HALF – AUTOMATIC COMBINED HEATING AND IRRADIATION DEVICE FOR PIGLETS

Jānis Fridrihsons
Latvia University of Agriculture, Institute of Agricultural Energetics
jafri6@inbox.lv

Abstract. The article analyses drawbacks of a certain heating and irradiation device for piglets and presents an improved device which eliminates these defects by applying a profiled floor panel with variable electrically heated areas and by artificially creating indirect ballast for powering of fluorescent lamps from the neutral point displacement voltage.

Key words: neutral point displacement voltage, erythemic lamp.

Introduction

Infrared radiation is not visible to human eyes. The energy of infrared radiation is converted to heat only in collision to some object, for example, a body of a domestic animal. Therefore, infrared heaters are successfully used in local heating of piglets and chicken avoiding heating the rest of the space thus energy economy is achieved. Ultraviolet rays are also invisible. Ultraviolet radiance has strong photobiological effect on living organisms. For example, after exposing in ultraviolet radiation for a certain period of time laying of hens increases by 15 – 17 %, milk yield of cows increases by 10 – 15 %, but growth of piglets is increased by 12 – 15 %.

Ultraviolet radiance prevents affection with rachitis of animals and birds, because it transforms provitamin D into active vitamin D, which regulates the amount of calcium and phosphorous in bones.

There is a well known combined heating and irradiation device, which consists of electrically heated floor lanes and groups of infrared and ultraviolet (erythemic) lamps. The main drawback of such systems is heating of large (~10 m^2), monolithic floor area. There is a lack of possibility of the fine on-site adjustment of the heating mode for each individual group of productive domestic animals depending on their age. There is also a problem to identify the defective part of the heater and to change or repair it without destruction of the floor structure.

There is also a device, which consists of a small (~1 m^2), movable panel with an electrical heater and irradiator with infrared and erythemic lamps positioned above [1]. This device in its turn has the following disadvantages. The panel of the heater is parallelepiped, which is characterised by expensive production and often non-effective operation as like in conventional floor heating systems lower part of the panel is also heated and this energy is not received by piglets.

The erythemic lamps operate at 120V AC and a special lowering transformer is necessary. These lamps have disproportionate small power (15 W) and are operated using inductive ballast chokes, which cause 20 % of active power loss. Whereas the power of infrared lamps is excessive (2x250 W) and the flow of radiation is not adjustable.

The above-mentioned disadvantages do not ensure optimal microclimate parameters in piglet sites.

Research object and methods

The heating and irradiation device for piglets presented in this paper is based on patented scientific developments [2-6]. The bottom side of the heating panel of the device is wave-shaped with two flat heating coils embedded into the profile. Both coils are of the same length, but with different pitch and covering area (Fig. 1). It was possible to use the waveform profile in panel 19 due to evoluted configuration of the heat flow from the discretely positioned heating element with a circular cross-section. Thus, an air gap between the heating panel and floor is formed. The main advantages of such configuration are savings of concrete and thermal insulation material and decrease of the total weight of the heating panel.

Both heating coils 5 and 6 form two heating areas on panel 19. Each area has different specific heating power P(W/m^2) and accordingly different temperatures of the surface.

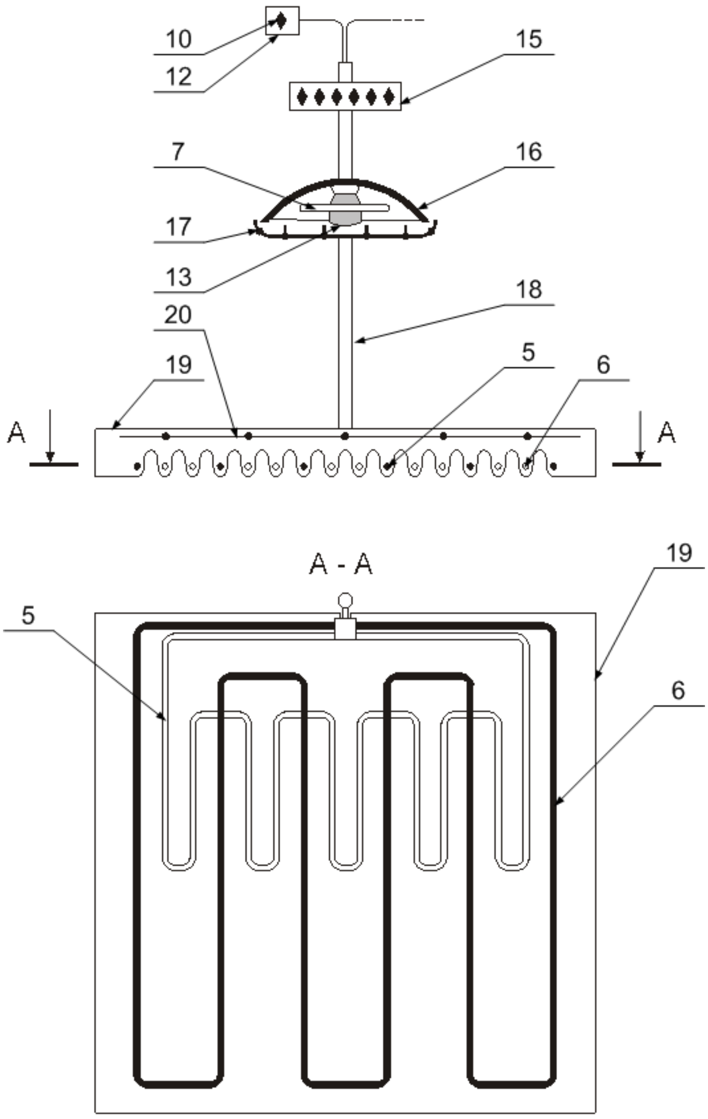

Fig. 1. **Design of the device**

It gives a possibility to ensure temperature modes relevant to zoohygienic requirements for piglets of a corresponding definite age and to obtain economy of electrical energy. A circuit is wired from one of the heating coils and infrared lamp. The circuit forms a three-phase, four-wire system with one phase and neutral disconnected, and with the erythemic lamp connected to the neutral point displacement voltage of the system. Note that the erythemic lamp is wired without inductive ballast choke, lowering the transformer and starter.

The lamps 7 and 13 are fitted in body 16 and are protected against mechanical damage by a wire sieve. In the upper part of the panel above heating wires a metallic grating 20 is placed in order to prevent the appearance of step voltage. The grating serves simultaneously as an earthing contour and a strength element.

A joint circuit is implemented through the single-pole switch 9 between zero points 01 and 0 of two devices thermal elements (heating coil and infrared lamp), see Fig. 2. This circuit allows to power the erythemic lamp using neutral point displacement voltage generated by paired device in another pigpen.

In order to achieve better starting conditions an additional electrode 3, 4 is fixed to the tube of the erythemic lamp wired to the grid's A-B-C neutral. The electrode is made of aluminum foil and serves also as a light reflector. A manual control unit 15 (Fig. 1) is welded to the steel tube 18, which also protects wiring from accidental damage.

The circuit operates as follows (Fig. 2).

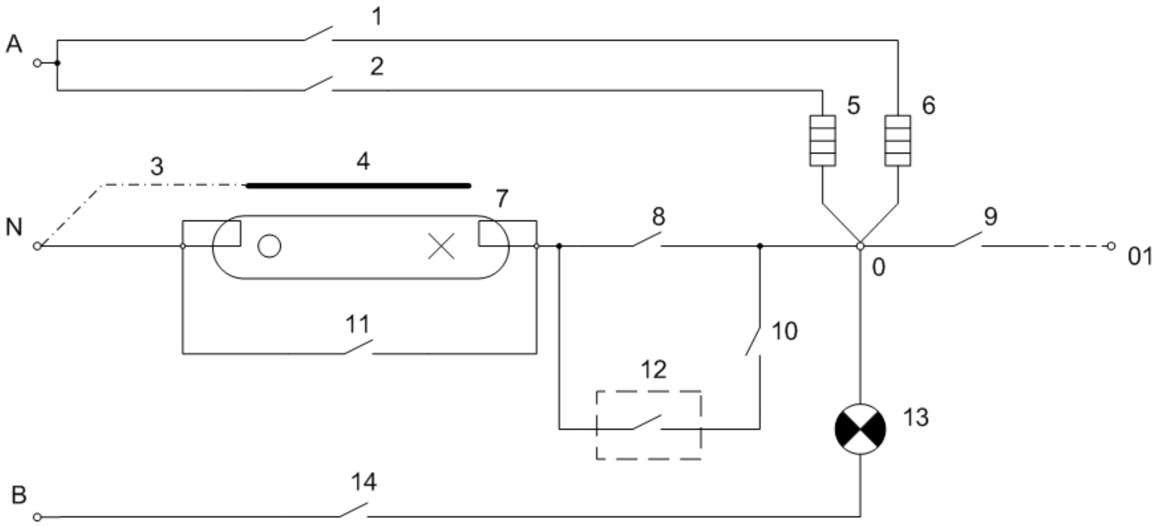

Fig. 2. **Electrical circuit of the device**

Depending on the age of piglets the heater switches 1 or 2 and the infrared lamp switch 14 are switched on while the switch 8 is switched off. By combining in this operation mode both various area covering heating coils and the infrared lamp it is possible to provide the necessary conductive heating of animals from the floor panel below and infrared radiation from above. By switching on the switch 8 while the switch 11 is open the erythemic lamp is turned on and piglets in addition are exposed in ultraviolet radiation.

Besides of the complex basic operating mode it is possible to set up various heating and irradiation modes locally. For example, shorting switch 11 turns off the erythemic lamp 7, but the heating coils 5 or 6 and the infrared lamp 13 receive full phase voltage, thus ensuring piglets with a greater amount of heat. Opening the switch 14 in this mode results in heating of only one of the areas, which is selected using the switches 1 and 2. Analogously at the switches 1 and 2 open, but the switches 8, 11 and 14 shorted piglets will get only infrared radiance. In addition other heating and irradiation commutation patterns are possible within the limits of the electrical circuit.

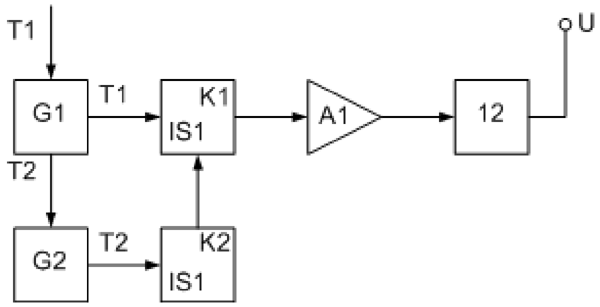

Fig. 3. **Block diagram of ultraviolet irradiation control system**

According to the existing zoohygienic requirements piglets should receive ultraviolet radiation only periodically, therefore it is purposeful to automatize the operation of the erythemic lamp. A control unit was designed for this purpose (Fig. 3). The control unit consists of two integral timer based pulse generators G1 and G2, two integral pulse counters IS1 and IS2 and the amplifier A1. The pulse period T2 of the generator G2 and the scaling coefficient K2 of the counter IS1 determine the irradiation frequency (how frequent the lamp 7 is turned on per day), but the period T1 of the generator G1 and the scaling coefficient K1 of the counter IS1 determine the duration of the illumination of the erythemic lamp at each turn on.

The automatic control unit operates as follows. The counter IS2 periodically depending on T2 (e.g., 3..6 times per day) forms a control pulse resetting counter S1, which in its turn starts trough feedback G1 and A1 and turns on the relay contact 12, ensuring turning on the lamp 7 while the switches 8 and 11 are open, but the switch 10 is shorted. The lamp will be on until contact 12, G1 and A1 will be turned off by the counter IS1 reset. At the next pulse at IS1 and IS2 the process will repeat.

Conclusions

1. The usage of profiled heating panels and indirect ballast erythemic lamps gives economy of building and electromaterials, and results in overall decrease of capital investments by 25%.
2. The decrease of specific heating power at the larger area as temperature requirements of older piglets are less and the possibility to use erythemic lamps without energy loss in ballast choke and lowering transformer decrease the exploitation costs of the system by 20%.
3. Diversification of heating and irradiation modes allows achieving better microclimate in piglet sites, thus ensuring a 15 % increase of live weight.

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