THERMAL UNIT FOR ARTIFICIAL HYPOTHERMIA WITH A PREDOMINATE LOWERING OF BRAIN TEMPERATURE

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Many authors have pointed out the virtues of the method of selective supercooling of the head and brain [1, 2, 5, 6, 9-12].

In our laboratory this method was carefully studied on more than 100 dogs.

The thermal device we used is mounted on stands which make it possible to change the level of the cooling chamber with respect to the height of the operating table. Figure 1 shows certain main features of the design of this apparatus.

The operating principle of the device lies in the conversion of liquid freon-12 to vapor. During this process it removes heat necessary for evaporation from the ambient medium and cools it (Fig. 2). The liquid freon is delivered under pressure to the evaporator through a regulating valve (see Fig. 2). After overcoming the narrow opening of this valve the pressure of the liquid freon drops and its temperature is lowered. In the evaporator (see Fig. 1), the liquid freon is converted at a low temperature to a vapor, removes the heat needed for evaporation from the object being cooled, and causes a drop of its temperature. A low temperature in the evaporator is maintained by a compressor which draws off the freon vapors. The freon vapors being drawn off from the evaporator are compressed in the compressor and their temperature and pressure are raised (see Fig. 2). The compressor consists of cylinders assembled in one unit. The cast-iron cylinders have fins on the outside for cooling and an intake cavity with a flange on the side for connecting the valve. The cylinder unit is installed vertically and is attached on the housing by a flange on six pins. The top of this unit is covered and made air-tight (see Fig. 1). In the condenser, the freon vapors are cooled by a stream of air from a fan and, while retaining a high pressure, are converted to a liquid state. The apparatus utilizes a finned-tube coil condenser consisting of three soldered vertical sections. To form a directed flow of the cooling air, a diffuser in the form of a box with a hole in which the fan turns is installed on the front part of the condenser.

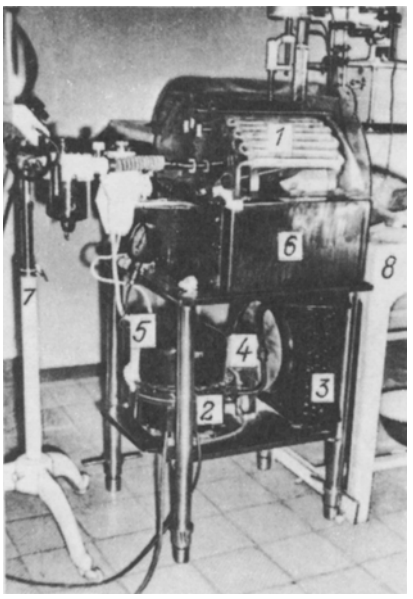

Fig. 1. Appearance of thermal device. 1) Evaporator; 2) compressor; 3) condenser; 4) fan; 5) regulating valve; 6) cooling chamber; 7) anesthetic apparatus; 8) operating table.

Thiopental sodium is administered intravenously at a rate of 12-20 mg/kg 10-15 min before cooling. The basal anesthesia is intubation ether-oxygen (see Fig. 1). The head of the animal is placed in the chamber for cooling. The change of body temperature is monitored by its readings in the nasopharynx and rectum. Since there is a definite relationship between the brain and rectal temperature (see the table), we will indicate only the latter for convenience.

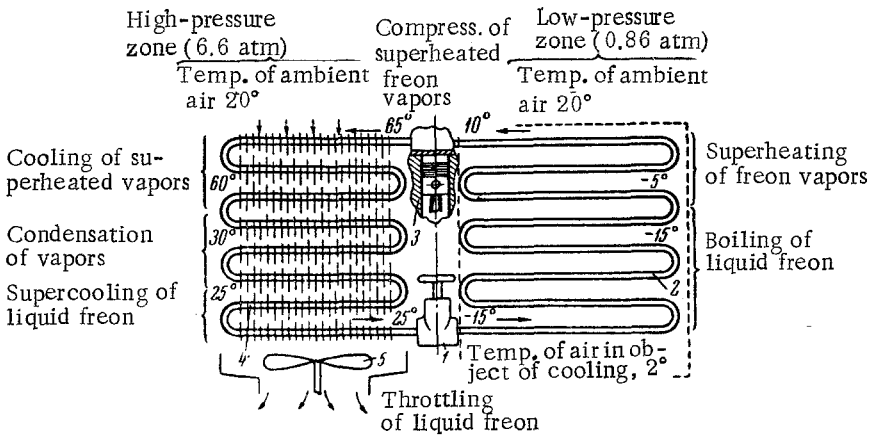

Fig. 2. Diagram of thermal device. 1) Regulating valve; 2) evaporators; 3) compressor; 4) condenser; 5) fan.

Relationship of Brain and Rectal Temperatures (in degrees)

Rectal temp.	Brain temp.
35 — 32	33 — 27
30 — 28	25 — 21
28 — 25	21 — 18

Cooling was stopped at various levels of hypothermia (from 25-32°) in accord with the purposes of the experiment. For warming the body we used hot water bottles and a reflector (Sollux lamp). Heating began immediately after the end of the operation and was stopped at a rectal temperature of 32°. Subsequently the body temperature gradually recovered independently (0.5-0.7° per h).

In our investigations, with the use of the proposed thermal device, it was found that the development of hypothermia is accompanied by a change of the external and internal temperature gradient, by a decrease of the heat insulation of the tissues, and by a change of the heat flux [3].

The higher nervous activity in experiments with supercooling of the head and brain generally recovered without noticeable disorders [8]. The mobility of the main nerve processes in the cerebral cortex with a predominance of their irradiation most frequently changed. Differentiation if disrupted occurred only on the first day after the experiment. Phasic states in normally created hypothermia rarely occur. Higher nervous activity is normalized after 1, 3-8 days.

An advantage of the proposed method of hypothermia is the combination of low brain temperature (21-25°) in the cortical region, with a relatively high body temperature (28-30° in the rectum). A low temperature reliably protects the brain against hypoxia during the time blood circulation is cut off, and the higher body temperature lessens the danger of the development of ventricular fibrillation [7].

A clinical test of the method showed that it is efficient, reliable, and simple to use [4]

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
