NEW APPLIANCES

Temperature Control in Extracorporeal Circulation

Dr. B. HAYES, consultant anaesthetist, Victoria Hospital, Blackpool, and Mr. T. K. D. HINDLEY, senior engineer, British Aircraft Corporation, write: The purpose of the apparatus described here is to provide a simple and safe method of independently controlling the temperatures of the various extracorporeal circulations in use during heart-lung and other organ bypass procedures.

The equipment is contained in a mobile trolley with a flat working top 6 by 3 ft. (183 by 91 cm.) by approximately 3 ft. (91 cm.) high, the only external service being a single-phase A.C. power connexion.

The operator uses a remote-control panel with four controls and four indicators (Figs. 1 and 2). The controls which set the temperature demand for each heat exchanger are self-indicating digital potentiometers reading directly in degrees centigrade. The temperature indicators are cirscale meters, also calibrated in degrees centigrade, and these continuously monitor the heat exchanger temperatures. If these temperatures deviate from those demanded, a system of heating and cooling valves is automatically brought into operation to correct the error. Water at the correct temperature is circulated continuously through each heat exchanger, and when the temperature deviates it is corrected by the appropriate valves, drawing hot or cold water from thermal storage tanks in the equipment.

The system is intrinsically safe on temperature range, and neither maloperation nor equipment failure will cause the range

of 2 to 42° C. to be exceeded. The equipment has two high-power channels which can circulate water through the heat exchangers at rates up to 30 l./min., and two of lower power which circulate water at approximately 5 l./min., for smaller thermal loads. For reasons of safety the high-power channels are operated at negative pressure, so that water is not sprayed over the working area if a hose becomes disconnected. In this unlikely event, air is drawn into the system, and the pump becomes non-functional. Self-priming is inherent in the design of the machine as soon as the pump is switched off. The low-power circuits deliver at a small positive pressure, required for the blanket circuit, of up to 2 lb./sq. in. (140 g./sq. cm.).

Circuit temperature changes of 1° C. a minute are available in all channels, the rate being varied at will by the control panel temperature selectors. Indicator lights conveniently situated display active heating or cooling in individual water circuits.

The pumps are of the centrifugal type, chosen for safe pressure-flow characteristic, good flow rate, and quiet running. The motors are enclosed induction types to minimize danger in explosive atmospheres, and the power switching for the heaters is via fully sealed mercury relays, with much of the internal electrical wiring in Pyrotex. In addition, the equipment is positively pressurized to keep out low-lying vapour concentrations, and all circulating air is passed through a fine stainless steel mesh.

The machine has the very large thermal storage of over four million calories, which is

adequate for prolonged procedures such as multiple valve replacements or organ transplantation work.

Electrical thermometers are used with meters combining long-scale length with compact design, giving good readability. As a complete guarantee of integrity, the temperature monitoring system is fully independent of the control system.

After exhaustive tests the equipment was first used in the operating-theatre in December 1967, and since then 24 extracorporeal cardiopulmonary bypass procedures of one to four hours' bypass time have been completed with this machine. All degrees of hypothermia and rewarming have been readily achieved and controlled in the largest adult patients.

Though present requirements demand only three-channel operation, the machine is provided with four, and could without difficulty be expanded to six channels if required. It has adequate reserve for the most prolonged operations, is singularly quiet in use, and occupies minimal theatre space.

This machine was built to the specification of Victoria Hospital, Blackpool, by the Preston Division of British Aircraft Corporation at its Warton Aerodrome Research and Development Establishment in Lancashire.

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FIG. 1

FIG. 1.—Temperature control machine.