Design, Simulation and Construction of Cockroft Walton Voltage Multiplier

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Abstract

In this cockroft – Walton Voltage Multiplier Project, the theory of this method is to build power supply that can generate High Voltage with a Low current. Designing the circuit based on the basic of cockroft Walton circuit that consists of ladder network of capacitor and diodes. The high voltage equipment is required to study the insulation behavior under all conditions, which the apparatus is likely to encounter. Some objectives are to study the fundamental of voltage multiplier such as type, characteristics, advantages and disadvantages before designed a cockroft-walton's voltage multiplier with 4KV output. the methodology is to study the characteristics of voltage doubler and Tripler circuit compared with cockroft Walton's voltage multiplier circuit before designing, simulate the designed circuit with simulation program as MULTISIM, PSCAD and other programs and construct the designing circuit to Prove the theoretical value. The result hopefully can be full filed the theory of the cockroft Walton voltage multiplier which is generate High Voltage with a Low current.

Keywords- Variable Frequency

I. INTRODUCTION

High voltage D.C. power supply is widely used in research work (especially in field of applied physics) and in industry level the main application of high voltage d.c. Power supply is in proof design of high voltage cables with relatively large capacitive load, which draws high current if it is tested with A.C. high voltage power frequency of sinusoidal waveform instead of d.c. voltage. High voltages are generated for dielectric testing of high voltage equipment's at power frequency A.C. / D.C. switching surge voltage and lightning impulse voltages. For dielectric testing of high voltage equipment's, voltages are increased up to several million volts but currents are decreased to few milliamps and maximum of one ampere for A.C. /D.C. high voltage test sets. There are several application of D.C. high voltage, in the field of electrical engineering and applied physics such as electron microscope, X-rays, electrostatic precipitators, particles accelerator in nuclear physics, dielectric testing and so on. Basically Circuit diagram consists of voltage source, inverter, transformer and cockroftWalton voltage multiplier circuit. 12 v dc voltage is using as the main voltage source which is injected to the inverting circuit which will convert it into the ac supply, then this ac voltage of low rating is given to step up transformer which is used in converting it into the high of 230 V. This voltage is used as the input of cockroft Walton voltage multiplier circuit.

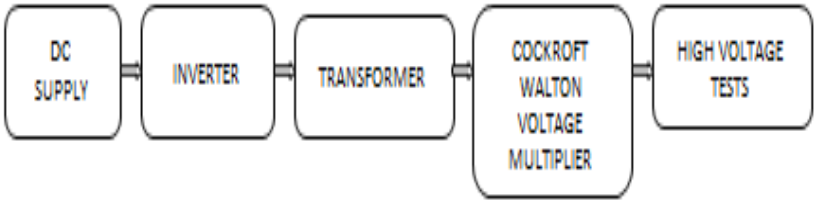

Fig. 1: Block Diagram of the Project

II. DESIGN

The CW is a voltage multiplier that converts AC or pulsing DC electrical power from a low voltage level to a higher DC voltage level. It is made up of a voltage multiplier ladder network of capacitors and diodes to generate high voltages. Unlike transformers, this method eliminates the requirement for the heavy core and the bulk of insulation/potting required. Using only capacitors and diodes, these voltage multipliers can step up relatively low voltages to extremely high values, while at the same time being far lighter and cheaper than transformers. The biggest advantage of such circuits is that the voltage across each stage of the cascade is equal to only twice the peak input voltage in a half wave rectifier. In a full wave rectifier it is three times the input voltage. It has the advantage of requiring relatively low cost components and being easy to insulate. One can also tap the output from any stage, like multitapped transformer.

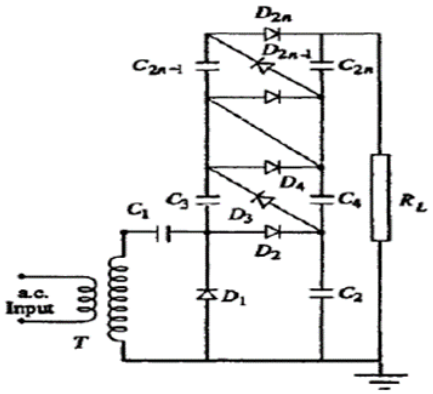

Fig 2: .Basic Cockroft Walton Multiplier Circuit

III. PRINCIPLE OF COCKROFT WALTON

In voltage double circuit fig. 1 shown below gives a brief idea about the principle of negative voltage double where the diodes are rectifier grade diodes and the capacitor diode assembly acts like half wave rectifier. In the circuit during positive half cycle of input voltage first diode is forward biased and second one is reverse biased. Therefore the flow of current charges the capacitor to negative peak value and capacitor C1 is charged through diode D1 to –Vin. Similarly in the fig. 2 shown below circuit during negative half cycle of input voltage hence first diode is reverse biased and second one is in forward biased. Therefore the potential of capacitor C1 adds with that of the source, thus charging C2 to –2Vin through D2.

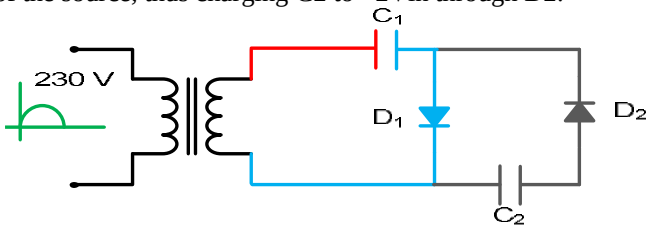

Fig. 3: Voltage Doubler in positive alternation

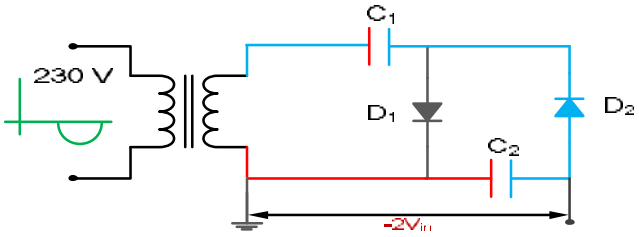

Fig. 4: Voltage Doubler in Negative Alternation

IV. SIMULATION OF CIRCUIT

A. Actual Output Gating on Inverter Circuit Using IC IR2153

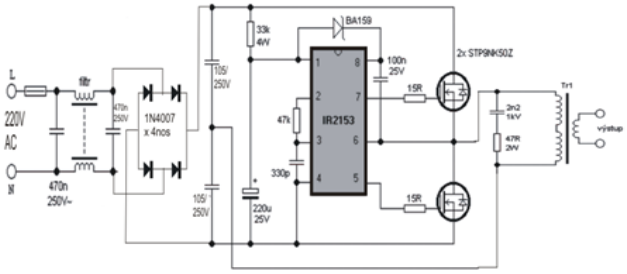

Fig. 5: Actual Output On Inverter Circuit using IC IR2153

This is the main Inverter circuit which we have used as input source of the Cockroft walton voltage Multiplier circuit used which is PWM generator which output can be controlled by varying resistor values. In our circuit diagram we have used 47K ohm variable resistor is used for frequency varying. Frequency can be varied by varying on time and Off Time period of PWM. Which will be resulted in the total variable time which is inverse of the frequency. So this circuit is Also Worked as a Frequency Changer. So we can change the frequency by changing the resistor port.

B. Simulation of Cockroft Walton Circuit in Multisim

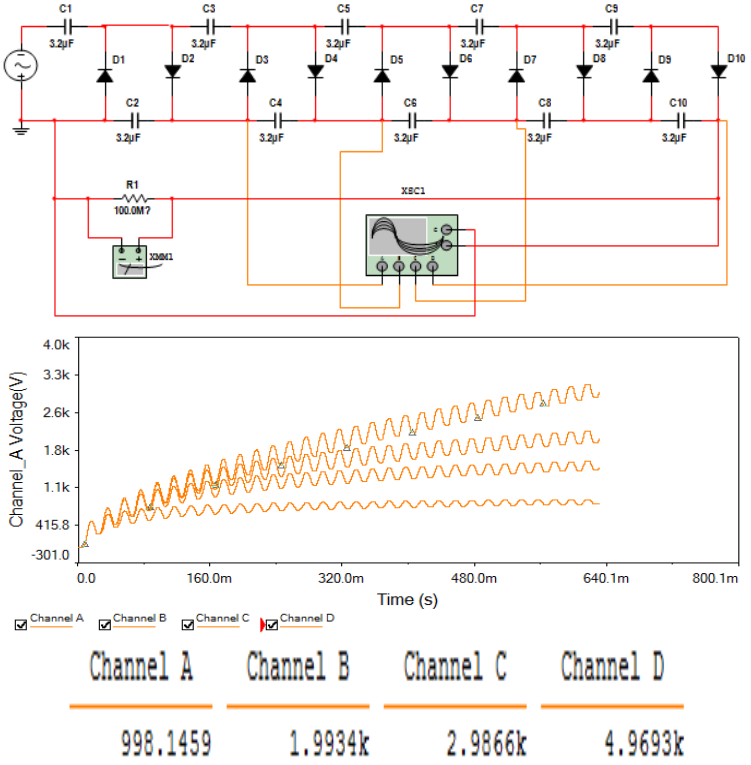

Fig. 6: Simulation of Cockroft Walton Circuit in Multisim and waveform

V. HARDWARE COMPONENTS

A. Inverter

We Made A Half bridge Inverter Circuit Using Ic IR2153 and Mosfet IRF Z44N.We used IC IR2153 for the Controling the Inverter circuit For Proper Gating And it will Give 180 degree Phase Shift between two gate Pulses.

Fig. 7: Inverter Hardwere Circuit using IC IR2153

B. Transformer

We Used A two 15-0-15 Standard transformer and two 12-0-12 Standard transformer for Step down and Step up Purpose.

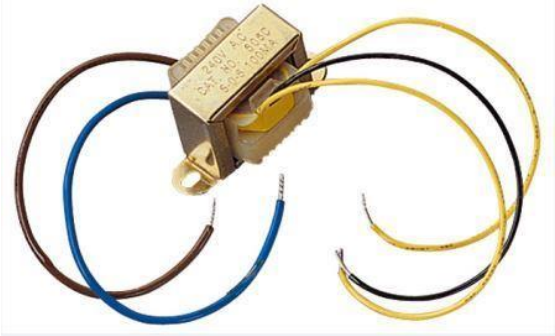

Fig. 8: 15-0-15 Standard Transformer

C. Cockroft Walton

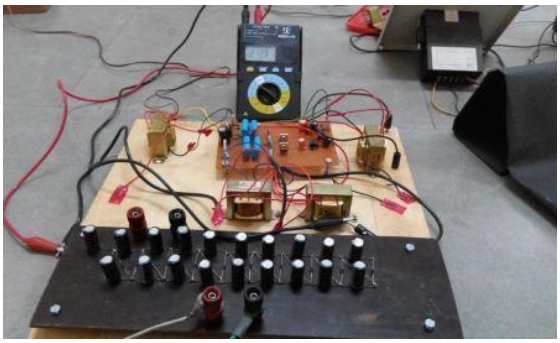

Fig. 9: Cockroft Walton hardware Circuit

VI. HARDWARE OUTPUT WITH DIFFERENT INPUT VOLTAGE

Table 1: output voltages with different input voltages

No of Stage	*5 volt*	*10volt*	*50 volt*	*230 volt*
Stage1	*13*	*26.8*	*140*	*408*
Stage2	*25.7*	*53*	*279*	*810*
Stage3	*39*	*80*	*360.4*	*1360*
Stage4	*50.8*	*106*	*442.7*	*2033.1*
Stage5	*63.1*	*133*	*519.3*	*2378.4*
Stage6	*75*	*158*	*602.9*	*2769.2*
Stage7	*89*	*181*	*675.2*	*3105.7*
Stage8	*102.5*	*205*	*756.88*	*3577.9*

VII. TESTING ON HIGH VOLTAGE EQUIPMENT

A. Rod Gap Test and Sphere Gap Test

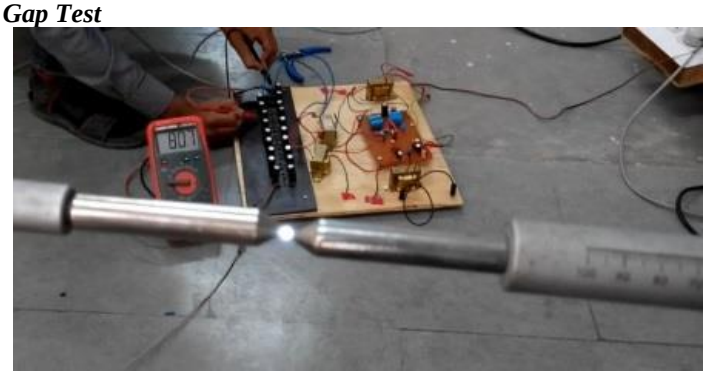

Fig. 10: Testing Of Rod Gap Assembly by Using Cockroft Walton Output

Fig. 11: Testing Of Spheare Gap by Using Cockroft Walton Output

1) Rod Gap Test

We applied our output voltage to rod gap arrester which are in our collage and we get the spark at 0.25 mm gap between two rods. When the spark is occur at time the voltage is 807 at stage 2 and then capacitor suddenly discharge up to 237volt which is a voltage drop when the spark occur.

2) Sphere Gap Test

In This test the output of the cockroft Walton is applied to sphere gap assembly and the spark is produce at 0.28mm gap between two spheres. due to very low current the spark is occur when the capacitor is fully charged and when spark occur then capacitor discharge immediately and agil capacitor charge and spark occur when capacitor is fully cgarge.it takes 22 seconds time period between the spark.

VII. CONCLUSION

The project is successfully developed and the project system which generates high voltage using cockroft Walton voltage multiplier circuit used in the company. Hence in this project one variable frequency generation system is developed which satisfies all the requirement to provide Quality assurance to the hv generating companies. Moreover the system developed is cost effective, User friendly, because it uses pwm generator for its implementation which makes it even more compact in size and greater in efficiency.

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