor connected to the ground plane. A further bias source is connected through this capacitor and series inductor and a series resistor to the transistor, with the resistor limiting the DC current flow through the transistor.

The low profile antenna can be used as an output tank circuit for a power amplifier, and in this case the feedback capacitor is omitted. For supplying a signal frequency to the transistor, a matching network is mounted on the opposite side of the ground plane and connected to the input circuit of the transistor.

Referring now particularly to the drawings, in FIG. 1 there is shown a high power stub tuned integrated low profile antenna according to the invention. The transmission line antenna 1 consists of a quarter wavelength of wire formed into a figure 8 and mounted parallel to and preferably of the order of 2.5 to 10 electrical degrees above a ground plane 2. This ground plane should have an extension which is large compared to the dimensions of the transmission line antenna 1. Each end 4 of the transmission line is shorted to the ground plane 2 at the signal frequency by large bypass capacitors 5, which have no effect on tuning. The quarter wavelength transmission line antenna 1 is tuned to half wave resonance by means of the capacitive reactance of a transmission line stub 6 connected to the mid-point of the antenna. Tuning is accomplished by adjusting the length of this stub 6. This transmission line structure provides a high Q antenna with a low impedance.

A power transistor circuit 3 consisting of a power transistor 7, a feedback capacitor 8 and an inductor 13 (FIGS. 2 and 3) is directly integrated into the transmission line antenna to form an oscillator, with the antenna structure as the resonant circuit. As the power transistor requires a low impedance, its impedance matching is accomplished simply by moving its connecting point along the transmission line antenna 1 from either ground end 4 until the proper input impedance is found. Thus, the transmission line antenna becomes the oscillator tank circuit.

As shown in more detail in FIG. 3, the feedback is achieved by coupling power from the collector into the emitter of the power transistor 7, so that the oscillator works as a common base circuit with the transmission line antenna as the tank circuit. The power transistor 7 is mounted directly on the ground plane 2. This provides both a good heat sink and direct connections to the antenna and ground points.

The equivalent circuit of the antenna is a sharply tuned parallel resonant circuit. The Q can be adjusted by varying the spacing above the grounded plane. As the Q is high, it provides the advantage that the antenna can serve as the oscillator tank circuit thus lending itself readily to integrated antenna techniques.

The DC power supply is applied to the output circuit of the transistor 7 through the antenna 1 from a DC

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bias source 14. In order to prevent the signal frequency from flowing to the DC bias source 14, an inductor 11 is connected between the capacitor 5 and the DC bias source providing a blocking filter for the signal frequency. A further DC bias source 15 is connected to the input circuit of the transistor through a series resistor 12 and inductor 13, with the common junction being bypassed by capacitor 10. The series resistor 12 limits the DC current flow through the transistor 7. As shown in FIG. 3, a PNP transistor has been used so that the DC bias source 14 is negative and the DC bias source 15 is positive in relation to the ground plane 2. It is obvious that the polarities of the bias potentials will be changed when a NPN transistor is used.

In FIG. 4 there is shown diagrammatically a power transistor amplifier integrated into the low profile antenna. The antenna 1 serves as the output tank circuit. The transistor 17 feeds the antenna at a real impedance point along the transmission line which just matches the low output impedance of the transistor 17. The amplifier is a common emitter circuit with the input signal to be amplified and radiated applied to terminal 24, and being matched to the base of the transistor by means of a π network filter consisting of capacitors 18, 20 and inductor 21. An inductor 22 connected between the base of the transistor and ground potential serves as an input circuit of the amplifier. In contrast to the oscillator integrated into the transmission line antenna (FIGS. 1 and 3), feedback from the radiated output power to the input circuitry must be prevented. This is readily accomplished with the figure 8 antenna design by mounting the π network filter on the opposite side of the ground plane 2 from the antenna. The DC power supply is fed from a bias source 25 through the bypass capacitor 5 and the antenna 1 directly to the collector of the power transistor amplifier.

The following circuit constants are given as illustrative values of circuit elements which may be utilized for a unit operating at 300 megacycles in the antenna system of FIGS. 1 to 3:

Bypass capacitor 5	1000 pf.
Bypass capacitor 10	1000 pf.
Feedback capacitor 8	1 to 10 pf. variable.
Inductor 13	0.33 μ h.
Power transistor	2N3375.

The low profile figure 8 transmission line antenna when integrated with a solid state signal frequency power source provides a compact, efficient, low silhouette, omni-directional radiating device. The integration of the transistor amplifier into the transmission line antenna results in 6 to 10 db more radiated power than from the equivalent non-integrated antenna. Integrated antenna techniques allow the maximum efficiency to be realized from a high Q low radiation resistance antenna. The ratio of radiation resistance to ohmic resistance is optimized by integrating the signal frequency source directly into the radiating antenna structure avoiding transmission line and coupling network losses.

What is claimed is:

1. A low profile antenna structure for operating in a given frequency band including in combination, conductive means forming a ground plane, an elongated rod-like conductor having a length equal to a quarter of a wavelength in the given frequency band, said conductor being mounted parallel to and above said ground plane, conductive end posts connected to the ends of said rod-like conductor, means coupled to said end posts and to said ground plane forming bypass capacitors isolating said end posts for direct current from said ground plane, a transmission line stub connected to the midpoint of said conductor and tuning said conductor to half wave resonance, a transistor integrated directly into the antenna structure and having input and output means, and means connecting said output means to said conductor at a point thereon

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having an impedance matching the output impedance of said transistor.

2. A low profile antenna structure for operating in a given frequency band including in combination, conductive means forming a ground plane, an elongated rod-like conductor having a length equal to a quarter of a wavelength in the given frequency band, said conductor being mounted parallel to and above said ground plane, conductive end posts connected to the ends of said rod-like conductor, means coupled to said end posts and to said ground plane forming bypass capacitors isolating said end posts for direct current from said ground plane, a transmission line stub connected to the midpoint of said conductor and tuning said conductor to half wave resonance, a transistor integrated directly into the antenna structure and having input and output means, means connecting said output means to said conductor at a point thereon having an impedance matching the output impedance of said transistor, and a filter network mounted on the opposite side of said ground plane and connected to said input means applying a signal frequency to said transistor to be amplified by said transistor and radiated by said antenna.

3. A low profile antenna structure for operating in a given frequency band including in combination, conductive means forming a ground plane, an elongated rod-like conductor having a length equal to a quarter of a wavelength in the given frequency band, said conductor being mounted parallel to and above said ground plane, conductive end posts connected to the ends of said rod-like conductor, means coupled to said end posts and to said ground plane forming first and second bypass capacitors isolating said end posts for direct current from said ground plane, a transmission line stub connected to the midpoint of said conductor and tuning said conductor to half wave resonance, a transistor integrated directly into the antenna structure and having input and output means, means connecting said output means to said conductor at a point thereon having an impedance matching the output impedance of said transistor, feedback means coupling power from said output means to said input means, and direct current supply means connected to said transistor for biasing the same to provide an oscillator with said conductor as the resonant circuit for the radiated signal frequency.

4. A low profile antenna structure comprising a quarter wavelength transmission line of low impedance formed into a figure 8 and having conductive end posts, a conductive ground plane mounted in parallel beneath said transmission line, first and second bypass capacitors connected to said end posts and to said ground plane and isolating said end posts for direct current from said ground plane, a transmission line stub connected to the midpoint of said transmission line tuning said transmission line to half wave resonance, a transistor having collector, base and emitter electrodes, said collector electrode connected directly to said transmission line at a real impedance point thereon having an impedance matching the output impedance of said transistor, said emitter electrode connected through a third bypass capacitor to said ground plane, a filter network mounted on the opposite side of said ground plane and connected through said ground plane to said base electrode applying a signal frequency to said transistor to be amplified by said transistor and radiated by said antenna.

5. A low profile antenna structure comprising a quarter wavelength transmission line of low impedance formed into a figure 8 and having conductive end posts, a conductive ground plane mounted in parallel beneath said transmission line, first and second bypass capacitors connected to said end posts and to said ground plane and isolating said end posts for direct current from said ground plane, a transmission line stub connected to the midpoint of said transmission line tuning said transmission line to half wave resonance, a transistor having collector, base

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and emitter electrodes, said collector electrode connected directly to said transmission line at a real impedance point thereon having an impedance matching the output impedance of said transistor, said emitter electrode being connected through an inductor and a third bypass capacitor to said ground plane, a feedback capacitor coupling power from said collector electrode to said emitter electrode, said base electrode being connected to the ground plane, and direct current supply means coupled to said transistor through said transmission line and providing an oscillator with said transmission line as the resonant circuit for the radiated signal frequency.

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