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A SYSTEM FOR THE CONTINUOUS INFUSION OF ALPHA-CHLORALOSE ANESTHETIC

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SEPTEMBER 1966

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The experiments reported herein were conducted according to the "Principles of Laboratory Animal Care" established by the National Society for Medical Research.

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A SYSTEM FOR THE CONTINUOUS INFUSION OF ALPHA-CHLORALOSE ANESTHETIC

ROBERT E. VAN PATTEN

FOREWORD

This report was prepared by the Environmental Medicine Division of the Biomedical Laboratory, Aerospace Medical Research Laboratories, Aerospace Medical Division, Wright-Patterson Air Force Base, Ohio. The work was performed in support of Project 7222, "Biophysics of Flight." The apparatus described in this report was developed over the period from December 1964 to May 1965.

Acknowledgement is given to Mr. Gene Hyer of Aeronautical Systems Division, Deputy for Flight Test, Directorate of Maintenance Fabrication and Modification Division, for his invaluable assistance in the fabrication of the delicate components of the system.

This technical report has been reviewed and is approved.

J. W. HEIM, PHD
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Biomedical Laboratory
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ABSTRACT

The development of a system designed to permit semiautomatic and continuous infusion of the anesthetic agent alpha-chloralose to dogs is described. The apparatus was developed for use in studies of cardiovascular and renal functions under various environmental conditions. The device has proved to be practical and trouble-free and the simple design uses easily available materials.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION I

INTRODUCTION

The apparatus described in this report was developed to provide continuous alpha-chloralose anesthesia for dogs in the study of cardiovascular and renal functions under various environmental conditions.

The relative insolubility of alpha-chloralose in water or physiologic salt solutions at room temperature, and its relatively short duration of action have previously required that a heated solution be injected manually as frequently as every 10 minutes. These inconveniences may explain the agent's decreasing use for animal physiologic studies, even though its physiologic advantages over other agents have recently been reaffirmed.

SECTION II

SYSTEM REQUIREMENTS

A system for the semiautomatic continuous infusion of chloralose requires the following basic elements:

Constant Infusion

This requirement was met through the use of a constant infusion pump (lead screw type) fitted with simple adapter hardware designed to hold the 50 cc reservoir syringe and its heater.

Temperature Control-Syringe

This portion of the system requires a source of voltage for heating, some means of controlling heater voltage, and of monitoring the temperature of the syringe heater element, as well as adaptors to allow mounting the syringe/heater assembly to the pump.

Temperature Control-Catheter

Requirements generally the same as for the syringe, involving control and monitoring elements as well as provisions for connecting the catheter to the syringe.

Solution Replenishment

As the contents of the 50 cc syringe used in this system are exhausted, the chloralose solution must be replenished. This is accomplished by keeping a bulk solution heated and by transferring this solution via another syringe to the heated syringe. This is accomplished by uncoupling the driver plate of the pump (to free the syringe plunger) and introducing the new solution via a 3-way stopcock connected between the heated syringe and the heated catheter.

SECTION III

SYRINGE HEATING

Figure 1 shows the essential portions of the device used to maintain a 50 cc syringe at a temperature sufficient to prevent precipitation of the chloralose solution. The central structure is a thin-walled aluminum tube with an internal diameter such that it provides a close slip fit with the syringe which will be used. Over this tube is wrapped a single layer of bakelized linen sheet, approximately 0.4 mm (0.016 inch) thick, fastened to the aluminum tube by a nonconducting commercial epoxy cement. The heater element composed of 20-gage nichrome wire is then wound (with the closest possible spacing that will avoid intercoil shorting) over the insulating bakelite sheath. After winding is completed, the coil is cemented in place with the same nonconducting epoxy cement used for the sheath. A copper constantan thermocouple was cemented in place on the mid-point of the coil to permit monitoring of the approximate heater temperature.

Following completion of this portion of the assembly, the heater unit was attached to the delivery end plate by press fitting and cementing it into a circular groove in the end plate. Note that the delivery end plate must be provided with an orifice large enough to permit passage of the end of the syringe to an accessible position.

The distal end of the heater element was secured to a screw terminal in the end plate (also made of bakelite) and a lead returned to the other end plate. The heater housing shell, consisting of a black anodized thin-walled aluminum cylinder was then fitted over the previous assembly, and the final end plate installed. Construction was completed by leading the thermocouple wires out and connecting the heater wires to a small commercial socket of suitable design.

In order to provide thermal and electrical insulation, the entire annular cavity of this assembly was filled completely with a commercial, liquid, room temperature, vulcanizing silicone rubber compound just before closure. The completed unit was fastened to the syringe adaptor plate by use of tapped holes provided for this purpose in the delivery end plate.

Experience has shown that, with a 1% solution, satisfactory operation results if the thermocouple embedded as described indicates a temperature of about 65 C. Voltage and current readings taken under these conditions show that only about 10 watts of electrical heat are required to keep the 50 cc syringe full of anesthetic solution at the required temperature. To reduce shock hazard, the main line supply voltage to the syringe heater is limited to 24 volts AC.

Some form of adapter is required to fasten the syringe heater assembly to allow the syringe to be operated by the pump. This was accomplished by simple aluminum fittings that did not require modification to the pump itself.

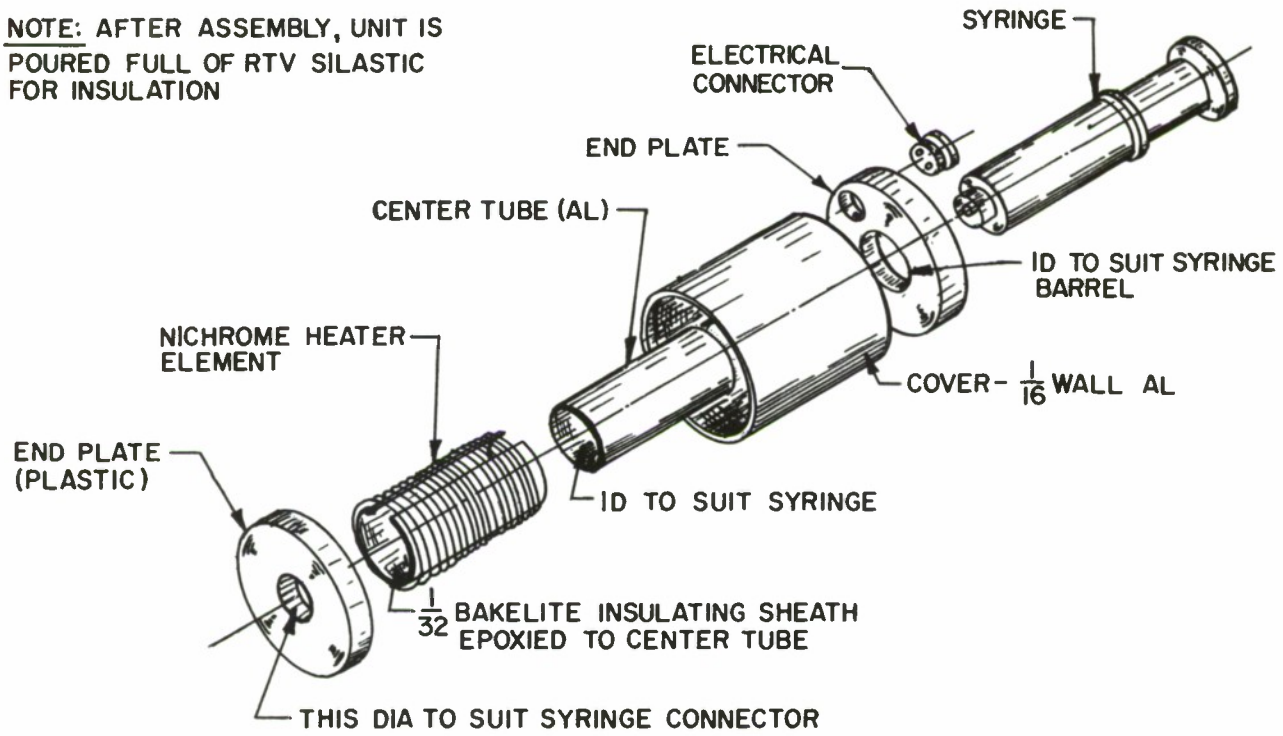

Figure 1. Syringe Heating Device

SECTION IV

CATHETER HEATING

From a practical standpoint, any means of supplying sufficient heat to the contents of the catheter would be acceptable. However, electrical heating seemed to offer the best solution in terms of bulk, close control, and convenience. The electrically heated catheter is shown in figure 2.

Basically, the unit consists of a piece of Teflon tubing (approximating a number 9 French catheter) which in turn is coaxially surrounded by a commercially available prewound nichrome wire heater coil. In order to avoid intercoil shorting, the length of the coil is cut to allow the turns to be spread apart when stretched the length of the catheter.

Fluid connections to the ends of the catheter are accomplished by introducing the catheter completely through the center holes of the end pieces. The catheter is then fixed at either end by cementing it to the end terminations with epoxy. Following this operation, standard commercial compression fittings with ferrule and gaskets removed are screwed into the threaded holes provided in the end fittings, the excess catheter material is then trimmed off as it extends into the fittings.

Connections to the ends of the electrical coil are made by feeding the wire into angled holes drilled in the plastic end terminations, electrical continuity being effected by threaded brass terminals that clamp the ends of the wire and are provided to allow the installation of a thermocouple (reading catheter wall temperature) in the delivery end fitting of the catheter.

To provide some mechanical strength to relieve the heater coil and catheter of tensile loads, and to provide electrical and thermal insulation of the heater catheter assembly, the entire length of the assembly is shrouded by Teflon chemical tubing having an inside diameter of 6.3 mm (0.25 inch). The Teflon tubing slips over bosses on each end fitting and is held in place by split circular screw clamps. The shroud must be installed before installing the final end fitting.

In the interest of being able to disassemble the unit should repairs be necessary, some of the earlier models used standard Touhy-Borst compression fittings to trap the catheter in each end fitting instead of cementing the fittings to the catheter as described above. This method resulted in such distortion of the catheter lumen as to completely restrict flow occasionally, owing to the rapid precipitation of chloralose at the site of restriction.

Experience has shown that, under normal room conditions, the heat requirements amount to about 1 watt per centimeter of catheter length. As with the syringe heater, the supply voltage is limited to 24 volts AC.

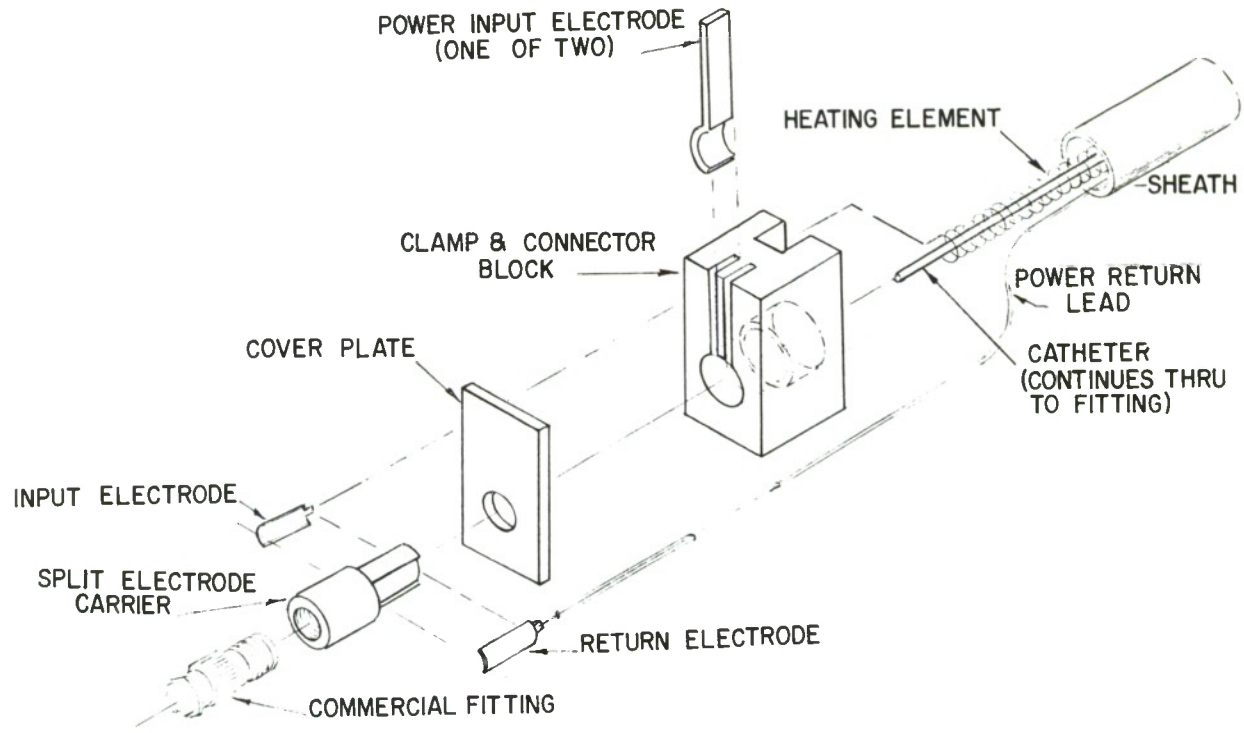

Figure 2. Heated Catheter

SECTION V

CONCLUSIONS

It has been shown that a practical, trouble-free system for the continuous infusion of chloralose is practical using devices of simple design composed of easily available materials. The system has been shown to overcome the usual difficulties encountered with the administration of this agent, rendering its use, where indicated, much less of a problem than experienced heretofore.

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