NASA TECH BRIEF
Ames Research Center

Programmed Physiological Infusion System

The problem:

A device was needed to infuse a substance into an animal's body at a preprogrammed rate. Such tailored inputs are necessary for reproducing or simulating natural time-varying inputs, the pulsating nature of many animal processes, and random dynamic inputs. Analysis of the frequency, phase, and amplitude characteristics of the responding system provides insights as to the ways in which body systems are capable of responding to dynamic chemical inputs.

The solution:

A rate-programmed infusion system capable of delivering incremental volumes from a reservoir with a piston pump at a rate that varies in time and follows the envelope of a preprogrammed curve.

How it's done:

The system consists of a printed paper tape, a photoelectric tape reader, a signal conditioner, and a solenoid-operated piston pump. The programmed curve is represented as marks printed on a continuous-loop paper tape prepared by a computer and a suitable program; a pulse-modulated signal is produced when the tape is run at constant speed through a photoelectric reader. As the marks are sensed by the tape reader, the resulting pulsed signals are used to activate the pump and thereby force a small volume of solution into the vein of the animal under examination. The marks on the paper tape are separated by distances which are determined by the shape of the desired programmed curve; at any given interval of time, the sum of the incremental volumes infused is represented by the area under the programmed curve up to that time. A signal conditioner operating on the output of the photoelectric tape reader has been found useful to provide additional latitude in system performance and for selection of the total volume and concentration of the infusion solution; for example, the signal conditioner generates one to ten pulses (depending on its setting) for each mark appearing on the paper tape.

By means of this system, the volume of infusions can be made to be sinusoidal in time. To obtain the tape for this curve, the computer is programmed to find the total area under the curve for one cycle; the trapezoidal method is used to integrate the function $1 + \cos X$ between 180° and 540°. Since the total number of marks on the tape is determined by the volume of solution and its concentration, a decision must be made regarding these factors. For convenience, the total area is divided by 100 and the centers of the 100 equal areas are located along the abscissa. Then, a representation of the relative positions of the centers is printed out at the computer terminal, using a dash to mark the centers and a line feed to provide relative distances; the result is a series of printed dashes of varying distances in modulation with the original curve.

The printout is removed from the terminal, trimmed to about a 5-cm width, and the ends are fastened to form a continuous loop. The loop is loaded onto a photoelectric tape reader with a capstan drive and moved under a metal mask with a slit that lines up with the path of the dashes. The speed of the tape is controlled by the variable-speed motor that drives the capstan. As the tape is run at constant speed,

(continued overleaf)

the photocell senses the appearance of a dash in the slit and actuates the signal conditioner. Depending on its setting, the signal conditioner will generate one to ten pulses of appropriate voltage, current, and duration to operate the piston pump.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: TSP72-10126

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code 200-11A
Ames Research Center
Moffett Field, California 94035

Source: Wayne H. Howard, Donald R. Young, and Richard R. Adachi
Ames Research Center
(ARC-10447)