

THE MODERNIZATION OF THE KINEMATIC CHAIN OF THE THERMOREGULATOR T 5N FOR THE AUTOMATIC INTERLOCKING OF THE ELECTRIC CONTACT AT POSITIVE TEMPERATURE

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Abstract: This paper presents the results of the researches overtaken by the authors for the achievement of a thermoregulator fit for controlling the automatic thawing of the freezing chamber.

By the modification of the kinematic chart and by the joint use of a cam and an adjustment temper screw, it was attained the getting of a constant interlocking temperature whereas the cutting-out and the differential temperature are variable.

Keywords: Kinematic chain, thermoregulator, electric contact, positive temperature, refrigerating machines, cold generator, interlocking temperature.

1. INTRODUCTION.

The Romanian industry of the refrigerating machines and air conditioning uses the thermoregulator T 5N made in The Mechanic Factory from Sadu for the automatic control of the assigned temperature range.

In figure 1 it is presented the kinematic chart (design) of the device used in the thermoregulator T 5N construction.

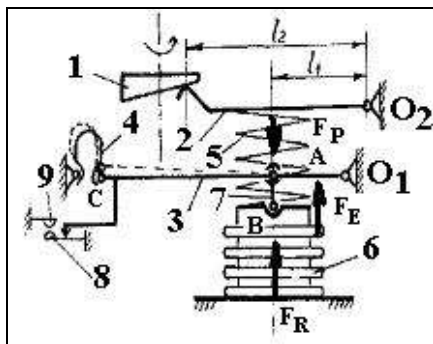


Fig.1. The kinematic chart of the device used in the thermoregulator T 5N construction

cam follower 2. The cam extremities have an angle of fall and they are representing the areas of maximum cold and maximum warm.

When the cam is rotated in the position which carries on a low compression on the range spring 5, we are in the

For carrying on an automatic thawing of the freezing chamber of the cold generator, or for having the possibility to control only in a positive temperature range, this paper presents the results of the researches overtaken by the authors for this purpose.

2. THEORETICAL PERCEPTS.

While operating a cold generator (with compressor or absorption) we request in its upper chamber a higher or lower temperature, higher or lower power consumption.

This variation of the operating conditions or of the power consumption is obtained by swinging the button of the thermoregulator, that is to say its cam on certain position. The cam 1 (figure 1) compress more or less the range spring 5 by the

situation of a maximum cold and when the cam is in the position of high compression of the spring, we are in the situation of maximum warm. From the kinetic point of view, when the the range spring **5** is not compressed, it operates on the corrugated bellows **6** only with a force F_R determined during the factory regulation by the adjustment of the length of the element **7**.

The force F_R operates in the hinge A using the element **7**, over the leverage of load **3** and creates a couple F_s which has the value:

$$\overline{F}_S = \overline{F}_R - (\overline{F}_P - \overline{F}_E); \quad (1)$$

Where: $\overline{F}_P$ = the force created due to the pressure of the freezing agent from the bellows;

$\overline{F}_E$ = the force of the bellows due to the modulus of elasticity (the bellows gradient);

At the same time the differential spring **4** operates a continuous force F_A in the hinge **C**. This force creates a dextrorsum couple in the articulation O_I .

When the couple F_s put on the articulation A surpasses the couple F_D from the articulation O_I , the leverage of load **3** is on the position opened contact (maximum cold). In this situation, the pressure of the agent within the bellows and the capillary tube will be low.

If the range spring is compressed at a maximum level (the cam is on the position maximum), the interlocking produces only when the temperature near the capillary tube is high enough.

The pressure of the agent within the bellows in this situation is capable of surpassing the range spring force. Which means that the bellows remains motionless until the force caused by the rising pressure becomes almost equal with that of the the spring **5**.

$$\overline{F}_P \cong \overline{F}_R. \quad (2)$$

In this situation the senestrorsum couple is balanced by the dextrorsum couple:

$$\overline{F}_S \equiv \overline{F}_d. \quad (3)$$

The force created by the bellows is given by the relation:

$$\overline{F}_P = p \cdot S_m, \quad (4)$$

where: p = the pressure of the freezing agent;

S_m = the average surface of the bellows.

This force $\overline{F}_P$ is opposed to the force $\overline{F}_R$ created by the spring **5** and to the force $\overline{F}_A$ created by the spring **4**. If we denote with :

Δx = the cam fall between maximum cold and maximum warm,

G = the range spring gradient,

Δp = the pressure variation within the bellows between maximum cold and maximum

warm,
 $S_m = 200 \text{ mm}^2$,

then the relation can be written: $\Delta_p \cdot S_m = \Delta_x \frac{l_1}{l_2} \cdot G$ [mm]. (5)

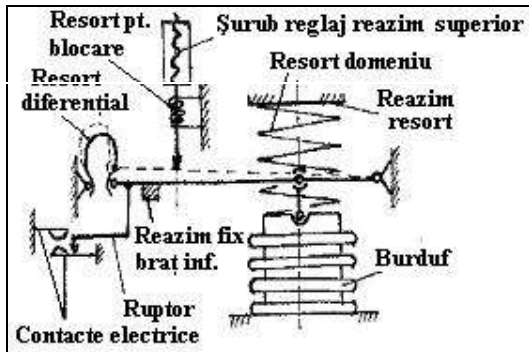


Fig. 2. The action element 3.

Whereas for the thermoregulator T 5N according to the factory documentation it is known that $l_1=15,4$ mm and $l_2=23,3$ mm then it can be written that

$$0,6609 \cdot \Delta_x \cdot G = \Delta_p \cdot S_m.$$

(6)

In this case, for a certain fall Δx of the cam, between maximum cold and maximum warm it can determine the pressure variation Δp with the relation:

$$\Delta_p = 0,6609 \cdot \Delta_x \cdot G \cdot \frac{1}{S_m}.$$

(7)

3. THE PROPOSED EXPERIMENTAL MODEL.

The experimental model proposed by us uses a modified kinematic chain, so that the interlocking temperature is constant (higher than the melting ice temperature).

In this way we cancel the cam follower 2 (figure 1), so that the range spring 5 has a constant position and vary

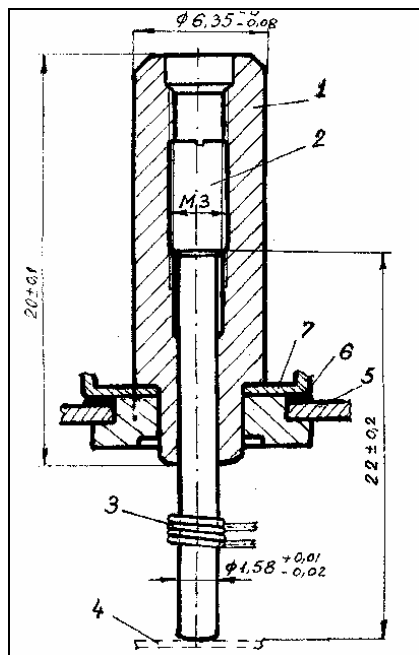


Fig. 3. Exterior screwed stem.

only depending on the pressure of the agent within the bellows 6. Also the action element 3 was conceived with a regular support corresponding to the contacts interlocking (figure 2). This support can be adjusted by the customer depending on the wished interlocking temperature. Constructively this support represents the extremity of an exterior screwed stem 2 (frog). Within the stem 1 (figure. 3) it has been carried out a fillet on a certain working part in which the stopper 2 is introduced by screwing. For not to rotate while the thermoregulator is functioning on the stopper 2 was located a balance spring.

The bottoms of this spring were fixed in the support set of the device. In this way by swinging the stem which works as a nut, the stopper 2 is forced to move or to retire. This move of the stopper makes the position of the frog to modify. In this case the distance between the stopper and the frog will be variable.

The device was assembled on the front plate 5 of the thermoregulator. Between this one and the next plate on the side with the bigger diameter of the axle 1, it was assembled a dial washer 6 and the feature 7 named drive paddle. Both of them have the possibility to remain interlocked with the axle. The drive paddle can receive on its side a button or a handling device which allows to the customer to print a rotation movement to the axle 1

during the dial washer 6 scrubs easily on the front plate.

4. THE RESULT OF THE EXPERIENCES.

The results of the experiences are presented in figure 4 and figure 5.

5. CONCLUSIONS.

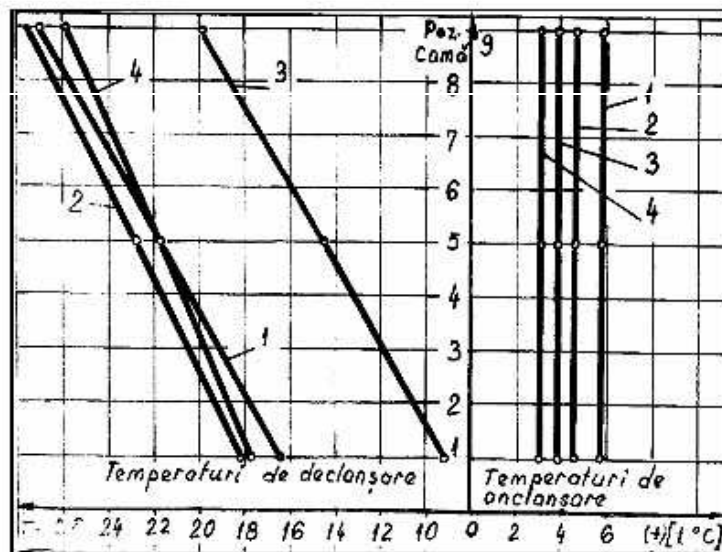


Fig. 4. The result of the measurements.

- At the thermoregulator T 5N at the variation of the pressure within the corrugated bellows and the range spring compressure the differential temperature Dt remains constant the interlocking and opening temperature varies. In this case the relation is consistent:

$$t_a - t_d = \Delta t = \text{constant};$$

- At the proposed model, by canceling the follower and the cam, the range spring keeps a constant position at the upper part and the compression will be achieved only by the pressure of the agent within the corrugated bellows;

- The interlocking temperature may be adjusted for a certain value by changing the drive paddle thickness (cam with fall 0) employed as upper support of the range spring; - For different positions of the frog (stem 1), included by the authors in the device chart (design), the interlocking temperature t_a remains constant, and the differential Δt and the opening temperature t_d vary proportionally.

The practical achievement and the experiences done with the proposed model, led to the following conclusions:

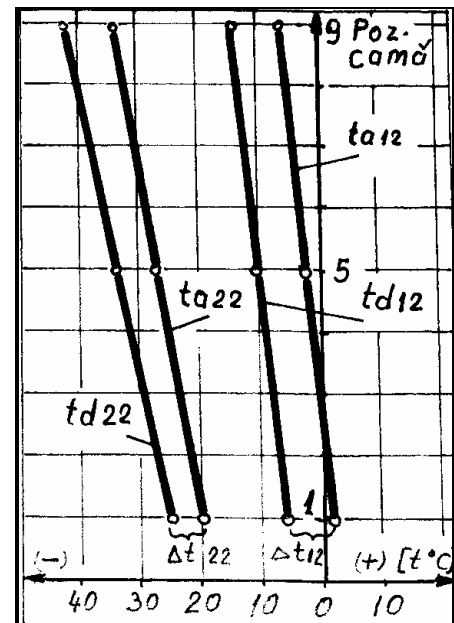


Fig. 5. The result of the measurements.

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