

A NOVEL DESIGN APPROACH IN REGULATOR SYSTEM FOR ENERGY CONSERVATION

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Revised: 23 January 2014 ,Accepted : 07 February 2014

Abstract

in currently conservation of the electricity is a vital factor which is effectively involved in economy of electricity generation. This paper presents a novel idea to save the electrical energy in the regulator. The energy consumed by any fan is not reduced by the regulator. The energy consumed becomes two parts. One is lost as heat energy in the regulator and the balance is used for rotating the fan. Even though fan runs slow, it consumes the same energy as it runs fast. In this new regulator, inductors are used instead of resistors. Resistor converts the electricity into heat but inductor converts it into emf and another inductor produces the same electricity from that emf. Since step up transformer is used serious with the fan. The consumed power by the transformer is returned and remaining power only can be consumed by the fan. If we use this technique, we can save 35-38% of electricity. We can also control more than ten fans by using single regulator. It is hoped that this small product can make a big change in the power consumption.

Keywords : Energy saving regulator, AC voltage controller, Step up transformer based regulator, Series transformer.

INTRODUCTION

Usually AC Choppers are used for the reduced voltage output. But the AC choppers also called as AC voltage regulators are bound to more voltage losses due to harmonics. This is rectified by using this technique. Boomerang is a thrown tool which is designed to circle back to the thrower. Here this regulator is named boomerang because it returns the remaining power of the load. The output of the secondary coil is named boomerang output. Resistor based regulators are simply power consumers which converts electrical energy into heat energy. Fans, Air conditionings and other instruments which are using regulators consume the same electrical energy during run either fast or slow.

We have an effective way to avoid the power loss (voltage drop). The purpose of this proposed regulator is to avoid the wastage of electricity due to resistor based regulators. Think that it can save nearly 35% of the electricity consumption by the fans in the world. In this regulator, transformer is used as a voltage divider which decides the voltage across the instrument. The remaining voltage can be returned to the switch box. The returning voltage should be high because if the voltage is lower than 220V. It cannot be sent again to the phase. The current flows only from high voltage to low voltage. It needs to send from the regulator to the phase. Hence step up transformer is employed. The output of the regulator varies in between 220 - 240V at the same time input voltage of the instrument can be controlled.

LITERATURE SURVEY

In recent years we are using the auto transformer to get the variable outputs but they are not energy savers. For an example, if 24 volt requires, they provides by taking 220V input. The output is either low or high but input is constant. So it cannot save the energy [1]. A step-up/down AC voltage regulator is proposed, in which a tap-changing transformer and a pulse width modulation (PWM) AC chopper are combined. The proposed regulator can step up or down the output voltage to input voltage. Also, the proposed regulator restrains more harmonics of output voltage compared to the conventional PWM regulator. The input current flows continuously

in the proposed regulator, while it flows discontinuously in the conventional PWM regulator. Through digital simulation, several characteristics are investigated theoretically and then compared with those of conventional schemes. Practical verification of the theoretical predictions is presented to confirm the capabilities of the proposed regulator. [2] So far all the regulators are just the voltage controller. All the remaining voltages can be considered as loss. But in this regulator we are using a step up transformer in different way. Here input is varied. Simply transformer is used as a potential divider.

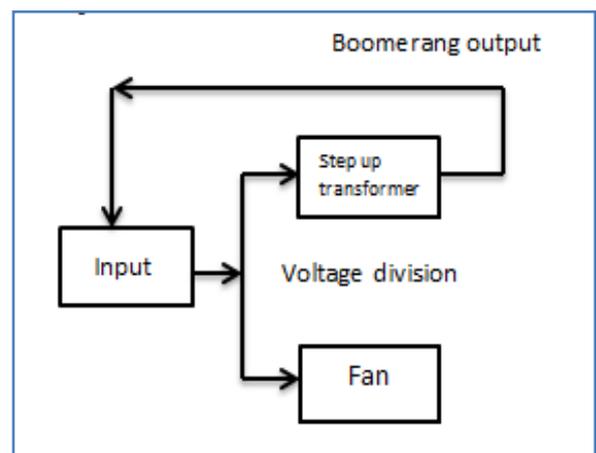


Fig.1: Block diagram for Boomerang Regulator

CONVENTIONAL VOLTAGE REGULATORS

Linear regulators

Linear regulators are based on devices that operate in their linear region (in contrast, a switching regulator is based on a device forced to act as an on/off switch). In the past, one or more vacuum tubes were commonly used as the variable resistance. Modern designs use

one or more transistors instead. Linear designs have the advantage of very "clean" output with little noise introduced into their DC output, but are less efficient and unable to step-up or invert the input voltage like switched supplies. Entire linear regulators are available as integrated circuits. These chips come in either fixed or adjustable voltage types [6].

Switching regulators

Switching regulators rapidly switch a series device on and off. The duty cycle of the switch sets how much charge is transferred to the load. This is controlled by a similar feedback mechanism as in a linear regulator. Because the series element is either fully conducting, or switched off, it dissipates almost no power; this is what gives the switching design its efficiency. Switching regulators are also able to generate output voltages which are higher than the input, or of opposite polarity something not possible with a linear design. Like linear regulators, nearly-complete switching regulators are also available as integrated circuits. Unlike linear regulators, these usually require one external component: an inductor that acts as the energy storage element. (Large-valued inductors tend to be physically large relative to almost all other kinds of component, so they are rarely fabricated within integrated circuits and IC regulators with some exceptions [4])

Electronic regulator

Now capacitor based electronic switches are widely used in series with the load like fan. It consumes lower power than the resistor based regulators but it also drops some voltage. It does not save electricity.

IMPLEMENTATION OF PROPOSED REGULATOR SYSTEM

Resistor opposes the electric current. Inductor opposes the change in electric current. It can also make the voltage drop. We are using inductor instead of resistor. The resistor converts electrical energy into heat energy and inductor converts electrical energy into emf. Here power consumed by the inductor is again converted into

electrical energy. Generally a resistor is used in series with the load. Current is same but voltage differs. Source voltage = voltage drop + voltage consumed by load. In boomerang regulator, inductor is used in series with load. Here also current is same but voltage differs. Voltage applied = Voltage consumed by inductor + Voltage consumed by load. The power consumed by the inductor is converted into emf and another inductor is used to convert emf into again electrical energy.

The couple of inductor is a setup of transformer. The input of the transformer can be adjusted. The output is maintained constant. The variation of input voltages causes division of voltage or power. Hence the power applied is divided into two parts one is consumed by the primary coil and another one is consumed by the load

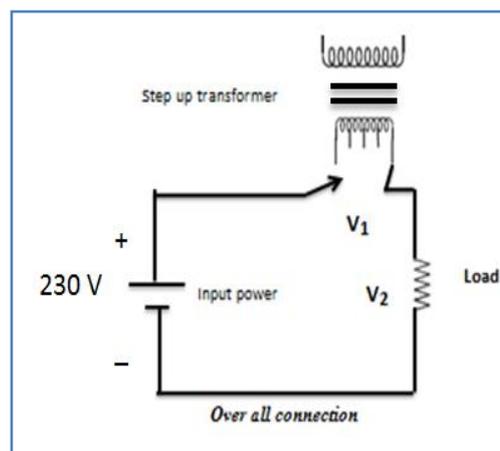


Fig. 2 Regulator for single load

Table 1: Specification of Transformer

Step Up Transformer Specification	
Input taps	60, 80, 100, and 140V
Output voltage	220 -240V
Power	100 w
Variable switches	Four taps

This regulator consists of three main areas. They are: 1. Variable input 2. Boomerang output 3. Load division

Variable input

A simple variable switch is used to vary the input voltage of the transformer. Generally an auto transformer may have variable output but here variable input tapped and constant output transformer (step up) is used. The variable switch also makes the changes in the load output

Boomerang output

The output of the transformer is named boomerang output. It is a returned power approximately equal to the difference between applied input power and consumed load power. The boomerang output power is again passed to the phase (switch box). If we use an ideal transformer, we can get the dropped voltage but it cannot be sent again to the phase. The reason is simple, current flows from higher potential to lower potential. In order to return the power to the phase, the step up transformer secondary winding is prepared with the constant output of 220-240 V.

Load division

Transformer behaves as a voltage divider. It consumes particular amount of power and ignores remaining power of the input. The remaining potential drives the load either fan or any instrument.

Applied voltage = voltage across the primary coil + voltage across the load. $V = \text{potential applied (220 V)}$ $V_1 = \text{voltage across the}$

primary coil of the transformer. $V_2 = \text{voltage across the load}$. At constant v , if V_1 increases V_2 decreases if V_1 decreases V_2 increases. Hence v_2 can be controlled by varying v_1 .

Total power = power consumed by inductor + power consumed by load. If a fan runs with the highest speed, it will need 220 V, if it runs with moderate speed, it will require 50% of electricity. If it runs with minimum speed, it will require only a certain amount of electricity. Input power is applied to the series combination of transformer and load. Now it is divided into two parts. Voltage across the load can be adjusted by varying v_1 . The v_1 voltage is stepped up about 220 v. It can be returned to the supply phase.



Fig. 3 Boomerang Regulator

Multi fan control by using single regulator

One of the main advantages is that it can control n number of fans by using only one regulator. It reduces the space and cost. Here the fans

are connected in parallel and regulator is connected in series with the fan. So that voltage can be varied in all the fans by varying variable switches which are connected with transformer. The input resistance depends on the position of tapping. Taps can be adjusted. The transformer is only connected in series with the load resistance. So there is no current loss. Hence power input increases with increase in number of fans.

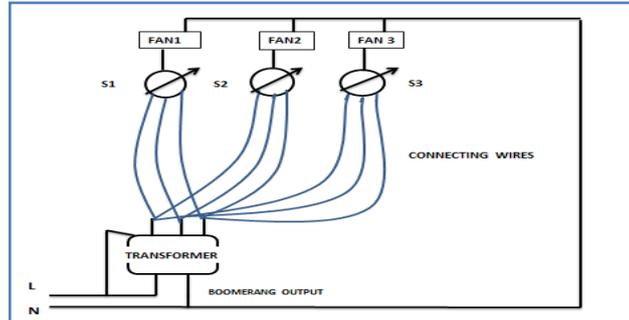


Fig. 4 Multi Fan Control

Mechanical Tap Changer

A mechanical tap changer physically makes the new connection before releasing the old, but avoids the high current from the short-circuited turns by using a variable switch. The multiple switches are connected in parallel and each of the output terminals are connected with the multiple fans. This technique overcomes the problems with open or short circuit taps. It can be also done by using remote control system as modern fan regulators. The programs and construction do not vary from the usual remote control system. Instead of resistors inductors are used.

Table 2: Regulator Input and Output

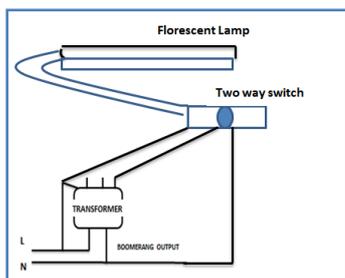
Speed	Voltage applied (volts)	Current through the fan (A)	Power applied (watts)	Voltage consumed by fan (volts)	Voltage returned (volts)	Power consumed by fan (watts)	Power returned (watts)	Gain (%)
1	230	0.4347	100	120	110	54.54	50.00	47.828
2	230	0.4347	100	140	90	63.63	40.91	39.133
3	230	0.4347	100	160	70	72.72	31.82	30.438
4	230	0.4347	100	200	30	90.90	13.64	13.047
5	230	0.4347	100	230	0	104.54	0	0

Fig. 5 Light dimmer

Consider the step up transformer with six terminals. Two terminals are the boomerang output. In other four terminals, one is line input and other three are various output voltages. The three output terminals are connected with variable switches by wires. The variable switch output and negative terminal are connected with the fans. N number of variable switches can be connected in parallel with the transformer. There is no need to fix the transformer in either wall or switch box. It can be placed anywhere in the home. Switch box may have the variable switches.

Application of proposed system: Light Dimmer

By using this regulator florescent lamps and incandescent lamps can be controlled. If the light output is dimmed by 10% the power consumption will be decreased by 30%. Sometimes there is no need of 100% brightness of light. In such cases, the light dimmer may very useful. The lamp is connected in series with the boomerang regulator same as the fan connection. Movable switches are used instead of variable switches. Light output can be controlled by the regulator through switch.



A typical air conditioner causes indirectly the emission of 17 tons of greenhouse effect gases of its life time, 1.5 kg of CO₂ because of the electricity. We hope that it can save about 30% of electricity consumption of the world. We can save nearly 35 – 45 % of our electricity bill in winter season. 25% of power consumption by light can be reduced. The size of the regulator is somewhat larger than the usual regulator. (Dimensions: 13 x13 x 13) cm but it occupies very small place at anywhere in the room. The weight of the regulator is nearly 3 kg but, there is no need to fix the regulator in the switch box.it can be placed anywhere in our home like a stabilizer. A single cable is only need to connect regulator and switch box. It occupies very less place. The cost of this regulator is around 700 INR. it will be reduced when it comes in the market. If we buy the resistor based regulator for 10 fans, the cost is around 1500 INR. but only one boomerang regulator is enough to control more than 10 fans. The cost will be less than 700 INR

CONCLUSIONS

Nowadays electricity plays an important role. We can't imagine the world without electricity. If we save a unit electricity, that is equal to the production of it. We can save up to 35-40 % of electricity in ceiling fans and also prevent 30% of pollution. If the light output is reduced by 10% then the power consumption of light will be decreased by nearly 30%. The proposed regulator can be used in ceiling fans, table fans, florescent lights, air conditioning systems, industries and laboratories where the regulated output is needed. A single proposed boomerang regulator can be employed for multiple fans. It has more benefits than other conventional regulators such as reasonable cost, long durability and reliability. It is more suitable for winter season and cold cities. It is believed that the boomerang regulator will be a gift for the energy conservation system.

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