

TPMC DEVICE

TYRE PRESSURE MONITORING AND CONTROLLING DEVICE

NOTE :- (TPMS) tyre pressure monitoring system is already developed , this device can only monitor the pressure .but with the use of (TPMC) people can fill air in the tyre by pressing button from the dashboard of car .

NOTE:-(TPMC) is similar to central tyre inflating system(CTIS) , but it's small in size , affordable , low cost, it's construction is different ,can be install in any car.

TPMC :- It is stand for tyre pressure monitoring and controlling device.

in this era of modernization every things are going towards automation .so with the help of embedded system, I have developed new type of device which is called TPMC.

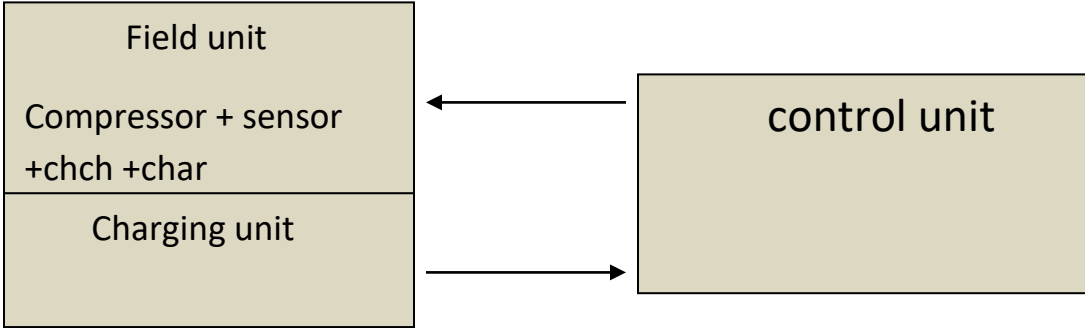
TPMC is an electronic system to monitor the tyre pressure or controlling in the wheels of the car. It consist sensor with mini compressor system on the internal circumference of the cars tyre.

Air supply pipe check on the tyre nozzle whenever there is reduction in the air pressure or any leakage due to puncture, the sensor wirelessly report the

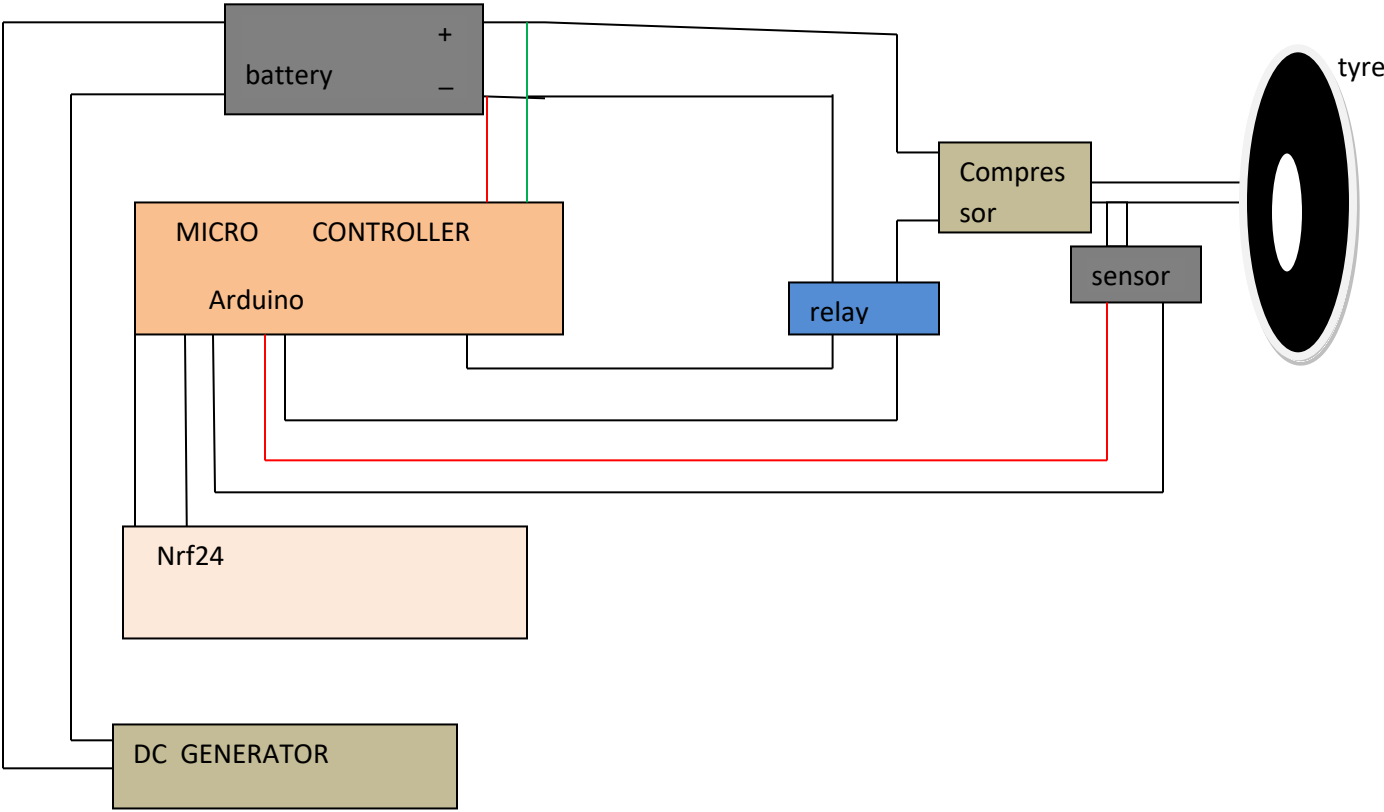
situation in the driver monitoring system . The compressor helps driver to maintain the tyre pressure, driver can operate it manually .

In case of emergency or puncture it gives warning by red led indicator.

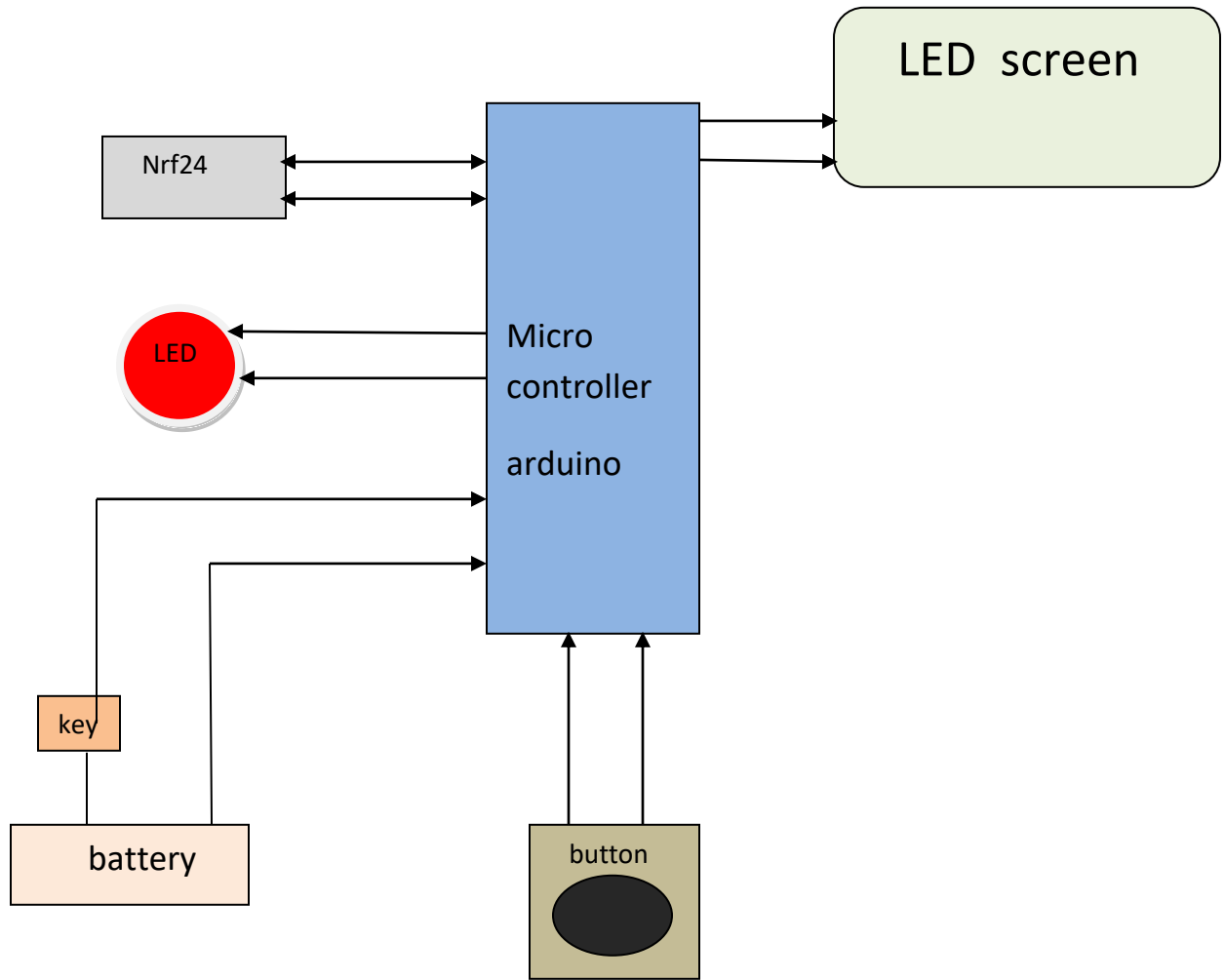
Block diagram:-TPMC is divided into two parts control unit and field unit.



➤ **FEILD UNIT :- Block diagram of field unit.**



- **CONTROLL UNIT : block diagram of control unit.**



TPMC working:-

When driver start the car then control unit become active , Suppose monitor showing there is low pressure in tyre. When driver push the button then control unit send signal to field unit hardware , then field unit give high signal to dc compressor(12 volt dc compressor). when 12v dc motor starts it give motion to circular gear and circular gear gives motion to compressor piston, then piston compress the air with the help of cylinder and send towards tyre nozzle .

And nozzle of TPMC fitted with the nozzle of tyre. TPMC nozzle keeps pressed the valve key of tyre and keeps all the nozzle of tyre isolated i.e, no air can come out side of tyre.

Charging unit helps to charge battery of field unit. This unit attached with wheel and its shaft attached with stator shaft of car that is axis shaft.

Control unit

This is the main unit from where the driver can control field unit. It consist screen which shows us the pressure of tyre, LED which shows as the emergency condition like during puncture, low pressure ,push button driver can control pressure by pressing push button drive can activate compressor.

TPMC use wireless communication to send command from control unit to field unit and from field unit to control unit.

Nrf24L01 :- nRF24L01+ is a single-chip radio transceiver for the worldwide 2.4-2.5 GHz ISM band. The radio transmitters and receivers include frequency generator, enhanced Shock Burst mode controller, power amplifier, crystal oscillator modulator and demodulator. we can select the output power channel and protocol by setting through the SPI port. The current consumption for the nRF24L01+ is extremely low - under the transmitter mode, when the transmitting power is 0dBm, the current consumption is only 11.3mA; under the receiving mode, it is 13.5mA; under the power down and idle mode, the consumption is even lower.

1. nRF24L01+ is a single-chip radio transceiver for the worldwide 2.4-2.5 GHz ISM band, suitable for Arduino .
2. Supports 6-channel receiving, with a transmission speed of up to 2Mbps.
3. Multi-frequency point: With 125 frequency points, it can meet multipoint communication and frequency hopping communication requirements.
4. Ultra-small: 24*15mm, with built-in 2.4GHz antenna.
5. Easy to develop: the link layer is fully integrated on the module, making it easy for development.

LCD MODULE:-

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

Command register stores various commands given to the display. Data register stores data to be displayed. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. In your arduino project LCD simplifies this for you so you don't need to know the low-level instructions. Contrast of the display can be adjusted by adjusting the potentiometer to be connected across VEE pin.

Arduino nano:-

The **Arduino Nano** is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B micro-USB cable or from a 9 V battery

In 2019, Arduino released the **Arduino Nano Every**, a pin-equivalent evolution of the Nano. It features a more powerful ATmega4809 processor and twice the RAM.

- Microcontroller: Microchip ATmega328P
- Operating voltage: 5 volts

- Input voltage: 6 to 20 volts
- Digital I/O pins: 14 (6 optional PWM outputs)
- Analog input pins: 8
- DC per I/O pin: 40 mA
- DC for 3.3 V pin: 50 mA
- Flash memory: 32 KB, of which 0.5 KB is used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock speed: 16 MHz
- Length: 45 mm
- Width: 18 mm
- Mass: 7 g

Working of control unit:-

When field unit send data to control unit via radio communication , control unit display that data. Suppose there is low pressure in tyre control unit indicate by red LED . When driver press the push button control unit send high signal to field unit and field unit give high signal to compressor pin.

Here both the control unit and field unit communicating with radio communication.

Field unit

Sensor :-

A pressure sensor is a transducer or instrument that converts an input mechanical pressure in gases or liquids into an electrical output signal. A pressure transducer consists of a pressure-sensitive element that can measure, detect or monitor the pressure being applied and electronic components to convert the information into an electrical output signal.

Pressure is defined as the amount of force (exerted by a liquid or gas) applied to a unit of "area" ($P=F/A$), and the common units of pressure are Pascal (Pa), Bar (bar), N/mm² or psi (pounds per square inch). Pressure transducers often utilize piezoresistive technology, as the piezoresistive element changes its electrical resistance proportional to the strain (pressure) experienced.

- ❖ **Relay:-** A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit.

A simple relay consists of wire coil wrapped around a soft iron core, or solenoid, an iron yoke that delivers a low reluctance path for magnetic flux, a movable iron armature and one or more sets of contacts. The movable armature is hinged to the yoke and linked to one or more set of the moving contacts. Held in place by a spring, the armature leaves a gap in the magnetic circuit when the relay is de-energized. While in this position, one of the two sets of contacts is closed while the other set remains open.

When electrical current is passed through a coil, it generates a magnetic field that in turn activates the armature. This movement of the movable contacts makes or breaks a connection with the fixed contact. When the relay is de-energized, the sets of contacts that were closed, open and breaks the connection and vice versa if the contacts were open. When switching off the current to the coil, the armature is returned, by force, to its relaxed position. This force is usually provided by a spring,

but gravity can also be used in certain applications. Most power relays are manufactured to operate in a quick manner

Battery:- A **battery** is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

❖ **Compressor:-**

It is the most important part of our (TPMC) device , the main function of this device is fill air on tyre. So, in simple ways compressor is a mechanical device that increases the pressure by decreasing its volume.

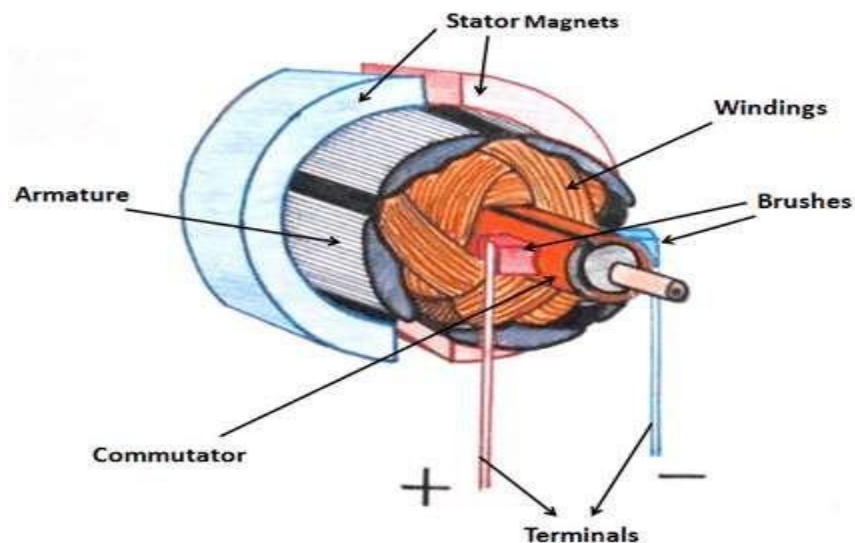
This is 12 volt dc operated compressor with rolling piston system, it's small in size.

➤ **Parts of compressor:-the the compressor is divided into three main parts 1)dc motor. 2) compressor section. 3)nozzle.**

- **Dc motor :-** A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation.

Different Parts of a DC motor

A DC motor is composed of the following main parts::



Armature or Rotor

The armature of a DC motor is a cylinder of magnetic laminations that are insulated from one another. The armature is perpendicular to the axis of the cylinder. The armature is a rotating part that rotates on its axis and is separated from the field coil by an air gap.

Field Coil or Stator

A DC motor field coil is a non-moving part on which winding is wound to produce a magnetic field. This electro-magnet has a cylindrical cavity between its poles.

Commutator and Brushes

Commutator

The commutator of a DC motor is a cylindrical structure that is made of copper segments stacked together but insulated from each other using mica. The primary function of a Commutator is to supply electrical current to the armature winding.

Brushes

The brushes of a DC motor are made with graphite and carbon structure. These brushes conduct electric current from the external circuit to the rotating commutator. Hence, we come to understand that the **commutator and the brush**

unit are concerned with transmitting the power from the static electrical circuit to the mechanically rotating region or the rotor

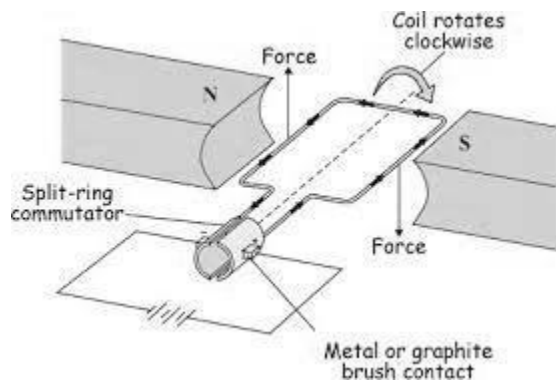
Working principle of DC motor

When kept in a magnetic field, a current-carrying conductor gains torque and develops a tendency to move. In short, when electric fields and magnetic fields interact, a mechanical force arises. This is the principle on which the DC motors work.

DC Motor Working Explained

In the previous section, we discussed the various components of a DC motor. Now, using this knowledge let us understand the working of DC motors.

A magnetic field arises in the air gap when the field coil of the DC motor is energized. The created magnetic field is in the direction of the radii of the armature. The magnetic field enters the armature from the North pole side of the field coil and “exits” the armature from the field coil’s South pole side.



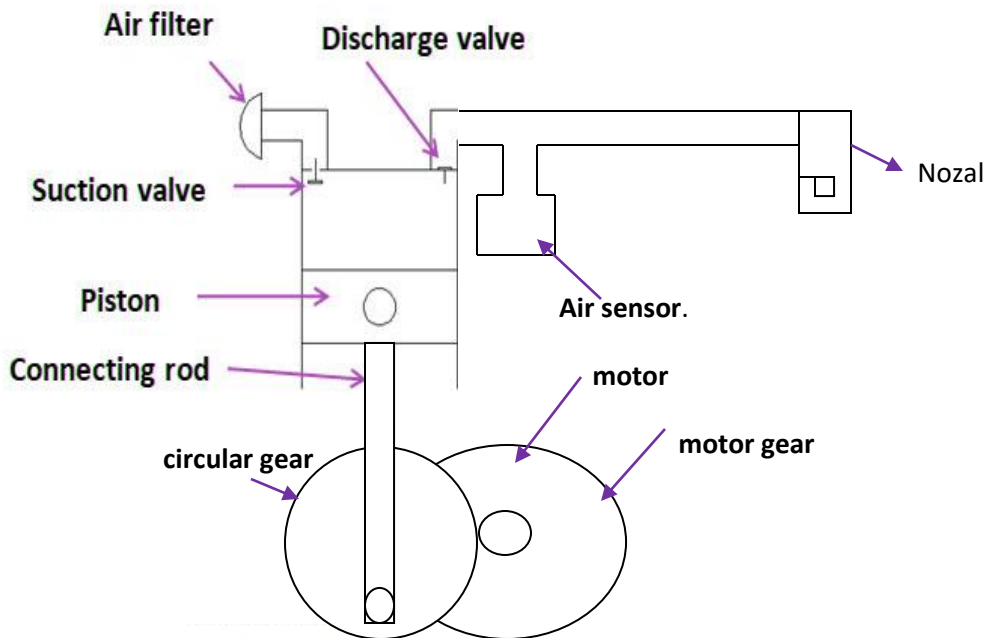
The conductors located on the other pole are subjected to a force of the same intensity but in the opposite direction. These two opposing forces create a torque that causes the motor armature to rotate.

- **Compressor section:-**

A reciprocating air compressor is a type of positive displacement compressor that uses a piston to transfer the high-pressure gases into the cylinder. In these types of air compressors, initially, the gas enters from the suction. This gas is flowing through a compression cylinder where it gets compressed by an attached piston, and it is released.

Reciprocating air compressors work on the principle of reciprocation, which means to move something back and forth. Also known as piston compressors, these machines are positive displacement equipment, meaning that they increase pressure in air to compress it.

Part of compressor section:- In the reciprocating air compressor, the piston moves to BDC and air is sucked into a cylinder from the atmosphere and moves it to the TDC. The compression of air starts and increasing and pressure is also increasing. After reaching the limit of the pressure the discharge open and the compressed air is flowing through to the storage tank.



Main Parts of Reciprocating Air Compressor

Piston: It has reciprocating motion in the cylinder and it compresses the air.

Cylinder: The air is compressed in the cylinder.

Connection Rod: This connects the piston and crankshaft.

Circular gear: This is connected to the gear of the electric motor and transfers rotary motion to the piston.

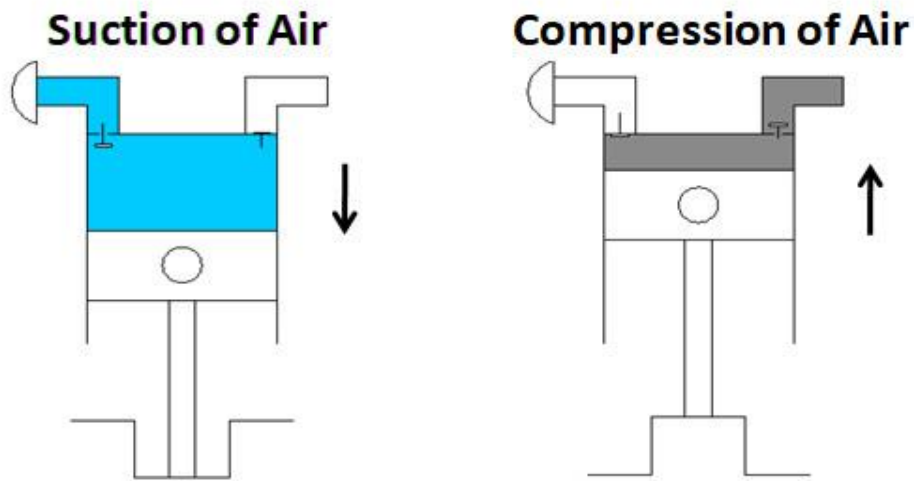
Suction valve: Air is sucked through a suction valve when the piston moves to BDC.

Discharge valve: Compressed air is discharged through the discharge valve to the storage tank.

Motor gear:- primary gear that provide circular motion to circular gear.

Motor :- source of motion it provide motion to motor gear.

Working:- The reciprocating air compressor is powered by an electric motor



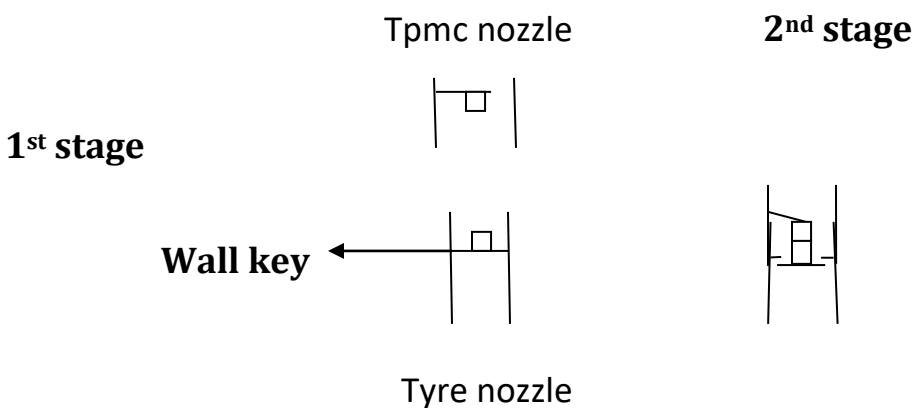
Single Stage Reciprocating Air Compressor

NOTE:- in TPMC I used single stage only.

When the power is on, the electric motor starts rotating and rotates the crankshaft which is attached to it and the piston starts moving to and fro motion inside a cylinder. The piston is moved downward the air from the atmosphere enters into the cylinder chamber.

❖ Nozzle:-

This is the part of TPMC device, simply the nozzle of TPMC is permanently connected to the nozzle of the tyre. The nozzle of the device works by continuously pressing the wall key of the tyre. When the wall key is pressed by the nozzle, the pressure goes from higher pressure to lower pressure, i.e., pressure goes from the tyre to the device and when the pressure goes, then the pressure sensor gets data and sends it to the microcontroller.

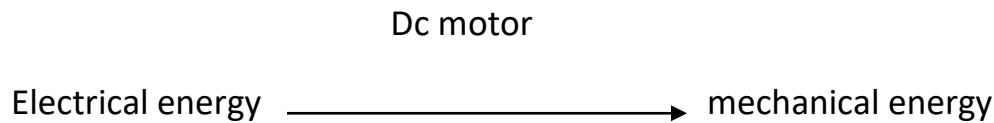


❖ Charging unit:-

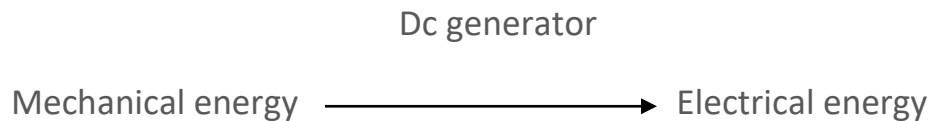
Charging unit helps to charge the battery through which our whole (TPMC) device depends.

Charging unit consist concept of dc generator for this part I have used 6volt dc motor

As we know that , when we apply current on dc motor it gets starts rotating, that means here electrical energy converts into mechanical energy.



Now , when we rotate the rotor part without help of electrical energy then mechanical energy converts into electrical energy.



➤ Charging unit Working:-

The rotor of the DC generator connected parallel with the stator part axial shaft of car when car runs DC generator rotor also rotate and then mechanical energy converted into electrical energy and with the help of diode generated current flows from generator to battery.

Construction of charging unit-

DC generator is using for charging unit, there are two terminal of Dc generator positive(+), negative(-).

one Terminal Is directly connected to terminal of battery and second terminal connected first with resistor and with diode 4007 in series and then terminal of diode connects to terminal of battery. Which make generator current unidirectional.

Dc generator:-

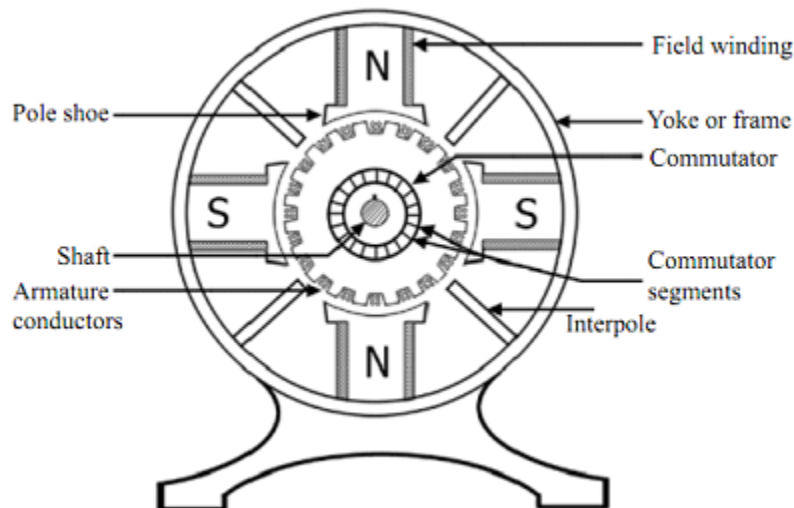
A direct-current (DC) generator is a rotating machine that supplies an electrical output with unidirectional voltage and current. The basic principles of operation are the same as those for synchronous generators. Voltage is induced in coils by the rate of change of the magnetic field through the coils as the machine rotates. This induced voltage is inherently alternating in form since the coil flux increases and then decreases, with a zero average value.

The field is produced by direct current in field coils or by permanent magnets on the stator. The output, or armature, windings are placed in slots in the cylindrical iron rotor. A simplified machine with only one rotor coil is shown . The rotor is fitted with a mechanical rotating switch, or commutator, that connects the rotor coil to the stationary output terminals through carbon brushes. This commutator reverses the connections at the two instants in each rotation when the rate of change of flux in the coil is zero—i.e., when the enclosed flux is maximum (positive) or minimum (negative). The output voltage is then unidirectional but is pulsating for the simple case of one rotor coil. In practical 2-pole machines, the rotor contains many coils symmetrically arranged in slots around the periphery and all connected in series. Each coil is connected to a segment on a multi-bar commutator. In this way, the output voltage consists of the sum of the induced voltages in a number of individual coils displaced around half the periphery. The magnitude of the output voltage is then approximately constant, containing only a small ripple. The voltage magnitude is proportional to the rotor speed and the magnetic flux. Control of output voltage is normally provided by control of the direct current in the field

Parts of Dc generator:-

A DC machine consists of two basic parts; stator and rotor. Basic constructional parts of a DC machine are described below.

1. **Yoke:** The outer frame of a dc machine is called as yoke. It is made up of cast iron or steel. It not only provides mechanical strength to the whole assembly but also carries the magnetic flux produced by the field winding.
2. **Poles and pole shoes:** Poles are joined to the yoke with the help of bolts or welding. They carry field winding and pole shoes are fastened to them. Pole shoes serve two purposes; (i) they support field coils and (ii) spread out the flux in air gap uniformly.

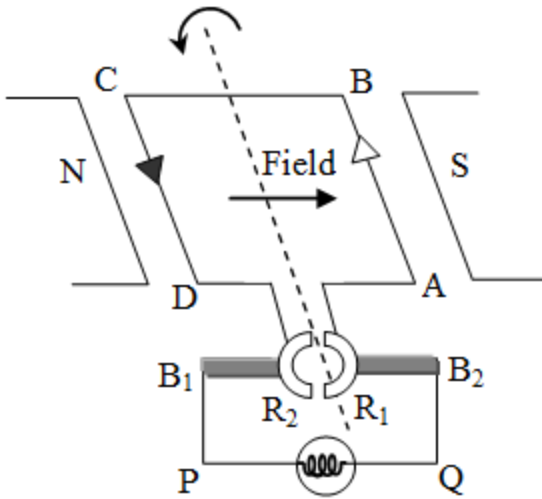
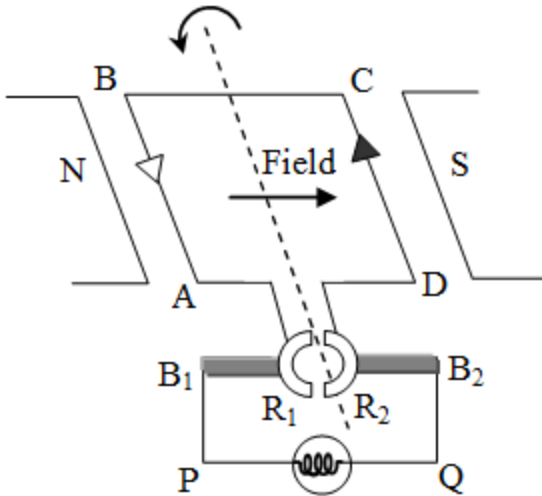


3. **Field winding:** They are usually made of copper. Field coils are former wound and placed on each pole and are connected in series. They are wound in such a way that, when energized, they form alternate North and South poles.

4. **Armature core:** Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding. The armature is built up of thin laminated circular steel disks for reducing eddy current losses. It may be provided with air ducts for the axial air flow for cooling purposes. Armature is keyed to the shaft.
5. **Armature winding:** It is usually a former wound copper coil which rests in armature slots. The armature conductors are insulated from each other and also from the armature core. Armature winding can be wound by one of the two methods; lap winding or wave winding. Double layer lap or wave windings are generally used. A double layer winding means that each armature slot will carry two different coils.
6. **Commutator and brushes:** Physical connection to the armature winding is made through a commutator-brush arrangement. The function of a commutator, in a dc generator, is to collect the current generated in armature conductors. Whereas, in case of a dc motor, commutator helps in providing current to the armature conductors. A commutator consists of a set of copper segments which are insulated from each other. The number of segments is equal to the number of armature coils. Each segment is connected to an armature coil and the commutator is keyed to the shaft. Brushes are usually made from carbon or graphite. They rest on commutator segments and slide on the segments when the commutator rotates keeping the physical contact to collect or supply the current.

Working Principle Of A DC Generator:

According to Faraday's laws of electromagnetic induction, whenever a conductor is placed in a varying magnetic field (OR a conductor is moved in a magnetic field), an emf (electromotive force) gets induced in the conductor. The magnitude of induced emf can be calculated from the emf equation of dc generator. If the conductor is provided with a closed path, the induced current will circulate within the path. In a DC generator, field coils produce an electromagnetic field and the armature conductors are rotated into the field. Thus, an electromagnetically induced emf is generated in the armature conductors. The direction of induced current is given by Fleming's right hand rule. A DC generator is also called DC dynamo. A simple DC generator diagram is shown in fig.



According to Fleming's right hand rule, the direction of induced current changes whenever the direction of motion of the conductor changes. Let's consider an armature rotating clockwise and a conductor at the left is moving upward. When the armature completes a half rotation, the direction of motion of that particular conductor will be reversed to downward. Hence, the direction of current in every armature conductor will be alternating. If you look at the above figure, you will know how the direction of the induced current is alternating in an armature conductor. But with a split ring commutator, connections of the armature conductors also gets reversed when the current reversal occurs. And therefore, we get unidirectional current at the terminals.

BENEFITS :- Benefits of TPMC.

- It give more comfort to people.
- Beneficial for industries.
- Increase fuel efficiency.
- Increase tyre life.
- People can increase or decrease tyre pressure as per the path.
- People can fill air from dashboard of the car by pressing button.