A SURGICALLY IMPLANTED MYO-TELEMETRY UNIT

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ABSTRACT

An implanted telemetry unit suitable for myo-electric control is described. This unit is similar in function to one reported previously [1], but incorporates significant improvements.

Designed for long-term use, the unit is powered by electro-magnetic coupling at radio frequencies. This allows construction of a unit with an expected life greater than ten years.

Notable improvements are provided by a new amplifier and oscillator design. Specifically, size and power consumption are reduced and % modulation capability is greatly increased.

In a previous paper [1] [2] an implant telemetry unit was described suitable for myo-electric control. An improved system has been developed and will be described here.

This new unit, rather than being a radical departure from the previous, employs a similar system. Designed for long-term implantation, the unit is powered by electro-magnetic coupling and since only high quality components are used, life expectancy is indefinite.

This unit, like the previous one, is intended for implantation in the medullary cavity after an amputation. For this reason, size must be kept to a minimum, especially the diameter, if smaller bones are to be used. The diameter of the implant has been reduced from ½ inch to 3/8 inch with a similar reduction in length as well.

A circuit diagram of the implant is given in Fig. 2. Power is provided by a simple rectifier-filter circuit comprised of L_1, C_7, Q_6 and C_5. This receives power from the 150 KHz external coil. The amplifier, Q_3, operates with 20µa of collector current. The voltage gain is 300 - 1000, depending on the value of R_2. This high gain is possible at low collector currents by operating with a very high collector load impedance. Q_2 acts as a constant current source [3] which even in parallel with the modulator input results in a load impedance of approximately 1 Megohm. Transistor Q_1 is required to bias Q_2. This arrangement of biasing, together with feedback to the base of Q_3 maintains the voltage at the modulator at approximately half the total supply voltage. This allows normal operation for supply voltages from 1.5 to 10 volts.

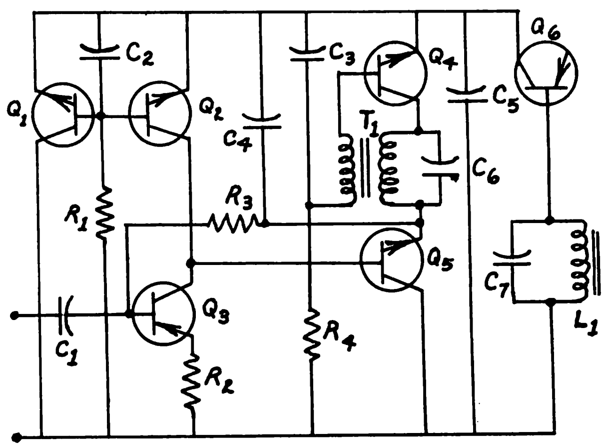

Fig. # 1

R_1 - 5 M*	C_3 - 33 pf, 50v
R_2 - 10 K	C_4 - 0.01 µf, 35v
R_3 - 5 M*	C_5 - 2.2 µf, 15v
R_4 - 330 K	C_6 - 100 pf, 50v
C_1 - 0.05 µf, 35v	C_7 - 0.01 µf, 50v
C_2 - 2.2 µf, 15v	

Q_1, Q_2 and Q_5 - all FX 2484

Q_3 and Q_6 - all FX 3962

Q_4 - FX 918

*adjusted to give correct bias

L_1 - 120 Turns #40, double layer, close wound on 1/8 inch ferrite core.

T_1 - Prim - 30 Turns ǂ#36

Sec - 14 Turns ɸ#36

Both, double layer, close wound on 1/8 inch ferrite core.

ǂadjusted to give desired frequency
ɸadjusted to give correct feedback

The modulator and oscillator are direct coupled to the amplifier. The modulator acts as a simple series regulator which varies the collector supply of the oscillator. This provides amplitude modulation up to 50% with low distortion. The crystal controlled oscillator of the original unit has been replaced by a transformer feedback oscillator and although crystal control is much preferred, size reduction made it necessary to remove the rather bulky crystal.

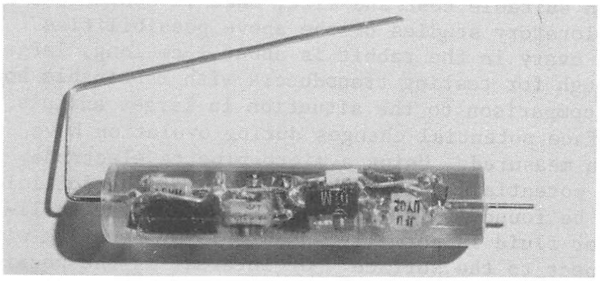

Fig. # 2

Size (after encapsulation)	- 3/8" Dia. x 1 3/4"
Power Input Frequency	- 150. KHz.
Carrier Output Frequency	- 5. MHz.
Power Consumption	- 0.7 mW
Nominal DC Supply Voltage	- 3 V
Modulation Capacity	-> 50%

The main improvements have been in power reduction, increased modulation range and insensitivity to supply voltage variations. Size reduction is mainly limited by coil sizes, and for this reason, more advanced construction techniques such as integrated circuits would not reduce size significantly.

Three different packages are being constructed. The first is a mushroom shape suitable for intramedullary implantation, with both electrodes brought out the distal end and inserted into the muscle. The second is an intramedullary unit with cylindrical shape, see Fig. # 2, with one electrode placed in the muscle and the other protruding further into the medullary cavity. The third unit is to be used without amputation, fitting crosswise in a hole drilled through the bone, with the electrode situated under a muscle in its normal position.

Tests are continuing with different electrode systems, and data are being compiled on the long-term effects of electrodes and encapsulating materials on body tissues. As yet no adverse reaction has been detected, with the longest in vivo test extending over a period of years. The objective is to develop a system suitable and ready for clinical use with human patients as rapidly as possible.

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