 ICCES, vol.5, no.3, pp.173-178

Automatic Photoelectric Device for Most Optimum Illumination of Objects

A.A.Bayramov[1], N.A.Safarov[2]

Summary

In paper the automatic photoelectric device (APD) for most optimum illumination of streets and objects is described. The offered photovoltaic system is mean for automatic switching on and switching off to an electric circuit of electric systems and illuminating lamps. This system differs from existing ones that the silicon solar cell is used for the purpose increase of input sensitivity and an output power, and so the circuit of our system is simpler. One of main technical advantages is that the relay for a current of 10A is used on an output of the automatic control system. This advantage allows linking up not only as it is usually, one lighting lamp, but also electric installation by power up to 2kW at 220V (for 1 APD). For automatic control of several of the photoelectric devices for optimum illumination of several objects the automatic control system (ACS) and software support are created. As have shown experiments, for one of areas of Baku use of only APD has allowed saving up to 16 % of the electric power. Use of ACS has resulted in addition up to 6 % of economy of the electric power.

Introduction

The problem is concerned the scope of use of automatic control of electric circuits for saving of electric power [1,2,3]. It is known the automatic switch of the illumination, allowing to switch off illumination with a delay of 3 minutes and to switch on light on the same time at a loud audible signal. Next, it is known the photosensitive cutout in which the output load can feed electric power from a current source. In this device the relay of power control of a load is switched on in the evening when the photosensitive device detects diminution of an illumination level. It is known also the system controlling streets or objects illumination depending on variable levels of natural illumination intensity within daylight hours for various parts of a city.

A great number of components of element basis and limitation of an application range of an output signal because of a low output power are common deficiency of known systems. The indicated first deficiency is that in these systems sensitive elements are used which are not having an especial generated voltage. For elimination of this deficiency of the offered system sensitivity has been increased.

The automaton follow-up controls an exterior lighting is known also. In this case the photo resistor is the sensor unit of illumination intensity. A low sensitivity,

[1]Inst. Of Physics National Academy of Sciences, Baku AZ143, Azerbaijan
[2]Inst. Of Physics National Academy of Sciences, Baku AZ143, Azerbaijan

complexity of mounting and unhandiness of a construction are the main deficiency of this system.

Experiment

The offered automatic photoelectric device (APD) is mean for automatic switching on and switching off to an electric circuit of electric systems and illuminating lamps. This system differs from existing ones that for the purpose increase of input sensitivity and an output power the silicon photovoltaic solar cell is used [4,5,6].

There are some innovations in the system. In an offered APD of an electric circuit as a result of usage of the silicon photovoltaic solar cell in which there is a photo effect, elemental composition of the system becomes much simpler. It, in turn, result is to a diminution of a weight of an automatic device, a time of wiring and the cost price.

The silicon photovoltaic solar cell with a antireflection film and square of a photo surface of 0,6 cm^2 is used in the system. SiO_2 is used as an antireflection film. It is for loss prevention of a solar stream at reflecting from a surface of silicon. There are not demands of availability of high power parameters to the photovoltaic solar cell, used in the system. Therefore, during manufacture of ADP it is possible to use photovoltaic solar batteries with nonstandard internal resistance.

The availability of several functions in electric systems is one of essential requirements in the modern electronics engineering. From this point of view in the offered system it is stipulated multifunctionality of input and output tracts. So, in an input tract the solar photovoltaic cell is installed instead of earlier widely used photo resistor. As a result, owing to a photovoltaic effect the sensitivity of the system was increased.

In known automatic control systems because of low sensitivity, regulating of illumination is not carried out optimally enough. Thus electric power is not effectively enough to be stored. For elimination of this deficiency of the offered system the sensitivity has been increased. Simultaneously, by operation in an autonomous mode, that is using on an output an electric lamp, it is possible to define distance between the photovoltaic solar cell and a lamp, or to define an angle of rotation. Besides in the system, applying the relay with a commutative current 10K it is possible to ensure power for online units up to 2kW. For example, apparently, it is simultaneously possible to link up 20 electric lamps to this system, each power of 100W. From the point of view of an economic gain these system has wide opportunities for economical utilization of electrical energy. The disadvantage of the offered system is limitation of an output power up to 2 kW. However, in our opinion, it is not essential.

The problem has been solved as follows: in the ADP system of auto control

of the electric circuit, consisting of the light source, a DC-amplifier and an illumination lamp, the silicon photovoltaic transformer is used as the detector of illumination. In an input section the solar cell is disposed instead of earlier used photo resistor. As a result, owing to a photovoltaic effect the sensitivity of the system was considerably increased. With increasing of illumination the photo electromotive force of the solar cell is increased, and as a result with the advent of a voltage on input of a direct current amplifier the relay is switched on. This relay, switching the contacts off, turns out from an electric circuit the load liked up to the automatic system. To diminution of illumination intensity there is an inverse process.

One of main technical advantages is that the relay for a current of 10A is used on an output of the automatic control system. This advantage allows linking up not only as it is usually, one lighting lamp, but also electric installation by power up to 2kW at 220V. It is especially important in the industry where manufacturing facilities are illuminated, practically, twenty-four hours a day. Therefore usage of an offered automatic device in the industry will especially essentially reduce power consumption.

Besides by operation of the automatic photoelectric device in an autonomous mode, i.e. using on an output of electric lamp, it is possible to determine distance between the solar cell and a lamp or to determine an angle of rotation. So, under condition of a persistence of an angle between the solar cell and a lamp, at variation of distance between them the pulse frequency in a lamp varies. Or at constant distance, the pulse frequency varies at variation of an angle.

On Figure 1 the offered automatic photoelectric device is diagrammatically shown. This method and the device are patented by us [4]. The detector of automatic illumination is consisted of a photocell assembled on transistors T1 and K of a DC-amplifier, relay K1 with contacts K.1 closed in a normal mode. Transformer Tr1, the diode bridge D1-D4 and smoothing capacitor S1 are used for promotion of necessary supply of other devices of the automatic device (transistors T1 and T2, relay K). Resistor R3 restricts a commutator voltage of transformer Tr1. “In” is an input signal from the block of exterior electric supply. “Out” is the system of electric consumption. R1 is a variable resistor. SE is a solar element. Used in our automatic control system solar element SE is our new developed element. It has a very high sensitivity and low cost.

The automatic control system operates as follows. The photo electromotive force of the solar cell increases with increasing of illumination intensity, which results to increasing of a base-line offset of transistor T1. As a result of occurrence of a voltage on a direct current amplifier input assembled on transistors T1 and T2, relay K1 is operated. This relay, in turn, breaks contact K.1 and turns out a load linked up to this automatic device. At diminution of illumination intensity there is an in-

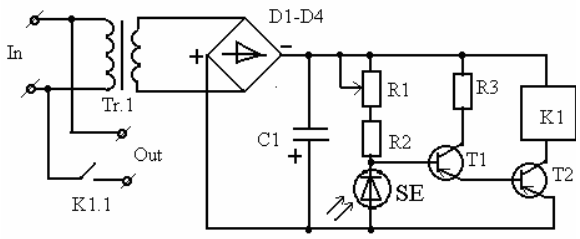

Figure 1: Electrical circuit of the automatic photoelectric device APD.

verse process and a load remains switched on through normally-closed contacts of relay K1. Resistance R1 is intended for achievement of necessary sensitivity of the automatic device. On an output of the automatic control system APD the standard connector is installed, it allows to use widely it for saving the electric power for in-house and exterior illumination apartments, objects, buildings and streets.

The automatic system APD is installed as follows. Let accept, there is some illuminated object (a building, an apartment, manufacturing facilities, streets, etc.) where with the purpose of electric power economy it is necessary to install automatic control of illumination. That is, the level of illumination should be in inverse relation from exterior, natural (solar) illumination. In this case, the automatic device APD is disposed on a link of an electric circuit between the block of exterior electric supply and systems of electric consumption. It can be lamps and other electric lighting facilities.

The offered automatic control system can find wide application at control of devices for illumination streets, in systems of public illumination, and also in any similar systems which operating power is up to 2kW. Application of the automatic control systems will promote significant economy of electrical energy. Besides because of ease of a construction, for its manufacture it is expended less funds. Thus, also the offered automatic control device has the low cost price.

In the large cities at presence of objects of the various spatial size and allocation density also the illumination is various. For example, for open district, at presence of objects not sizable or absence of them, the natural illumination is better, than in areas at presence of the giant objects (high buildings, skyscrapers) or at high density of buildings. Therefore, to achieve the greater efficiency in energy saving it is necessary to take into account the natural illumination in open districts and artificial darken in dense built-up areas of city.

For optimum and efficient control of illumination, for economy of energy, the automatic control system (ACS) and software support have been developed and created (fig.2). This system allows to control of objects and streets illumination in view of natural solar illumination and allocation density of objects. As experiments

have shown, for one of district of Baku use of only APD has allowed to save up to 16 % of the electric power. Use of ACS has allowed saving in addition up to 6 % of economy of the electric power (fig. 3).

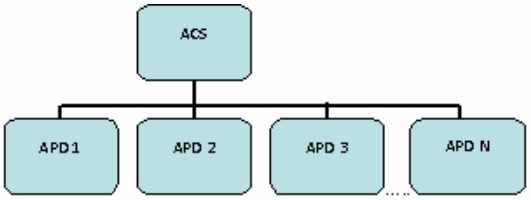

Figure 2: The function chart of automatic control system (ACS).

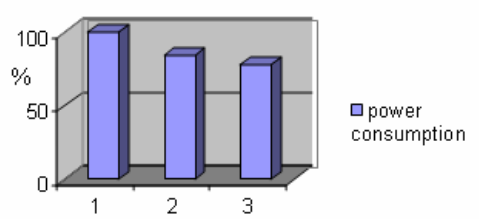

Figure 3: Power consumption in one of district of Baku: 1-there are not APD and ACS (power consumption is 100%); 2-there is only APD (power consumption is 84%); 3- there are APD and ACS (power consumption is 78%).

Conclusion

In paper the automatic photoelectric device (APD) for most optimum illumination of streets and objects is described. The offered APD is mean for automatic switching on and switching off to an electric circuit of electric systems and illuminating lamps. This system differs from existing ones that the silicon solar cell is used for the purpose increase of input sensitivity and an output power, and so the circuit of our system is simpler. One of main technical advantages is that the relay for a current of 10A is used on an output of the automatic control system. This advantage allows linking up not only as it is usually, one lighting lamp, but also electric installation by power up to 2kW at 220V (for one APD). For automatic control of several of the photoelectric devices for optimum illumination of several objects the automatic control system (ACS) and software support are created. As have shown experiments, for one of district of Baku use of only APD has allowed saving up to 16 % of the electric power. Use of ACS has resulted in addition up to 6 % of economy of the electric power.

References

1. Bayramov A., Hashimov A., Safarov N., Akhmedov G. (2006): "Thermophotovoltaic solar energy converters on the basis $A^{V}B^{VI}$", *2006 IEEE 4th World*

conference on Photovoltaic Energy Conversion, Hawaii, USA. vol.1, pp.651-654.

2. Bayramov A.A., Hashimov A.M., Safarov N.A.(2006): "Solar concentrator", *Patent No. a2006 0027*, Baku.
3. Bayramov A.A., Hashimov A.M., Safarov N.A. (2006): "A solar power plant with a high performance solar cells and thin concentrators made of aluminum-backed epoxy coated polymers", *Proc. TPE-2006*, Ankara, Turkey, pp.1037-1039.
4. Safarov N.A., Jafarova E.A., Madatov P.C., Akmedov Q.M. (2005): "Devices self-steering of electrical circuit", *Patent. I 2005 0059, No. a0030081*, Baku.
5. Safarov N.A., Jafarova E.A.,. Tapdiqov E.S., Iskenderzade Z.A. (2005): "Effect of temperature processing on generative time of life of the bearers in detectors of nuclear particles on the basis of high-ohmic silicon", *Proc. International Conference "Fizika-2005"*, Baku, Azerbaijan, pp. 827-829.
6. Safarov N.A., Shukurova V.D. (2004): "Structural change SiO_2 used in multilayered silicon solar elements", *Ecoenergetics*, No. 2, pp. 26-27.