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Design and construction of remote-controlled fluorescent lamp and its effectiveness to classroom and offices

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Abstract

This study focused on recycling and prolonging the lifespan of most fluorescent tubes produced by commercial products. The gadget can help lessen the expenditures of the school in purchasing fluorescent bulbs installed mostly on its buildings and offices. In addition, the gadget contributes to a healthy environment by minimizing the waste of busted fluorescent tubes, which these tubes contain mercury vapor. It should be properly disposed of, or if not, once it is broken and exposed to the air, mercury content could threaten one's health by inhaling and later creates complications to our respiratory system. The study employed a descriptive-experimental design to test the efficiency of the gadget in terms of the time and the number of blinks before a fluorescent lamp lights up and its effectiveness on the load capacity it can handle. Comparing it to commercial fluorescent, the gadget is faster in terms of lighting up a fluorescent lamp. The study revealed that the gadget can efficiently and effectively lights-up and prolongs the lifespan of most waste of commercial fluorescent. It is because of the immediate response of the remote-controlled receiver as it receives an infrared pulse from a remote controller. Also, the efficiency of the electronic boost starter is used to maintain the illumination and stop the fluorescent tube flickers many times before it lights up normally. This can answer the problem of recycling and minimizing the waste of fluorescent bulbs and helps one's expenditures on lighting fixtures.

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Introduction

Light is one of the needs of human beings, especially at night. It is defined as the energy that produces a sensation of brightness that makes seeing possible. The fluorescent lamp is one source of light, and they are mostly installed in commercial buildings, offices, schools, and households because of their high brightness and low cost (Li, Zhou, Yang, & Zheng, 2016). However, too much use of fluorescent lamps today causes a problem in our waste (Hu & Cheng, 2012). All fluorescent lamps are considered hazardous waste because they contain mercury (Rey-Raap & Gallardo, 2011). When mercury-containing lamps are placed in the trash and collected for disposal, there is a big possibility that the lamps or tubes will be broken, and mercury is released into the environment. The mercury vapors from broken lamps or tubes can be absorbed through the lungs into the bloodstream, and people who are particularly close to the breakage are especially at risk (Bose-O'Reilly, mcCarty, Steckling, & Lettmeier, 2010).

Many are aware that proper waste disposal of fluorescent lamps is significant because they are considered hazardous materials if they are not properly disposed of (Onwughara, Nnorom, Kanno, & Chukwuma, 2010). This means that there is a need to provide a special gadget that lessens/reduces the number of waste of lamps. This is to save money, time, and effort and to minimize the health risk that this material produces in the environment. Fluorescent lamps and tubes are indeed an energy-efficient alternative to incandescent lamps (Yuen, Sproul, & Dain, 2010) for the following reasons: they are three to four times more energy-efficient, reduce greenhouse gas emissions, cost less to use, and other pollution from energy production and last up to ten times longer than standard incandescent light bulbs when it is properly used.

However, technology plays a significant role in solving this effect of mercury produced by fluorescent tubes in our bodies (Abbas, Al-Amer, Laoui, Al-Marri, Nasser, Khraisheh, & Atieh, 2016). Technology is one of the most influential industries at this time, and we could now develop a better way of creating inventions or new gadgets (Noveck, 2010). Furthermore, as we are expecting, inventors and researchers continuously grow up as time goes by. Electronics is the branch of technology that concerns the design, manufacture, and maintenance of electronic devices (Scruggs, Nimpuno & Moore, 2016). It provides different functions like controlling the flow of current in a circuit, creating a circuit using different electronic components, and designing gadgets that could be useful to everybody.

Electronics technology is the fastest-growing industry dealing with the application of electricity through special tools, equipment, and materials. Therefore, we need to know the basic principle of electronic parts to create an invention that could help solve problems related to electronic premises.

One of the essential gadgets invented is the remote sensors and detectors because it gives convenience to all the users of the gadget (Megalingam, Radhakrishnan, Jacob, Unnikrishnan, & Sudhakaran, 2011). These sensors are widely used in appliances, traffic light detectors, parking areas, security systems, robotics, and many more (Hancke, de Carvalho e Silva, & Hancke Jr, 2012).

A remote-controlled boost starter is a gadget that helps to lengthen the lifespan of fluorescent tubes. It can light up most of the waste tubes produced by commercial fluorescent lamps. The control switch, connected to the fluorescent lamp via a wire, is generally installed on the wall. To turn on or off the lamp, it is necessary to be physically at or near the location of the switch when turning on or off the lamp. A simple task, no doubt, but consumers these days expect minimum inconvenience and maximum comfort in the daily appliances used, including lamps that are lightened with ease to suit the activities at hand (Paetz, Dütschke, & Fichtner, 2012). The gadget to be developed is one of the keys to promoting a healthy environment, reducing waste, and saving time, effort, and money. In this way, we can also minimize the waste of fluorescent lamps and lessens the hazardous chemicals found in our surroundings (Lim, Kang, Ogunseitan, & Schoenung, 2012). The Cagayan State University Lal-lo Campus, in particular, finds ways and means to help the community by creating a gadget that benefits everybody, hence, this study.

This research study applied and installed the design to test the effectiveness of the gadget in schools and offices. Generally, this study aimed to design, construct and test the effectiveness of the remote-controlled boost starter for fluorescent lamps that can be used for schools and offices who were the main beneficiary of the gadget. Specifically, it aims to: design and construct a remote-controlled boost starter for fluorescent lamps; test the effectiveness of the remote-controlled boost starter for the fluorescent lamp; and determine the capacity and efficiency of the gadget in terms of giving a load to the remote-controlled receiver.

Materials and methods

The materials used in this study were bought from an electronics shop, and some parts were recycled. The researcher made the design himself. The remote-controlled boost starter for fluorescent lamp consists of the following bought parts: Relay Switch 6A-6V, Transformer 6V – 0V – 6V, IC NE555, Diode 1n4007, 1n4001, Power Regulator LM7508, Electrolytic Capacitors 1uf, 10uf, 47uf/16v, Mylar Capacitors 474k, Transistor BC558, BC547, Ceramic Capacitor 103,104, Regular Convenience Outlet 16A, Resistor 1.2k, 56k, 470 ohms, Square Box, Bolt & Nuts, Shielded Wire (4 built-in wire), Lead, Stranded Wire #18, Male plug (10A), and recycled parts: TSOP sensor 1738 and LED Green and Red.

Research Design

This study used the descriptive-experimental design. The study used the descriptive method to describe the designed remote-controlled boost starter for fluorescent lamps and tested the gadget's efficiency on how it reacts when powered on. Furthermore, the experimental research design was employed since the researchers compared the efficiency of the designed remote-controlled boost starter when it lights up fluorescent lamps compared to the commercial fluorescent lamps.

Data Gathering Procedure

Innovation and Assembly Procedure

The original circuit of the power supply used two capacitors for the input and output voltage of the circuit and a center tap transformer 6v–0v-6v secondary output. It also uses two rectifier diodes and a voltage regulator for fixed voltage. This was modified to produce a simple circuit with a similar function. The revised circuit of the power supply used three capacitors for the input and output voltage of the circuit and a single winding transformer of 0v-6v output. It also used bridge rectifier diodes and voltage regulators to stable the output voltage. This was used to produce a smooth output fed to the circuit.

The original circuit of the remote control used a center tap type transformer 6v-0v-6v secondary output. This circuit is fed off the signal of any kind of remote control used at home to transmit pulses to the IR sensor receiver (TSOP 1738). The output pulses coming from the IR sensors are amplified by the T2 (BC558) and pass it to the first relay, therefore, switching the first stage. The switching I.C.1 NE555 is used as the triggering source for the T1 (BC548). A manual switch will also be placed in the circuit to test the functionality of the second stage of the design. T1 amplifies the signal coming from the I.C.1 and throws the signal in the second relay, and switches the load. The circuit's range or distance that detects pulses is 20 meters away from the gadget without any blocks.

The modified circuit of the remote control (refer to Fig. 4.) used a single winding transformer with an output of 0v-6v. The circuit is being fed off the signal of any remote control used at home to transmit pulses to the IR sensor receiver (TSOP 1738). The output pulses coming from the IR sensors are being amplified by the T2 (BC557/ BC558) and pass it to the first relay, therefore, switching the first stage. To adjust the sensitivity of the IR receiver, capacitor C5 must reduce its capacitance. Once relay 2 is switched on, the pulse will automatically switch on the IC1. The switching I.C.1 NE555 is the triggering source for the T1 (BC557/BC548). A push-button switch is also placed in the circuit to test the functionality of the second stage of the design. T1 amplifies the signal coming from the I.C.1 and throws the signal in the second relay, and switches the load. Since the sensitivity of the IR will improve, the input pulse's range also increases. The range or distance that the circuit detects pulses is at least 20 meters away from the gadget; this is attainable as long as the signal will not be blocked.

This was the detailed assembly package of the modified circuit of the remote control that uses a plastic case and a square box for better insulation. The size of the case is 5cm (height) X 13cm (width & length). The gadget was placed parallel to a wall in the most accessible area, wherein you can easily switch it on and off the gadget using any remote control. This was the package of the modified circuit of the remote control, which uses a square box for better insulation.

The original circuit of the fluorescent starter used only one capacitor for the start-up of the fluorescent tube, and it has a small light bulb as starting indicator. The starter throws pure ac voltage to the tube around 400VAC as a triggering voltage. This high voltage causes the short lifespan of the fluorescent tube.

The revised circuit of the fluorescent starter uses two capacitors and a bridge rectifier diode for the start-up of the fluorescent tube and, at the same time, the source of the tube. The circuit supplies the tube around 86VDC only. This means a smooth supply for the fluorescent tube and prevents the filament from being busted. This type of supply fed to the tube will lengthen the bulb's lifespan because it produces a pulsating dc voltage as the source of the power of the fluorescent tube. This was the package of the revised circuit of the fluorescent starter, which uses a plastic case for better insulation. The size of the case is 2cm X 4cm. The gadget was placed inside the case of the fluorescent lamp. The end of the wire will be socket type for an easy way of disassembling. This was the sample connection of the gadget with a remote-controlled controller and an installed electronic boost starter inside the fluorescent lamp case.

Testing Procedure

While testing the innovative remote-controlled boost starter, removing and changing parts were considered. The procedures that were done in testing the innovative remote-controlled boost starter were as follows:

The original circuit used a full-wave type power supply. To make the supply more sufficient, a bridge-type power supply has been made to replace the original power supply. After changing the design, measure the voltage output of the regulated power supply by the use of a multi-tester, and it should display an exact voltage of 5VDC. This regulated output will be the voltage source of the remote controller.

The circuit needs a regulated 5vDC connected to the remote controller. The red LED in the power stage should glow, indicating that the voltage enters the remote control circuit, and then feeds an input pulse on the IR receiver using a universal remote. When the signal is released by the input source (universal remote), the green LED should glow, indicating that the remote-controlled circuit is functioning. Once the green LED glows, circuit relay 2 in the second stage switches the load, and the electronic boost starter is installed in a fluorescent lamp. The sensitivity of the receiver improved when a resistor R1 and C5 were adjusted to their value of 1.2k ohms and 10uf/16v.

Connect the electronic boost starter on the output of the remote controller from relay 1 as the source of the circuit. As the Green LED illuminates at the remote controller stage, the fluorescent bulb should also Glow or light up. Once the universal remote is pressed again, the Green LED shuts off with the fluorescent bulb. As the Green LED lights up in the controller stage, the lamp also does the same because the gadget got the current source at that stage.

During the testing, the IR sensor receiver cannot fully detect the output pulse of a universal remote. The input capacitor (C5) was adjusted so that the sensitivity of the IR would increase. This solves the problem when switching the remote controller at a distance of at most 20 meters. The remote controller reacts and also with the fluorescent lamp as the load. In addition to this, you must wear Personal Protective Equipment (PPE) to test the gadget for safety because you are dealing with high voltage.

Remote Controller Capacity per Load

The capacity of the Remote Controller was based on the number of loads (fluorescent lamps) it could control. In this case, the gadget holds ten fluorescent lamps or 400 watts in the testing. The gadget can carry a maximum of 1,320 watts respectively, as computed in an Ohm's Law formula P = V x I. We should remember that 2/3 or a maximum of 871.2 watts of the total capacity should only be capacitated to avoid any overload of the gadget.

Results and discussion

Effectiveness of the Remote-Controlled Boost Starter

In utilizing the remote-controlled boost starter, it was found that the waste fluorescent bulbs from commercial fluorescent lamps are lighted up and can still maintain the bulb's illumination. This process happens because of the bridge-type rectifier diode installed as an Electronic Boost Starter, of which the current flowing from the bulb flows in one direction only. As the current flows in one direction, the voltage output produced is filtered by the Mylar capacitors, which also smoothens the voltage supply of the fluorescent bulb.

The gadget prevents the flickering/blinking of the bulb because of the electronic parts used in the gadget. As the fluorescent bulb blinks many times, the more tendencies that the bulb is bust (HRRC, 2011).

Efficiency of the Gadget

The gadget's efficiency was determined by the time it lights up fluorescent lamps compared to commercial fluorescent lamps. In the experiment and observation of the study, most commercial fluorescent lamps blink many times before it lights up, which range from 2-5 blinks up and 2-5 seconds or more. This was because of the timing of the magnetic field produced by the fluorescent ballast and the trigger voltage from the commercial starter. The fluorescent lamp continuously blinks when these two parts do not meet at the high or peak magnetic field. The commercial fluorescent only lights until the two parts meet at the peak magnetic field pulse. Studies show that commercial fluorescent lamps quickly bust due to the frequent blinks it occurs and the number of times we switch on the fluorescent lamps.

The gadget solves this problem because it will not let the fluorescent tube blink many times. Instead, when switching on the gadget, the bulb lights up immediately, preventing it from being busted and keeping it last longer. The rectified and filtered voltage of the revised fluorescent starter prevented these circumstances in the performance of commercial fluorescent lamps. The revised starter meets the peak magnetic field pulse produced by the fluorescent ballast as we switch on the gadget, which functions instantly in less than a second.

Capacity and Efficiency of the Gadget

The gadget used a 1-Ampere transformer and 6-Ampere Relay, and it has a load of 10 fluorescent lamps (40w) and four ceiling fans (75w) as an additional load for the gadget to test its wattage capacity. The power rating that the gadget can hold is 1,320 watts maximum based on the computation of Ohm's Law (P = V x I).

The gadget lights up in 0.56 seconds or even faster when switched on with a remote controller. This indicates that the ballast and the electronic boost starter meets-up in the highest magnetic field produced by the ballast (Delair & Rick, 2010). This was also the main reason a fluorescent tube stays longer than commercial lamps. The time it blinks when the lamps are switched on has something to do with the lifespan of the fluorescent bulb because in every blink a commercial lamp does, it creates a

400vac pulse to switch on the fluorescent bulb. In this case, the bulb's filament is forced to produce light with an overvoltage causing it to be busted (Rush & Frank, 2011).

The gadget is easy to install because it has only two main stages; the remote control receiver and the electronic boost starter. If these two stages have already been assembled, plug in the receiver to 230vac, and a fluorescent Lamp with the boost starter is plug-in into the receiver's output. The gadget is very effective in terms of lighting speed and energy consumption because the fluorescent bulb supply is only 86vdc to 100vdc, depending on the fluctuation of the AC source. The gadget uses a 200mAmpere and has a wattage of 46w/h (Pt = ExI). The gadget then only consumes 0.046Kw/hour. The current consumption is minimal, which took only P0.497/hour, which is the gadget's maximum performance.

Conclusions

Based on the discussion of findings, the gadget is very efficient since its characteristic is to recycle and lengthen the lifespan of waste bulbs of commercial fluorescent. It is also very effective as it operates well in a specified load. It also gives comfort to the user of the gadget.

Recommendations

Based on the findings and conclusions, the following recommendations are offered.

a. The innovative remote-controlled boost starter should be used by households and business establishments.
b. Parallel studies should be conducted to improve the said gadget and innovate other gadgets that would function the same or better.

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