DESIGN AND CONSTRUCTION OF AN AUTOMATIC LAMINATING MACHINE

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DEDICATION

This thesis is dedicated to Almighty Allah, who has seen me through the period of my studies, also to my loveable parent Alhaji Salihu Aliyu Evuti and Mallama Hassana Umaru Zabbo.

DECLARATION

I Salihu Abdulrahaman Evuti, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This project is all about the design and construction of an automatic laminating machine, embarked upon to enhance the safety and efficiency in laminating essential papers.

The design is based on the principle of the application of electric current through resistance wire, which thus produces the heat required for Lamination using polythene material. An electronic timer controls the laminating machine, of which material is expected to be laminated for the time set. The design method adopted in this project involves three different stages; the power supply unit, the control (Timing), circuit and the temperature regulating unit. The project work was found working satisfactory.

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CHAPTER ONE

INTRODUCTION

An automatic laminating machine is an electrical appliance exclusively constructed to enhance the lamination of essential documents. There by preventing papers from becoming sun damaged, wrinkled, stained, smudged, abraded and mark by grace, finger prints and environmental concerns. Phot identification cards and credit are almost are laminated with plastic film. Generally, a laminate is a material constructed by uniting two or more layers of material together. The process of creating a laminate is lamination, which refers to sandwiching something between layers of plastic and sealing them with heat and pressure, usually with an adhesive. However, in electrical engineering, lamination is a construction technique used to reduce unwanted heating effects due to eddy currents in components, such as the magnetic cores of transformers. [1]

Laminating paper, such as photographs, can prevent it from becoming creased, sun damaged, wrinkled, stained, smudged, abraded and/or marked by grease, fingerprints and environmental concerns. Photo identification cards and credit cards are almost always laminated with plastic film. [1]

One of the most useful electronic gadgets in the preservation of our paper documents is Laminating machine (laminator). This is the main reason why I decided to pursue this particular design of project for my final year project. I hope to incorporate the concepts, I have learned from my electronic classes into the design and construction of an "Automatic Laminating Machine".

There are basically three types of laminating machine, based on their functions. These include:

i. Heated roll laminating machine

ii. Pouch laminating machine

iii. Cold roll laminating machine

This project is specifically based on the heated roll laminating machine. The heated roll lamenting machine use one or two large rolls of lamination film. The film used in the roll laminator has a heat-activated glue on one side of the lamination that sticks to the print when it is run through the laminator. In the case of digital prints, the strength of the bond is limited by the adhesion strength of the thermal glue to the ink layer on the printed media. The rolls of lamination film look very similar to a large roll of Saran Wrap. One roll is mounted on top of the machine, while a second is fed simultaneously from the underside. The top roll laminates the top of the print, while the bottom roll laminates the bottom side in a process called encapsulation. You can also use just the print side lamination film, since the bottom of any mounting board does not usually require lamination. There are also hybrid types of laminators that provide only top heat for lamination with thermal material. This type of laminator would not be able to encapsulate. After a print has been laminated, a sharp blade is usually needed to cut the laminated print from the machine. Different types of laminators have different numbers of rollers. Lamination film, as it enters the laminator, passes through the rollers, which help evenly distribute heat and keep the lamination pouch pressed shut during the lamination process. [2]

The laminate usually consists of 2 plies with each ply made up of an over laminate film and an adhesive, which is dry and not tacky to the touch. A heat source and pressure are required during the lamination process. The document is placed between the two plies of the laminate film and then sent through the laminator where the dry adhesive is made tacky by heat and is pressed onto the document under high pressure. After cooling, the adhesive solidifies and provides a permanent bond between the document and laminate film. [3]

The laminating machine is important in electronics, due to its main reason, which is in the protection of paper documents (using laminate) and controlled heat (using thermostat). The use of lamination serves several purposes:

- Lamination adds luster or gloss to a printed product.
- It provides stability to the sheet, allowing it to be more durable or stand upright.
- It provides protection to sheets that are handled frequently or may encounter moisture.
- Many laminated documents are waterproof, tear proof, and tamper proof.

Lamination can be a useful and often necessary addition to various products including posters, maps, membership cards, calendars, food labels, menus, signs, price tags, ID cards, point-of-sale materials, business cards, charts, photographs, placemats, badges, covers, certificates, and many others.

1.1 AIMS AND OBJECTIVES

i. To design and construct an Automatic Laminating Machine, which is capable of laminating various sizes of paper which are not more than A4 sheet.

ii. To practically understand the principles of electronics that was been taught in class.

1.2 METHODOLOGY

The various component used in this project were all specifically selected, and where further grouped into stages, so as to give us the final product, which is an

Automatic Laminating Machine. Those various sections include; electronic section and the power section.

1.3 SCOPE OF WORK

The following are what are featured in this project:

i. A DC volts power supply.

ii. Heating element

iii. Adjustable heat control (Thermostat)

iv. Metallic rollers

v. Thermal sensor

CHAPTER TWO

LITERATURE REVIEW

The idea of building up a complete material from a number of relatively thin layers to give a product of increased strength is an old idea. The patent for the first machine for pasting sheets of paper together in layers, forming chipboard, was granted in 1824 to an Englishman by the name of John Dickinson (1782-1869). The idea was applied again to paper in 1902, when naturally occurring resinous bonding materials were used as adhesives, still before the days of synthetic materials. [4] [5]

Since the time of Leo Hendrik Baekeland (1863-1944), laminates have come to refer to composites consisting of thermosetting plastics (phenolic, polyester, epoxy, or silicone) bonded to paper, cloth, asbestos, wood, glass fiber, or other material. Contemporary walls for housing, which have been made of thin aluminum sheets epoxied to polyurethane foam, are examples of laminar composites. The foam provides excellent thermal insulation, and the composite has a higher structural rigidity than the aluminum sheets or polyurethane foam alone. The polyurethane foam is itself a composite of air and polyurethane. [4] [6]

Baekeland's search for what would become the first commercial phenol-formaledhyde resin (Bakelite) was motivated by a desire to produce a synthetic shellac substitute for bonding mica in electrical apparatuses. Out of this pioneering research arose a technique for lamination.

High pressure laminates of paper and phenol-formaldehyde resins, used for electrical insulation since 1913, were an early entry into the field. By 1939, high strength weather resistant plywood was being made by interleaving veneers (with the grain oriented at a 90-degree angle on successive layers) with an extremely thin paper preimpregnated with a special phenolic resin, then molding with heat and pressure. In Britain, during World War II, the de Havilland Aircraft Company built its Mosquito aircraft with this type of plywood; motor torpedo boats were also made of this material. [4]

American designers first became aware of the potential of plastic as a modern material when the popularity of radio brought glossy black phenolic laminate into the homes in the mid-1920s. Designers shifted to Bakelite laminate initially as an imitative substitute for lacquer trim, and eventually as a material for surfacing entire pieces. Furniture designer Donald Deskey was particularly active in promoting phenolic laminate. In the 1930s, phenolic laminate (or Formica as it came to be known) quickly spread to every nook and cranny of public life--cafeterias, diners, even railway coaches. By the late 1930s, flawless Formica surfaces were to be found wherever one looked, seeming to contrast a futuristic dream with the real world of the Depression. [4] [7]

Today, paper or textile fabrics to be laminated are first impregnated with thermosetting compositions, and then pressed with multiplaten presses. Such presses are also used for the manufacture of fiberboard (phenolic plastic with wood chips as filler). In a slight modification of this technique, hot plastic sheets are adhered to paper or fabric by pressing together while in contact, then allowing the laminate to cool. Still other techniques include the introduction of a hot filament between layers of the laminate, or the use of ultrasonic welding to join the sheets. [4]

2.1 HEATING ELEMENTS

A heating element converts electricity into heat through the process of Joule heating. Electrical current running through the element encounters resistance, resulting in heating of the element.

Most heating elements use Nichrome wire or ribbon as the conductor. Nichrome is an ideal material as it is inexpensive, has relatively high resistance, and does not break down or oxidize in air in its useful temperature range. There are four kinds of commercial heating elements: [8]

i. Bare Nichrome wire or ribbon: Either straight or coiled, usually found in toasters and hair dryers.
ii. Calrod (sealed element): a fine coil of Nichrome wire in a ceramic binder, sealed inside a tough metal shell. These can be a straight rod (as in toaster ovens) or curved to fit in a smaller space (such as in electric stoves, ovens, and coffee makers).
iii. Heat lamp: a high-powered incandescent lamp usually run at less than maximum power to radiate mostly infrared instead of visible light. These are usually found in radiant space heaters and food warmers, taking either a long, tubular form or an R40 reflector-lamp form. The reflector lamp style is often tinted red to minimize the visible light produced; the tubular form is always clear.
iv. PTC ceramic: This material is named for its Positive Thermal Coefficient of resistivity. Most ceramics have a negative coefficient; most metals, a positive one. While metals do become slightly more resistive at higher temperatures, this class of ceramics (often barium titanate and lead titanate composites) has a highly nonlinear thermal response, so that it becomes extremely resistive above a composition-dependent threshold temperature. This behavior causes the material to act as its own

Equation (2.0) if round wire and equation (2.1) is for tape. The resistance is been calculated with the equation (2.2).

As a heating element, tape offers a large surface area and therefore, a greater effective heat radiation in a preferred direction making it ideal for many industrial applications such as injection mould band heaters.

An important characteristic of these electrical resistance alloys is their resistance to heat and corrosion, which is due to the formation of oxide surface layers that retard further reaction with the oxygen in air. When selecting the alloy operating temperature, the material and atmosphere with which it comes into contact must be considered. As there are so many types of applications, variables in element design and different operating conditions the following equations for element design are given as a guide only.

2.1.1 Electrical Resistance at Operating Temperature

With very few exceptions the resistance of a metal will change with temperature, which must be allowed for when designing an element. As the resistance of an element is calculated at operating temperature, the resistance of the element at room temperature must be found. To obtain the elements resistance at room temperature, divide the resistance at operating temperature by the temperature resistance factor shown below:

$$R = \frac{R_t}{F} \tag{2.3}$$

Where:

F = Temperature-Resistance Factor

R_t = Element resistance at operating temperature (Ohms)

R = Element resistance at 20°C (Ohms)

2.2 THERMOSTAT (HEAT CONTROL)

A thermostat is a device for regulating the temperature of a system so that the system's temperature is maintained near a desired setpoint temperature. The thermostat does this by controlling the flow of heat energy into or out of the system. That is, the thermostat switches heating or cooling devices on or off as needed to maintain the correct temperature. [10]

Thermostats can be constructed in many ways and may use a variety of sensors to measure the temperature. The output of the sensor then controls the heating or cooling apparatus. Common sensors include:

i. Bi-metal mechanical sensors
ii. Expanding wax pellets
iii. Electronic thermistors
iv. Electrical thermocouples

2.3 THERMAL SENSOR

In many physical phenomena heat is exchanged. This goes together with heat fluxes and changes of temperature. Thermal sensors serve to measure those two quantities. When applied in the appropriate way, not only heat flux and temperature but also a number of other quantities can be measured. [10]

Thermal sensors display some specific positive characteristics, which include extreme stability; no moving parts; large dynamic range and a little or no energy consumption. These characteristics will improve the reliability of measurement and control systems in which they are used.

Note that when inserting a thermal sensor and a heater into a medium, the thermal sensor's response to heating contains information on the thermal properties of the medium. In this project the thermal sensor senses the heat, which is generated by the heating element. The thermal sensor acts as a medium of control for the laminating maching.

A good thermal sensor obeys the following rules:

i It should be sensitive to the measured property.

ii. It should also be insensitive to any other property.

iii. And lastly, it should not influence the measured property.

It is often ideal that the output signal of a sensor is proportional to the value of the measured property. The gain is then defined as the ratio between output signal and measured property. In this case, the thermal sensor measures temperature and has a voltage output, the gain is a constant with the unit [V/K].

2.4 FILMS TYPES

The type of films used with the laminating machine is of great importance, because when a wrong type of laminate or film is used during the lamination process, it might result in either damaging the document or even the laminating machine.

Laminate film is generally categorized into these five categories: standard thermal laminating films, low-temperature thermal laminating films, heat-assisted laminating films, pressure-sensitive films and liquid laminates. [2]

1. Standard thermal laminating films: This is typically a polyester film with a polyethylene (copolymer) adhesive that requires temperatures between 210°-240°F

to bond. These are the most popular films today, largely due to their low price. They can also be the most problematic to work with.

2. Low-temperature thermal laminating films: These are virtually identical to standard thermal films in that they are constructed of polyester with a polyethylene adhesive. They bond at a lower temperature, 185°-210°F. It is likely that these laminates will replace standard thermal films at some point in the future.
3. Heatset (or heat-assisted) laminating films: Usually these films are PVC- or polyester-based films, although there are a few exceptions. The adhesive is thermoplastic and only requires 170°-195°F to bond to the substrate.
4. Pressure-sensitive films: These laminates are frequently PVC (vinyl) or polyester with an acrylic adhesive, with the composition of the adhesive varying from one manufacturer to the next. Sometimes they are referred to as "cold" laminating films, because they don't require heat to bond with a substrate, just pressure.
5. Liquid laminates: Liquid laminates are just that--liquid coatings that require a specific liquid-coating machine or applicator. These coatings are for the most part solvent- or aqueous-based; chemical composition will vary from manufacturer to manufacturer.

Many of the films used for laminating are available in various thicknesses and finishes ranging from clear gloss to delustered. The three main film materials used for lamination processes are: [3]

i. Polyester - Polyester is the most widely used film and can be used for almost any type of application, but it is most often used for book covers, dust jackets, folders, and video slipcovers. Polyester film is heat resistant, foldable, scuff and scratch resistant, flexible, and tough. Polyester film will not become brittle with age because it contains no plasticizers.

ii. Polypropyline - Polypropyline is the clearest and brightest type of film and it is used for such applications as posters, labels, marketing, materials, and write on/wipe off calendars. It offers chemical resistance and good optical properties.

iii. Nylon - Nylon film is another good choice for applications such as book jackets because of scratch resistance and excellent non-curling properties. Nylon laminate is a very stable material. When it is exposed to heat, it will not stretch, and when it is cooled, it will not shrink.

There are few guidelines when operating a laminating machine, this guidelines include the following: [3]

- Use caution when applying a lamination film to varnished sheets. Use a varnish that dries quickly, contains minimal residual solvent, and contains no wax additives.
- Do not laminate printed materials containing metallic inks since air bubbling adhesion problems may occur.
- Use caution when a significant amount of anti-setoff powder has been sprayed on the sheet during printing because it causes adhesion problems.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

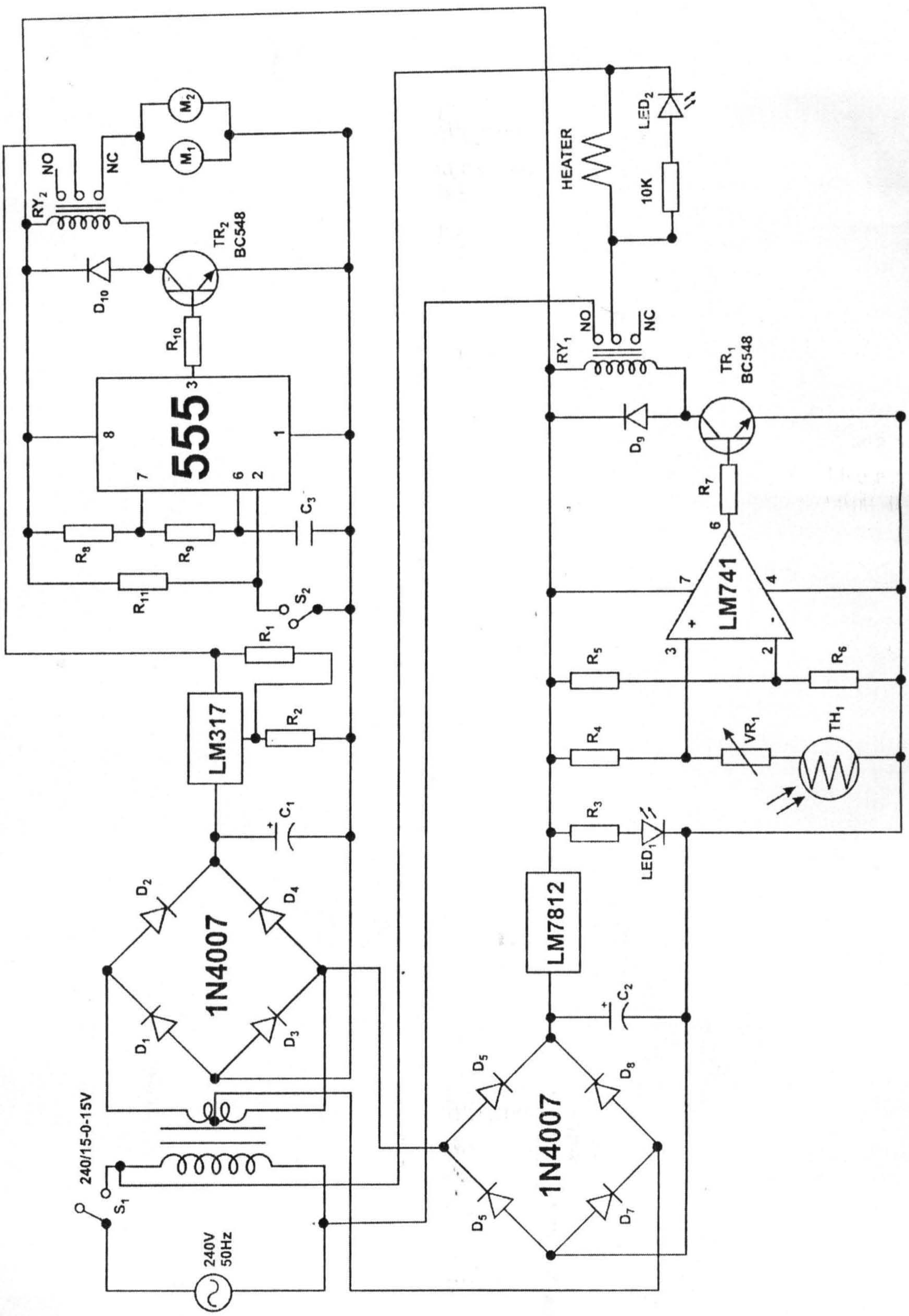

Fig. 3.1 Laminating machine

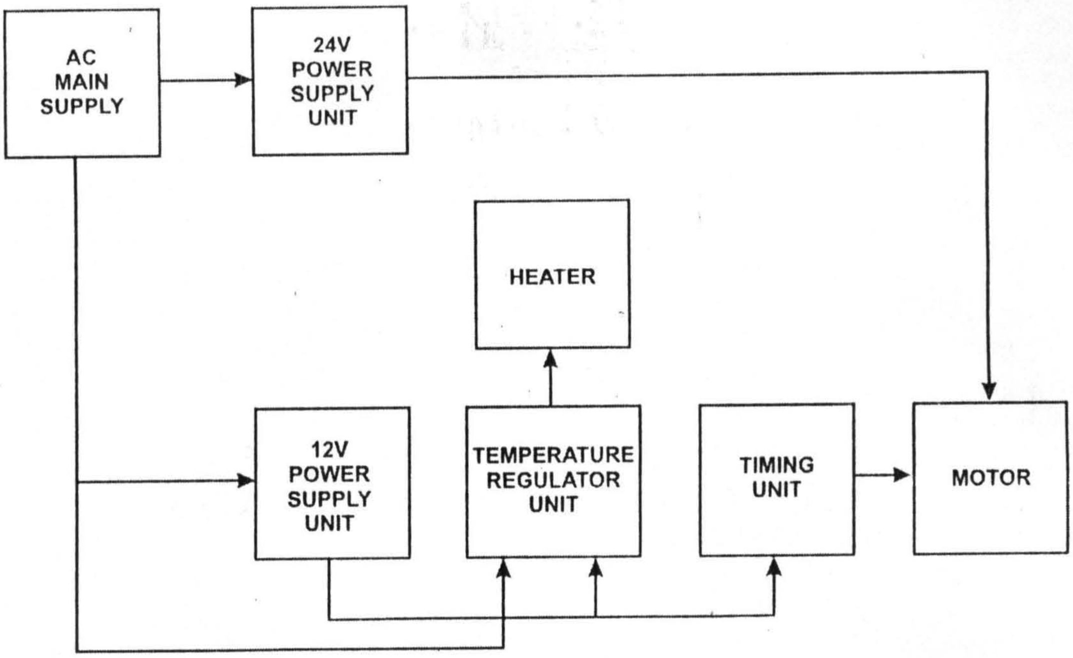

Fig. 3.2 Block diagram for laminating machine

The system makes use of two power supplies. A 24V regulator supply unit built around a bridge rectifier (D_1, D_2, D_3, D_4) and LM317 (regulator IC), whose output is determined by R_1 and R_2 values.

$$V_{OUT} = 1.2 \times \left(1 + \frac{R_2}{R_1}\right) \tag{3.0}$$

The second power supply is used to power the rest of the control circuitry (comprising the temperature regulator and timing circuit).

The temperature sensing circuit is built around LM741 (operational amplifier). It is connected as a comparator. Its output at PIN 6 goes high if the voltage at PIN 3 (Non-inverting terminal) is higher than that at PIN 2 (Inverting terminal) and vise versa. R_5 and R_6 are of the same value so they form a voltage divider that fix the voltage on PIN 3 at 6V constant. The voltage divider at PIN 2 is variable depending on the temperature of the thermistor and value of the variable resistor. The resistance values are fixed such that the heater is disconnected at the desired temperature but reconnected as soon as the temperaure attempt to fall. This is achieved through the automatic relay switch.

If S_2 (press to make contact switch) is pressed IC_4 (555), connected as a mono-stable timer is triggered and the output (PIN 3) goes high for a period of time, set by R_8 and R_9. During this period, IR_2 is ON and the relay contacts are activated, motor M_1 and M_2 starts to rotate the roller which in turn roll in and out paper. The motors return toothier rest state as soon as the time period set for the mono-stable timer is elapsed. This time interval is made adequate enough for the first roller to roll in polyethylene containg paper acroos the heater to the second roller that finally rolls out the laminated paper.

3.1 POWER SUPPLY UNIT

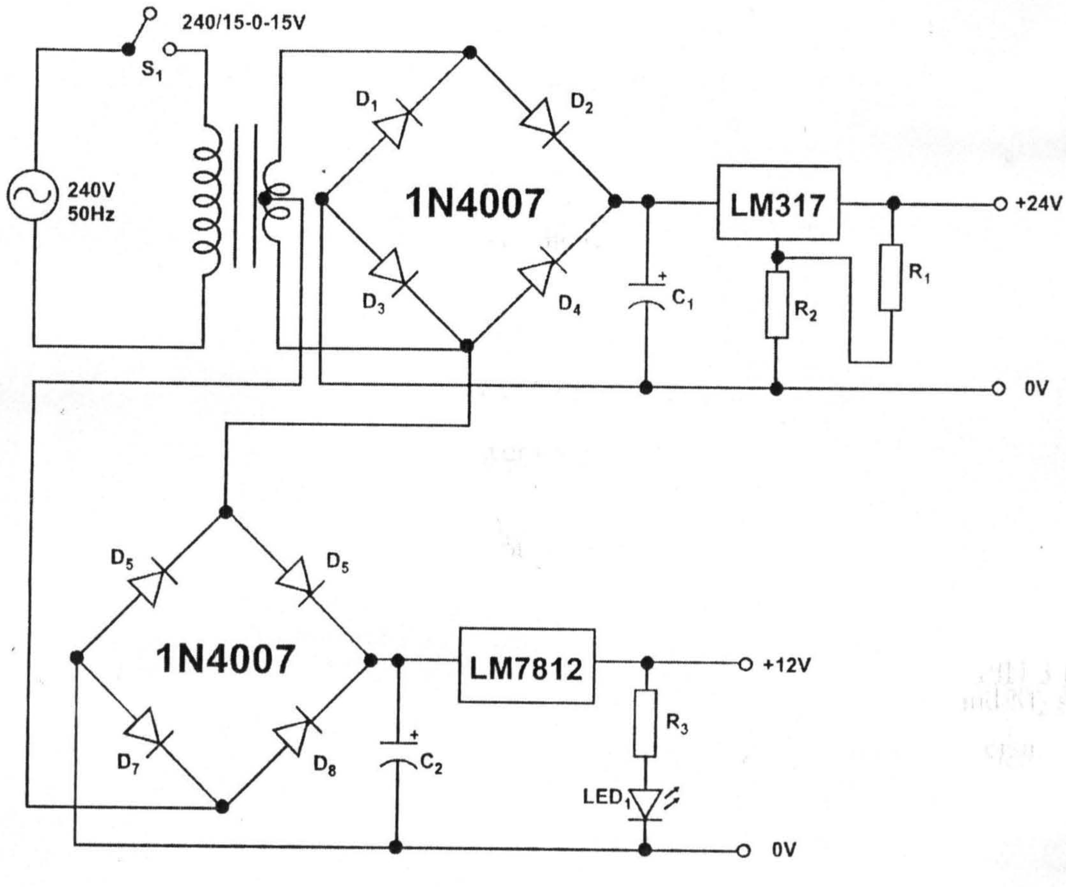

Fig. 3.3 Power supply circuit

A 30V center tapped transformer was choosen. 30V is rectified and used for power supply to the DC motor.

Peak value of the transformer voltage V_{peak} is given as

$$Vpeak = 30 \times \sqrt{2} = 42.4V \quad (3.1)$$

Where V_{peak} = Peak output from transformer.

V_{rms} = Root mean square output voltage of the transformer

For safe operation the PIV (peak inverse voltage) rating of the diodes must be greater than V_{peak} as a standard the PIV rating should be at least two times Vpeak. In this design 1N4007 diodes with PIV rating rating of 700V was chosen. The filtering capacitor should also have a voltage rating up to at least two times V_{peak} i.e. $42.2 \times 2 = 84.8V$.

The filtered DC is now fed into the LM317 regulator to get a constant 24 volts output needed to drive the motors. The output voltage is given by the formular

$$V_{OUT} = 1.2 \times \left(1 + \frac{R_2}{R_1}\right) \quad (3.2)$$

Required output voltage = 24V

If R_1 is fixed at 270Ω, the required R_2 is calculated as follows

$$24 = 1.2 \times \left(1 + \frac{R_2}{270}\right) = 1.2 + \frac{1.2R_2}{270}$$

$$6480 = 324 + 1.2R_2$$

$$R_2 = \frac{6156}{1.2} = 5130\Omega \approx 5.1K\Omega$$

Available standard value is 5.2KΩ

The regulator 12V power supply is derived from the 15 volts centered taped of the transformer. The bridge rectifier formed by D_5, D_6, D_7 and D_8 rectifies this AC supply. The rms rating of the transformer is 15V. Therefore the peak voltage is

$$\text{peak voltage} = V_{rms} \times \sqrt{2} = 15 \times \sqrt{2} = 21.2V \quad (3.3)$$

Therefore rated value of filtering capacitor C2 should be greater than

$$2 \times V_{peak} = 2 \times 21.2 = 42.4V \quad (3.4)$$

A 50V 2200μF capacitor is suitable. The recitified voltage is fed into IC_2 (7812) which gives a constant of 12 VDC.

R_3 is a current limiting resistor to LED, whose maximum current rating is 35mA and has a voltage drop of about 1.7V

$$I = \frac{V_s - V_d}{R} \tag{3.5}$$

Suppose we wish to limit the current to 10mA

Where V_s = supply voltage

V_d = volateg drop across LED

I = current through LED

R = current limiting resistor

$$\text{Then } R = \frac{V_s - V_d}{I} = \frac{12 - 1.7}{10 \times 10^{-3}} \tag{3.6}$$

Available standard value is 1KΩ

3.2 TEMPERATURE CONTROL CIRCUIT/UNIT

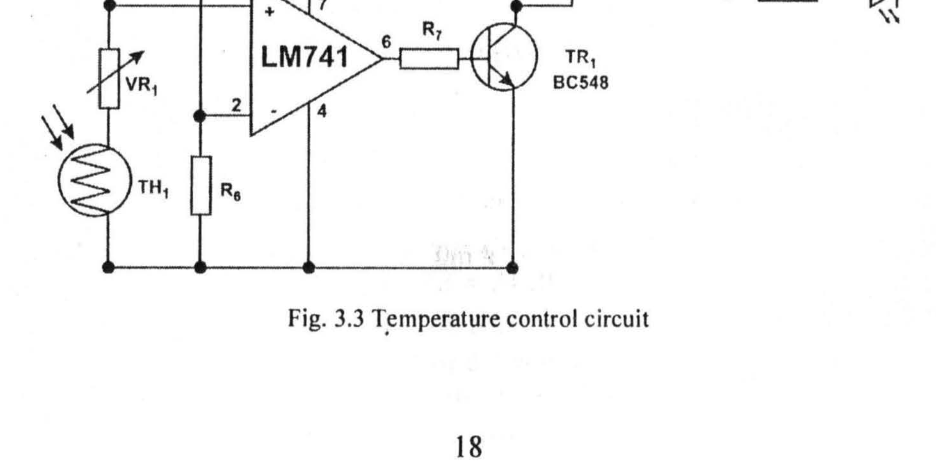

Fig. 3.3 Temperature control circuit

R_5 and R_6 are chosen as 10KΩ each form a voltage divider that fix the voltage on PIN 2 at 6V. Thermistor TH_1 in series with VR_1 form another voltage divider with R_{11}, which dropsa voltage on PIN 3 whose value is dependant on resistance of the termistor. At the initial stage when the circuit is pwered. The voltage at PIN 3 is slightly greater than that at PIN 2, the output at PIN 6 goes high. The relay switch is activated. Its normally open contacts are closed, current is supplied to the heater and LED_2 comes ON. When the temperature rises to a level set by VR_1, the resistance of thermal resistor drops and likewise the voltage at PIN 3. As the voltage at PIN 3 slightly drops below that at PIN 2 the output at PIN 6 goes low, the transistor TR_1 is cut off and the relay is deactivated and voltage supply to the heater is stopped. The process reverse itself when the temperature of the heater begings to drop. Thus the temperature is maintained at a desired level.

3.3 TRANSISTOR BIASING

The relay coil has a resistance that serve as collector resistance of TR_1. The coil resistance of the 12V relay is about 400Ω

Therefore $I_{Csat} = \frac{V_{CC}}{R_C} = \frac{12}{400} = 0.03A = 30 \times 10^{-3} A = 30mA$ (3.7)

β = 200 Type

Therefore $I_{Bsat} = \frac{I_{Csat}}{\beta} = \frac{30 \times 10^{-3}}{200} = 0.00015A = 150 \times 10^{-6} = 150\mu A$ (3.8)

Require value of $R_B = \frac{V_{CC} - V_{BE}}{I_B} = \frac{12 - 0.6}{150 \times 10^{-6}} = 76000\Omega = 76K\Omega$ (3.9)

D_9 is a free wheeling diode that prevents damage to TR_1 due to back emf from the relay coils.

Table 3.1 Datasheet specification for BC548 (TR1)

Type of transistor	NPN-Si
V_{CBO}	75V
V_{CEO}	40V
V_{EB}	6V
IC_{MAX}	0.6A
h_{fe}	200 Typical
Max Power dissipation	0.5W
Ft	300MHz

3.4 TIMING CIRCUIT/UNIT

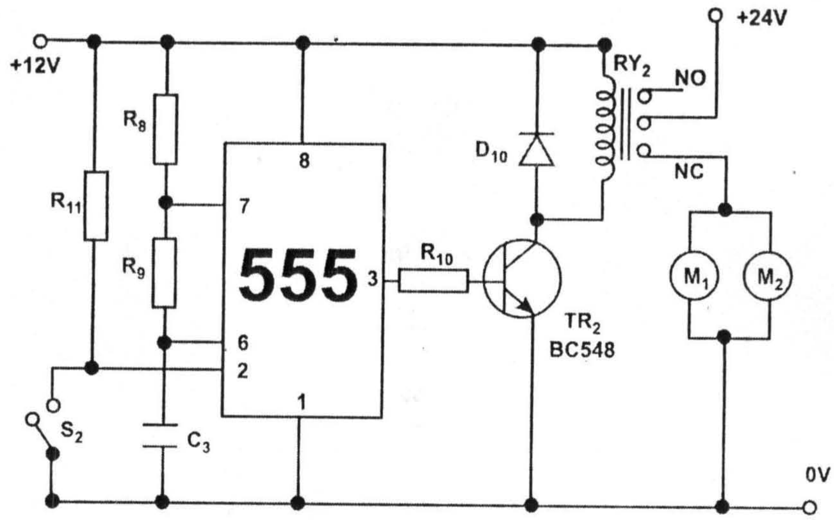

Fig. 3.3 Timing circuit

The timing circuit helps reduce the duty cycle of the DC motor thereby minizing power waste by bringing the motors into action only when a lamination process is to take place and putting them off on standby. The heart of the circuit is a NE555 IC, which acts as both as a timer and oscillator. In this design it has been connected in the mono-stable mode, whose timing period is dependant on R8, R9 and C3. The timer will give a high output at PIN 3. If the voltage at 2 falls below a third of the supply voltage.In this case a third of the supply voltage is 4V. This output will last for a time period given by

$$T = 1.1RC_3 \tag{3.10}$$

Where $R = R_8 + R_9$ and C_3 is to be determined

Suppose T is set at 10 seconds and R_8 = 100KΩ and R_9 = 1KΩ, than by making C_3 the subject of the formular

$$C_3 = \frac{T}{1.1R} \tag{3.11}$$

But $R = 100K + 1K = 101K\Omega$

Therefore $C_3 = \dfrac{10}{1.1 \times 101000} = 90 \times 10^{-6} = 90\mu F$

Nearest available standard value = 100μF

Bias of TR_2 is the same as that for TR_1, while D_{10} is a free wheeling diode for same reason given for D_9

3.5 TRANSFORMER

A transformer is an electrical device made up of coil wound around a magnetic core, it makes use of the principle of electromagnetic induction to transfer electrical energy from one coil to another different voltage level [12] thus a step down centre tapped transformer of 30V is used in this project which provides the necessary voltage required in the circuit.

3.5.1 CALCULATION

For a sinusoidal input voltage, the flux Φ varies alternatively i.e.

$$\Phi = \Phi_{max} \sin wt \tag{3.12}$$

The instantaneous voltage in the primary is due to faraday's law

$$E_1 = \frac{d\Phi N_1}{dt} = 2\pi f N_1 \Phi_{max} \cos wt \tag{3.13}$$

Where w= 2πf

Thus $med_{ead} = 2\pi f N_1 \Phi_{max}$

$$E_{rms} = \frac{2\pi f N_1 \Phi_{max}}{\sqrt{2}} = 4.44 f N_1 \Phi_{max} \tag{3.14}$$

Neglecting the losses in the coil, the flux is the same for the primary and secondary winding. Thus, the secondary voltage and current could be derived from,

$$\frac{V_s}{V_p} = \frac{E_s}{E_p} = \frac{4.44 f N_s \Phi_{s\max}}{4.44 f N_p \Phi_{p\max}}$$

Therefore, $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

$$\text{Thus } V_s = \left(\frac{N_s}{N_p}\right) V_p \tag{3.15}$$

Where, V_p = input Voltage

V_s = Output Voltage

N_p = Number of turns in the primary windings

N_s = Number of turns in the secondary windings

Φ_{smax} = maximum flux in the secondary windings

Φ_{pmax} = maximum flux in the primary windings

E_s = the e.mf value of output voltage.

E_p = the e.m.f value of the input voltage.

And

$I_pN_p = I_sN_s$

$I_s = (N_p/N_s)I_p$ (3.16)

Where I_p = the input current

I_s = the output current

Combining equation 3.15 and 3.16

$V_s/V_p = N_s/N_p = I_p/I_s$ (3.17)

3.6 RECTIFICATION

Rectification involves the conversion of alternating current (a.c.) to direct current (d.c) with the use of the rectifiers. A rectifiers is an electric device that offer low resistance to the flow current in the positive direction (forward bias) and high resistance to the flow of current in the negative direction [12]

Rectifier may be used to carry out either half wave or full wave rectification depending on the application. In this project we will concerned. Ourselves in full-wave bridge rectifier, which in essence allow the flow of d.c. current in the output throughout the alternating cycle of the input signal.

3.7 THE HEATING ELEMENT

To produce the required heat, a heating element is needed. Thus a heating element which is a resistance wire is used in which when voltage is supply to the wire, it will draw sufficient current from the supply which in turn generate heat of circular cross-section or rectangular conducting ribbon is used as the heating element. Under steady state condition, a heating element dissipates as much heat from the surface as it received the power from the voltage supply [13].

If "P" is the power input and "H" is the heat dissipated by radiation then, P = H (under steady state condition) as per Stefan's law of radiation, heat radiated by a body is given by.

$$H = 5.72e^{k\left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right]} W / M^2 \tag{3.18}$$

Where T_1 is the temperature of the hot body in ^{o}k

T_2 is the temperature of the cold body (surrounding) in ^{o}k

Now $P = \frac{V^2}{R}$ and $R = \frac{\rho l}{A}$

$$R = \frac{4\rho l}{\pi d^2}$$

$$P = \frac{\pi d^2 V^2}{4\rho l} \tag{3.19}$$

Total surface area of the element = $(\pi d)l$ (3.20)

If H is the heat dissipation by radiation per second per unit surface area of the wire, then

Heat radiation per second = $(\pi d) \times l \times H$ (3.21)

Equating (1) and (2) we have

$$P = (\pi d) \times l \times H$$

Or $P = \frac{\pi d^2 V^2}{4\rho l} = (\pi d) \times H$ (3.22)

3.8 THE SWITCHING CIRCUIT

The switching operation in archived with the and of the transistor and retry: the transitory in used to amplify the current to the release which in turn switch ON /OFF the heating element. Which the output of the timer is fed to the base of the transistor, the transistor goes into saturation, thereby making the current to flow through the relay coil that is connected to the collector formal of the transistor the collector current IC, energized the coil of the relay, thereby operating the relay.

3.9 TRANSISTOR SWITCH

Using often most transistor are used as electronic switch, with help of such switches, a given load can turned on/off by a small signal. The power level of the control signal is usually very small and it is capable of providing enough bases derive to switch a transistor on /off, hence the transistor is made to switch the load

Using transistor as switch, two levels of control signal are employed with OFF level, the transistor operates in the cut-off region (open) whereas with the other level it operates in saturation region and act as short circuit. For basic operation of a transistor, its emitter base Junction (EBJ) has to be forward biases, while its base-collector junction (BCT) has to be reversed biased. Hence a transistor under saturation (ND) condition could be switch off by more making its base voltage equal or less then that of the emitter-base junction.

3.9.1 THE RELAY

This is an electro magnetic element that energize whenever there is a supply of current through its coil. Thus it is and electro magnetic control switch, in which a coil pulls an armature when sufficient current flows hence it is capable of turning on and off the circuit automatically The types of relay employed in this project is 12 volt dc relay, which has two contacts, i.e. the normally close (NC) and the normally open (NO) contact.

When the output of the 741 IC goes high, the transistor will b e contact to closes as the armature clicks down ward, thus complete the circuit of the heating element. Which when the output of the timer become low, the transistor is cut off and the relay will be deactivated, the armature. Springs upward to its normally open (NO) position thus breaking the circuit of heating element.

3.9.2 EMF SUPPRESSION

In most cases, a diode (DM) is usually connected across the relay coil. Depending on the types of the relay it can be 2 IN4148 for a very small relay (reed) or a IN400I for a normal miniature relay like the one employed in this design. The divide IN4001 connected in parallel with the relay coil is called the free wheeling diode or a commutating diode, it is use as a protective devices. When the current is flowing through an inductor or coil in interrupted 2 higher voltage in the inverse direction is generated by the collapsing magnetic field. This voltage can be as high as ten times the Vcc (source voltage) as coil in connected to a transistor the back. Electromagnetic force (EMF) can be enough to destroy the device anyways, the same happens across the relay contact when commented to a conductive source. This creates contact arcing which is energy that must be dissipated some how. One way of doing that is to place a diode across the relay coil (or contact) which conducts when the magnetic field collapses and so effectively short circuit the voltage. The devolved. Also placing a diode across the inductor comes current coil the coil of the relay has a large amount of inductance when the transistor is operating in cut off mode, this generate very large voltage spikes (Arching), The diode thus block the voltage splices from hitting the rest of the circuit i.e., prevent the high voltage inductive kill back from the relay coil.

CHAPTER FOUR

TESTS RESULTS AND DISCUSSION

The resistor value were identified by interpreting their colour code, the transformer were tested for continuity with the aid of digital multi-meter dial to the other range. The value of the capacitor was read from inscription on them. The relay coil resistance was measured using a digital ohmmeter all other component were also tested to see that there were all in good working condition.

These components were connected on a bread board and each sub-unit was confirmed as required. After this the components were transfer to the Vero-board soldered permanently.

A rectangular casing measuring about 49 cm by 22cm was made using plywood and the rollers were placed in the position and mechanical connected between the rollers were made. A heater was place between the two rollers and fastened. The circuit made on the Vero board was place within the casing and fastened and then the power cord was connected. The circuit was then connected to 240v supply and then tested.

4.1 FINAL TESTING OF THE CIRCUIT /OVERALL TESTING

The supply cable (power cord) was connected to the mains (220/230) voltage. Thus the power transformer is energized and the push button (Trigger) controlling the electronic timer is activated, the output voltage of the regulator was checked for stability and this given 24V and 12v for the proper operation of the circuit. The 741 produced one-short pulse as it is triggered through PIN 6, while the variable resistor (potention meter) circuit of the heating element with 3 event from the transformer, this cause the element to glow. When the present time has reached, the output of the 741 goes low and the relay coil de-energized and completed circuit to the heating element was opened, there was no more power supply to the heating element, thus it cools off.

4.2 DISCUSION OF RESULT

The result of this project did not meet the full expectation o f this design, this limitation did not arise from the original design but from the unavailability of the actual component intended for the design.

Alternative component had to be used which give rise to the limitation of this system operation.

4.3 PROBABLE FAULTS, CAUSES AND REMEDIES (TROUBLES SHOOTING)

An aromatic laminating machine that incorporates an electric timing system for varying the required time of operation fault of various kings can occur within the system. But, before maintenance or repair is carried out on the machine, the following are the common trouble shooting guide.

Table 4: Fault and remedies.

S\N	TYPE OF FULT	PROBABLE CAUSES	SOLUTION
1.	The machine fails to operate	i. Power supple failure ii. Open circuit in the supply/heating element. iii. Switch fails to close	i. Check if there is supple from the mains. ii. Test for open circuit in the heating element circuit using an

			ohmmeter. iii. Replace the switch with good one.
2.	Power indicator lamp on and off continuously	i. Loose socket\ plug, resulting in possible loss of contacts.	i. Replace the socket\plug and make sure it is *firmly fixed.*
3.	Fuse or circuit breaker goes off on load	i. Short circuit in the cable ii. Earth fault.	i. Test for short circuit within the cable ii. Test for earth fault on the transformer.
4.	Control circuit fails to operate.	i. Failure of supply to the control input ii. Relay coil fails to energize iii. Open circuit in the control circuit	i. Restore the supply to the input ii. Replace the relay iii. Test for open circuit and clear the fault
5	Motor fail to roll	i. Inadequate power supply	i. Check for opening circuit
6	Paper fails to roll	i. The spring are tight	i. Check to see whether the roller spring are tight

CHAPTER.FIVE

CONCLUSION

The aim and objectives of this project work has to a large extent been achieved, which is a contribution to the field of engineering. Its principle is based on the application of heat to laminate a paper using a polythene material. This was achieved through the heat produced in the heating element, is being controlled by the timing circuit, and *timing* a relay of magnetic type whose operation is thereby producing the automation lamination machine. This venture in the field of advance circuit theory, which can also serve as a stimulant for other who consider undertaking topic related to it. However,

Not only relatively cheaper and easier to maintain, this automatic lamination machine is also highly economical and safer to operate

5.1 RECOMMENDATION

I recommended that this project work should be assigned to incoming final year student to further improve on this work so that the limitation face can be overcome, it is also recommended that the department should assist student in sourcing fund and component which are hard to find within local market, which are very essential for successful implementation of the design.

5.2 PROBLEM ENCOUNTERED AND PREFERED SOLUTION

In the course of carrying out the construction, some problem were encountered, to which solution were proffered. Some of the problems are: getting the right specific heater rating to use, getting rollers, cost of transportation and mechanical connections of the construction work made me go out to search for ideal on how such connection could be achieved.

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APPENDIX

LIST OF COMPONENTS AND PRICES

S/N	COMPONENTS/MATERIALS DESCRIPTION	QUANTITY	RATE ₦	AMOUNT ₦
1	Transformer 240/30V	1	700	700
2	Roller/Motor	2	2000	4000
3	Operational Amplifier (LM317)	1	150	150
4	Operational amplifier (LM7812)	1	110	110
5	Operational amplifier (LM741)	1	90	90
6	Diodes (1N4007	10	20	200
7	Resistor R1 270Ω	1	20	20
8	Resistor R2 5.2KΩ	1	20	20
9	Resistor R3 1.03KΩ	1	20	20
10	Resistor R4,R5,R6,R7,R9 10KΩ	5	20	100
11	Resistor R8 100KΩ	1	20	20
12	Resistor R10 101KΩ	1	20	20
13	Capacitors	10	100	1000
14	Variable Resistor 10KΩ	1	20	20
15	Thermistor	1	200	200
16	Light emitting diode (LED)	2	20	40
17	IC 555 Timer	1	70	70
18	Transistor (BC548)	2	40	80
19	Heater	2	70	140
20	Relays	2	100	200
21	Conductor wire (yard)	4	50	200
22	Switches	1	50	50
23	Output Power supply jack	1	100	100
24	Power plug	1	100	100
25	Plywood 100x100cm	1	200	200
26	Vero Board	1	150	150
27	Miscellaneous			2000
			TOTAL	**10,000**