Improving Capacity Thermoelectric Generator Using Current Booster Circuit

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Abstract---Formerly increase the current in the power electronics device is through a transformer by means of making the incoming voltage on the primary side large and the current small. Then to get a large current, the output voltage on the secondary side is reduced and the current rises. A 550Watt power is injected on the primary side of a single phase transformer with a voltage of 220 Volts and a current of 2.5 Amperes. The objective is to increase the current 20fold to 50 Amperes. Assuming an ideal transformer, then with the equation V1I1 = V2I2 the voltage on the secondary side of the transformer is designed with 11 Volt voltage. To produce current and dc voltage on the secondary side of the transformer a rectifier or adapter is installed. And also so far the dc current of 0.5 Ampere with a 10 Volt dc voltage can only be increased in the range of 1 to 2 Amperes in the range of 10 to 12 Volt dc voltage. The presence of a circuit of Current Booster innovated / equipped with TIP 3055 type transistors, dc current from 2 to 3 Amperes at 30 Volt dc voltage can be increased up to 15 Amperes of fixed voltage of 30 Volt dc. In this circuit the current rises and the voltage remains.

Keywords---Current Booster, Power Electronics, One Phase Tranformator,Transistor of TIP 3055 Type.

I. Introduction

In an integrated Power Electronics system we often encounter that it cannot run as we want it to due to the small input of current in the system due to the small capacity of the regulator power supply [1]. For example LM 78xx for positive voltage regulators and LM 79xx for negative voltage regulators on a symmetrical power supply system [2]. To overcome this, we try to make a device that can increase the output current according to the system requirements using a TIP 3055 [3-6] bipolar transistor. From the data sheet of the transistor TIP 3055, the collector's maximum voltage is 125 Volt, the collector current is 10 Amperes and the emitter current is 8 Amperes. Also known from the data sheet that the power is large enough around 125 Watt in one transistor if using collector as output. This 3055 TIP transistor will be used in the TIP 3055 Current Booster Circuit.

The circuit of Current Booster TIP 3055 is a circuit that serves to raise a small input current into a large output current, in which the output current (Iout) can be set / adjusted according to our needs. The current of 2 Amperes can be increased up to 15 Amperes with a maximum fixed voltage of 60 Volt dc [7-10].

II. Research Methods

1. Literature Study

The Figure of The Circuit of Current Booster TIP 3055 is like that of Figure 1 [1-2]. The working principle of the Circuit of Current Booster TIP 3055 is that input begins from pin 3 on IC LM 317 as voltage and current regulator. The voltage and input current will be filtered by capacitors C1 and C2 with a capacity of 4700 µF / 50 Volt dc, and from pin 2 on IC LM 317 R2 is installed which functions to avoid reverse current to pin 1 IC LM 317 and IN 4004 diode as switching (breaker and connector), and VR (Variable Resistor) which functions as a setter to set the voltage to be larger/smaller. The voltage and current that has been set from IC LM 317 will be filtered again at the output part of this circuit using electrolytic capacitors C3 with a capacity of 10,000 µF/50 Volt dc. The current and voltage entering the Current Booster circuit, which is 2-3 Amperes and a voltage of 30 Volt dc will be raised by the collector (IC) on the transistors of TR1, TR2, TR3, TR4, TR5, and TR6 to become 15 Amperes with a voltage of 30 Volt dc from the data sheet transistor TIP 3055 [3]. The number of TIP 3055 transistors needed can be determined from how much power is needed [11].

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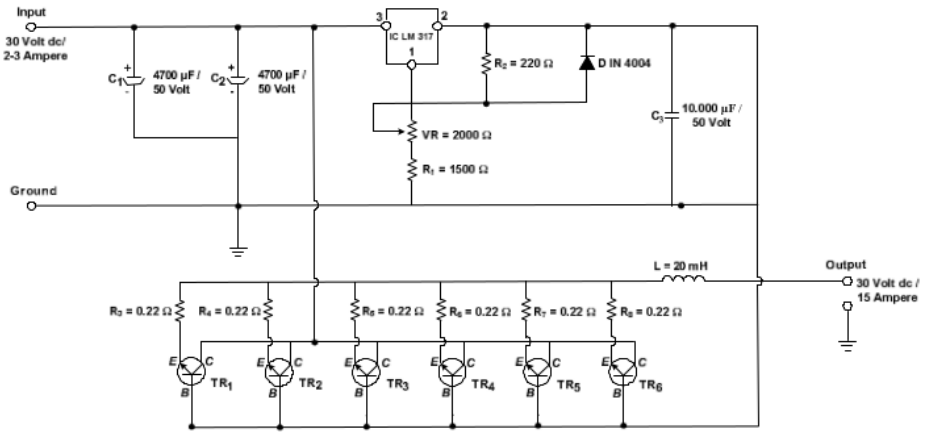

Figure 1. The Circuit of Current Booster TIP 3055.

2. Application of the Circuit of Current Booster TIP 3055 on the Power Plant

The output current of the Step Up circuit is very small ranging from 2 Amperes to a maximum of 3 Amperes with a voltage of 30 Volt dc. This current will be increased by the Circuit of Current Booster TIP 3055 to 15 Amperes with a working voltage of 30 Volt dc. Box 2 shows the TEG application block diagram for Electrical Generation (Figure 2).

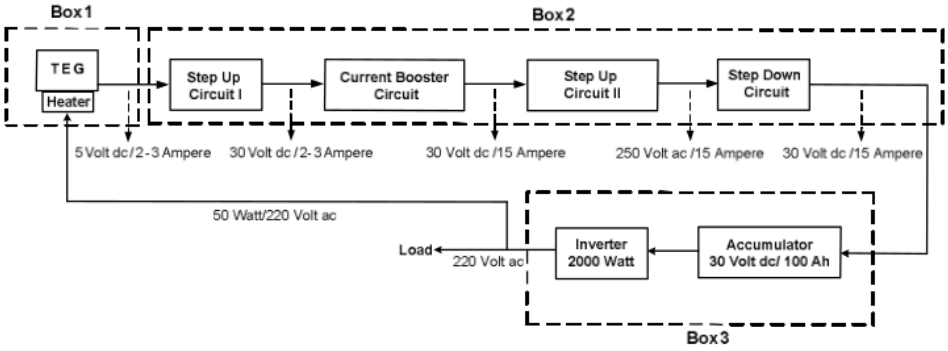

Figure 2. Block Diagram of the TEG Application for Electrical Generation.

III. Results and Analysis

3.1. Tool Design

In this design the materials used are: 2 pieces of electrolytic capacitor of 4700 μF / 50 Volt dc, 1 piece of electrolytic capacitor of 10000 µF / 50 Volt dc, 1 piece of resistor of 1.5 kΩ / 0.25 Watt, 1 piece of resistor of 220 Ω/0.25 Watt, 5 pieces of resistor of 0.22 Ω / 5 Watt, 1 piece of variable resistor of 2 kΩ, 1 piece of IC LM 317, 1 piece of inductor of 20 mH, and 6 pieces of bipolar transistor NPN TIP 3055.

The design results are in box 2 of the block diagram of Figure 2 as shown by the white block in Figure 3.

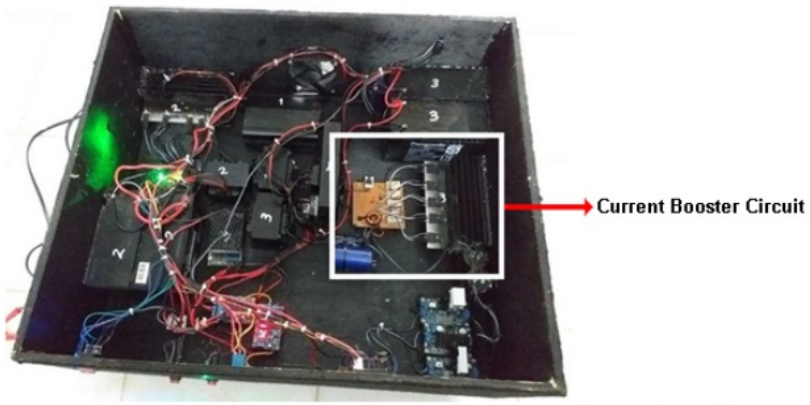

Figure 3. Design Results of the Circuit of Current Booster TIP 3055

in box 2 on the block diagram of Figure 2.

3.2. Measurement Results

The measurement of the overall tool design results in physical form of Figure 2 can be seen in Figure 4 that are loaded with LED lights with varying magnitude from 60, 75, 90, 130, 180, 300, and 500 Watts as shown in Figure 5. The measurement results in the form of currents entering and exiting the Circuit of Current Booster as shown in Table 1.

Figure 4. Physical Form of Figure 2.

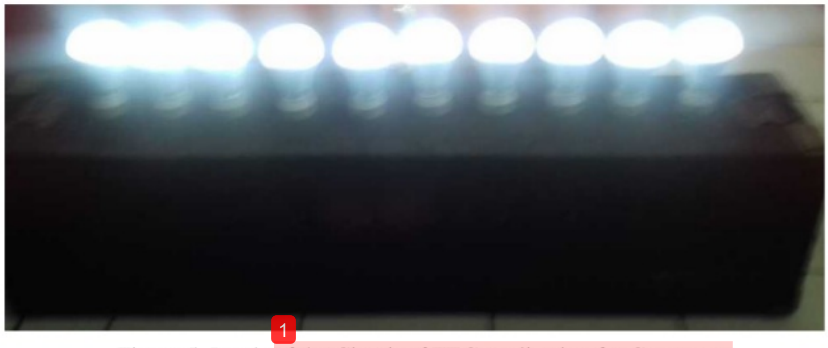

Figure 5. Loads of the Circuit of TEG application for Generators.

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Table 1. Results of measurements of incoming and outgoingcurrents on the Circuit of Current Booster with varying loads.

Loads (Watt)	Incoming current (Ampere)	Outgoing current (Ampere)	Description
60	2.02	2.27	loaded with LED lights of Hannochs brand
75	2.05	2.5	
90	2.07	3	
130	2.11	4.28	
180	2.13	6	
300	2.34	10	
500	2.76	15	

3.3. Analysis

This circuit of current booster is made to increase the current from 2-3 Amperes to a maximum of 15 Amperes with a voltage of 30 Volt dc. The current increase reaching a maximum of 15 amperes that we want is obtained from the data sheet transistor TIP 3055 at the output current the collector is 10 Amperes with a maximum voltage of 125 Volt and with a maximum power of 125 Watt per transistor. To calculate how many final transistors as booster of current needed, the following equation can be used

$$N = \frac{I_{load}}{I_C}$$

in which Iload = 15 Amperes and IC (current collector) = 10 Amperes, so the number of final transistors needed is:

$$N = \frac{15}{10} \approx 2 \text{ pieces}$$

In order that the circuit will not be easily damaged and to maintain heat, the number of transistors used isthree times as many, that is 6 pieces of TIP 3055 transistors.

The measurement results shown in Table 1 can be presented in graphical form like that of Figure 6.

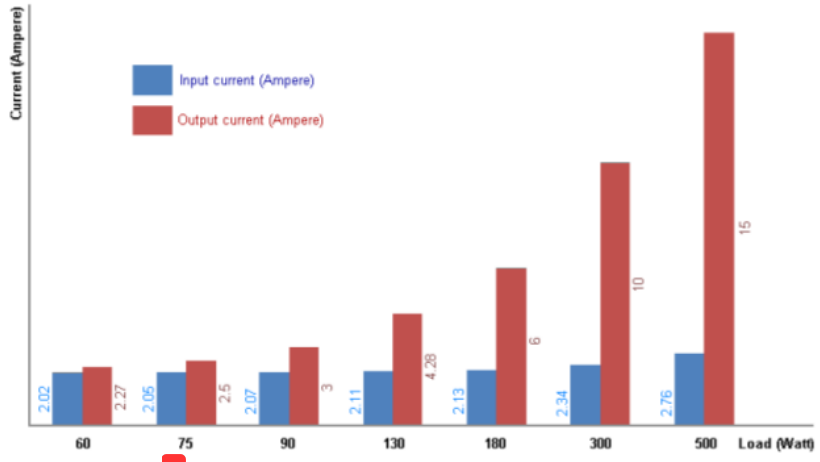

Figure 6. The graph of the measurement results of the load against the incoming and outgoing currents.

As shown in Figure 6, the comparisons between the incoming and outgoing current began to show fairly large figure when the circuit began to be charged with 180 Watt, the inflow current was 2.13 Amperes and outgoing current was 6 Amperes; On a 300 Watt load, the inflow current was 2.34 Amperes and the outgoing current was 10 Amperes; And at a 500 Watt load, the incoming current was 2.76 Amperes and the outgoing current was 15 Amperes. When the circuit was loaded with 500 Watts, the maximum outgoing current of 15 Amperes occurred. As a standard of the maximum outgoing current and in order that the circuit remains in a durable state, it should be loaded under 500 Watts.

IV. Conclusion

Formerly, to increase current in the power electronics device is through the transformer. If the voltage on the primary side of the transformer is V1 and the voltage on the secondary side is V2 in which V1>V2, so is the current on the primary side is I1 and that on the secondary side is I2 in which I1<I2. The transformer is assumed to be ideal with a fixed power, then the equation for increasing the current on the secondary side is $V_1^{\uparrow} I_{1\downarrow} = V_{2\downarrow} I_2^{\uparrow}$. To get direct current on the secondary side a rectifier circuit is made.

With the Circuit of Current Booster TIP 3055 the current from 2-3 Amperes can be increased up to 15 Amperes with the input and output voltages are still 30 Volt dc. The number of the final transistors as booster that we need depends on the maximum load current, then divided by the output current from the collector (from the TIP 3055 data sheet). However, to maintain the security of the circuit so that it does not break down quickly, the number of the transistors used should be 2 or 3 times as many, and also the circuit should be loaded less than 500 Watts.

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