REMOTE CONTROLLED EQUIPMENT FOR MULTIPLE BLOOD WITHDRAWAL IN GRAVITATIONAL PHYSIOLOGY EXPERIMENTS

Frollo, Ivan.[1] - Banič, Branislav.[1] – Mravec, Boris[2] - Juráni, Marián[3] – Greksák, Miloslav[3] – Macho, Ladislav[2] - Kvetňanský, Richard[2]

[1]Institute of Measurement Science, SAS, Dubravska 9, 84219 Bratislava, Slovakia, Email: frollo@savba.sk
[2]Institute of Experimental Endocrinology, SAS, Vlarska 3, 833 06 Bratislava, Slovakia, Email: ueenkvet@savba.sk
[3]Institute of Animal Biochemistry and Genetics, SAS, Moyzesova 61, 900 28 Ivanka pri Dunaji, Slovakia, Email: ubgzgrek@nic.savba.sk

ABSTRACT

Electro-mechanical equipment for multiple blood withdrawal from small experimental animals applied to a centrifuge with maximal 6g gravitational overloading has been developed and tested. The equipment consists of a transmitter and receiver equipped by microcomputers. Active rotor stepping motors are driving four pairs of syringes. It is also possible to measure the instantaneous gravitational force using an accelerometric transducer [1].

This telemetrically regulated blood sampling allows studying selective effects of hypergravity during centrifugation. It can be also used for study of microgravity effects in the animal organism during space flights for the understanding of the mechanism of the changes of the activity of neuroendocrine system and metabolic processes.

1. INTRODUCTION

Biotelemetry is the transmission of biologically-important information from an animal to a receiver without the use of connecting wires. The signals used are generally carried by radio waves [2]. Specific claims are necessary when telemetric control of a mechanical operation is needed, e.g. for movement of rods of blood syringes.

In space biology the project relating to changes of functions of neuroendocrine system during exposure to simulated microgravity and hypergravity is performed. Observations are proposed for the group of animals exposed for a short time to hypergravity by using centrifuge device simulating a gravity load at start or landing of space satellite up to 6g, $g = 9.80665\ m\ s^{-2}$.

Also the studies of adaptation to hypergravity of 2g for the period of two weeks, simulating the process of postflight readaptation, are proposed. Results of these experiments are important for the understanding of the mechanism of the changes of the activity of neuroendocrine system and metabolic processes observed in human subjects and experimental animals after space flights, and also to distinguish between specific effects of microgravity, hypergravity during the landing and postflight readaptation to gravity conditions on Earth.

2. TECHNICAL EQUIPMENT

For these studies an electronic equipment for multiple blood withdrawal from small experimental animals with telemetric control has been developed and tested. A pair of rats is placed in a box rotating in a centrifuge with maximal 6g gravitational overloading. The equipment consists of a telemetric transmitter (placed outside the room of the centrifuge) and receiver. Both transmitter and receiver are equipped by microcomputers. The instantaneous gravitational force is also measured using an accelerometric transducer (Analog Devices ADXL210) placed near the testing box with telemetric data transmission.

2.1 Transmitter

The transmitter, Fig. 1, (placed outside the room of the centrifuge) and receiver, Fig. 2, are working on frequency (UHF range) f = 433.92 MHz, pulse code modulation, output power 5 mW, coverage within 100 m. Both transmitter and receiver are constructed on hybrid modules AUREL: TX-SAW 433s and STD 433 DIL.

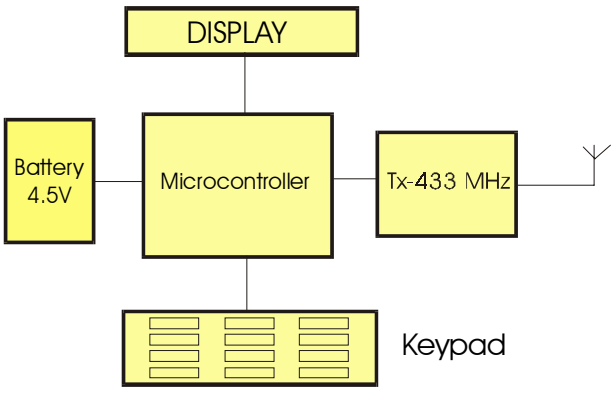

Fig. 1 Transmitter controlled by a microcontroller. Using a keypad it is possible to pre-program the time sequences for suction and exhaustion of particular pairs of syringes.

2.2 Receiver

After switching on the receiver, it is waiting for a radiofrequency signal comprising pre-programmed

sequence. After a LED diode is confirming the successful receiving, the count down is starting and the applied sequence is starting. The receiver is switching on the selected driving rods of syringes in precise time moments. After sequence is finishing the syringes are removed and using manual control (pushing button) the driving rods are returned to the initial position.

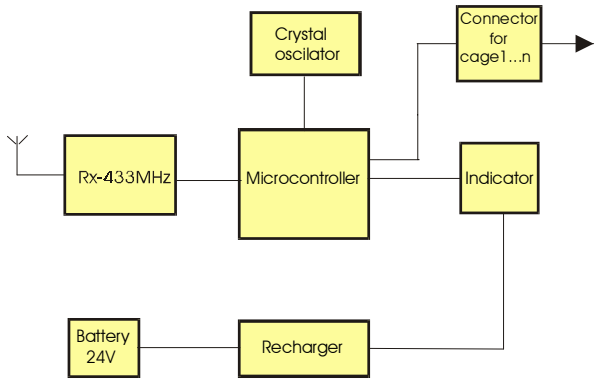

Fig. 2 Receiver controlled by a microcontroller placed in the room of the centrifuge. Through a cable it is connected with step motors placed in every cage driving the syringes.

2.3 Programming unit

After switching on the transmitting unit it is possible to pre-program sequences t0, q0, t1, q1, t2, q2, Fig 3. It is possible to set up width of pulses, their time schedule and blood volume typing t and q values. For the blood volume selection q it is necessary to type the keyboard in steps 1, 2, 3. Number 1 means 0.33 ml, 2 – 0.66 ml and 3 – 0.99 ml.

The programmer automatically controls the input values. After typing a number bigger than the pre-programmed step the procedure is returned back. After typing t and q the programmer confirms acceptation by two short blinks. After typing all the values and confirming the acceptation it is possible to switch of the programmer.

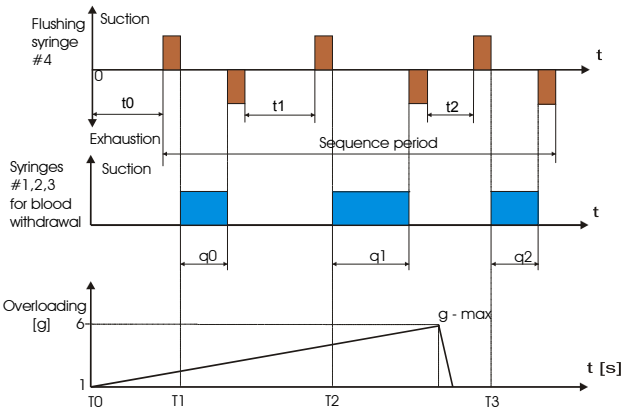

Fig. 3 Programmable sequences.

Fig. 4 Equipment for multiple blood withdrawal with telemetric control – 4 channels, for 2 animals.
1 - box for 2 experimental animals, 2 - four pairs of syringes controlled by step motors, 3 - modules for step motors driving, 4 - receiving module controlled by a microcomputer, 5 - transmitting module, frequency: 433.92 MHz, modulation PCM, 6 - transmitting module of an accelerometric transducer, 7 - receiving module of an accelerometric transducer.

3. CONCLUSION

Electro-mechanical equipment, Fig. 4, has been tested on a cetrifuge placed in a laboratory of The Institute of Animal Biochemistry and Genetics, SAS. In the centrifuge there is possible to place 10 boxes with 20 experimental animals, plus 1 control box with two animals rotating in the centre of the centrifuge where g= 9.80665 m s^{-2}.

This telemetrically regulated blood sampling allows to study selective effects of hypergravity during centrifugation. It can be also used for study of microgravity effects in the animal organism during space flights.

4. REFERENCES

1. Frollo I., et al. Electronic Equipment for Multiple Blood Withdrawal with Telemetric Control. Technical Report, Institute of Measurement Science, SAS, 2001, pp. 1-32.

2. Schnell C.R. Marmoset telemetry: present applications and future highlights. EUPREN/EMRG meeting, Göttingen, 1995.

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