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Automatic Fixation of RD Cap in IRDS Condenser Tube

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Abstract: Safety is a state that implies to be protected from any risk, danger, damage or cause of injury. In the automotive industry, safety means that users, operators or manufacturers do not face any risk or danger coming from the motor vehicle or its spare parts. The condenser in air conditioning unit of the automobile transfers the heat from the refrigerant to the outside environment. Hence the manufacturing process of the condenser draws attention in terms of safety. IRDS type condensers are generally in use. Integrated Receiver Drier Sub cooling (IRDS) is one of the type of condenser which has a desiccant bag, insulated by the condenser core and uses receiver drier in their processing unit. The receiver drier cap is fed into the condenser tube manually. In order to overcome that disadvantage we create a proposal for automatic fixing of cap into the condenser tube.

Keywords: IRDS condenser, receiver drier caps, desiccant bags, automation, robotics technology

1. Introduction

The automotive industry is a wide range of companies and organizations involved in the design, development, manufacturing, marketing, and selling of motor vehicles. The term automotive was created from Greek autos (self), and Latin motivus (of motion) to represent any form of self- powered vehicle. This term was proposed by SAE member Elmer Sperry. In the automotive industry, safety means that users, operators or manufacturers do not face any risk or danger coming from the motor vehicle or its spare parts. Safety in the automotive industry is particularly important and therefore highly regulated. Automobiles and other motor vehicles have to comply with a certain number of norms and regulations, whether local or international, in order to be accepted on the market. The standard ISO 26262, is considered as one of the best practice framework for achieving automotive functional safety. Air conditioning unit in automobile is also a major part where safety have to be concerned. Hence the design and manufacture of these units needs special approach. Air conditioning unit consists of refrigerant, evaporator, compressor and condenser parts. The function of condenser is to transfer heat from refrigerant to outside environment. There are many types of condensers such as IRDS condenser, parallel flow condenser and serpentine condensers. Integrated Receiver Drier Sub cooling is one of the type of condenser which use receiver drier. Some sub-cool design have detachable receiver driers which can be replaced as a component**.** Other designs have receiver driers that cannot be detached and are serviced by removing a plug from the lower end of the receiver. Service kits include new a new plug, desiccant bag, and filter. In some condenser the receiver drier is fixed in a core and it is rightly fixed. In some condenser the desiccant bag is put in the core and insulated with the RD cap. Thus manufacture of IRDS condenser can be automated for our beneficial purposes.

2. Literature Review

Before our proposal to the project, the receiver drier cap is fed into the condenser tube manually. The operators who have the desiccant bag and the receiver drier cap will wait in the fixing section and they will unload it one by one. At this stage, it takes more time and hence decreases the productivity. The operators will unload the condenser and then fill the desiccant bag, which is flexible and is inserted deeply into the condenser tube. Then the receiver cap is fixed at that condenser tube manually. In this section, lubricant oil is separately placed and the purpose of the oil is to avoid friction between the receiver drier cap and condenser tube tap. The worker will manually take the receiver drier cap and then dip into the oil before placing it to the condenser tube. All the above process are done manually and it takes more time and makes a heavy impact on the production of the condenser. In order to overcome the disadvantages of manual fixing of the cap, a proposal was made for the automatic fixation of the receiver drier cap in the condenser tube.

FIG 2.1 MANUAL OPERATION

FIG 2.2 MANUAL OIL DIPPING

3. Problem Statement

The problem identified by us is the enormous time factor involved in the manual fixation of receiver drier cap in the condenser tube. Thus the automation of the fixation process would reduce the time. Because, implementation of automation methodology enhances the operational performance and requires less skilled labor to operate the machines. In industry, for automatic fixing of the cap there are no methodologies or machines at present. Without the automation of the process, the receiver drier cap is fixed manually and sometimes human error may also occur. Hence, to reduce the time consumption and to overcome the human errors, a small machine was devised by us.

4. Proposed Methodology

4.1. PROPOSED IDEA

Automation or automatic control, is the use of various control systems for operating the machineries. The biggest benefit of automation is that, it saves labour. However, it is also used to save energy, materials and to improve quality, accuracy and precision. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. In our proposal, we are going to insert the receiver drier cap in the condenser core by simple

application of the robotics technology. For our implementation, certain components such as stepper motors, DC motors, sensors, relays, transistors and timer circuits are employed. The electrical components are arranged based on the design. The function and arrangements are so simple and it is beneficial to the industry. As shown in the figure 4.1.1, the gripper will be holding the cap which is fed through the cap feeder mechanisms. The caps are aligned according to the position, that it should be held by the gripper. Now, the shaft which is holding the gripper will linearly move backwards. And then with the help of another stepper motor the shaft which is holding the shaft carrying gripper motor will move downwards. And then shaft carrying gripper alone will move to the right where the condenser is located. The conveyor will carry the condenser tubes. The sensors will be sensing the condenser tubes. Once it senses, the conveyor will get stopped and the gripper carrying the receiver drier cap will fix the cap in the condenser tubes with help of DC motor. After that, gripper along with the shafts will move to the initial position. After that bypass circuit gets on and the conveyor will move with the RD cap fixed condenser tubes. At particular time period the sensor, senses the condenser tubes. The above process are repeated to fix the receiver drier cap in the condenser. The above process are controlled by 555 timer circuit. The timer is controlled by using the Thyristor connection. The time can be altered according to our specifications. The bypass circuit is used to bypass the supply to the conveyor. Because the sensor will be sensing the condenser tubes continuously. At that time even when the RD cap is fixed, the sensor will be sensing it. In order to overcome that, the bypass circuit which supplies the power to the conveyor is set for specified time to move the condenser without being sensed by the sensors. After that bypass circuit gets reset and the above process are repeated.

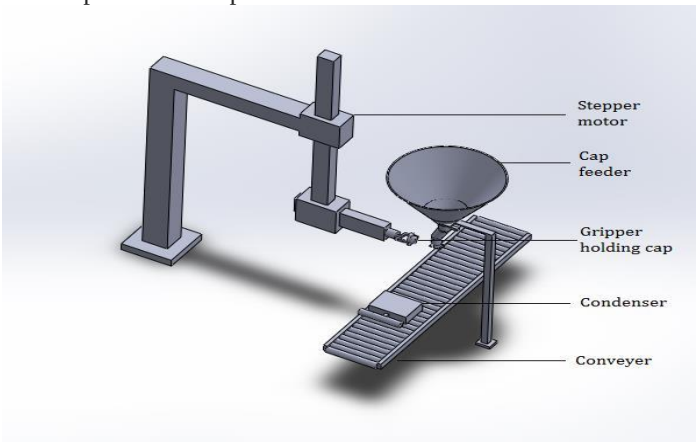

FIG 4.1. ASSEMBLED UNIT TO ACTUATE PICK & PLACE ARM

4.2. STEPS INVOLVED

Step 1: Horizontal shaft moves in reverse direction with cap held on gripper which is already in position.

Step2: Vertical Shaft moves down to the specified limit according to the required position which is set along the length of the shaft.

Step3: Horizontal shaft moves in forward direction towards the condenser.

Step4: Rotary motor which is holding the gripper in the shaft will rotate to fix the RD cap in the condenser.

Step5: After fixing the cap in the condenser the gripper opens.

Step6: The above five process are repeated in reverse direction to move the horizontal shaft to the initial location.

4.3. WORKING

The core which is taken from the furnace is subjected to the fixation of receiver drier cap in the biggest condenser tube. The fixation of receiver drier cap in the condenser tube is carried out manually. But based on our proposal the fixation of RD cap is done automatically which in turn saves more time, increases the productivity rate and requires semi-skilled labour for the operation process. At first the condenser is

loaded with sub parts into the fixtures and the operator will initiate the automatic process. The condenser is loaded in the sliding bed ways. So the condenser is moved to the position where the receiver drier cap is to be fixed. The receiver drier cap is filled in the cap feeder machines which feeds the cap according to the position required into the thread feeding sections. The cap feeder mechanism has a vibrating motor, which vibrates to position the cap according to the requirement. Now the receiver drier cap is aligned in position with the condenser tube. The gripper head unit will pick the cap and rotate ninety degrees. The cap feeder is aligned in position with the thread runner. The gripper runner purpose is to fix the receiver drier cap into the condenser tube. The condenser is loaded in the each fixtures with adjustable clamps so the receiver drier cap is fixed in the condenser tube and hence the cap is insulated to prevent the leakage of heat from the surroundings.

5. DESCRIPTION OF COMPONENTS

5.1. COMPONENTS USED

1) IR sensor
2) Cap feeder
3) Stepper motor
4) Relay
5) Transistor
6) 555 timer circuit

5.2. IR SENSOR

All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation is not visible to the human eye as it is radiated at infrared wavelengths. But it can be detected by electronic devices designed for such purposes. The term passive in this instance refers to the fact that PIR (Passive Infrared Sensor) devices do not generate or radiate any energy for detection purposes. They work entirely by detecting the energy given off by other objects. PIR sensors do not detect or measure "heat". Instead they detect the infrared radiation emitted or reflected from an object. Once the receiver receives the signal the sensor will on or off the power based on our required conditions. The IR sensor consists of transmitter and receiver sections. The light waves are emitted from the transmitter and the receiver receives the signal. Then, the required actions are carried out according to the signals in which it is processed. In our proposal, the IR signal continuously passes the signal in order to detect the condenser tubes.

FIG 5.2.1. IR SENSOR

5.3. CAP FEEDER

Cap feeders supply and attach caps to jars, bottles, and other similar types of containers for food products. These can move caps from hoppers to cappers and properly align the caps in correct orientation, while simultaneously sending improperly aligned ones back to the hoppers. Cap feeding systems can come in either a rotary centrifugal or vibratory bowl construction, with a hopper, or an elevator mechanism. The vibrating motor is fixed to the side of the hopper which vibrates in such a way that the cap which are poured into the hopper are aligned according to the required position. So that our gripper can hold the cap, to fix the cap in the condenser core suitably. The cap feeder has a guide vane through which the cap falls in a vertical tube so that the RD cap is placed according to the position in which the gripper holds to fix the cap in the condenser.

FIG 5.3.1. CAP FEEDERS

5.4. STEPPER MOTOR

A stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed. Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed- loop commutated. DC motor rotate continuously when DC voltage is applied to their terminals. The stepper motor is known by its property to convert a train of input pulses (typically square wave pulses) into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle. Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an external driver circuit or a micro controller. To make the motor shaft turn, first, one electromagnet is given power, which magnetically attracts the gear's teeth. When the gear's teeth are aligned to the first electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. From there the process is repeated. Each of those rotations is called a "step", with an integer number of steps making a full rotation. In that way, the motor can be turned by a precise angle.

5.5. RELAY

A relay is an electrically operated switch. Many relay use an electromagnetic to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first application of relays was in long telegraph lines, where the weak signal received at an intermediate station could control a contact, regenerating the signal for further transmission. A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. The armature is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board via the yoke, which is soldered to the PCB. Relays are used wherever it is necessary to control a high power or high voltage circuit with a low power circuit, especially when galvanic isolation is desirable. High-voltage or high-current devices can be controlled with small, low voltage wiring and pilots switches. Operators can be isolated from the high voltage circuit. Low power devices such as microprocessors can drive relays to control electrical loads beyond their direct drive capability. In an automobile, a starter relay allows the high current of the cranking motor to be controlled with small wiring and contacts in the ignition key.

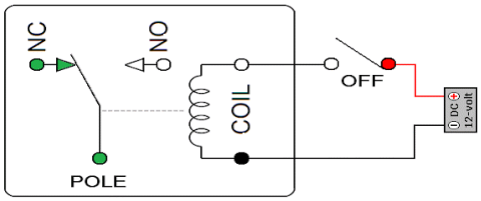

FIG 5.5.1 RELAYS

5.6. TRANSISTORS

The transistor is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. A transistor is used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled output power can be higher than the controlling input power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits. The transistor's low cost, flexibility, and reliability have made it a ubiquitous device. Transistorized mechatronic circuits have replaced electromechanical devices in controlling appliances and machinery. It is often easier and cheaper to use a standard microcontroller and write a computer program to carry out a control function than to design an equivalent mechanical system to control that same function. Transistors are commonly used in digital circuits as electronic switches which can be either in an "on" or "off" state, both for high- power applications such as switched-mode power supplies and for low-power applications such as logic gates. Important parameters for this application include the current switched, the voltage handled, and the switching speed, characterised by the rise and fall times.

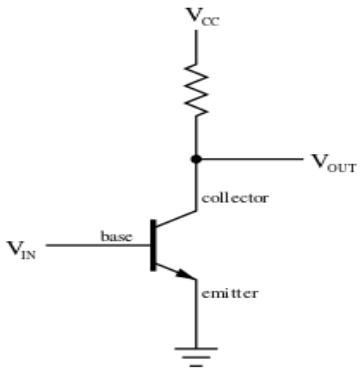

FIG 5.6.1 TRANSISTOR

5.7. 555 TIMER CIRCUIT

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide two or four timing circuits in one package. The purpose 555 timer in our proposal is to give the output power to the relay and the transistor which in turn energizes the relay coil which supplies the necessary voltage to the respective motors. The purpose of relay is to actuate the gripper and motors because it acts as a switch. The timer signals are used in simple applications such as traffic signals. In simple terms, the red light will glow for certain period which is being controlled by the timer circuit.

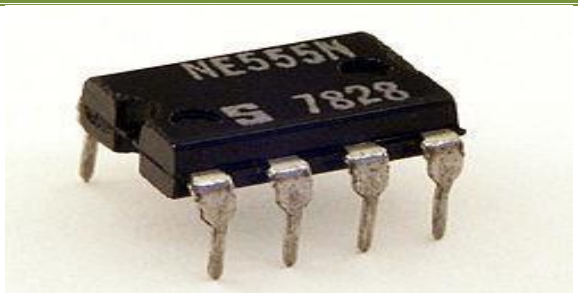

FIG 5.7.1. 555 TIMER CIRCUIT

6. Design of Components

The above discussed components are designed using solid works software.

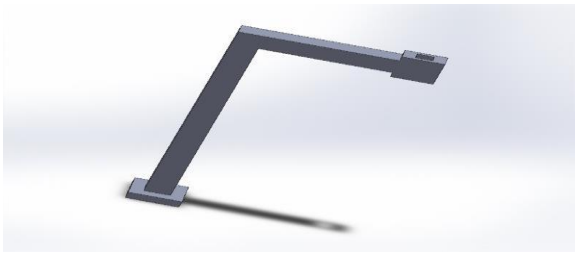

Fig 6.1 Frame

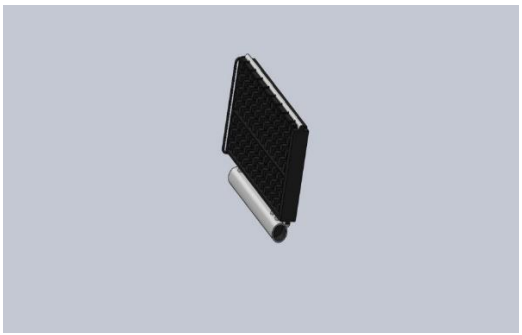

Fig 6.2 IRDS Condenser

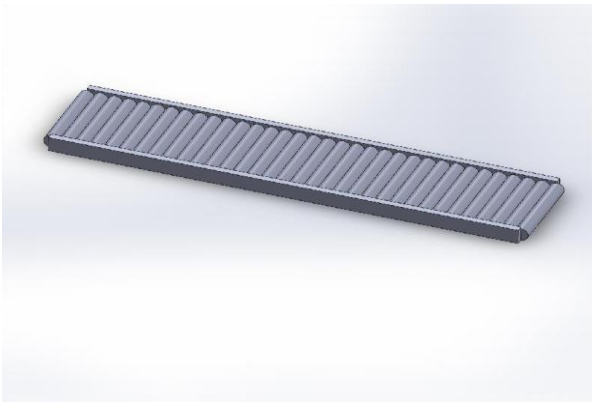

Fig 6.3 Conveyor

Fig 6.4 Part stand

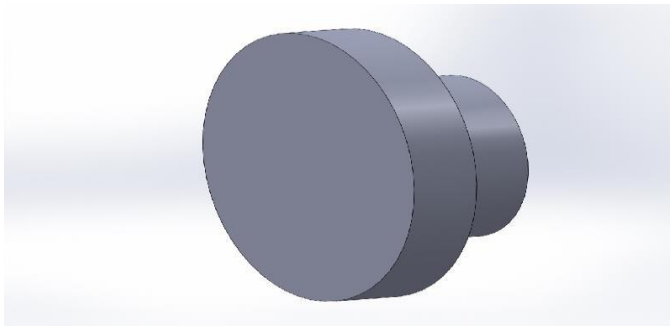

Fig 6.5 Cap

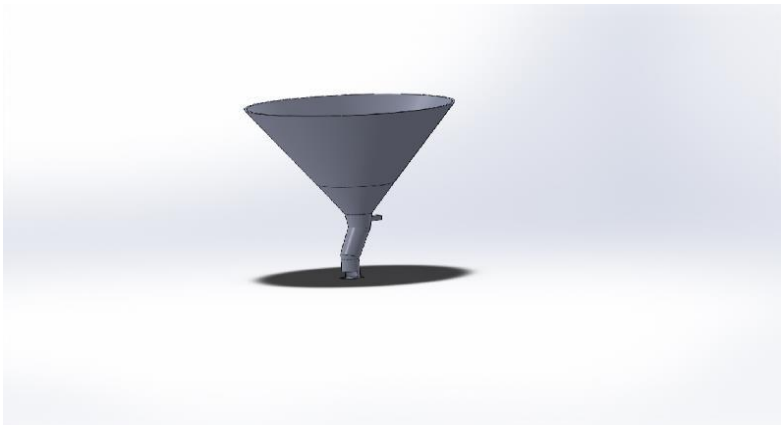

Fig 6.6 Cap feeder

7. Calculations

7.1 STEPPER MOTOR

P = 2 □NT / 60

P = POWER N = SPEED
T = TORQUE N = 800rpm
T = 10 kg-cm

P = (2π×800×9.81) / 60

= 49285.44 / 60

P = 0.821kw

7.2 DC MOTOR

P = 2 □NT / 60

P = POWER N = SPEED
T = TORQUE N = 1000rpm
T = 0.5N-m

P = (2π×1000×0.5) / 60

= 3140/60

P = 52.3w

7.3 MAN POWER CALCULATION For one working shift,

Labor Wage per manpower = Rs.8300

For three working shifts,

Labor Wages for three manpower = 3 * Rs.8300

= **Rs.24900 /month**

For 3 working places to fit RD cap = 3 * 24900

= **74,700 / month**

Hence,

Labor Wages for a year = Rs.74, 700 * 12 months

= **Rs.8, 96,400 / year**

Thus amount of Rs.74, 700 can be saved per month on considering the wages paid for the labors. So for a year an amount of Rs.8, 96, 400 can be saved. On implementation of this automatic process, amount could be one of the major criterion which can be saved. This reduces the operational cost ultimately.

8. Cost Estimation

TABLE 1. COST ESTIMATION OF COMPONENTS

S.NO	COMPONENTS	QUANTITY	COST (RS.)
1	SENSOR	1	1000
2	DC MOTOR	1	600
3	STEPPER MOTOR	2	2000
4	RELAYS	10	3000
5	TRANSISTORS	10	1500
6	SHAFT	2	500
7	TIMER CIRCUIT	9	1170
TOTAL			**9770**

9. Circuit Diagram

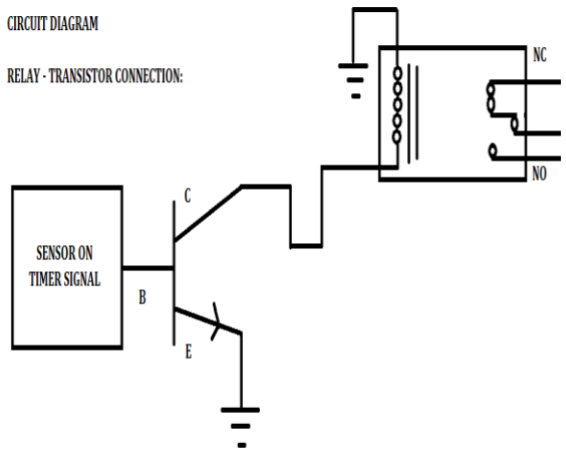

Fig 9.1 Circuit Diagram

The sensor sends the output signal to the timer circuit which inturn sends the signal to the transistors and from there, the output energy is sent to the relay. The relay consists of a normally open and a normally close conditions which allows to supply the power at required conditions. The timer circuit operates according to the time pinned in the circuit. So it supplies the power to the relay that helps in working of the motors and the other grippers to act accordingly. Once the sensor receieves the signal, the conveyor gets stopped and when the output is received from the sensor to the time circuit, the transistor and relay starts working. Then the required actions are carried out by the gripper and the motors accordingly. When the current process is finished, the conveyor starts moving and the further processes are repeated.

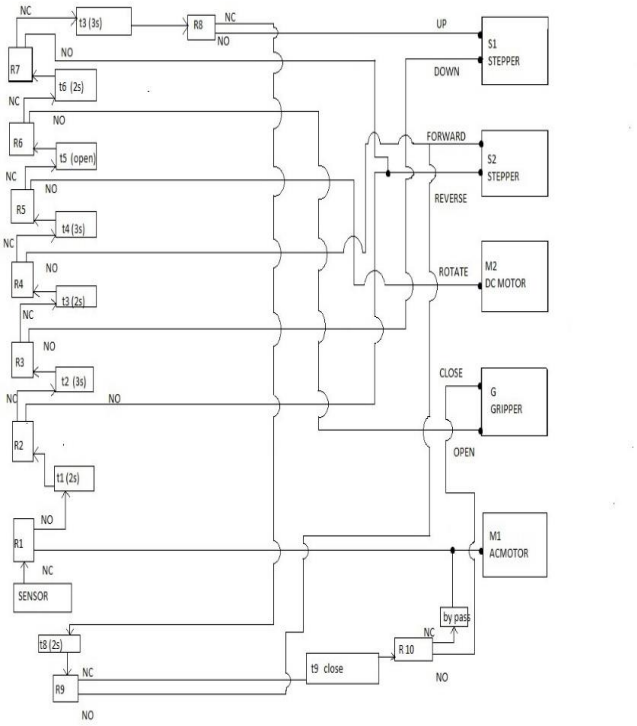

Fig 9.2 Circuit Diagram to Actuate the Pick and Place Arm

- R – Relay
- t – Timer circuit
- NO – Normally Open
- NC – Normally close
- S1 – Stepper motor1
- S2 – Stepper motor2

9.1 Circuit Explanation

The working of the above circuit is simple and elegant for its convenient performance. The conveyor keeps moving with conveyors in it. The sensor senses for the condenser, once the sensor senses the condenser the conveyor stops because the signal is send to the normally open conditions of the relay.The output of the relay1 gives the signal to the timer circuit1 which inturn gives the output to normally closed condition of the relay which helps in actuating the stepper motor1 to move the gripper backward along with the shaft. After that the power keeps flowing through the normally closed condition of the relay giving the output power to the timer circuit2 and the above process is repeated .

10. Conclusion

Before our proposal the receiver drier cap is fixed manually and it takes more time. Sometimes it may damage the fin so that the core gets damaged and the productivity gets decreased. Thus the automatic insertion of RD Cap increase the productivity and saves time. There is also a another advantage of using this automation. It requires only less skilled labor and the man power gets reduced. Thus by fixing the RD Cap the insulation of the tube is properly made. Before our proposal a tool called ' Desoutter' is used which is used to ensure the fixation of the RD Cap. But with our idea a simple mechanism with gripper is used to fix the cap which is controlled by the electrical circuits. This concept would benefit Hanon systems in achieving its goals.

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