DIRECT CURRENT IN FLUORESCENT LIGHTING INSTALLATIONS

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ABSTRACT

Electric energy costs jumped up several times during the last years in Lithuania. It is necessary to save electric energy in industry, commercial buildings, schools, offices, residences, etc.

Electric energy for lighting purposes can be saved by improving the illumination quality. The lamp's flicker factor is one of the illumination quality factors. One of the ways for reducing the lamp's flicker is to employ the direct current in fluorescent lamps. The paper presents the principle of the direct current control in fluorescent lamps without ordinary ballast. Dimming of lamps including their switch-off and switch-on can be carried out by means of the light sensor, as well as, by using programmed or manual control devices.

FLUORESCENT LAMP CURRENT CONTROL CIRCUIT

It isn't easy to stabilize the direct current in a fluorescent lamp without significant power losses in ordinary ballast's. On the other hand, the direct current circuit is more convenient for controlling the current in a lamp and reducing the lamp's flicker. The problem of reducing the power losses in ballast's is solved by using non-ballasting principle for the stabilization of the lamp's current. This principle is realized by the circuit shown in Fig.1. This circuit includes one direct current (DC) power supply for all lamps of lighting installation. The voltage of this power supply is a little lower than the lamp's

operating voltage. Each fluorescent lamp is connected to the power supply in series with the auxiliary DC source and the current sensing and limiting circuit. The functions of auxiliary DC sources are to preheat the lamp's electrodes, to supply the high voltage necessary to ignite the lamp and to add the voltage in order to support the operating current of the lamp. The main function of the current sensing and limiting circuit, as well as, of the feedback circuit is to control the auxiliary DC source voltage and to stabilize the lamp's current. As the lamp's current increases, the voltage of the auxiliary DC source decreases. The current sensing and limiting circuit limits the lamp's current only in such cases when the DC power supply voltage exceeds the lamp's operating voltage. The luminous flux of the lamp may be dimmed in accordance with the illuminance level of the light sensor or can be controlled by means of input signals of manual or programmed control devices.

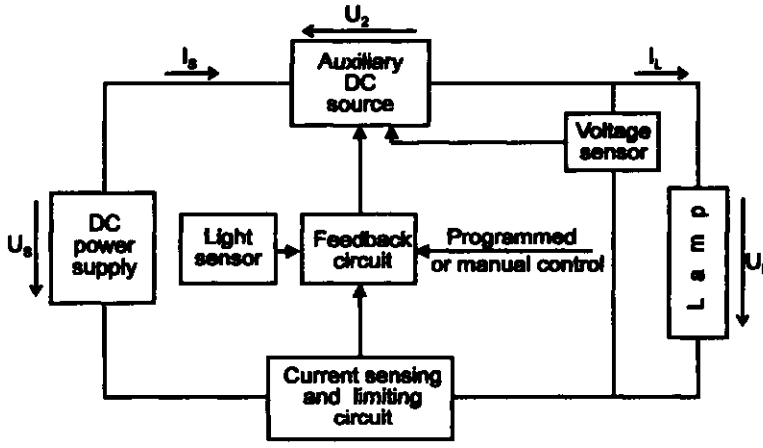


Figure 1 The DC circuit structure for energy supply and current control of the fluorescent lamp

The power is supplied to the lamp from the main and auxiliary DC sources. The ratio of the power supplied to the lamp by each of the sources depends upon the ratio of their voltages. The voltage of the DC power source is several times higher than the voltage of the auxiliary DC source, therefore the main part of the power is supplied to the lamp by the main DC power source. The control of the current of the lamp is carried out without ballasting resistors, therefore power losses in the circuit are minimized.

EXPERIMENTAL RESULTS

The semiconductor DC apparatus for the fluorescent lamp was made on the basis of the suggested principle according to the scheme presented in Fig.1. The apparatus was intended for the 65-80 W fluorescent lamp. Experimental investigations of the apparatus were carried out at 110V DC power supply voltage. The power of the lamp was varied by means of the manual control or by varying the illuminance of the light sensor.

The data presented in Fig.2 were obtained by controlling manually the current and power of the fluorescent lamp by adjusting the auxiliary DC source voltage. As a particular case, the voltage of the auxiliary DC source may be adjusted so that the lamp is switched off.

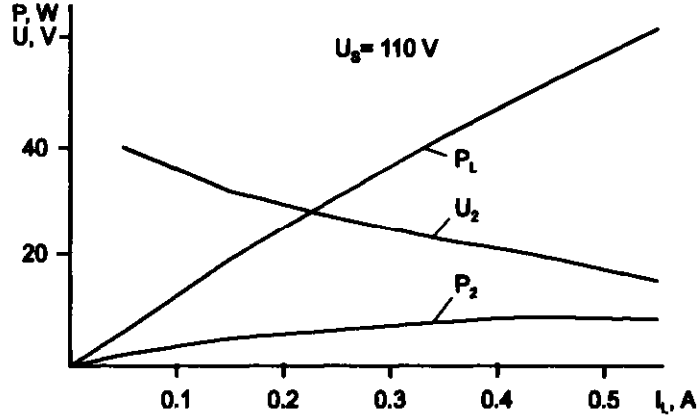
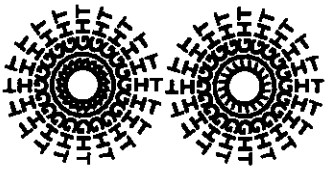


Figure 2 Total power (P_L) and the auxiliary DC source power (P_2) supply to the fluorescent lamp in the case of the manual control.

The results of the experimental investigations by regulating the power of the lamp by means of the light sensor are presented in Fig. 3. When the illuminance of the light sensor reaches the predetermined level the lamp is switched off, and it switches on again when the illuminance decreases.



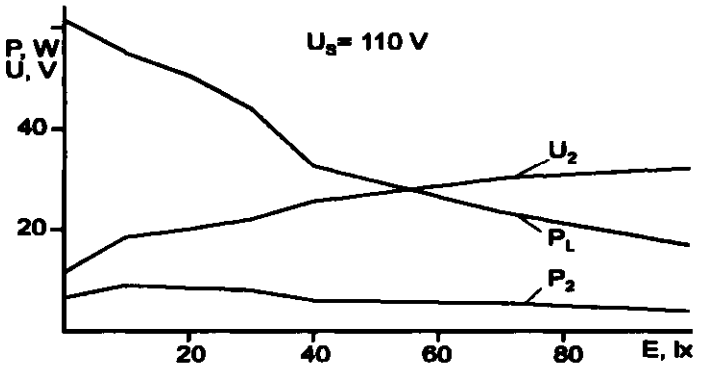


Figure 3 Power and voltage of the lamp against the light sensor luminance (experimental data)

The influence of the voltage of the DC power supply upon the parameters of the lamp and the circuit is shown in Fig.4. It may be noticed that stable operation of the lamp circuit is guaranteed if the variations of the voltage do not exceed 10% of its nominal value.

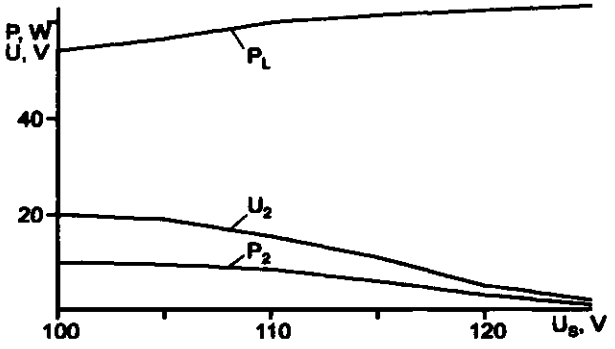
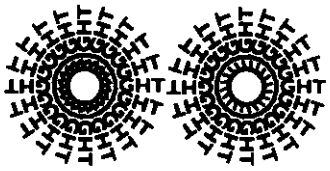


Figure 4 The response of the power of the lamp and of the output voltage of the auxiliary DC source (U_2) to the voltage changes of the DC power supply (U_s).



The results of the experimental investigations show that the non-ballasting control principle of a fluorescent lamp wattage by using auxiliary DC source is important for saving of the electric energy. The auxiliary DC source being of the low wattage, (it supplies less than 20% of the total power of a lamp) and the absence of ballasting resistors in the current circuit of the lamp enables to reduce the power losses. There is no flicker, because the direct current flows in the lamp.

The direct current fluorescent lighting equipment was made on the basis of the investigations mentioned above and was installed in a sewing shop of a hosiery enterprise. The three-phase rectifier was used as the DC power supply source. It's output voltage oscillations doesn't exceed 10% and, the flicker of the lamp's is under 10%. The mass of the DC apparatus is several times less than the mass of ordinary inductive ballast. It is possible to change the direction of the current in the DC apparatus according to a desirable program in order to avoid the consequences of the cataphoresis.

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