

EXHIBIT

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Loftin et al.

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(54) **LOW-POWER, HIGH-MODULATION-INDEX AMPLIFIER FOR USE IN BATTERY-POWERED DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 613 days.

(21) Appl. No.: **10/445,121**

(22) Filed: **May 23, 2003**

Related U.S. Application Data

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(51) **Int. Cl.**
A61N 1/02 (2006.01)
H04B 5/00 (2006.01)

(52) **U.S. Cl.** **607/60; 607/156; 607/32; 128/903; 128/902**

(58) **Field of Classification Search** **607/60, 607/32, 156, 61; 128/902, 903; 340/870.01; 455/41.1, 41.2**

See application file for complete search history.

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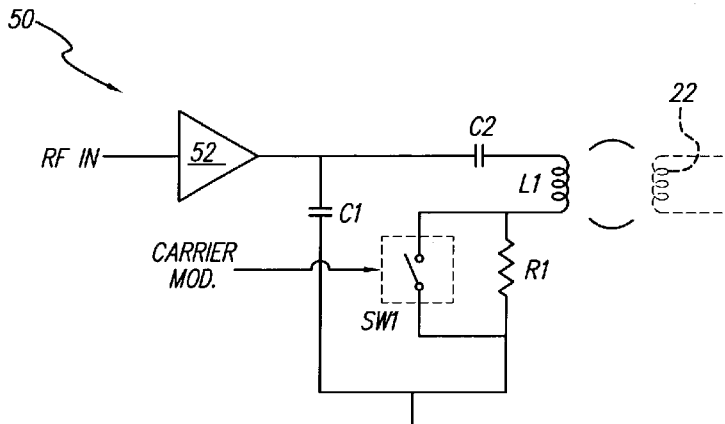
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(57) **ABSTRACT**

An external transmitter circuit drives an implantable neural stimulator having an implanted coil from a primary coil driven by a power amplifier. For efficient power consumption, the transmitter output circuit (which includes the primary coil driven by the power amplifier inductively coupled with the implanted coil) operates as a tuned resonant circuit. When operating as a tuned resonant circuit, it is difficult to modulate the carrier signal with data having sharp rise and fall times without using a high power modulation amplifier. Sharp rise and fall times are needed in order to ensure reliable data transmission. To overcome this difficulty, the present invention includes an output switch that selectively inserts a resistor in the transmitter output coil circuit in order to de-tune the resonant circuit only during those times when data modulation is needed. Such de-tuning allows sharp rise and fall times in the data modulation without the need for using a high power modulation amplifier. Because data modulation is typically needed for only a small percent of the time that a carrier signal is present, it is thus possible using the present invention to achieve reliable data modulation, transmission and reception without having to use a high power modulation amplifier in the transmitter.

7 Claims, 4 Drawing Sheets



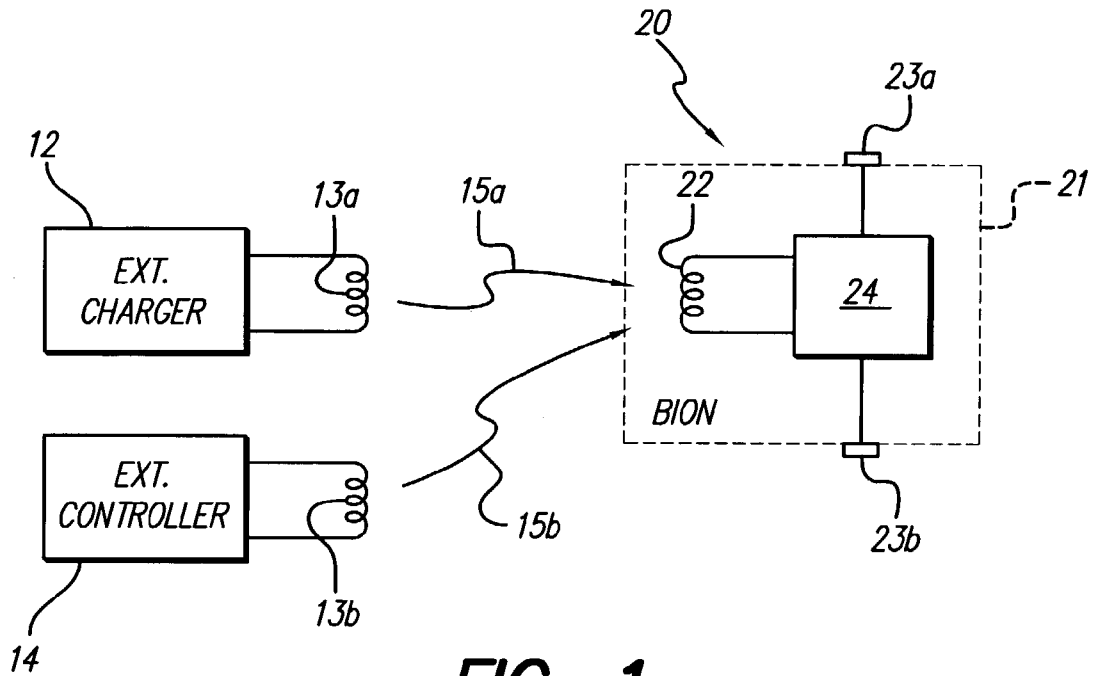


FIG. 1

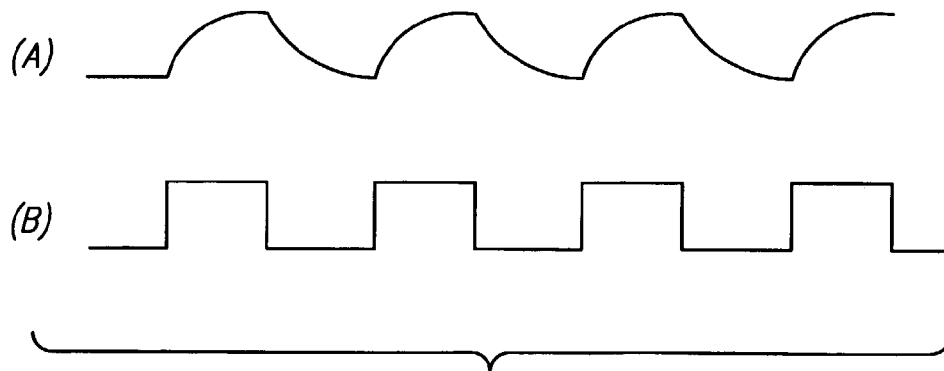


FIG. 3

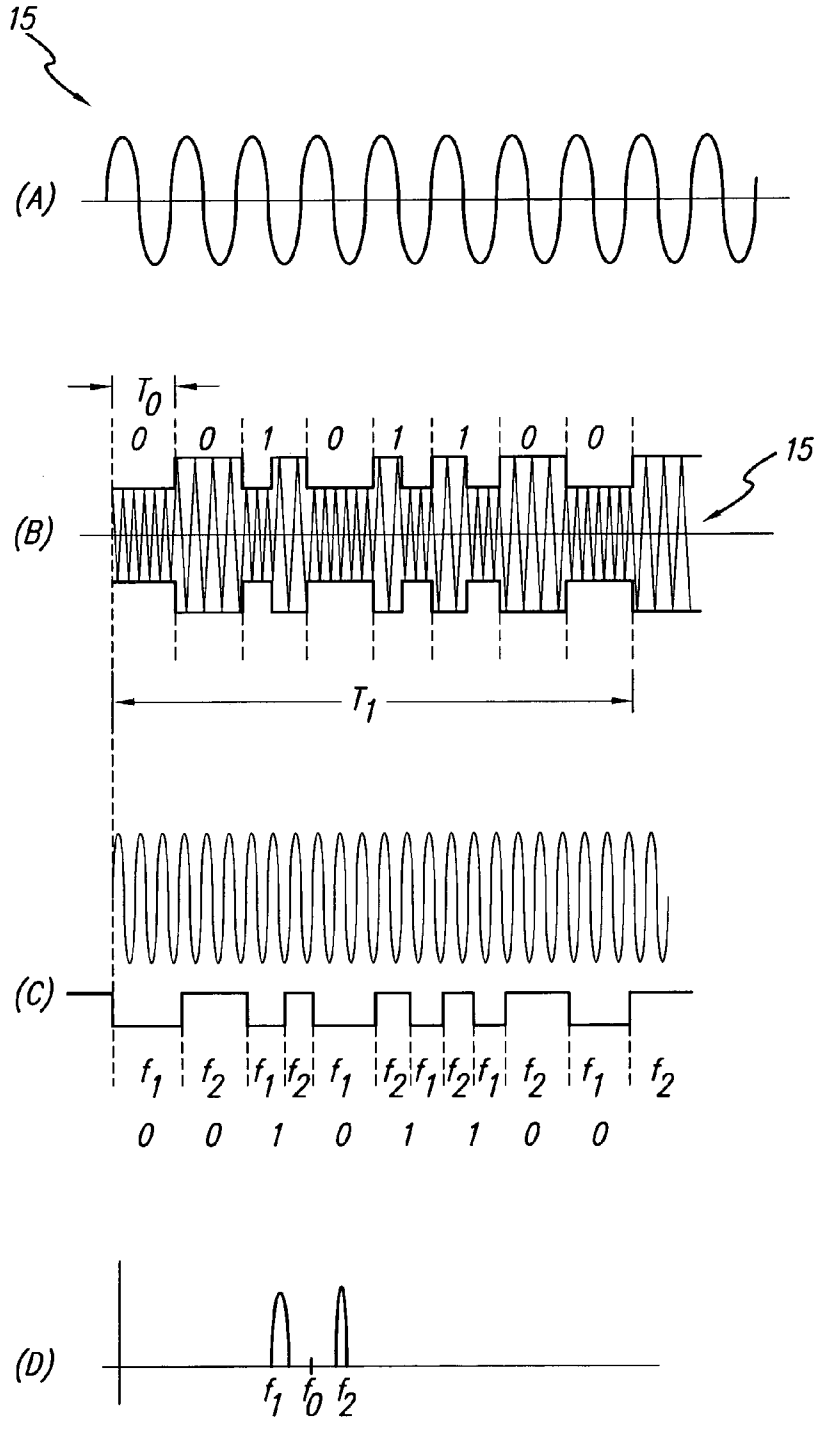


FIG. 2

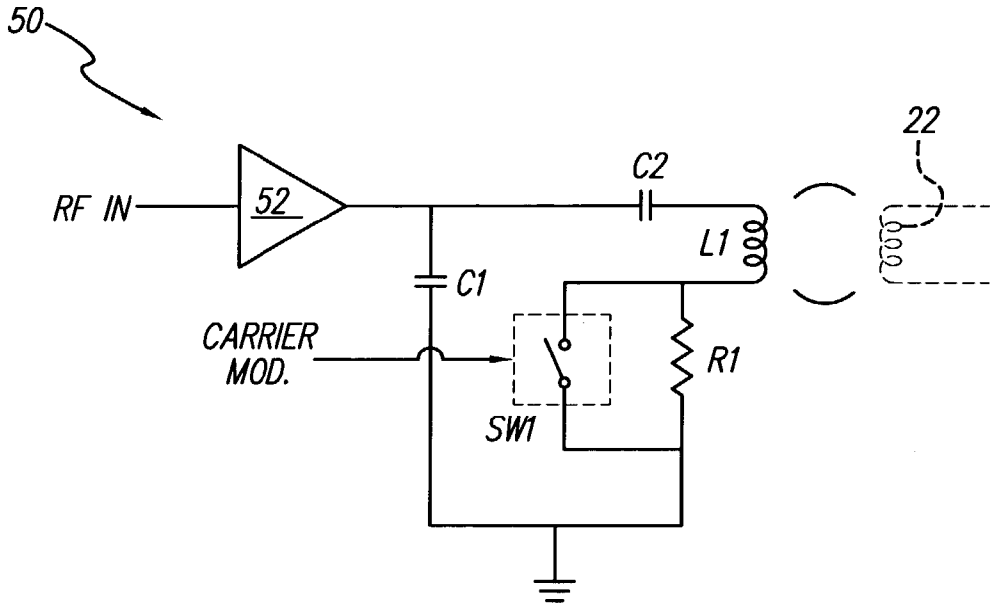


FIG. 4A

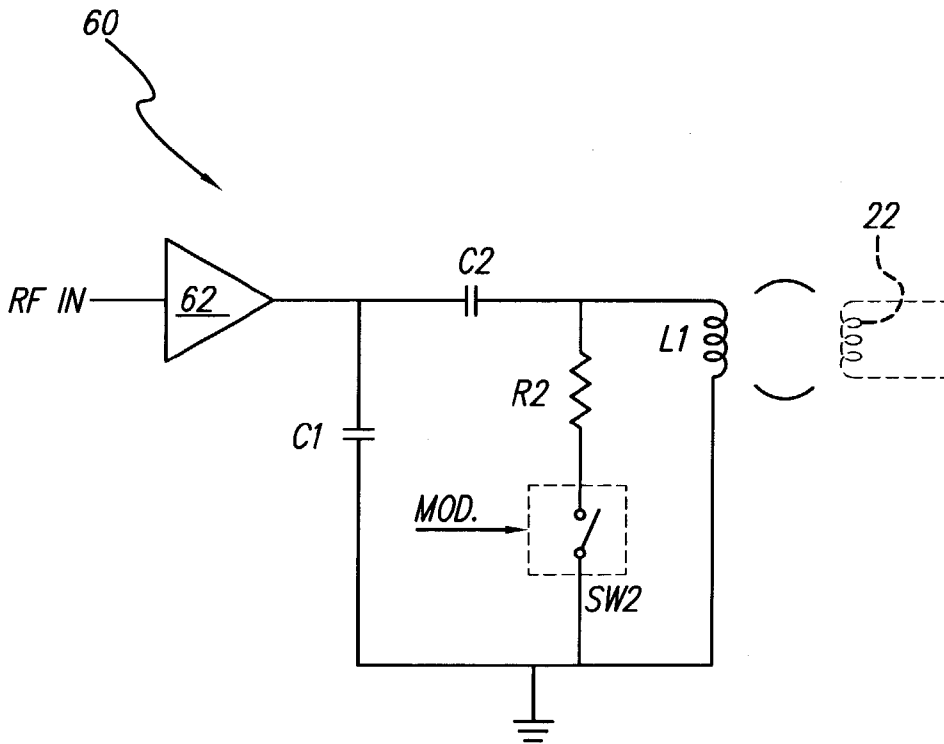


FIG. 4B

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