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Automatic can machine / Mohd Aizat Ahmad Murad.

AUTOMATIC CAN MACHINE

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree Of Bachelor In Electrical Engineering (Control, Instrument & Automation)

Electrical Engineering Faculty

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control instrument and Automation)"

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ABSTRACT

This project is to design the implementation of an Automatic Can Machine using PLC control. The product is base on liquid shaped such as paint or drinks in can product. The machine is design for batch operation where a set of inputs to be process is received as a group, and an operation produces the finish product. The batch operation of the machine is divided into several processes such as filling, capping and sealing process. The PLC unit is used as the controller of the machine system to control the steps and monitoring the flow of the system by the output indicator lamp. The machine consists of PLC system, DC motor control and drive, pneumatic system, proximity sensor or switch, relays and stepper motor.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Automatic filling machines are mainly used for filling expensive liquids like edible oils, paints, lubricant oils, non-corrosive non-forming chemicals, and adhesives into containers like tins, cans and mini barrels. Their main advantages are reduced wastage of filling liquid and improved consistency in filling. They eliminate the dependency of the operator and fill every batch of container without over-fill and under-fill conditions, within the tolerance levels. Further repetitive filling sequences for the operator improve production volumes. They also keep the environment clean due to reduced spillage and handling. Special filling requirements can be met with custom designed machines.

This analysis deals with lower capacity liquid filling machines used by small to medium sized companies and excludes high speed rotary liquid filling machines typically found only in the mass market beverage industry. In contrast, the liquid filling machines used throughout all industries including food, beverage, chemical, cosmetic and pharmaceutical but at lower speeds; usually less than 200 containers per minute. In fact, most of the market for liquid filling machines in terms of units sold is for semi automatic equipment that operates at speeds not exceeding 20 containers per minute.

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Not one type of filling machine can handle all liquids in all industries. For example, a machine that fills bottled water cannot fill cosmetic cold cream. Nor would chemical duty filler be used to fill pharmaceutical grade or dairy products. Although there are many different types of filling technologies, there are relatively few that are versatile, practical and cost effective to own and operate. The choice of filling machine depends on the range of viscosities, temperature, chemical compatibility, particulate size, foam characteristics, and hazardous environment considerations.

1.2 PROBLEM STATEMENT

1.2.1 DC motor spec not reliable for conveyor system.
1.2.2 Proper program or driver circuit for stepper motor.
1.2.3 Overflow at filling process.
1.2.4 Sealer not working and product reject.
1.2.5 Can not in position.

1.3 PROJECT OBJECTIVE

1.3.1 Able to use the knowledge and experience in lab to design the project.
1.3.2 Implement the positive thinking in problem solving.
1.3.3 Able to use PLC program and implement the installation.
1.3.4 To learn more on troubleshooting and analysis.

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CHAPTER 2

LITERATURE REVIEW

2.1 MOTOR

2.1.1 SHUNT WOUND DC MOTOR

A shunt-wound DC motor has a decreasing torque when speed increases. The decreasing torque- vs-speed is caused by the armature resistance voltage drop and armature reaction. At a value of speed near 2.5 times the rated speed, armature reaction becomes excessive, causing a rapid decrease in field flux, and a rapid decline in torque until a stall condition is reached. Shunt-Wound Motor Applications The characteristics of a shunt-wound motor give it very good speed regulation, and it is classified as a constant speed motor, even though the speed does slightly decrease as load is increased. Shunt-wound motors are used in industrial and automotive applications where precise control of speed and torque are required.

Many people are familiar with DC motors. If you have ever had an electric toy train or car as a child, you may know how a DC motor works. If you were like me you probably took one apart and couldn't put it back together. Usually the brush springs get lost.

The stator is the stationary outside part of a motor. The rotor is the inner part which rotates. In the motor animations, red represents a magnet or winding with a north polarization, while green represents a magnet or winding with a south polarization. Opposite, red and green, polarities attract.

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The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole pieces. The rotor is composed of windings which are connected to a mechanical commutator. In this case the rotor has three pole pairs. The opposite polarities of the energized winding and the stator magnet attract and the rotor will rotate until it is aligned with the stator. Just as the rotor reaches alignment, the brushes move across the commutator contacts and energize the next winding. In the animation the commutator contacts are brown and the brushes are dark grey. A yellow spark shows when the brushes switch to the next winding.

Notice that the comutator is staggered from the rotor poles. If the connections of a dc motor are reversed the motor will change directions. Although it will not always works well in both directions.

This is a permanent magnet dc motor. Two other types of dc motors are series wound and shunt wound dc motors. These motors also use a similar rotor with brushes and a commutator. However, the stator uses windings instead of permanent magnets. The basic principle is still the same. A series wound dc motor has the stator windings in series with the rotor. A shunt wound dc motor has the stator windings in parallel with the rotor winding. The series wound motor is more common. A series wound motor is also called a universal motor. It is universal in the sense that it will run equally well using either an ac or a dc voltage source. Reversing the polarity of both the stator and the rotor cancel out. Thus the motor will always rotate the same direction irregardless of the voltage polarity. A universal motor is in a sense an ac motor in that it will operate from an ac power source. I prefer the term universal motor to avoid confusion with ac induction motors.

DC motors consist of one set of coils, called an armature, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion. Small permanent magnet motors are cheap, but as size increases, the price advantage shifts to wound motors.

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2.1.2 DC Motor Types

- **Permanent Magnet**: No field coils at all.
- **Series Wound**: the field coils are connected in series with the armature coil. Powerful and efficient at high speed, series wound motors generate the most torque for a given current. Speed varies wildly with load, and can run away under no-load conditions.
- **Shunt Wound**: the field coils are connected in parallel with the armature coil. Shunt wound motors generate the least torque for a given current, but speed varies very little with load. Will not run away under no-load, but may if the field windings fail.
- **Compound Wound**: a combination of series and shunt wound. This is an attempt to make a motor that will not run away under no load or if the field fails, yet is as efficient and powerful as a series wound motor.

2.1.3 Torque VS RPM

For permanent magnet DC motors, there is a linear relationship between torque and rpm for a given voltage.

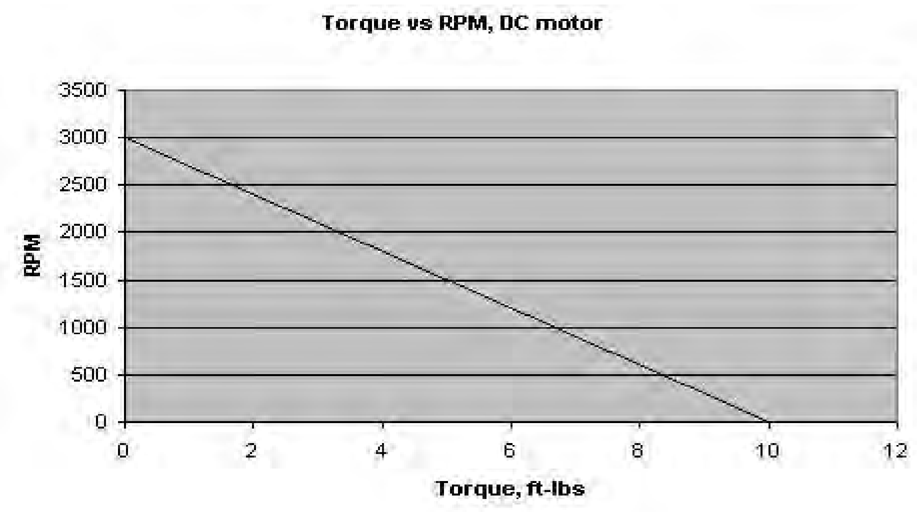

FIGURE 1.0 TORQUE VS RPM

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The maximum torque occurs at 0 rpm, and is called *stall torque*. The minimum torque (zero) occurs at maximum rpm, reached when the motor is not under a load, and is thus called *free rpm*. The formula for torque at any given rpm is:

$$\mathbf{T = T_s - (N\ T_s \div N_f)}$$

where **T** is the torque at the given rpm **N**, $\mathbf{T_s}$ is the stall torque, and $\mathbf{N_f}$ is the free rpm.

Power, being the product of torque and speed, peaks exactly half way between zero and peak speed, and zero and peak torque. For the above graph, peak power occurs at 1500 rpm and 5 ft-lbs of torque; 1.4 hp. However, you do not generally want to run a motor at this speed, as it will draw much too much current and overheat. The above motor might be rated for only 0.5 hp (1 ft-lbs of torque at 2700 rpm).

Knowing the stall torque and the free rpm, we can derive two important constants for the motor in question. First is the *induced voltage constant*, which relates the back-voltage, induced in the armature to the speed of the armature.

$$\mathbf{K_e = V \div N_f}$$

Where $\mathbf{K_e}$ is the induced voltage constant, $\mathbf{N_f}$ is the free rpm, and **V** is the voltage.

The second important constant is the *torque constant* which relates the torque to the armature current.

$$\mathbf{K_t = T_s \div V}$$

where $\mathbf{K_t}$ is the torque constant, $\mathbf{T_s}$ is the stall torque, and **V** is the voltage.

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Using these two constants, we can write the motor equation (these are all the same equation, solved for different variables):

$$\mathbf{T = K_t \times (V - (K_e \times N)}$$

$$\mathbf{V = (T \div K_t) + (K_e \times N)}$$

$$\mathbf{N = (V - (T \div K_t)) \div K_e}$$

Where **T** is torque, **V** is voltage, **N** is rpm, $\mathbf{K_t}$ is the torque constant, and $\mathbf{K_e}$ is the induced voltage constant. The units don't matter, as long as they're the same units you used to calculate the constants.

Stall Torque	10	ft-lbs
Free RPM	3000	Rpm
Reference Voltage	12	volts
Torque constant		
Induced Voltage constant		
RPM	2700	Rpm
Torque	1	ft-lbs
Voltage	12	volts

FIGURE 2.0 MOTOR CALCULATION

Note that these formulas *only* apply to shunt motors and permanent magnet motors. Series motors behave differently.

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2.1.4 Torque and Current

Torque is proportional to the product of armature current and the resultant flux density per pole.

$$\mathbf{T = K \times f \times I_a}$$

Where **T** is torque, **K** is some constant, **f** is the flux density, and $\mathbf{I_a}$ is the armature current.

In series wound motors, flux density approximates the square root of current, so torque becomes approximately proportional to the 1.5 power of torque.

$$\mathbf{T = K \times I_a^{1.5\pm}}$$

Where **T** is torque, **K** is some constant, and $\mathbf{I_a}$ is the armature current.

2.1.5 Speed, Voltage, and Induced Voltage

Resistance of the armature windings has only a minor effect on armature current. Current is mostly determined by the voltage induced in the windings by their movement through the field. This induced voltage, also called "back-emf" is opposite in polarity to the applied voltage, and serves to decrease the effective value of that voltage, and thereby decreases the current in the armature.

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An increase in voltage will result in an increase in armature current, producing an increase in torque, and acceleration. As speed increases, induced voltage will increase, causing current and torque to decrease, until torque again equals the load or induced voltage equals the applied voltage.

A decrease in voltage will result in a decrease of armature current, and a decrease in torque, causing the motor to slow down. Induced voltage may momentarily be higher than the applied voltage, causing the motor to act as a generator. This is the essence of regenerative breaking.

Induced voltage is proportional to speed and field strength.

$$\mathbf{E_b = K \times N \times f}$$

where $\mathbf{E_b}$ is induced voltage, **K** is some constant particular to that motor, **N** is the speed of the motor, and **f** is the field strength.

This can be solved for speed to get the "Speed Equation" for a motor:

$$\mathbf{N = K \times E_b \div f}$$

Where **N** is rpm, **K** is some constant (the inverse of the K above), $\mathbf{E_b}$ is the induced voltage of the motor, and **f** is the flux density.

Note that speed is inversely proportional to field strength. That is to say, as field strength *decreases*, speed *increases*.

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2.1.6 Runaway

In a shunt-wound motor, decreasing the strength of the field decreases the induced voltage, increasing the effective voltage applied to the armature windings. This increases armature current, resulting in greater torque and acceleration. Shunt-wound motors run away when the field fails because the spinning armature field induces enough current in the field coils to keep the field "live".

In a series-wound motor, the field current is always equal to the armature current. Under no load, the torque produced by the motor results in acceleration. As speed increases, induced voltage would normally increase until at some speed it equaled the applied voltage, resulting in no effective voltage, no armature current, and no further acceleration; in this case, however, increasing speed decreases field current and strength, stabilizing induced voltage. Torque never drops to zero, so the motor continues to accelerate until it self-destructs.

Runaway does not occur in permanent magnet motors. Starter motors, electric car motors, and some golf cart motors are series wound, however, and can run away.

2.1.7 STEPPER MOTOR

Stepper Motors convert electrical pulses into discrete mechanical rotational movement or steps. Typical stepper motors consists of two coils with two stator cups formed around each coil. Pole pairs are mechanically displaced by one-half each pole pair. When current is applied, the pole pairs become alternatively energized north and south poles. Between the stator coil pairs, there is a displacement of one quarter of each pole pitch.

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Stepper motor operating performance specifications may be as follows: Holding torque, step angle (Degrees), steps/rev, DC operating voltage, resistance/windings (ohms) for a given applied voltage. Length, diameter, shaft size, and interface are other mechanical specifications available from the manufacturer.

Typical stepper motors are used in any application which requires a discrete rotational movement. Examples; an indexing table or conveyor, optical scanner (3D laser scanner), photo or film processing machine, BBQ grill (we don't want that chicken to burn), etc. Stepper motors are also used with accompanying mechanisms (gears) to translate the rotational movement into linear displacement applications.

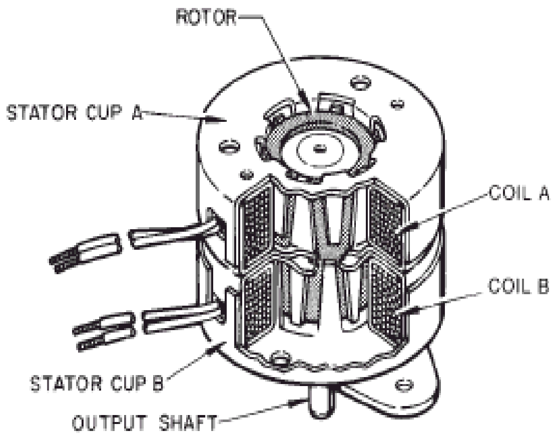

FIGURE 3.0 MOTOR DIMENSION

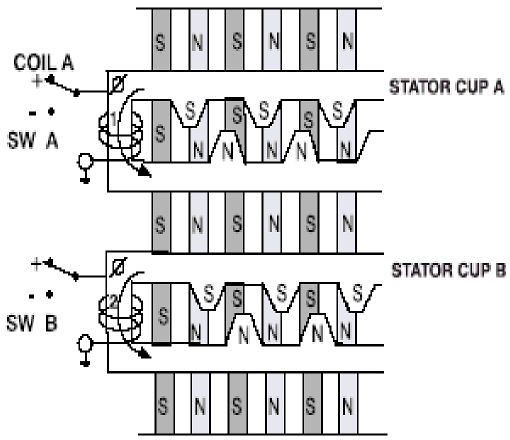

FIGURE 4.0 STATOR POSITIONS

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2.1.8 Full Step Stepper Motor

This animation demonstrates the principle for a stepper motor using full step commutation. The rotor of a permanent magnet stepper motor consists of permanent magnets and the stator has two pairs of windings. Just as the rotor aligns with one of the stator poles, the second phase is energized. The two phases alternate on and off and also reverse polarity. There are four steps. One phase lags the other phase by one step. This is equivalent to one forth of an electrical cycle or 90°.

This stepper motor is very simplified. The rotor of a real stepper motor usually has many poles. The animation has only ten poles; however a real stepper motor might have a hundred. These are formed using a single magnet mounted inline with the rotor axis and two pole pieces with many teeth. The teeth are staggered to produce many poles. The stator poles of a real stepper motor also have many teeth. The teeth are arranged so that the two phases are still 90° out of phase.

This stepper motor uses permanent magnets. Some stepper motors do not have magnets and instead use the basic principles of a switched reluctance motor. The stator is similar but the rotor is composed of an iron laminates.

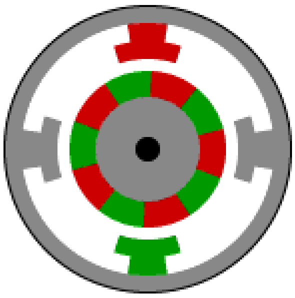

FIGURE 5.1 FULL STEP

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2.1.9 Half Step Stepper Motor

This animation shows the stepping pattern for a half-step stepper motor. The commutation sequence for a half-step stepper motor has eight steps instead of four. The main difference is that the second phase is turned on before the first phase is turned off. Thus, sometimes both phases are energized at the same time. During the half-steps the rotor is held in between the two full-step positions.

A half-step motor has twice the resolution of a full step motor. It is very popular for this reason.

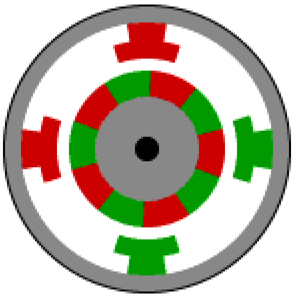

FIGURE 5.2 HALF STEP

2.1.10 Stepper Motor Driver Circuit

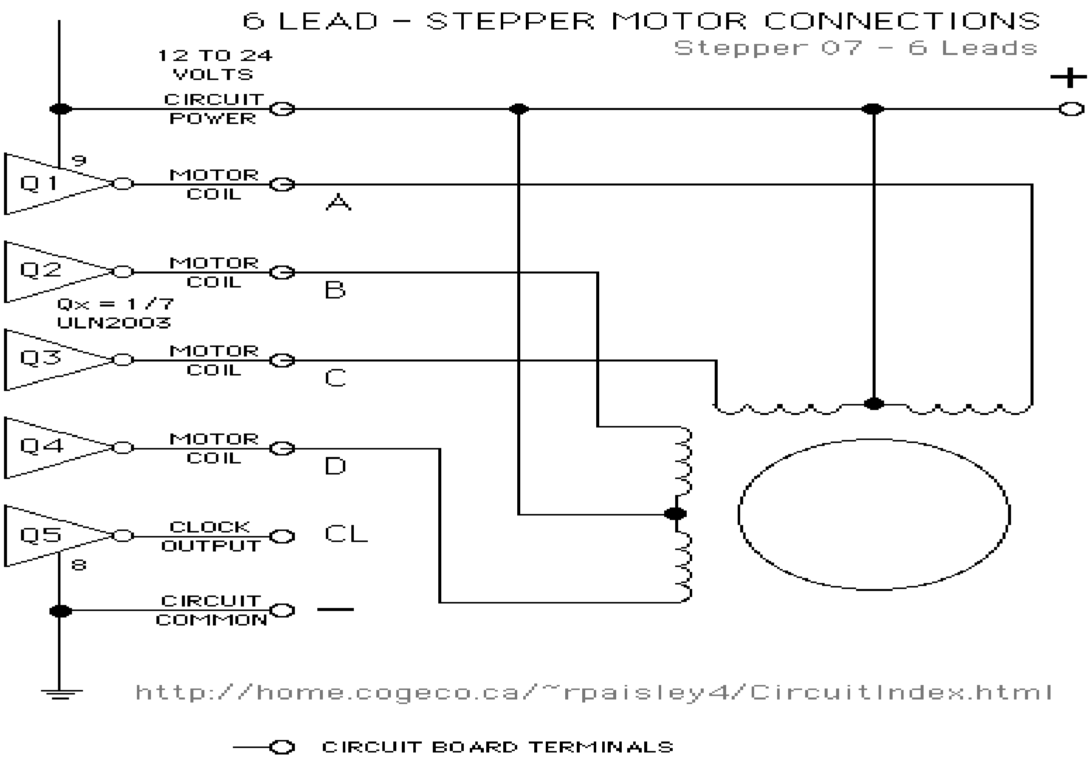

FIGURE 5.3 6-LEAD OF STEPPER MOTOR CONNECTION

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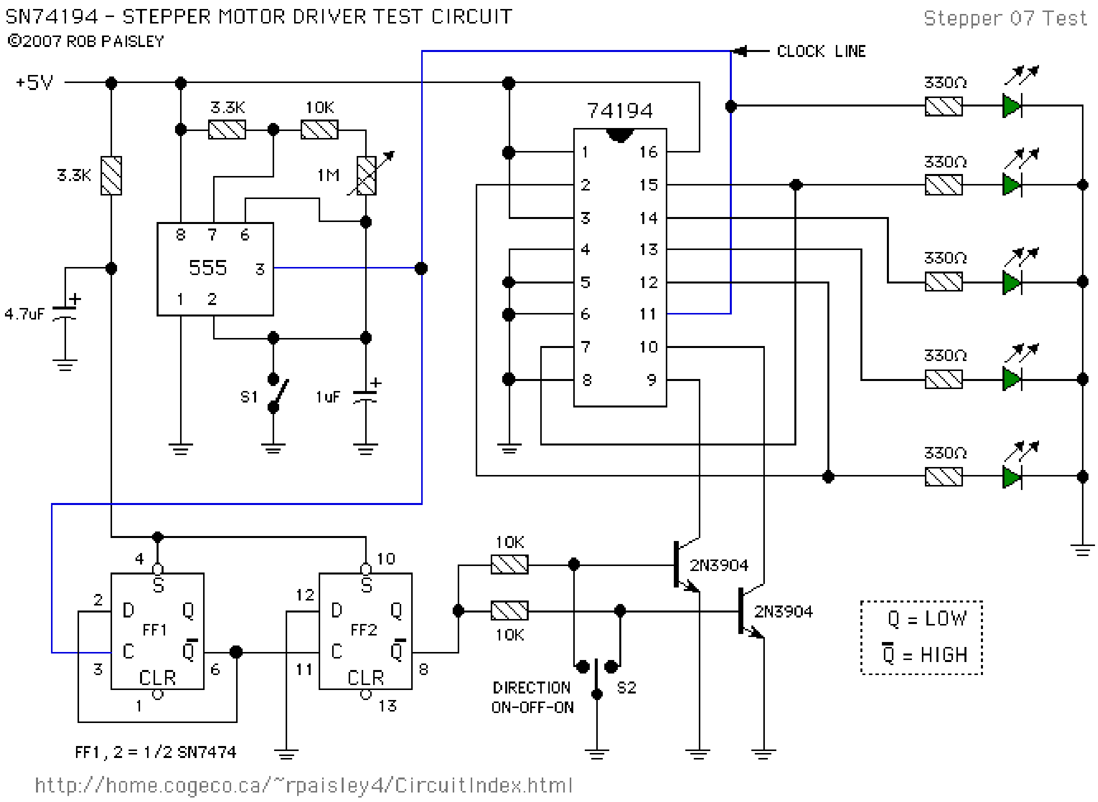

FIGURE 5.4 STEPPER MOTOR DRIVER TEST CIRCUIT

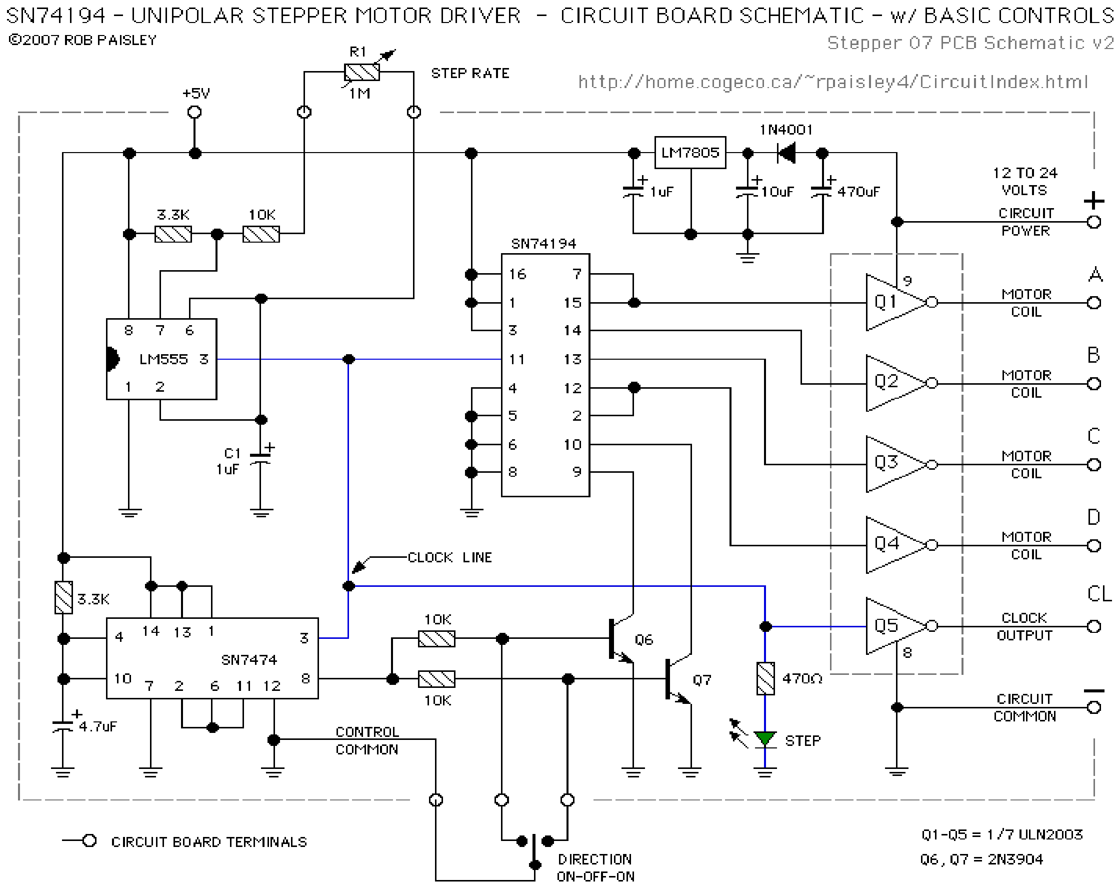

FIGURE 5.5 STEPPER MOTOR COMPLETE DRIVER CICUIT

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