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Research Paper

THREE PHASE PROPORTIONATE POWER CONTROLLER (CYCLIC CONTROL)

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Design of an industrial heating system starts with assessment of the temperature required, the amount of heat required, and the feasible modes of transferring heat energy. Depending on the area of application of heater and the material to be heated depends on the heat generated by heater. Heat generated by heater is directly depended on the power supplied to the heater. The 3-phase cyclic power controller aims in controlling the power input to a 3-phase heater. The controller uses a temperature detector circuit which helps decide the power needed, LCD display for status of controller, PC interfacing for regulation and back to back SCRs put in series of each phase for cyclic control of heaters.

Keywords: 3-phase heater, SCRs, Cyclic power controller

INTRODUCTION

Heaters are appliances whose purpose is to generate heat. Industrial heating processes can be broadly categorized as low-temperature (to about 400 °C or 752 °F), medium temperature (between 400 and 1,150 °C or 752 and 2,102 °F), and high temperature (beyond 1,150 °C or 2,102 °F). Low temperature processes include, baking and drying, curing finishes, soldering, molding and shaping plastics. Medium temperature processes include melting plastics and some non-metals for casting or reshaping, as well as annealing, stress-relieving and heat-treating metals. High-temperature processes include steelmaking, brazing, welding, casting metals, cutting, smelting and the preparation of some chemicals. The present invention relates to electric heating systems and more particularly to improved control circuit for electric heating systems. It is an object of this invention to provide an improved controlled rectifier switching circuit in which the switching of the controlled rectifiers is accomplished at or near zero degrees in the power line cycle. The system provided by the invention has the advantages that when the bidirectional thyristor is punctured, the output of the bidirectional

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thyristor can be cut off effectively and timely, and the heating load is prevented from burning loss. There is significant power savings with respect to conventional contactor type temperature control system.

PROPORTIONATE CONTROL

A proportional power control circuit is that in which the average power applied to the load

Figure 1: Block Diagram

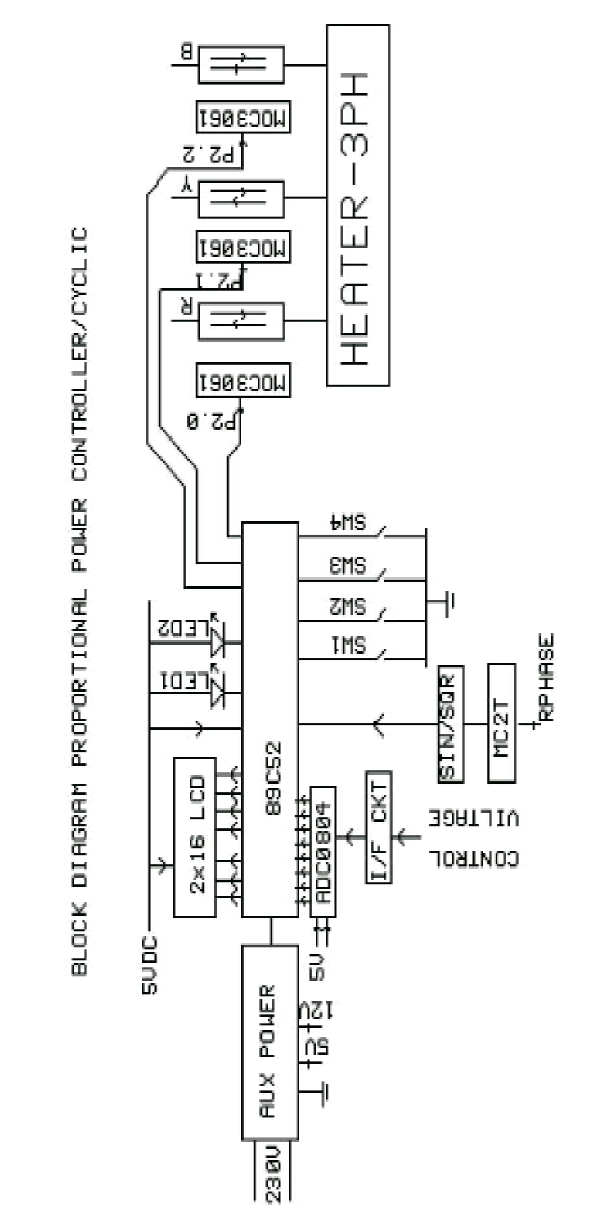
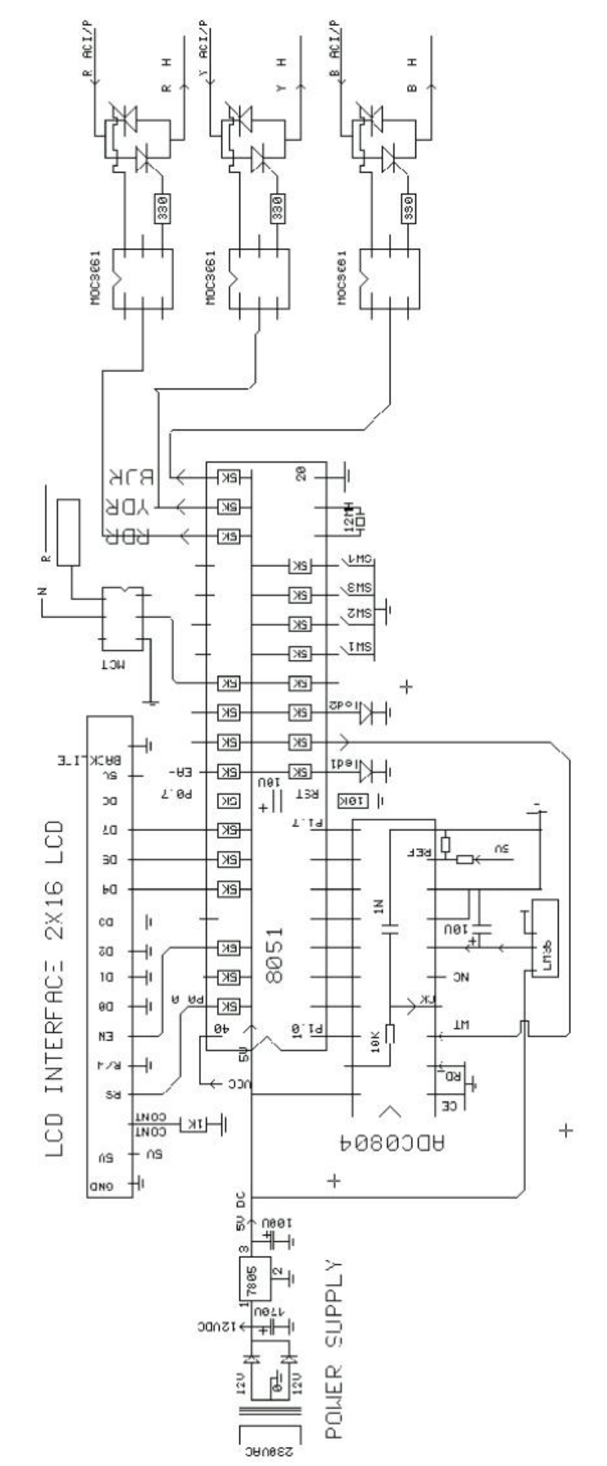


Figure 2: Circuit

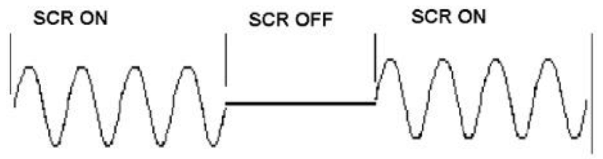


is controlled by controlling the number of cycles of power applied to a load in a series of available cycles of power. The Power control circuit of the present creation can be used for controlling loads of many different types. However, it is especially useful in controlling the current supplied to heaters. It is a object of this invention to provide controlled rectifiers switching apparatus in which proportional control to a load is accomplished by allowing the controlled rectifiers to conduct through a number of complete cycles of the a.c. power source and then to maintain the controlled rectifiers non-conductive for a predetermined number of cycles.

EXPLANATION WITH DIAGRAM

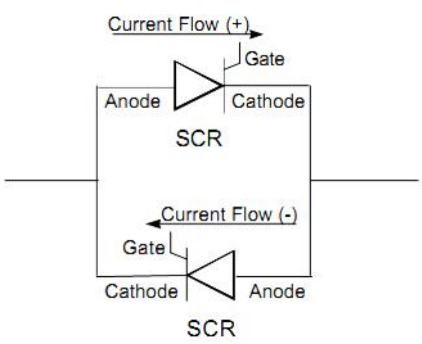
This invention involves an improvement in a solid state full wave a.c, switch utilizing controlled rectifiers.

Figure 3: SCR On / Off Sequence



A Silicon Controlled Rectifier (SCR) is a semiconductor rectifier that has the added feature of controllability. The SCR is capable of conducting OR blocking current in the forward direction, depending upon the gate signal. The SCR, like the diode, will always block current flow in the negative or reverse direction.

Figure 4: SCR Configuration



In order to deliver maximum power to the load, both halves of the AC waveform must be conducted. To achieve full wave conduction, two SCR's must be used. They must be connected in parallel but opposite directions (Figure 4). This circuit configuration is known as anti-parallel or "back-to-back" configuration.

Also, Light emitting diodes and photo detectors are employed in various gating control channels to provide high voltage isolation between the gates and the circuits generating the gate control signals.

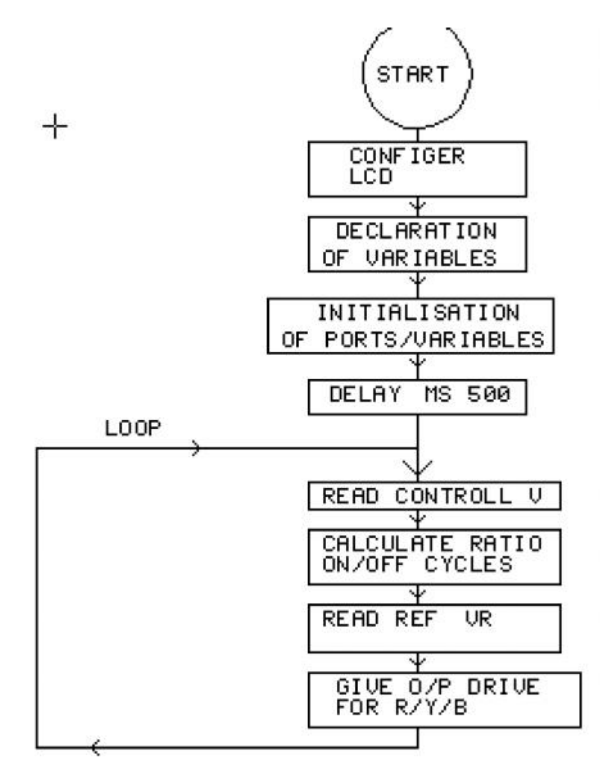
WORKING

In this system, the SCR is triggered using an opto-isolator containing a combination of a LED and a TRIAC. When pulses are applied to the LED, it emits light which falls on the TRIAC and it conducts, causing the output pulses from the opto-isolator to the SCR. The principle involves controlling the rate of application of pulses by varying the frequency between adjacent pulses. A microcontroller is used to provide pulses to the opto-isolator based on the push button input interfaced to it. The number of times the push button is pressed decides the amount of delay of application of pulses. For example, if the push button is pressed once, the Microcontroller delays the application of pulse by 1ms. Thus the angle at which the SCR is triggered is controlled accordingly and the application of AC power to the load is controlled.

OPERATION PROCESS

We measure the temperature through LM35 and display on LCD. Temperature limit can be

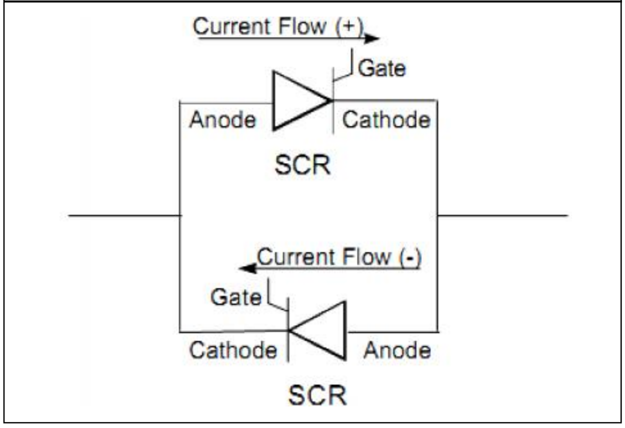
Figure 5: Operation Flow



set by pressing sw2 and sw3. If temperature difference is more, more power is pumped to 3-phase heater through cyclic control. If measured value is near to limit power, power is reduced through cyclic control to minimize the temperature overshoot. Back to back SCRs are put in series of each phase.

Reference signal is taken from R-phase through MC2T opto-coupler. SCRs are driven through drivers MOC3061 (Figure 6). Four switches are there to up down the power and on off power. A back to back SCR connection is used to provide AC power to the load in both half cycles of the AC signal. Two opto-isolators are connected to each SCR. In the first half cycle of the AC signal, one of the SCR conducts after getting triggered using an opto-isolator and allows the current to pass through the load. In the second half cycle, another SCR

Figure 6: Driver Circuit



connected in reverse direction to that of the other SCR, it gets triggered using another opto-isolator and allows current to flow to the load. Thus the load gets AC power in both the half cycles.

ADVANTAGES

The system provided by this invention has the advantages that when the bidirectional thyristor is punctured, the output of the bidirectional thyristor can be cut off effectively and timely, and the heating load is prevented from burning loss. There is significant power savings with respect to conventional contactor type temperature control system.

APPLICATIONS

- This circuit set up can be used in large tank heating and mechanical relay replacement, Thermoforming, textiles, industrial furnaces and ovens, extruders, chemical process heating, fast water heat.
- It finds application in Paper and pulp drying, packaging machines, pharmaceutical processes, infrared ovens and dryers.
- Further, it can be used where heating has to be regulated depending on processes

like High-temperature ovens and furnaces, glass, ceramics and high-temperature alloys, also High-speed paper and ink dryers, high temperature, high temperature materials processing.

- Thyristor based Power controller has a varied application and can be used with heating elements like Nichrome, Tungsten, Kanthal, Infra-Red, etc., where precise and accurate power control is required. It can be used for small laboratory ovens, furnaces, Air heaters, etc.

CONCLUSION

Thyristor based controls are recommended for smooth and steady state control, which enhances the heater life and thereby reduces the maintenance cost. Further features of the invention pertain to the particular arrangement of the elements of the electric heating system and of the associated control networks and circuits, whereby the above-outlined and additional operating features thereof are attained.

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