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THEORETICAL ASPECTS REGARDING THE ELECTROMAGNETIC INDUCTION'S USE IN WARMING THE HEATING AGENT FOR THE CLOSED CIRCUIT HEATING INSTALLATIONS

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ABSTRACT

In this project is revealed the possible use of electric power in warming the heating agent, through electromagnetic induction inside a metallic tube placed in a home closed circuit heating circuit. An electric generator with power tubes with an AC frequency of over 10000 Hz, will be used in order to obtain the electromagnetic field. The generator was built by professors Teodor Maghiar and Stefan Roman for the University of Oradea and was the first used for joining non-ferrous metallic parts through "hard knitting" and in the electronic magnetron type vacuumed tubes techniques.

This high frequency generator, inserted in the sanitary water based heating installations hydraulic circuit, is non-polluting

The novelty of the heating installation's construction is the heating tubes made of OLT35 with a metallurgic cake porous core, having a preheating and heating resistance role.

1. INTRODUCTION

The use of electric energy for heating metallic parts, others then through resistance, can be made through high frequency current electromagnetic induction. This method is based on the alternative current's property. The alternative current is circulating into a bobbin, inducing circulating currents into a metallic part situated in the bobbin's core. The metallic part's heating is done through heating inductors, which convert electromagnetic energy from one high frequency generator to the heating parts. The physical phenomenon, which appears when heating metallic parts through electromagnetic induction is called the film effect.

Among the many high frequency generators types used for heating metallic parts with inducted currents between 8000 Hz and 5000 Hz, are the electronic power tube generators. Such an electronic power generator was built at the University of Oradea by professors Teodor Maghiar and Stefan Roman and applied in microwaves technique for joining nonferrous metallic parts through "hard knitting" CIF.

This modernized electronic generator can be applied in applied science research for heating the sanitary water from the closed circuit home heating installations. In the project is presented a home heating installation through heating the thermal agent into a steel tube, through CIF electromagnetic induction. The heat transfer is done at the thermal agent through conduction and convection.

The advantages of this installation are: a simple construction easy to reproduce, being an alternative for heating houses in remote areas, apartments etc., with an exceptional environment protection.

2. THEORETICAL PREMISES

The creation of an alternative magnetic flux of high-energy value and frequency inside the body is needed for heating of a metallic body through induction. The alternative magnetic flux is obtained through some inductor bobbins, built in order to obtain a density as high as possible in the part's section from an induction current. The thermal energy-E_t, needed for heating a G-weight body, from an initial t_1 temperature to a t_2 temperature is given in the relation below:

$$E_t = G \cdot c[t_2 - t_1] \quad (1)$$

, where: c-represents the specific heat.

In Fig. 1 is presented the practical heating of a cylindrical component using IF inducted currents.

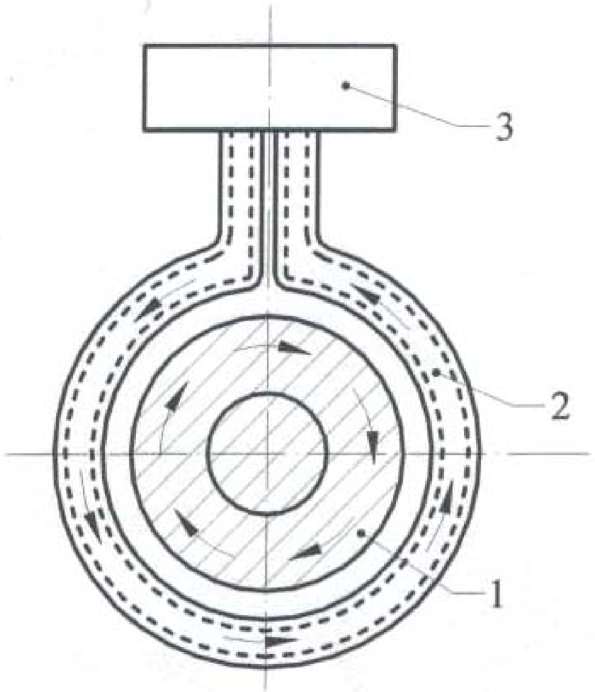

Fig. 1. Heating a metallic component through induction.

The CIF heating of the thermal fluid scheme has presented in figure 2.

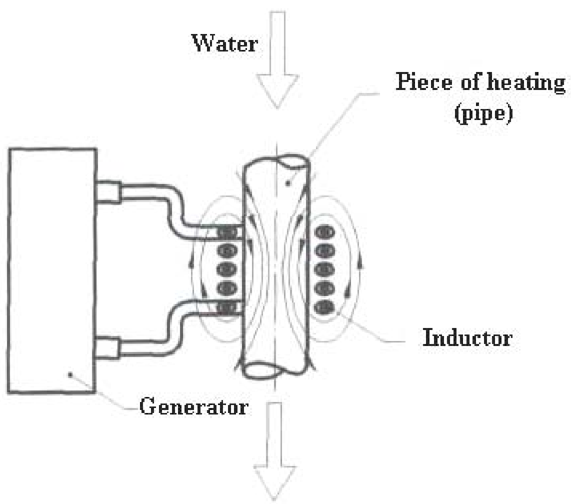

Fig. 2. Scheme of heating the thermal fluid through CIF.

The surface concentration on a relative thin film of the induced currents and of the magnetic flux in the metal tube (OLT35) and the heat transfer to the thermal agent, which circulates through the pipe, compose the basis phenomenon of induction heating. The fluid heating is indicated as sufficient penetrating the alternative high frequency current in a depth of 0.8 cm into the metallic tube's wall, which it heats at a temperature higher than 50-60°C through the Joule effect and from there the heat is transferred through convection to the thermal fluid. The efficiency of the maximum energy transfer, using induction for OLT35 is situated between 93 – 99%. The heat is transmitted by conduction through the metal tube, based on Fourier's law:

$$\dot{Q} = -2\pi r l r \left(\frac{dT}{dr}\right) \quad (2)$$

, where: Q – thermal flux in W;
r – metal cylinder's radius;
l – length of the cylinder.

The thermal flux is transferred in the metallic cylinder, depends on the medium logarithmic surface and the steel's thermal conductivity:

$$Q = \lambda \cdot s_m \cdot \frac{T_i - T_e}{\Delta} \quad (3)$$

, where:

$$\Delta = r_e - r_i$$

$$s_m = \frac{s_e - s_i}{\ln s_e / s_i}$$

$$s_e = 2\pi \cdot r_e \cdot l \quad (4)$$

$$s_i = 2\pi \cdot r_i \cdot l$$

The cylinder's heat resistance is:

$$R_e = \frac{\Delta}{\lambda \cdot s_m} \quad (5)$$

From the relations (3) and (5) it can be deducted that the thermo resistance Re is in direct proportion with the thickness of the wall of the metallic tube (Δ) and in indirect proportion with the thermo conductivity (λ) of the pipe's material and with the medium logarithmic surface-s_m. The heat transfer from the metallic pipe to the fluid is made through convection as it is stated in Newton's law.

$$Q = \alpha \cdot s\left(T_f - T_0\right) \quad (6)$$

Where: T_f is the fluid's temperature
T_o-the cylinder's interior surface temperature
α- fluid's convection coefficient in w/m^{2}k
s-thermo transfer surface

By introducing a metallurgic coke core with a spongy texture into the metallic pipe heated through C.I.F, the thermo resistance R_t to the forced convection of the fluid is reduces:

$$R_i = \frac{1}{\alpha \cdot s} \qquad (7)$$

From the above, mentioned relations and physical phenomena, it can be deducted that electromagnetic induction can be used to heat fluid in a forced closed circuit heating installation for homes.

3. THE FORCED CLOSED CIRCUIT HEATING INSTALLATION, FOR HOME WITH HIGH FREQUENCY ELECTRONIC GENERATOR

A high frequency electronic generator used for heating water in a metallic pipe can be easily installed in the hydraulic circuit of a heating installation, home, house or small green house.

Figure 3 represents the electronic scheme of an electronic high frequency alternative current generator, the model having been built at the University of Oradea and used for binding, through strong gluing, special metallic parts from the microwave technique which can be used successfully as an energy source for a closed circuit fluid heating installation.

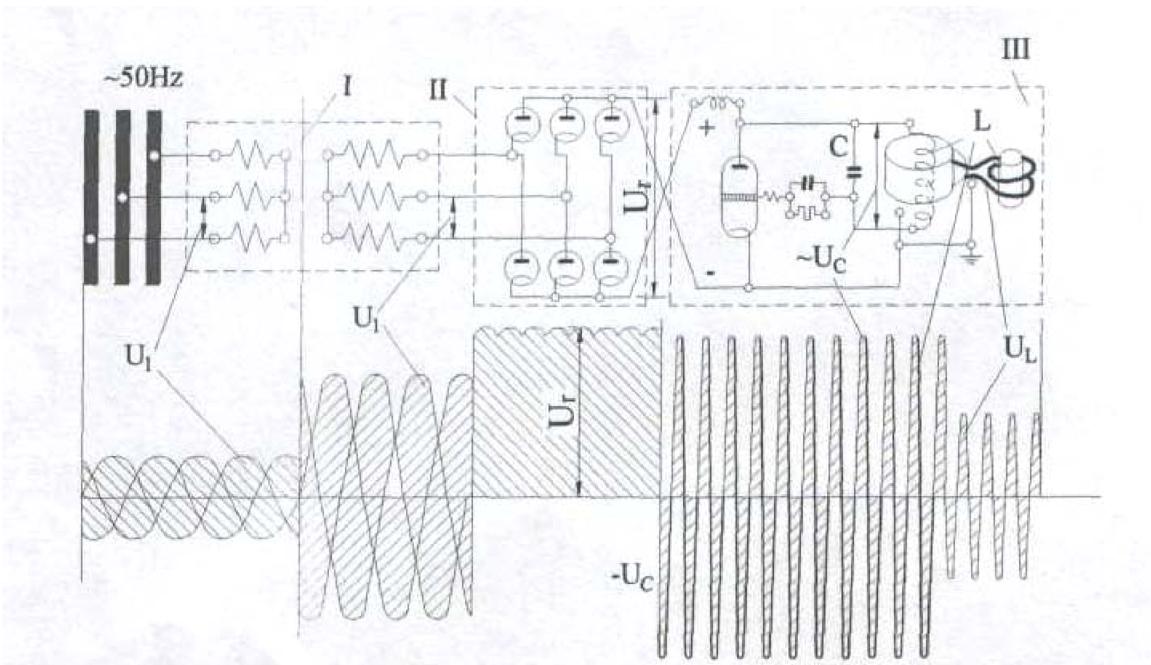

Fig. 3. The scheme of an electronic generator for C.I.F with the tension forms.

The electronic generator from University of Oradea has a frequency of 15 kHz and a power of 2 kW. The electronic generator is made out of these parts: fueling bloc, power oscillator and a charge connecting circuit.

The fueling block receives energy from the alternative current network and transforms it into high-tension continuous current. The fueling block is composed out of a high-tension transformer and a rectifier with gas tubes. The power oscillator transforms the continuous current energy into high-tension alternative current energy, being composed out of many electronic tubs (triodes).

The bloc scheme of the closed circuit heating installation with warm water preheated directly through C.I.F has presented in figure 4.

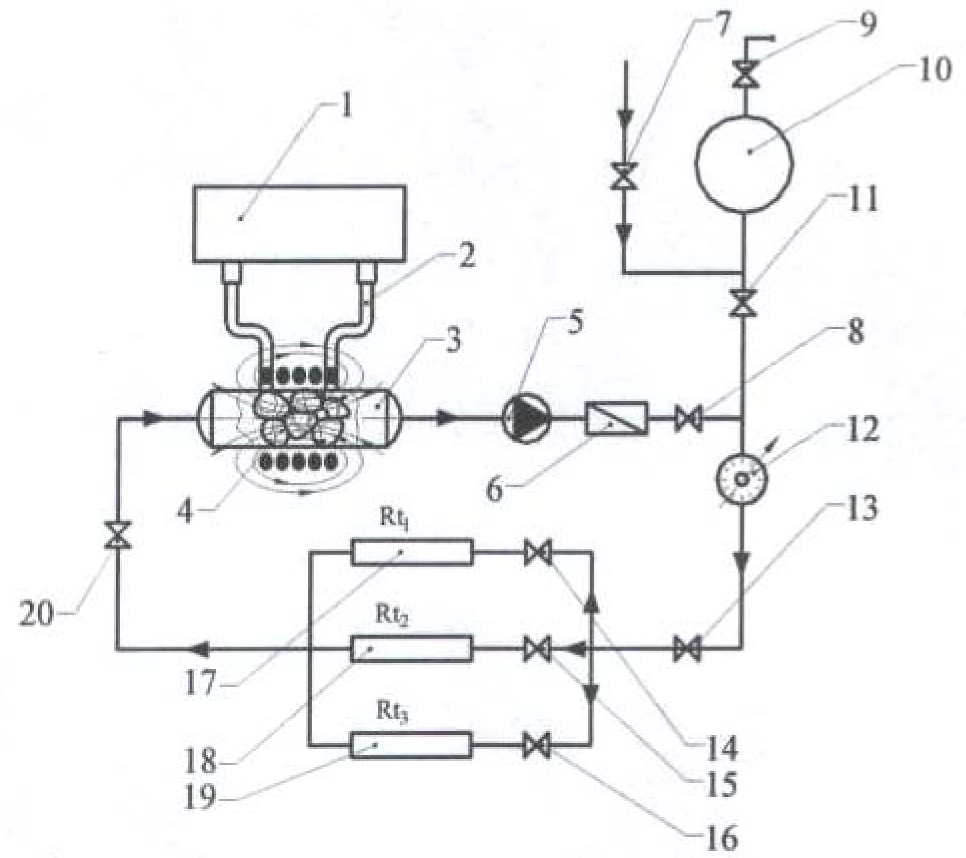

Fig. 4. Heating installations by C.I.F. with thermo tubes.

The special installation is composed of: 1- high frequency electronic generator, 2- inductor, 3- thermo tube or pipe made out of OLT 35, 4- coke core, 5- electric hydraulic pump, 6- holding flap, 7- faucet, 8- faucet, 9- safety valve, 10- closed tampon tank, 11- faucet, 12- pressure gauge, 13- faucet, 14,15,16-faucet, 17,18,19-thermo register armed with metallurgic coke core, 20- faucet.

The thermo agent circuit pressure is maintained in tampon tank 10, thus the pump will make only the pressure difference between the pressure necessary for the installation and the power available in the hydraulic resistance points.

Tampon tank 10 is fueled with cold water under pressure through faucet 7, where the water is held under the pressure of an air cushion. The water from the installation is preheated through C.I.F. in a armed pipe made out of OLT 35 with a metallurgic coke core, and the circulation of the hot water through the closed circuit, under the pressure of a few bars is ensured by an electric hydraulic pump.

The new characteristics presented in the paper are the preheating of the water in a cylindrical tube armed through C.I.F. and the heat exchange with the environment through armed thermo registers.

4. CONCLUSIONS

1. The closed circuit, armed tubes heating installations through C.I.F., ensures a heat transfer towards the unpolluted environment.

2. A high frequency electronic current generator cu frequencies higher than 10 000 Hz. can be used as a thermo generator.
3. The construction of the heated thermo tube used as a heat changer, with a metallurgic coke core is simple and can be easily done.
4. The armed thermo registers and the armed thermo tube result in a minimum amount of thermo agent, which needs to be heated.
5. The thermo efficiency of the above, mentioned installation is positive, recommending the continuation of the research.

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