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Lewis et al.

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[54] **SINGLE CYCLE TRANSMITTER**

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[73] Assignee: **The United States of America as represented by the Secretary of the Air Force**, Washington, D.C.

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[52] **U.S. Cl.**..... **325/128**, 325/162, 325/164, 325/169, 325/178, 325/186, 343/701

[51] **Int. Cl.** **H04b 1/04**

[58] **Field of Search**.... 315/346, 352, 356; 325/104, 325/105, 125, 128, 120, 121, 141, 161, 162, 164, 166, 168, 169, 185, 186; 343/701

[56] **References Cited**

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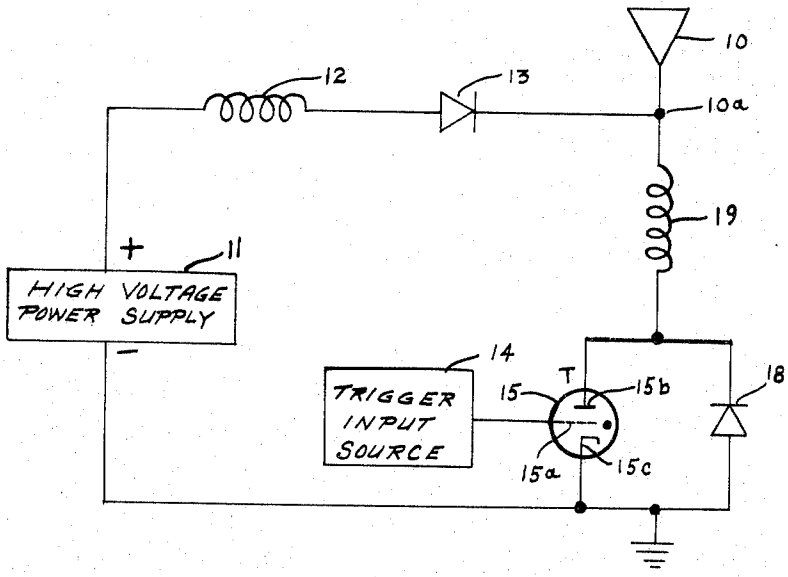
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Primary Examiner—Albert J. Mayer

[57] **ABSTRACT**

A single cycle transmitter at low and very low frequencies operates with an electrically short antenna. The transmitter produces an extremely short pulse of approximately one cycle duration. In response to a trigger signal, the transmitter's thyratron directly switches the antenna driving voltage, producing the first half cycle of a radiation pulse. The second half cycle is produced when diodes conduct. During this time, the thyratron deionizes, cutting off radiation.

2 Claims, 4 Drawing Figures



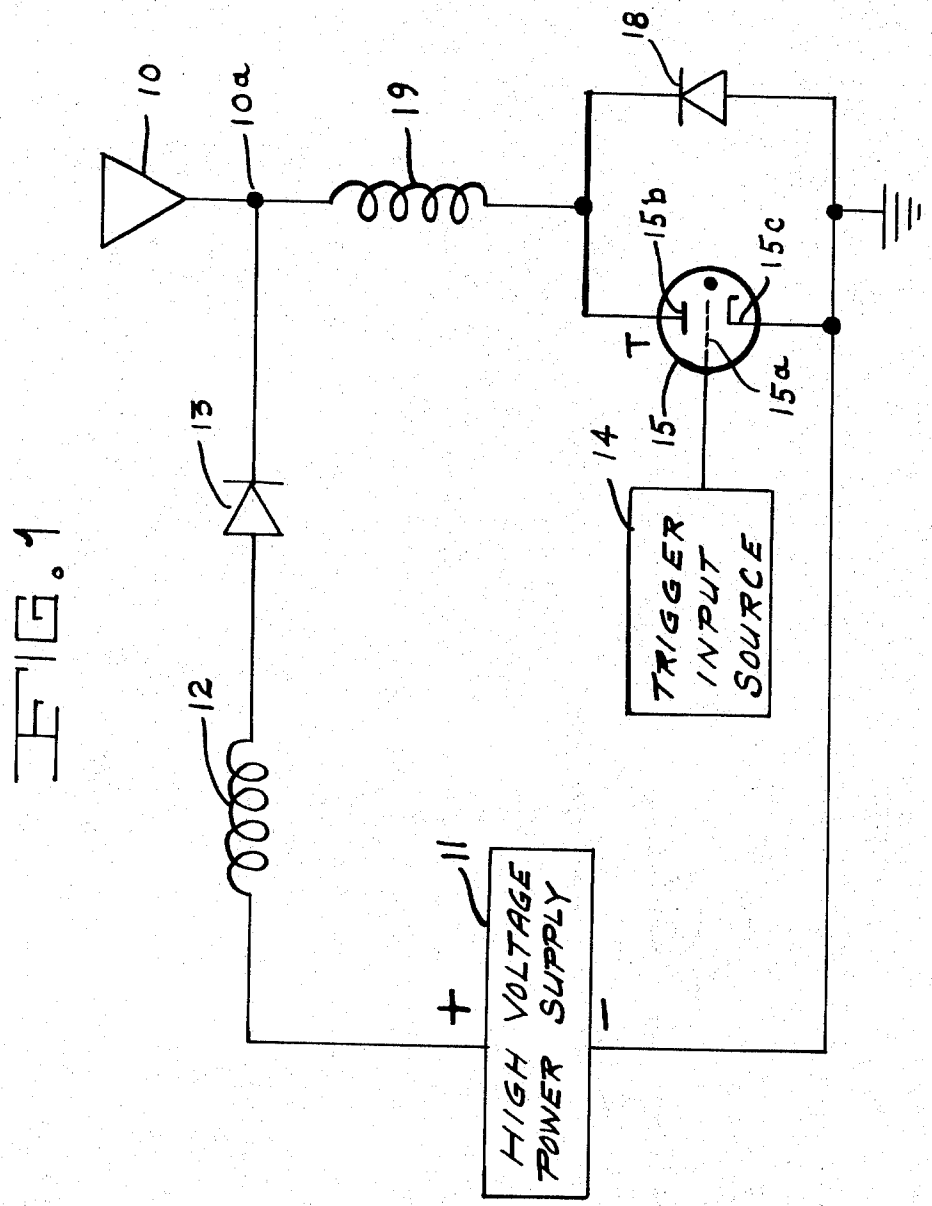

10
10a
19
18
15b
15c
T
15a
15
14
13
12
11
TRIGGER INPUT SOURCE
HIGH VOLTAGE POWER SUPPLY
+
-

FIG. 1

FIG. 2

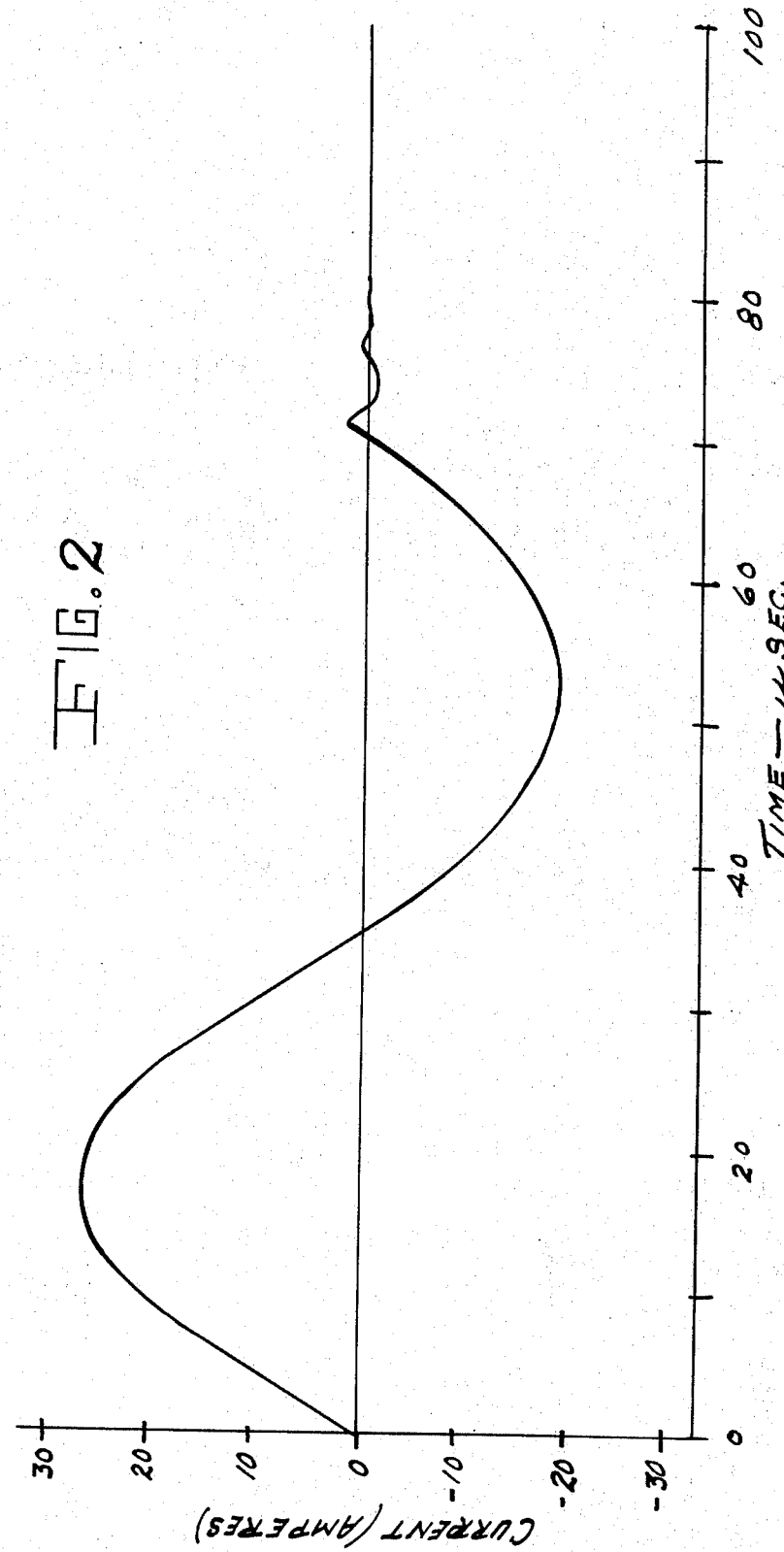

CURRENT (AMPERES)
30
20
10
0
-10
-20
-30
0
20
40
60
80
100
TIME — MILLISEC.

FIG. 3

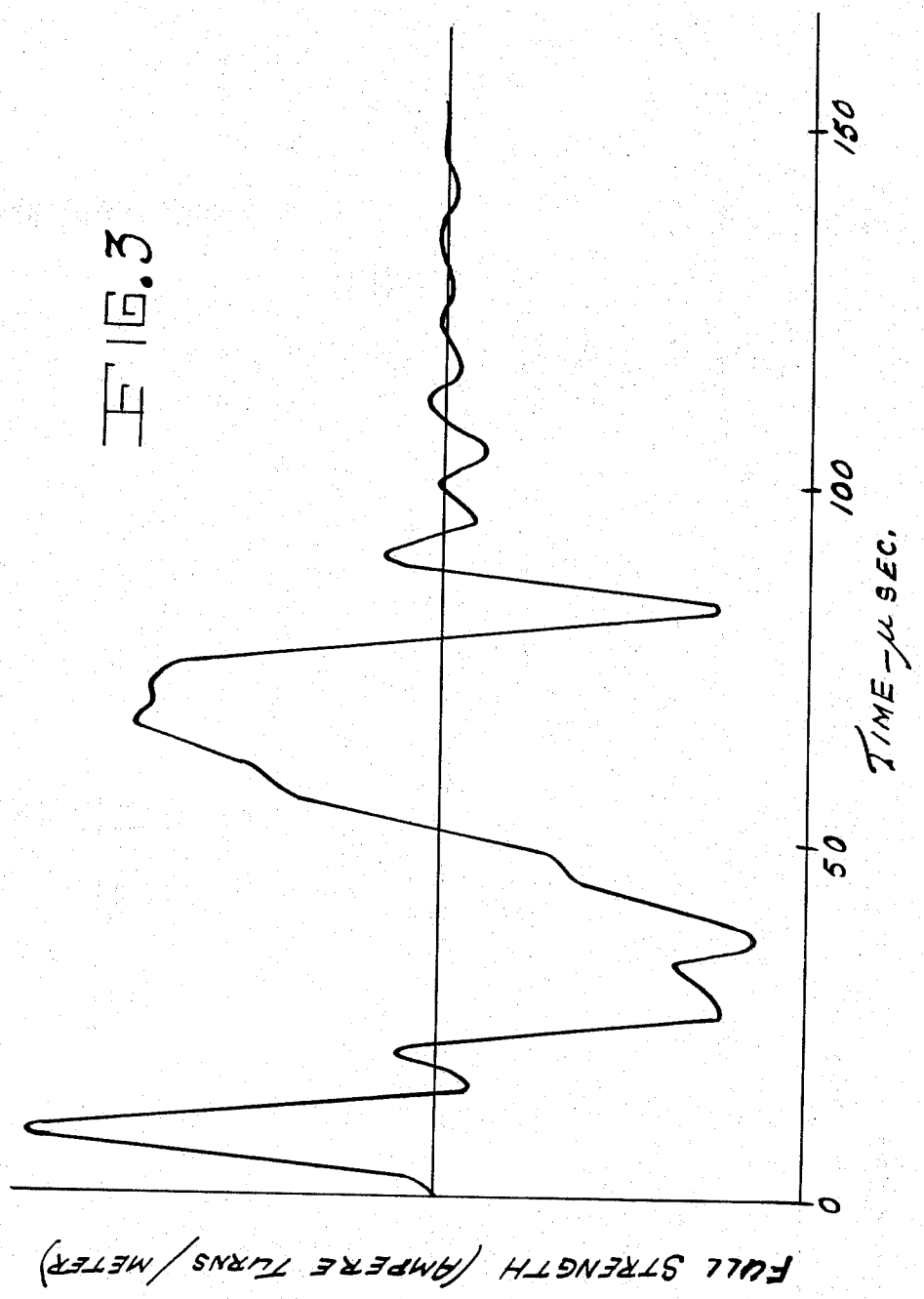
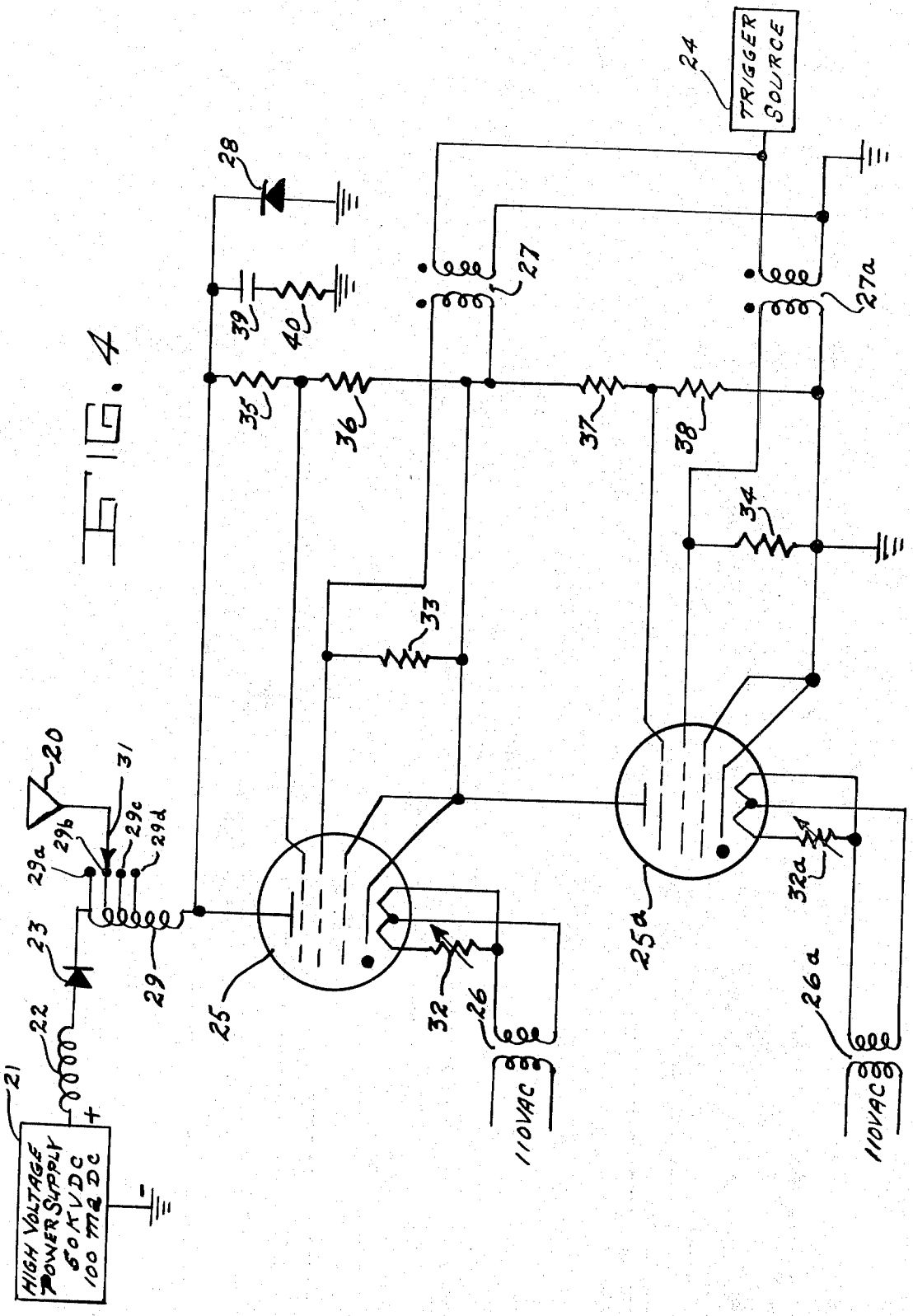


FIG. 4


TRIGGER SOURCE
24
28
27
27a
39
40
35
36
37
38
34
33
20
31
29a
29b
29c
29d
23
22
21
29
25
25a
32
32a
26
26a
110VAC
110VAC
HIGH VOLTAGE POWER SUPPLY
50 KV DC
100 MA DC
+
-

SINGLE CYCLE TRANSMITTER

BACKGROUND OF THE INVENTION

Very low and low frequency (VLF, LF) transmitters are particularly useful for navigation, time synchronization, geophysical exploration, and in scientific research on ionospheric, upper atmospheric, atmospheric, and ground wave propagation.

The single cycle transmitter of the present invention overcomes the difficulty conventional transmitters and coupling circuits have in producing pulses which do not ring and are short enough for the aforementioned applications. The present transmitter produces shorter pulses of high stability than the prior art VLF, LF pulse transmitters.

SUMMARY OF THE INVENTION

A single cycle VLF, LF transmitter is provided which is designed to operate with an electrically short antenna. The transmitter includes a thyratron which in response to a trigger signal directly switches an extremely high DC antenna drive voltage to produce the first half cycle of a radiation pulse. The second half cycle is produced when a solid state high voltage diode conducts. During this time the thyratron deionizes, cutting off the radiation.

DESCRIPTION OF THE DRAWINGS

FIG. **1** shows in schematic form the basic embodiment for the single cycle transmitter;

FIG. **2** shows a typical waveform of the current from the antenna terminal of FIG. **1**;

FIG. **3** shows the waveform of the transverse magnetic field at a distance of **15** kilometers from the transmitter; and

FIG. **4** shows a second schematic circuit of the single cycle transmitter of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring in detail to FIG. **1**, there is shown the basic embodiment of the VLF, LF single cycle transmitter for pulsing electrically short antenna **10**. 48 KV DC high voltage power supply **11** having a negative output connects to ground and a positive output which charges transmitting antenna **10** through inductor **12** and diode **13**. Antenna **10** acts somewhat like an open ended section of a lossy transmission line, but the circuit may be understood by considering the antenna as a lumped capacitance C of about 6,000 pf (for an antenna 1.5 Km long). Thyratron **15** is provided. It has control grid **15***a*, plate **15***b*, and cathode **15***c*. When a trigger voltage from trigger input voltage source pulse generator **14** is applied to grid **15**a of hydrogen thyratron **15**, the charge flows from antenna **10** through inductance **19** (about 20 mh) for a time $t = \pi \sqrt{LC} \approx$ 35 μsec. The lumped capacitance C then has its maximum negative charge, thyratron **15** ceases to conduct, and charge flows back into antenna **10** through now conducting diode **18** for an additional 35 μsec, at which time the lumped capacitance C is recharged positively. The system remains in this condition until thyratron **15** is triggered again. If the length of antenna **10** is reduced without charging inductance **19**, the capacitance C is reduced and the transmitted pulse is of shorter duration and smaller amplitude. FIG. **2** shows a typical waveform of the current from antenna terminal **10***a*. It is approximately one cycle of a sine wave, but the area under the second half cycle is slightly less than that of the first, so that for each actuation antenna **10** loses some charge. However, this is resupplied within 500 μsec by charge flowing through inductor **12** from high voltage power supply **11**. Because of inductance **12**, the voltage on the antenna **10** is about 25 percent higher than the supply voltage. With antenna **10** charged to 60 KV, each actuation of the thyratron circuit consumes about 2 joules. For a 1.5 km antenna, the total radiated energy is estimated at 0.35 joule per actuation. When operated at 400 actuations per second the total radiated power is 140 watts, with a power consumption of 1,500 watts, resulting in an overall efficiency of about 10 percent for the basic transmitter. Of the total power consumed, 700 watts is used by the thyratron heaters. FIG. **3** shows the waveform of the transverse magnetic field at a distance of 15 km from the transmitter observed with a loop antenna resistively loaded to flatten the response.

FIG. **4** shows a second schematic circuit for a single cycle transmitter which is basically identical in structure and operation to that illustrated in FIG. **1**. 50 KV high voltage supply **21** charges transmitting antenna **20** through charging inductor **22** and diode **23**. Diode **23** consists of six high voltage diodes in series. Antenna **20** also has a fixed lumped capacitance C_1. Antenna **20** is associated with tuning inductor **29**. Tuning inductor **29** includes taps **29***a* – **29***d*. Switch **31** selectively connects antenna **20** to the appropriate tape for antenna tuning purposes.

There is provided a pair of hydrogen thyratrons **25** and **25***a* operating in conjunction to handle more effectively the voltage required. Isolation transformers **26** and **26***a* provide the heater and reservoir voltages to thyratrons **25** and **25***a*, respectively. Adjustable resistors **32** and **32***a* are utilized for control of the reservoir voltages of thyratrons **25** and **25***a*, respectively. Resistors **33–38** conventionally utilized in association with thyratrons **25** and **25***a* to provide the proper operating voltages. Series arrangement of capacitor **39** and resistor **40** is in parallel arrangement with diode **28**. A trigger voltage of 2,000 volts of 2 μsec duration is supplied from trigger source **24** to thyratrons **25** and **25***a* by way of isolation pulse transformers **27** and **27***a*, respectively. When the aforesaid trigger is applied to thyratrons **25** and **25***a*, the charge flows from the antenna through the inductance for a time hereinbefore described. The lumped capacitance C_1 of antenna **20** then has its maximum negative charge, the thyratrons cease to conduct, and charge flows back through diode **28** for an additional time substantially equivalent to the first named time, at which time lumped capacitance C_1 is recharged positively. The system remains in this condition until the thyratrons are triggered again.

What is claimed is:

1. A very high power single cycle transmitter at low and very low frequencies comprising electrically short antenna means for low and very low frequencies, said antenna means having a predetermined lumped capacitance, first inductance means having a preselected magnitude, first diode means in a series arrangement with said first inductance means, a very high voltage power source having a positive and negative output, with said negative output connected to ground, said positive output being connected to said antenna means by way of said series arrangement to charge said an-

tenna means, thyratron means having a cathode, control grid, and plate, said cathode being connected to ground, second inductance means having a preselected magnitude, said second inductance means interconnecting said antenna means and said plate of said thyratron means, means to trigger said thyratron means to permit the antenna charge to flow for a preselected time as determined by the magnitude of said lumped capacitance and said second inductance to complete a half cycle of said single cycle, said lumped capacitance then having its maximum negative charge whereupon said thyratron means ceases to conduct, and second diode means connected between said second inductance and ground becoming conductive upon the cessation of conduction in said thyratron means thus permitting a charge to flow back into said antenna means for a period substantially identical to said preselected time, completing the second half of said single cycle at which time said lumped capacitance is recharged positively.

2. A very high power single cycle transmitter as described in claim 1 wherein said trigger means is comprised of a pulse generator.

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