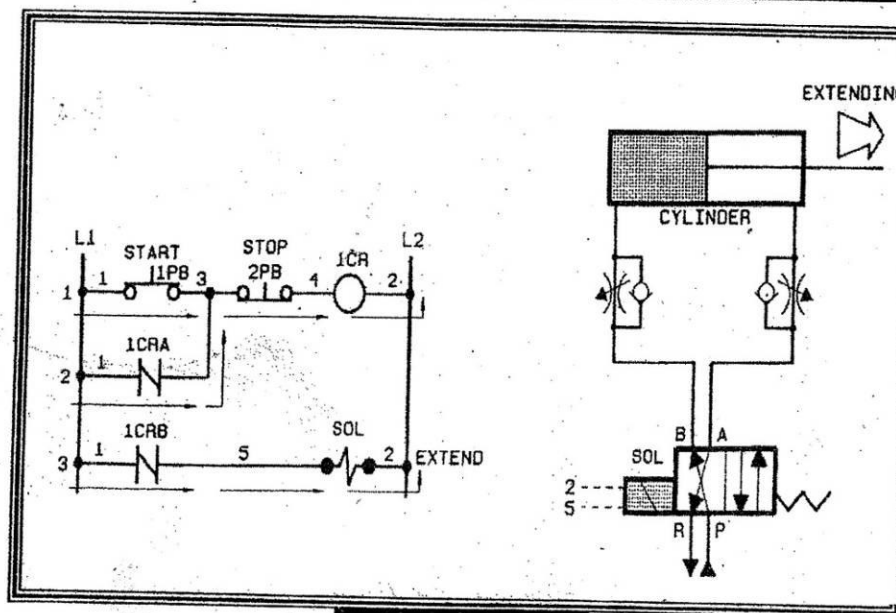


Reading Material on

Electro Hydraulics



**HUMAN RESOURCE DEVELOPMENT CENTRE
ROURKELA STEEL PLANT**

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SAFETY IN ELECTRO HYDRAULICS

When working with electrical controlled fluid power systems, the safety precautions for manual controlled hydraulic and pneumatic system still apply. In addition, you should also observe the following rules.

- NEVER hook up any electrical wires or change any connections while the electrical power is still on.

Always turn off the control power switch before setting up any circuits and changing any circuit connections.

- DO NOT allow any bare control wires or terminal connections to touch metal surfaces. This can cause you to get shocked when you touched the metal surfaces.
- DO NOT touch any bare electrical wires.
- Before you connect the main power cord, make sure the control power switch is in the off position.
- Keep surface clear of oil or grease. A spark from electrical system can cause oil-soaked materials to catch fire.

CONTROL LOGIC

The control signal used in electrical control circuits is the electricity itself flowing through the conductors and input devices to the output devices.

To form the control logic needed to perform machine operations, multiple input switches of various types can be wired together in certain configurations. There are six logic configurations that you will learn in this experiment. With this you will be able to develop circuits to perform industrial machine control sequences.

AND LOGIC

- *Normally open push button switches are wired in series.
- *both must close in order for the output to energized.

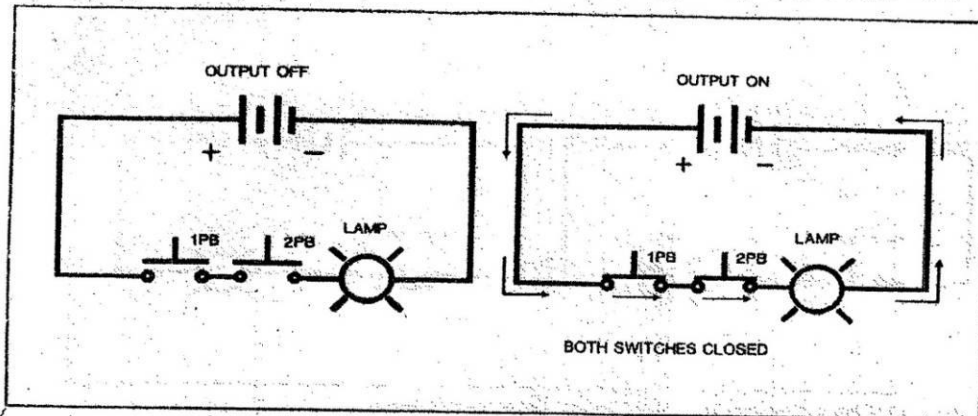


FIGURE 6. Two or more normally open switches wired in series form an AND logic element. In order for the output to energize, all input switches must close.

OR LOGIC

- *Two or more normally opened switches wired in parallel.
- *The out put is off when neither pushbutton is off.

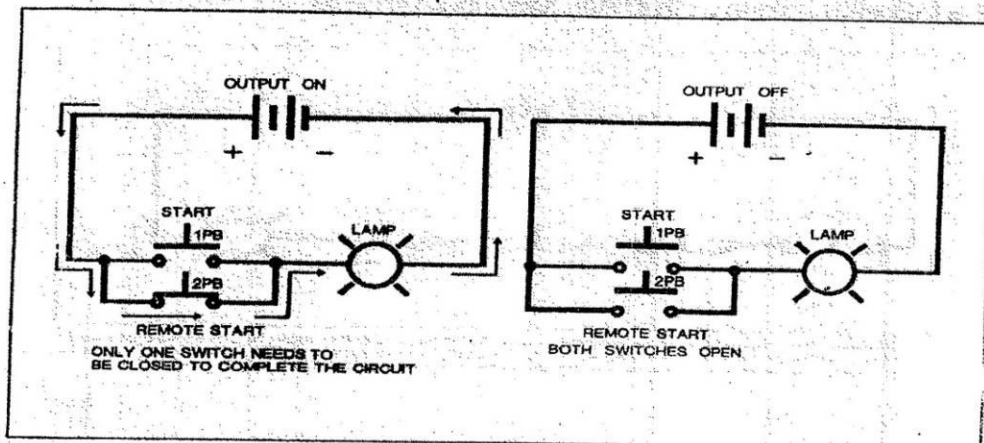


FIGURE 7. Two or more normally open switches wired in parallel form an OR logic element. In order for the output to energize only one of the inputs has to close.

NOT LOGIC

- *It is formed by a single normally closed switch.
- *The output is energized or on when the input switch is not actuated.
- * When the input is actuated , the output is not on.

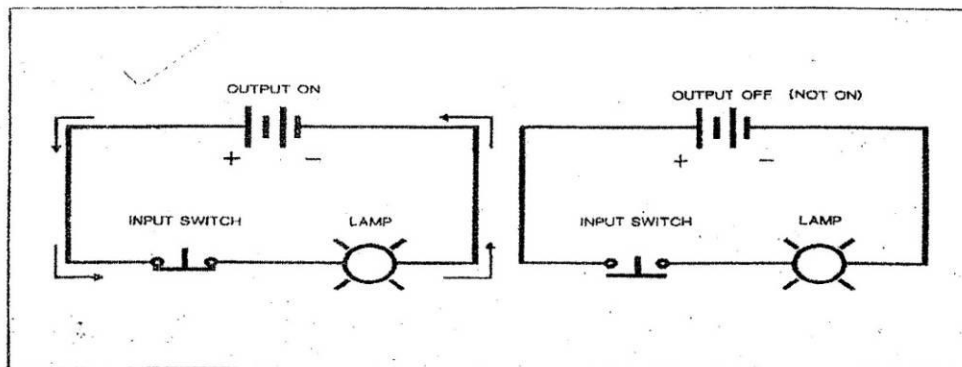


FIGURE 9. NOT logic is formed by a single normally closed input switch.

NOR LOGIC

- *Not logic can also be linked together in series to form NOR logic
- NOR logic consist two or more normally closed pushbutton wired in series to the output.
- It is frequently used to multiple stop pushbuttons in circuit.

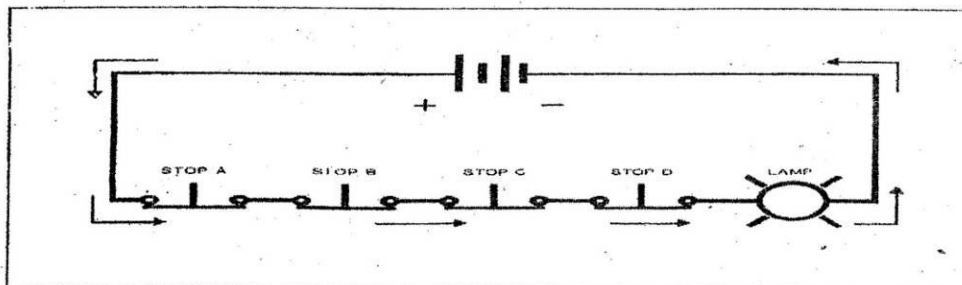


FIGURE 10. Circuits with multiple stop pushbuttons use NOR logic. NAND logic is composed of two or more normally closed input switches wired parallel to the output device. Illustrated in Figure 11, all three switches must be actuated in order for the output to NOT be on.

NAND LOGIC

- ⇒ NAND logic is composed of two or more normally closed pushbutton switches wired parallel to the output device.
- ⇒ All switches must be actuated in order to turn off the output.

MEMORY LOGIC

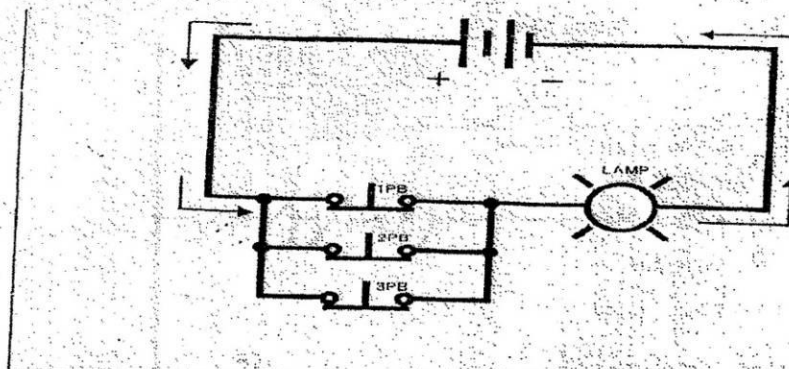


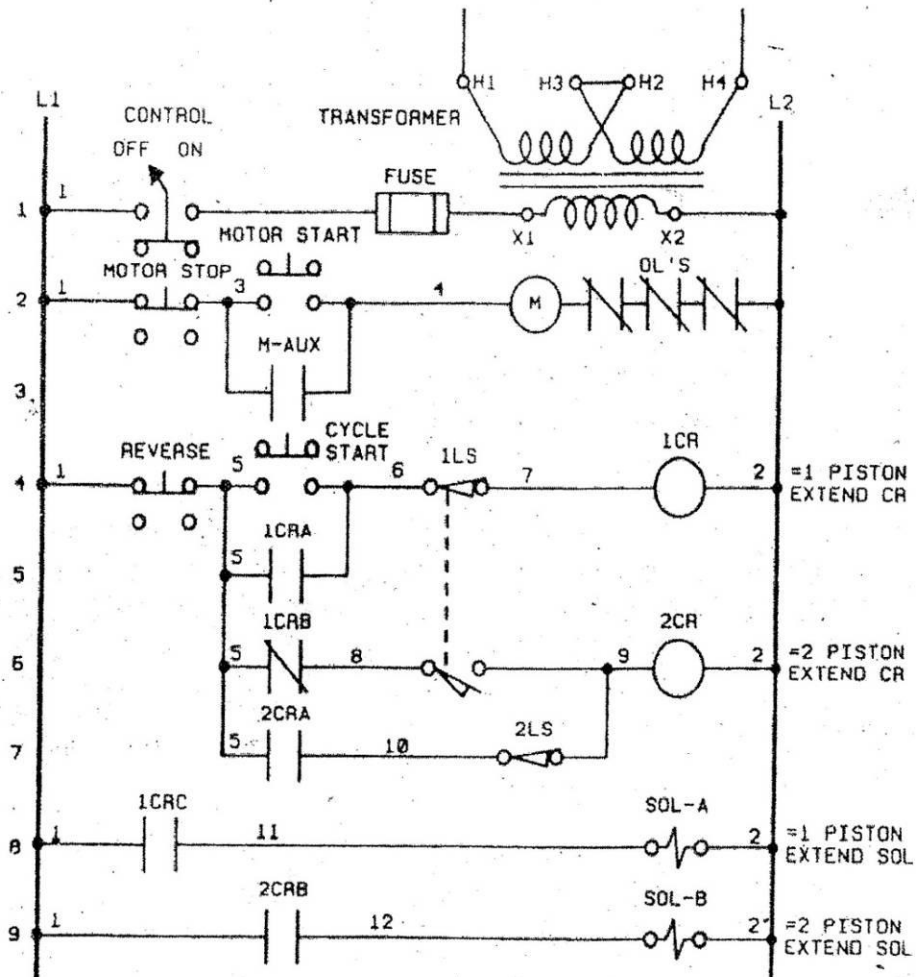
FIGURE 11: Normally closed switches wired in parallel must all be actuated in order to turn off the output.

The five logic elements introduced so far are made up of normally open and normally closed switches wired in either parallel or series. In all cases, the elements determine what input conditions have to occur before an output will come on. The sixth logic element, called MEMORY, performs a different function than the others. The memory logic function used to maintain an output energized even after the input signals that turned on the output have been removed.

LADDER DIAGRAM

- ⇒ This diagram is used to control most automatic sequences.
- ⇒ This diagram shows a schematic used to control a fluid power valve.
- ⇒ When the operator press 1PB, solenoid A energized causing the valve to shift and extend the cylinder.
- ⇒ Then the cylinder became fully extended, it actuates a limit switch causing the switch to close and turn on the lamp.
- ⇒ In ladder diagram the power source is bridge between the vertical lines or the "side rails" of the ladder.
- ⇒ The left side rail is the Hot side and is often called L1.
- ⇒ The right side is the ground side is often called L2.
- ⇒ All input switches are located on the rungs between L1 and the output device.

- ⇒ When the input switch in series on a rung close and form a close circuit to the output device the power flows from L1 to the output device causing it be energized.



Ladder Diagram Rules:

- ⇒ It shows only control device such as switch, solenoid and relays.
- ⇒ Output devices are located on right side such as lamp, solenoid and control relays.
- ⇒ Input devices are located left side such as push button, limit switch.
- ⇒ All rungs shall be numbered.
- ⇒ All components should be labeled with its functions i.e. Start and a abbreviation identified what it is i.e. PB.
- ⇒ At least one switch per line. (if there are no switch on a rung and only an output device, the output would always be on)
- ⇒ Only one Load per Rung.
- ⇒ Vertical Lines represent Power.

Control Relay:

The device most often used to perform the memory function in electromechanical relay circuits is the CONTROL RELAY. The control relay is the key component by most electromechanical component circuits to sequence a series of machine operations.

The relay is used in electrical control circuit to perform a number of different functions but is most often used as a memory logic element.

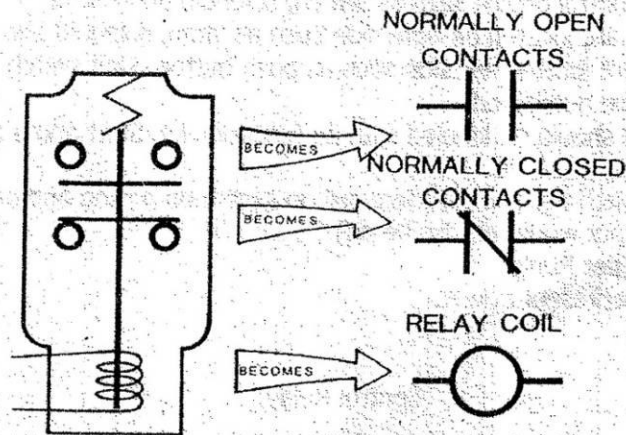
In this function the relay holds outputs energized even after the inputs have been removed.

Basic Operation:

An electromechanical relay consist of a solenoid coil and one or more sets of normally open NO and normally closed NC contacts. When the relay's solenoid coil is energized, it shifts the contacts to the opposite state. NO contacts go closed and NC contacts go opened. When the solenoid is de-energized.

PICTORIAL DRAWING

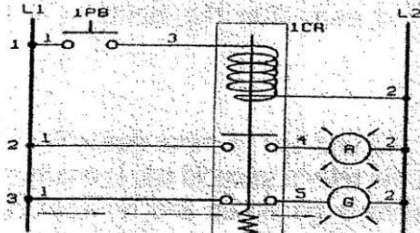
DETACHED SYMBOLOGY



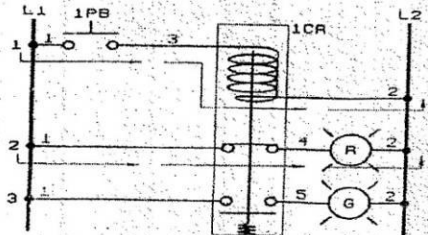
3. Pictorial Drawing and Corresponding Ladder Diagram Symbols of a Control Relay

PICTORIAL DIAGRAM

NORMAL CONDITION

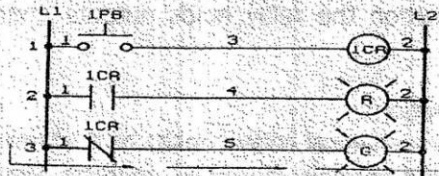


ENERGIZED CONDITION

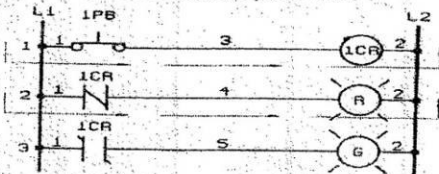


LADDER DIAGRAM

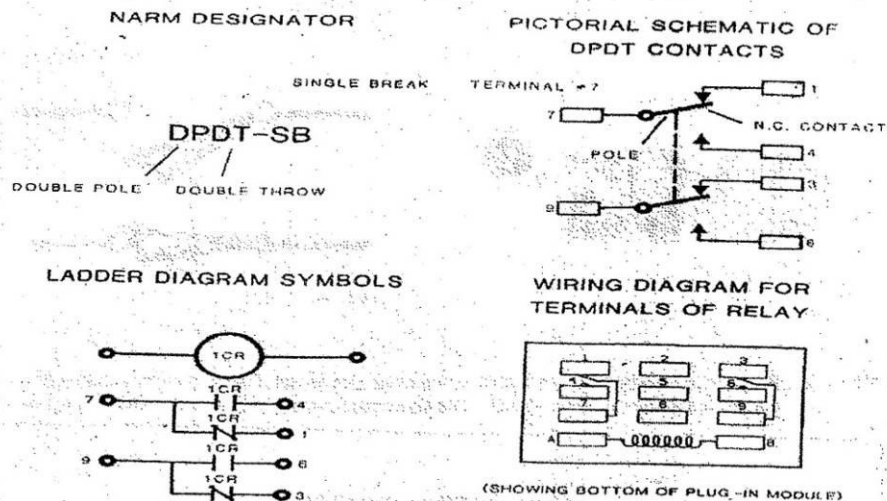
NORMAL CONDITION



ENERGIZED CONDITION



URE 4. Operation of a Control Relay Circuit Using Detached Symbology and Pictorial Symbology



JRE 7. Designations and Schematics of Amatrol 850 Series Control Relay as Accepted by the NEMA (National Association of Relay Manufacturers)

Limit Switches:

- ⇒ A limit switch is an input device used on automatic machines to sense the position of a machine member by mechanical means and convert it into an electrical signal.
- ⇒ This electrical signal is then used by the control logic to initiate a new step in the machines sequence.
- ⇒ As its construction is simple, reliable and low in cost the limit switch is by far the most frequently used input device on automatic machines.

Operation:

- ⇒ A limit switch consists of an actuating mechanism and a electric-switch. The popular type actuating mechanism is roller arm is pushed over by a movement of a machine member, it actuates the switch inside. If the switch has both NO and NC contacts, the NO contact go closed and the NC contact go opened. If the machine member moves away from the roller arm an internal spring moves the arm back to its original position and the contacts of the switch revert to the normal position.

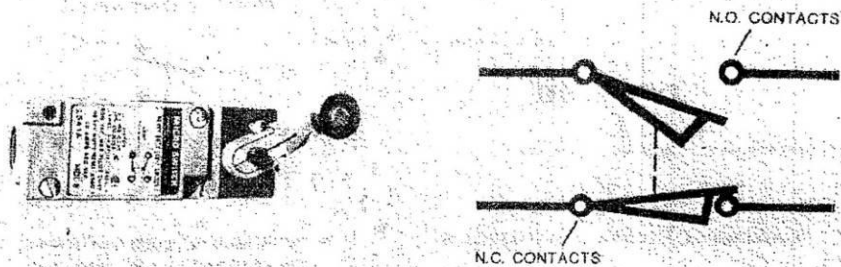


FIGURE 2. A heavy duty industrial limit switch with a roller arm actuator is used in the Amatrol 800 series electro-fluidpower training system. The schematic symbol indicates the switch has one set of

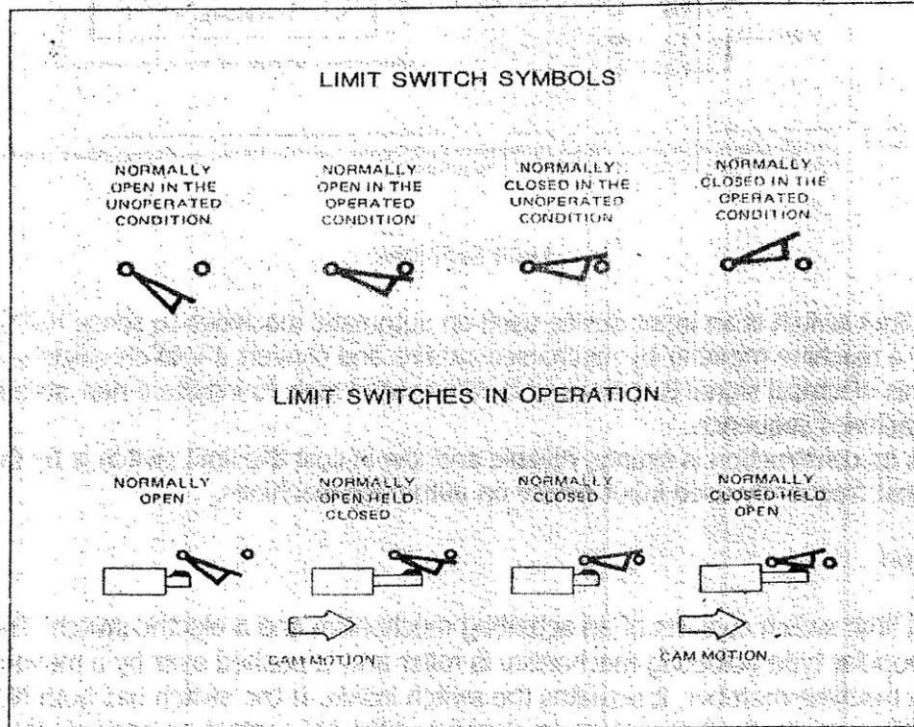


FIGURE 6. Ladder diagram symbols for normally open and normally closed limit switches can be shown in either the normal or held states.

Time-delay relay

The time delay –relay is a type of control relay that switches its contacts to a new state after a predetermined time has elapsed.

It is popularly used in fluid power applications to sequence cylinder operation, cause a dwell between steps in a sequence.

Operations

A time –delay or timer relay consists of a coil, one or more NO or NC contacts and a timing mechanism.

It can be designed to have either ON -DELAY or OFF – DELAY operation.

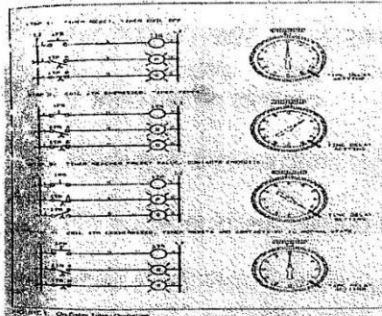
ON-DELAY

Step -1, When the coil 1TR deenergized in step 1, the timer relay contacts are in their normal states and the internal clock is reset to zero.

Step-2, The 1 TR is energized, this cause timer internal clock to run but the contacts remain in their normal states.

Step-3, The timers internal clock has reached a preset time and the relay contacts energized. The relay contacts will energized as long as coil 1 TR is energized.

Step-4, When the coil is de-energized, the contacts will immediately return to their normal state and the clock resets to zero.



OFF-DELAY

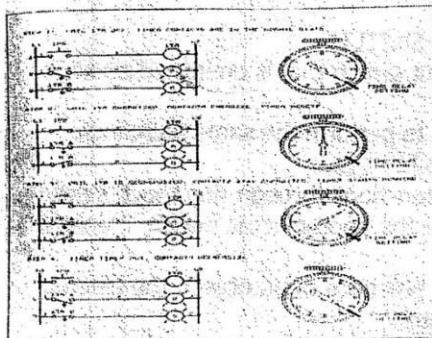
The off-delay time relay operations in a manner that is opposite to the on-delay timer just descry bed.

Step -1, the timer relay contacts deenergized when the 1 TR is OFF.

Step-2, These contacts will remain energized as long as the coil is energized. the internal clock of the OFF DELAY timer relay does not run while the coil is energized.

Step-3, when the coil 1 TR deenergized, the internal clock starts running.

You should notice, however, that the contacts remain energized. When the internal clock reaches some preset time, the timer contacts then return to their normal state.



PRESSURE SWITCH

The pressure switch is a type of electrical input switch that is actuated by pressure. When the pressure rises a pressure level the contacts of pressure switch are actuated causing some new machine action to occur.

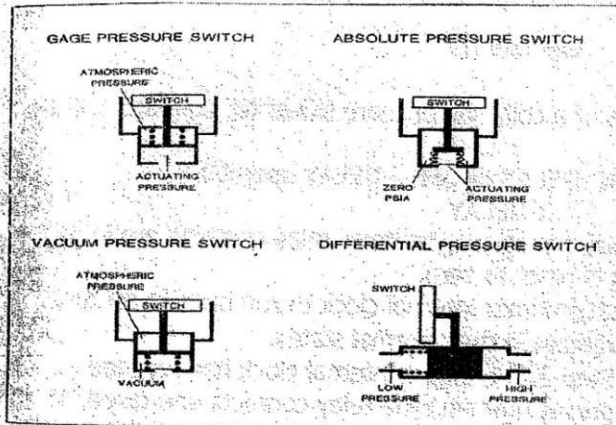


FIGURE 4: The four main types of pressure switches are gage, absolute, vacuum, and differential

Pressure switches perform the same basic logic functions in a circuit as limit switches.

They function cylinder sequencing, safety interlocking, and ON/OFF control. almost any machine that uses fluid power can potentially use a pressure switch.

PRESSURE SWITCH OPERATION

⇒ The pressure switch consists of two basic parts:

- ⇒ an actuating mechanism and an electrical switch.
- ⇒ The actuating mechanism of the pressure is plunger attached to a diaphragm.
- ⇒ The diaphragm is in direct contact with the fluid.
- ⇒ As the pressure rises, the diaphragm flexes and pushes the plunger up towards the switch.
- ⇒ When pressure rises some preset level, the plunger will actuate the switch. This preset level where the switch is actuated is most often called the **SET POINT**.
- ⇒ The set point of the pressure switch can be adjusted by turning the hex nut on the diaphragm cartridge assembly. What this does is to compress a spring that resists the movement of the plunger.
- ⇒ The more the spring is compressed, the higher the set point pressure will be.
- ⇒ Turning the hex nut of the pressure switch clockwise will increased the pressure point.

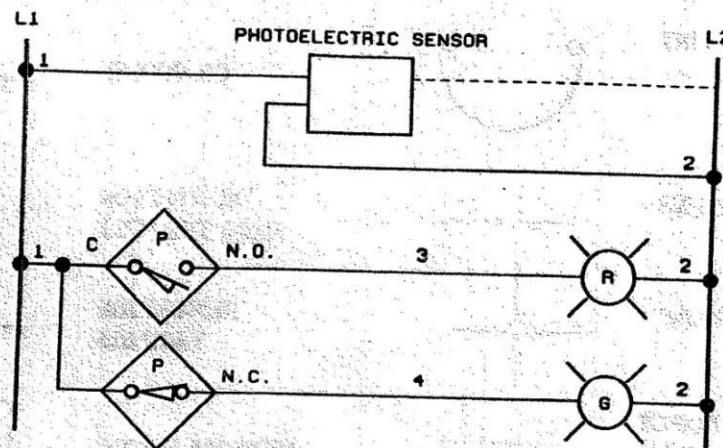
PHOTO ELECTRIC SWITCH

- ⇒ The photo electrical switch is a type of input switch that is energized by a light beam.
- ⇒ It is used in machine control applications to perform the same basic logic functions as a limit switch or pressure switch.
- ⇒ However, it has the ability to perform the functions through non touch sensing.
- ⇒ When a light beam from some source strikes the photoelectric switch, it energizes the contacts of the switch.
- ⇒ When the light beam is interrupted by the presence of an object, the electric contacts are switched to their opposite state.

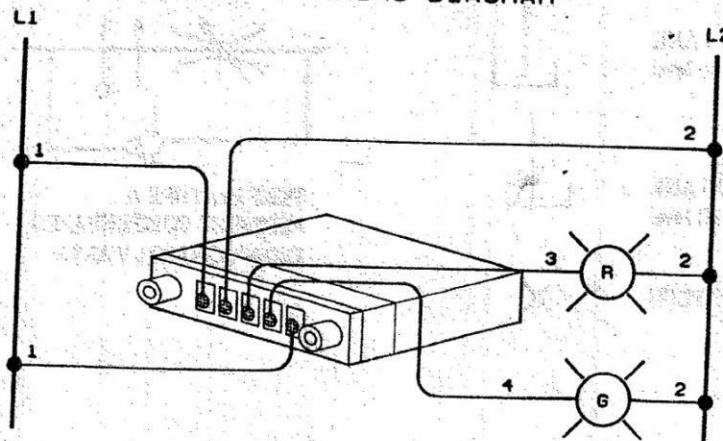
PHOTOELECTRIC SWITCH OPERATION

- ⇒ A photo electric switch consist of three basic components; light source, receiver, and one or more electrical switch contacts.
- ⇒ When the light source is aimed directly at the receiver the light beam cause a photo diode inside the receiver to energize the electrical switch contacts.
- ⇒ If an object interrupts the light beam the electrical switch contact return to their normal state.












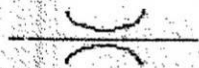



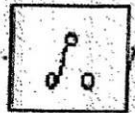

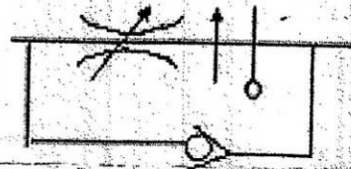


LADDER DIAGRAM



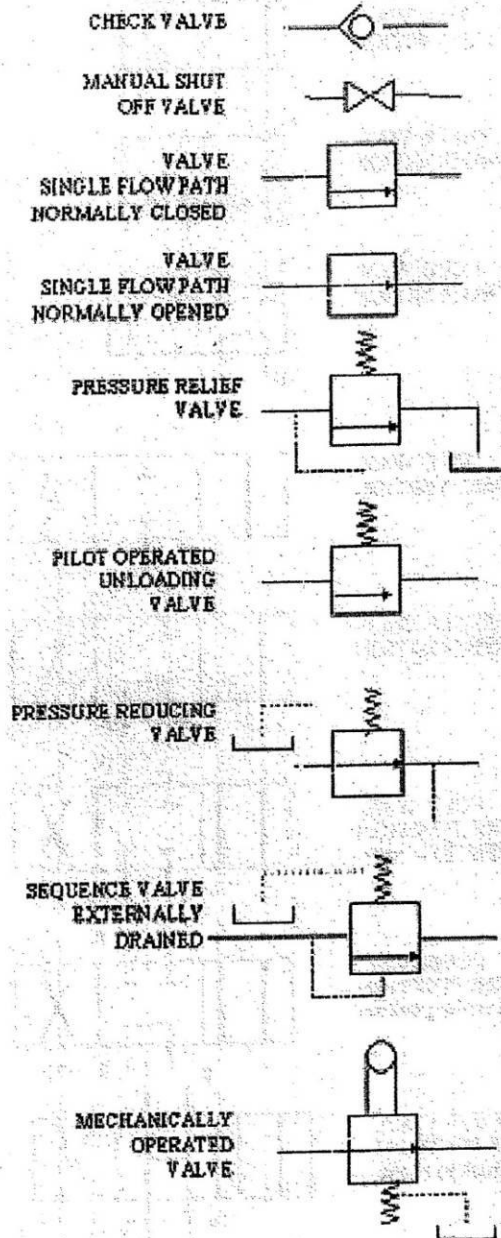
ACTUAL WIRING DIAGRAM



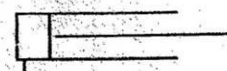
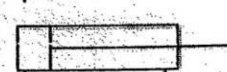
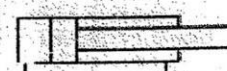
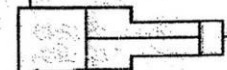
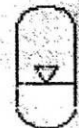
HYDRAULIC STANDARD GRAPHICAL SYMBOLS

LINE		PRESSURE GAUGE	
PILOT LINE		TEMPERATURE GAUGE	
DRAIN		FLOW METER	
CONNECTOR		FILTER OR STRAINER	
FLEXIBLE LINE		OIL COOLER	
JOINING LINE		RESTRICTION FIXED THROTTLE	
PASSING LINE		RESTRICTION VARIABLE	
DIRECTION OF FLOW		PRESSURE SWITCH	
LINE TO TANK above oil level		TEMPERATURE & PRESSURE COMPENSATED FLOW CONTROL VALVE	
LINE TO TANK below oil level			
PLUG			

BASIC VALVE SYMBOLS

PUMP, MOTOR, CYLINDERS
ACCUMULATOR SYMBOLS

ELECTRIC MOTOR

SINGLE PUMP
FIXED
DISPLACEMENTSINGLE PUMP
VARIABLE
DISPLACEMENTHYDRO-MOTOR
FIXED
DISPLACEMENTHYDRO-MOTOR
VARIABLE
DISPLACEMENTCYLINDER
SINGLE ACTINGCYLINDER
DOUBLE ACTINGCYLINDER
DIFFERENTIAL
RODPRESSURE
INTENSIFIERACCUMULATOR
GAS CHARGED
DIAPHRAGMACCUMULATOR
GAS CHARGED