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Automatic wipers with mist control

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***Abstract*: -** This paper illustrates Automatic wipers with mist control. In modern days, the accidents are most common in commercial vehicles. One of the reasons for these accidents is formation of the mist inside the vehicle due to heavy rain. In rainy seasons for commercial vehicles, the wiper on the windshield has to be controlled by the driver himself, which distracts his concentration on driving. Also when the rain lasts for more time (say for about 15 minutes) the formation of mist on the wind shield is also hinders the visibility of the driver and makes driving difficult.
The main aim of the project is to prevent the distractions to the driver of a truck or bus. The rain intensity is measured by the set of sensors placed in the beaker at the predetermined levels. The level of the water in the beaker decides the rain intensity and the same will be sensed by each set of sensors and passes the signals corresponding to the level of water in a beaker to microcontroller. Depending on the rain intensity microcontroller controls the speed of the wiper motor. The principle of conductance is used for the working of external and the internal sensors. The programmed microcontroller is used to actuate external and internal wiper motors.

***Keywords*: -** *Microcontroller, Mist Control, Sensor, Wiper motor*

I. INTRODUCTION

All the four wheeled vehicles are equipped with the wipers. These wipers are used to wipe the water on the windshield during rainy seasons. When the wipers were first implemented in the vehicles, the wipers used to oscillates at a single speed. This caused distraction to the driver's visibility. This led to the invention of different speed wiper motors. This increases the visibility of the driver. But the wiper actuation has to be controlled by the driver himself. To provide tension free driving, automatic wipers were invented. For the working of the automatic wipers, the sensing of rain intensity must be provided. There are different kinds of rain sensing methods. Some of them are as discussed below

1.1 CONDUCTIVE METHOD

This method uses a sensor, which consists of two sets of contacts separated by an insulator. When water falls on the sensor, the water conducts the signal and closes the circuit. Then it sends the signals to the next unit to operate the wiper motor. This system has some fundamental problems, the sensors used here are prone to oxidization and become unusable. Also the dirt can foul the sensors. So it is very difficult to design such sensors.

1.2 CAPACITIVE METHOD

Capacitive method utilizes capacitive proximity detection techniques. They are reasonably successful, but can be susceptible to stray electrical fields. The electronic component used in this case is highly expensive due to the incorporation of tuning components.

1.3 PIEZO ELECTRIC METHOD

This method uses a piezo crystal element. While Rain falls on the windscreen generates the sound waves at a certain frequency. These waves are transmitted through and across the windscreen. The Piezo crystal

senses the sound waves, and also compares them with the other noises caused due to wind, dust, etc. this crystal responds only to the sound waves due to rain. Again this system is susceptible to false triggering.

1.4 OPTICAL METHOD

Optical sensors utilize light and the principle of total internal refraction within the windshield. The optical sensor consists of a light source, a light detector and an optical assembly. The optical assembly consists of two lenses and a light guides. A beam of light is directed through the optical assembly to the windshields, the light is trapped within the glass due to total internal refraction. The light reflect from the outside surface of the glass back to the inside surface of the windshield glass until it is picked up by the second optical assembly. If rain falls on the windshield within the sensing area, light is directed by the water droplet in the other direction opposite to the optical assembly. This causes a corresponding reduction in the light intensity falling on the second optical assembly. The microprocessor is used to distinguish between different amounts of rain and to provide the best wiping method. So the Optical sensors are reliable and effective detectors of rain. By using the suitable rain sensing methods it is possible to develop the automatic wipers

1.5 NEED OF AUTOMATIC WIPERS

In case of trucks, the actuation of wipers during rainy season is based on the switch which is being operated by the driver. In plain roads or four lane roads, this may not be big problem. But in the congested or hilly areas during heavy rain driving is a bit difficult because of operating the wiper continuously along with the driving.

Few years ago, there were some accidents reported in north India. These accidents claimed precious lives due to hinder in the visibility of the driver during heavy rain.

There was an accident reported in the hilly regions of Himalayas. A driver was driving the truck in heavy rain in this region. Due to heavy rain, the mist formed inside the windshield, the driver was unable to see the road properly. The result was that the truck fell into a cliff of height 50mts. This accident claimed four lives.

Even though driver operates the wiper, will not clear the visibility because of formation of the mist inside the vehicle. The same mist should be removed frequently to improve the visibility of the driver in case of commercial vehicles.

From the above incident it clearly shows that one of the reason for the accidents due to unclear vision during heavy rain.

II. WORKING PRINCIPLE OF AUTOMATIC WIPERS

The working of automatic wipers and internal wiper to wipe the mist formed inside the vehicles is based on the concept, which makes use of a combination of a sensor, microcontroller and the wiper motor.

The external sensors placed inside the beaker at a prescribed position are used to detect the amount of rain falling on the vehicle. These sensors send data to the microcontroller depending on the water collected in the beaker, which measures the rain intensity. The microcontroller is programmed in such a way that to actuate the wiper motor at predetermined speeds. The principle of conductance is used for the working of external sensors. Each part of this project is described in detail in the successive sections.

The internal mist sensor is placed on the windshield inside the vehicle at prescribed position, is used to sense the mist formed during heavy rain. This sensor works on the principle of conductance and sends the signals to the microcontroller to actuate the internal wiper motor.

III. BASIC COMMPONENTS OF AUTOMATIC WIPERS

The basic components of automatic wipers are

- External sensors
- Internal sensors
- Microcontroller
- Wiper motor

The details of each component are explained below

EXTERNAL SENSORS

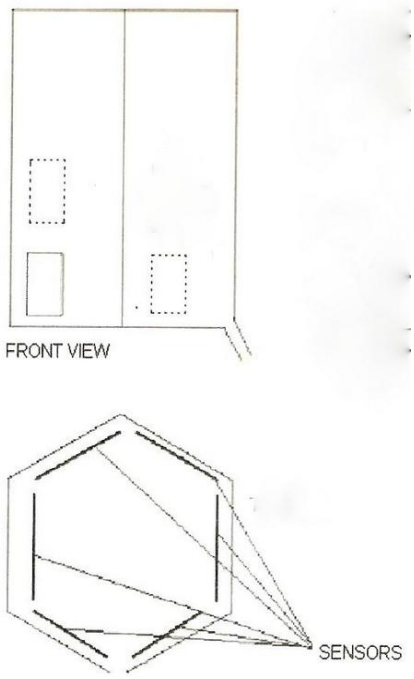


Fig 1 Position of external sensors in the beaker

INTERNAL SENSORS

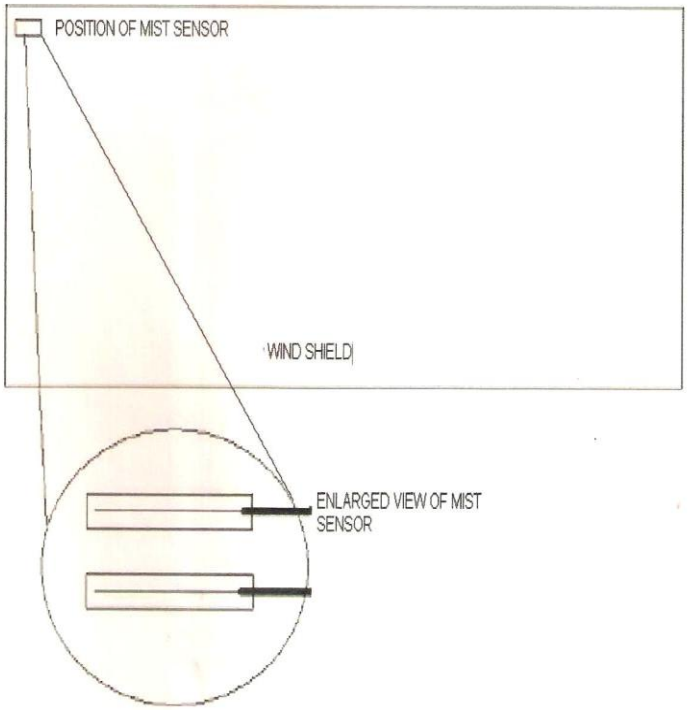


Fig 2 Internal sensor and its position on the windshield inside the commercial vehicles**.**

In the Fig1, there are three sensors which are used to sense the level of the water in the beaker. The water falling on the windshield is collected in the beaker which is placed at a prescribed position. The beaker has a constant outflow at the bottom. This provided to ensure right amount of water, which is collected in the beaker based on the amount of rain falling. If the rain drizzles, only small amount of water will be collected in the beaker. At this point sensor1 are kept in the opposite sides of the beaker at the same level. When the rain is medium, the water collected in the beaker will up to the half of the beaker. At this place another sensor2 are placed opposite to each other in the beaker. When the rain is heavy, the water collected in the beaker will be up to the maximum level of the beaker. At this level another sensor3 are placed opposite to each other in the beaker.

These sensors are supplied with a current of 5V from the micro controller. So, when the water collects to the bottom level covers the sensor1, the current pass between these sensors and hence completes the circuit of the first set of sensors. In the same way, the other two sets of sensors 2 and 3 will conduct the current when the water level reaches respective positions

The mist sensors are placed on the windshield in such a way that the wires connected to the set of sensor I are faced towards the windshield. So that the mist formed on the wind shield is being sensed by these sensors. The two set of sensors are placed very close to each other.

The internal sensor is also works on the same principle as that of the external one as explained in the previous section. Internal sensor also has a current of 5V from the same microcontroller. When the mist is formed on the windshield inside the vehicle the circuit is closed and sends the signal to the microcontroller to actuate the internal wiper motor.

WIPER MOTOR

The wiper motor is used in this project is of two speed stepper motor of 12V. The two speeds are used for the wiping actions.

MICROCONTROLLER

The microcontroller used is an 8051 microcontroller The details of microcontroller explained in the next chapters.

IV. METHODOLOGY

2.1 EXTERNAL WIPER CIRCUIT FOR DRIZZLE

For the actuation of wiper motor during drizzle, the microcontroller receives the signal from the first sensor1. As this signal is sensed by the microcontroller, it sends the signals to the wiper motor to run at slow speed. This signal is timed one. After one complete revolution of the motor it gives an interval of about four seconds. This action is continued until the water in the beaker is lowered or goes below the sensor1 position. Delay period is provided to stop the motor for four seconds by microcontroller. The program for the delay period of the microcontroller is given in the Appendix I.

2.2 EXTERNAL WIPER CIRCUIT FOR MEDIUM RAIN

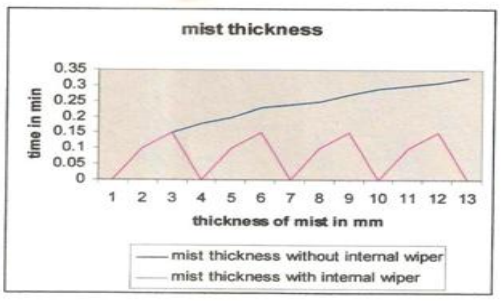
When the rain is medium, the microcontroller receives the signal from the sensor2. Then its sends a continuous signal to the wiper motor to actuate at a slow speed. At this time the microcontroller switch OFF the first output signal corresponding to the sensor1. This action is continued, till the water in the beaker is lowered or goes below the sensor2. Here the motor rotates continuously at the slow speed only

2.3 EXTERNAL WIPER CIRCUIT FOR HEAVY RAIN

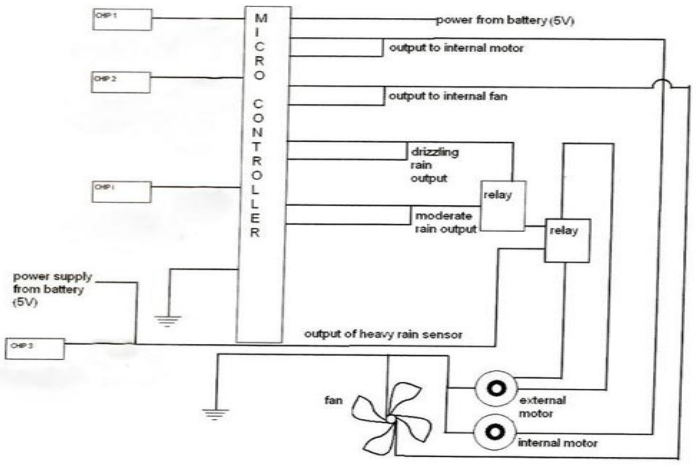
The microcontroller 8051 is limited to two interrupts only, the third cannot be provided. For heavy rain set of sensors +3 & -3, the relay is used. When the sensor3 sends the signal, the relay switch OFF the output from the microcontroller . At this time relay switch ON the direct circuit which runs the motor at high speed.

2.4 INTERNAL WIPER CIRCUIT FOR MIST CONTROL

When the mist is formed on the windshield, the set of sensorI senses the mist and sends the signals to the microcontroller. Then the microcontroller sends the signals to the internal wiper motor. The internal wiper motor rotates once and turns OFF. The blower is placed near by the sensors is switched ON as soon as the wiper motor stops. This blower blows away the mist between the sensors in 20 sec and turns OFF. This action is continued, when the mist is formed again, during heavy rain



The Fig 3 shows a schematic representation of the circuit used in the project. This circuit compromises of basic components used in automatic wiper.

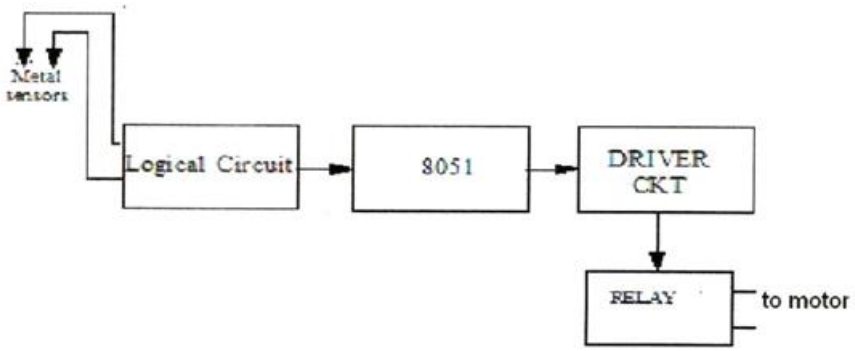


The fig 4 shows a schematic representation of the circuit used in the project . this circuit compromises of basic components used in automatic wiper .

2.5 MICROCONTROLLER

This aim of the project is to wipe the windshield automatically on both the sides of motor is controlled. This project is facilitated with an internal wiper, which removes the mist formed inside the commercial vehicles.

This project is executed with the help of digital circuits, to sense the mist. This digital circuit is connected to the microcontroller to control the wiper motors with the help of relays. The microcontroller is depicted as in the Fig 7.1



Each components of the microcontroller is explained below in detail

2.5.1 METAL SENSORS

Metal sensors are made of low resistance metal for sensing the water and also the mist. The low resistance metal sensors are preferred because of their good conductivity.

2.5.2 LOGICAL CIRCUIT

This circuit consists of logical gate which provides high output to the microcontroller when the water is sensed. When there is no sensing of water, the logical circuit gives low output to the microcontroller.

2.5.3 DRIVER CIRCUIT

The output of microcontroller circuit is 5V only. By having this 5V, it is not possible to drive the relay and DC motor. So the driver circuit is used to increase the output signal from 5V to 12V. A driver circuit comprises of signal transistor, which increases the DC level to a required value of 12V. This 12V is enough to operate the relay and DC motor.

2.5.4 RELAY

A relay is a switch, which works with the help of an electromagnet. A relay is used as an amplifier. The12V current in the circuit is used by the relay to control the motor circuit, which drives the wiper motor.

2.6 WORKING OF DUAL POWER SUPPLY

To construct the power supply circuit of different voltages, different transformers, rectifier circuits, filter circuits and regulator circuits are required. This type of construction requires many components like transformers, capacitors, regulators etc. So, the size of the power supply becomes bulky and costly. This problem can be eliminated by using a regulator, integrated chip and a transformer.

The circuit consists of following components. The function of each component of the circuit is explained below in detail.

- Transformer
- Rectifier
- Filter and
- Regulator

2.6.1 TRANSFORMER

It is an electrical device which transfers the power from one winding to the other winding with isolation. All the electronic gadgets work for less voltages. So a step down transformer is used, whose function is to step down the AC voltage from 230V to required 12 V. The output of the transformer is 12V AC which is connected to the diodes for rectification.

2.6.2 RECTIFIER CIRCUIT

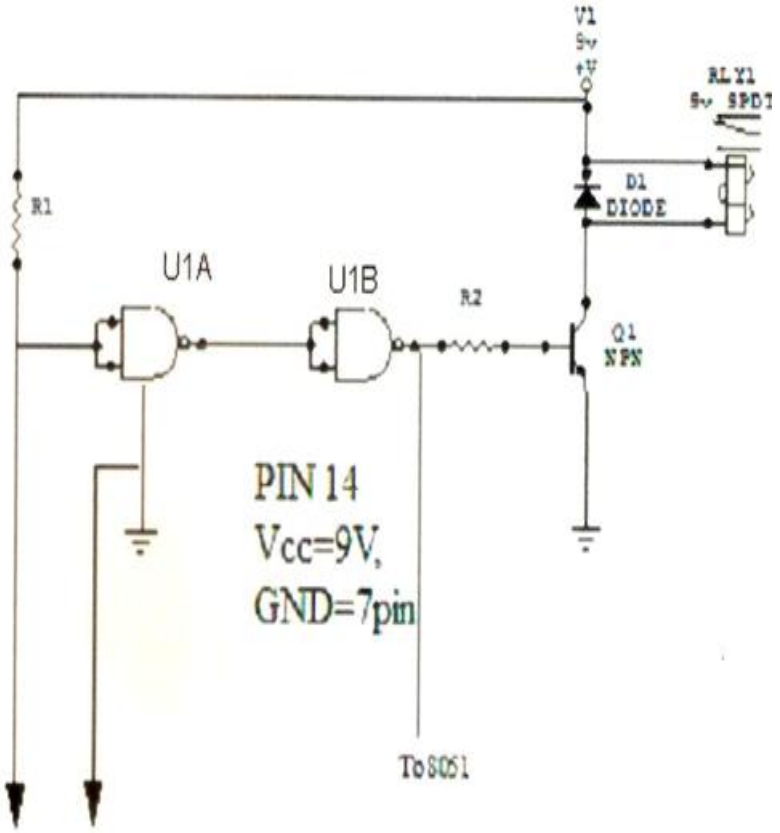
It employs diodes, which convert AC into DC. The output of the rectifier circuit is not a DC. It also consists of some AC components, which are called as ripples. In order to remove these ripples, filter circuits are employed. So the output of the rectifier circuit is input the filter circuit or capacitor.

2.6.3 FILTER CIRCUIT

Filter circuit employs electrolytic capacitors in order to remove the AC components. The capacitor does not allow AC components to pass through it, because it offers high reactance to the AC components, so all DC components will be bypass the capacitors. Hence the output from the filter circuit will be DC only.

2.6.3 REGULATOR

Regulator is an electronic circuit whose function is to keep the output always constant, though the input is varied. The three terminal Integrated Chip regulators are used for providing output DC voltages.



WORKING OF MIST SENSING CIRCUIT:

The Fig shows a circuit diagram shows a circuit of a mist sensing unit. When the rain falls on wind shield, the input to U1A (NAND gatel) becomes LOW and the output of U1A becomes HIGH. The output of U1A is input to the U1B (NAND gate2). The input and output of the U1B are HIGH and LOW respectively. The same LOW output is input to the microcontroller. Similarly, when there is no rain fall on the wind shield the, input of U1A becomes HIGH and the output of the same will be LOW. The output of Ul A is the input to the U1B, Now the input of U1B becomes LOW and the output of the U1B is HIGH. The same HIGH output of the U1B becomes input to the microcontroller. The same circuit is used for drizzle and heavy rain, but the program executes as per the signals received by the microcontroller.

DETAILS OF PIN DIAGRAM.

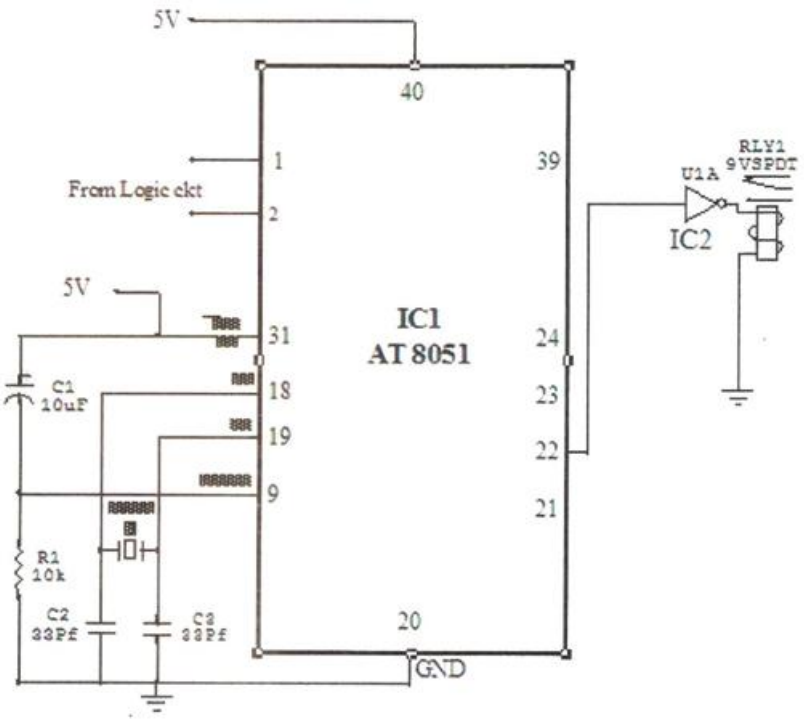


Fig 7 pin diagram of a mist sensing device

The parameters relevant to the pin diagram as shown in the Fig 7 are explained as follows

INPUT VOLTAGE (V_{CC})
Pin 40 provides supply voltage to the sensor. The voltage source is +5V.

GROUND (GND)
Pin 20 is the ground.

INPUT PINS (XTAL1 and XTAL2)
Even though the microcontroller has an on-chip oscillator to maintain the time intervals, also it requires an external clock to operate it. In most of the case a quartz crystal oscillator connected to the inputs XTAL1 (pin 19) and XTAL2 (pin 18). The quartz crystal oscillator needs two capacitors of 30 micro Fared. One side of each capacitor grounded as shown in pin diagram.

V. RESET

Pin 9 is the RESET pin. By applying a high pulse to this pin, the microcontroller will reset and terminate all the activities. This is often referred as power-ON reset. By activating the power- ON reset, the values stored in the register will be erased.

When the Microcontroller is ON, the Program stored in the ROM of Microcontroller starts execution and microcontroller functions as per the program. The microcontroller keeps on checking the signals arriving at the input port. If there is no signal, no function will be executed. Depending upon the signal received by the port, the microcontroller makes the relay to operate the motor.

3.1 WIPER MOTOR

Wiper motor used is a two speed steeper motor. It uses a current of 12 volt supplied by the microcontroller. The output of the wiper motor is connected to the linkages to actuate the wipers.

In case of two speed motor, the high speed is obtained when the current is supplied to the brush g and brush 1 as in Fig . By Fleming's right hand rule the current, force and the magnetic fields are mutually perpendicular to each other. In this motor as the current is supplied to the brush 1 and brush g, the magnetic field is generated perpendicular to the armature shaft. This induces a force in the armature which makes the armature to rotate. Since, the magnetic fields generated are opposite to each other the shaft rotates at a high speed. In the second speed the brush 2 and brush g gets magnetized. Since the magnetic fields produced by them are at perpendicular to the force generated on the copper winding, will be less than the force generated by the brush 1 and brush g. This makes the armature shaft to rotate at a lower speed.

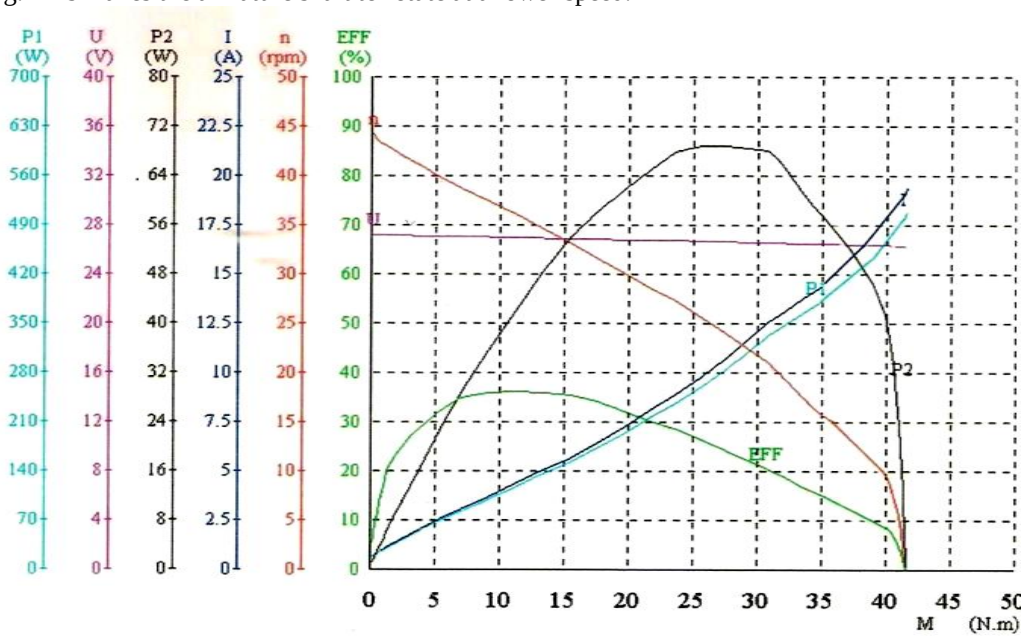


Fig 8 Performance characteristic curves of the motor

The Fig 8 shows the graph in which the variation of the force generated with respect to the power generated in the brush 1, voltage applied to the motor, power generated by the brush 2, current flowing through the motor, speed and efficiency of the motor respectively.
From the graph it is clear that the torque is generated by the brush 1 and brush g will be higher than the torque generated by the brush 2 and brush g.
The maximum efficiency of a motor is 35%. At this efficiency the torque generated by the motor is 10 to 15Nm. Further, increase in the torque, will reduces the efficiency of the motor.
The voltage applied across the brushes will be constant of 27 volts. As indicated in the graph the speed of the motor reduces as the torque increases

3.2 WIPER LINKAGE MECHANISM

The linkage mechanism is used to convert the rotary motion to linear motion. One end of the link is connected to wiper motor and other end is connected to the ankle. The wiper linkage combines two mechanisms.
A combination of electric motor and worm gear reduction provides power to the wipers.
A linkage converts the rotational output of the motor into the to and fro motion of the wipers.

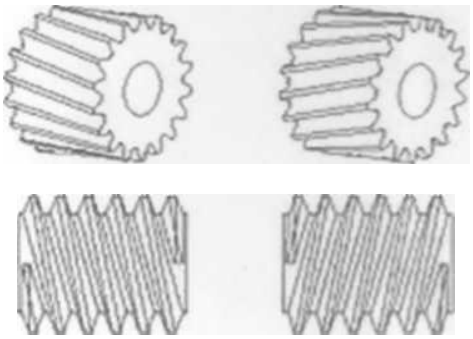


Fig 9 Worm and worm wheel arrangement used in wiper motor.

It takes a lot of torque to accelerate the wiper blades to and fro across the windshield. In order to generate this type of force, a worm gear is used on the output shaft of the electric motor.

The main function of this gear is to multiply the torque generated by the motor. This torque is used to drive the linkages which connect the external wiper sticks. The worm is connected to the armature shaft of motor. The worm wheel drives the motor wheel. This wheel is connected to the linkages which drives the wiper stick. In this project, the motor used multiplies the torque by 25 times.

3.2.1 EXTERNAL LINKAGE MECHANISM

THE LINKAGE FOR EXTERNAL WIPER

The link mechanism for the external wiper mainly has 3 parts

- Link
- Link rods
- Knobs

The link, from the motor is a simple one. The output wheel of the motor, which has a shaft with outer groves on it. The one side of the link has a hole with internal grove fixes into the wheel of the motor. This link will also fit to the wheel of the motor by screw and nut arrangement. The other side of the link has a spherical ball which connects to the linkage rods.

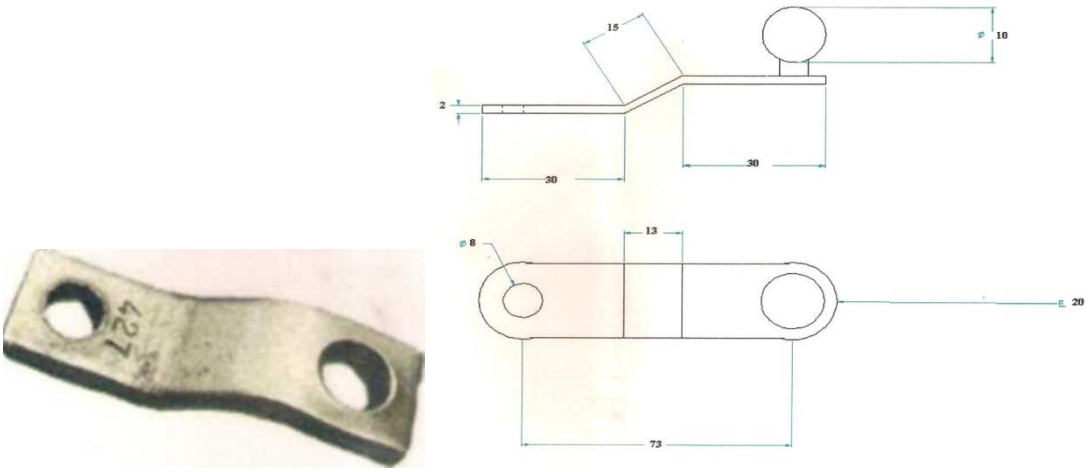


Fig 9.1 Dimensions of a link

Link rods used for the external wiper actuation has two cylindrical rods of outer diameter 12mm. In the figure shown, one end of the link 1 is connected to the motor. The other end of the link l is connected to the ankle, which converts the linear motion of the rod to the rotary motion of the wiper holder. The link 2 is connects the ankle. The other end of the link2 is connected to the wiper holder.

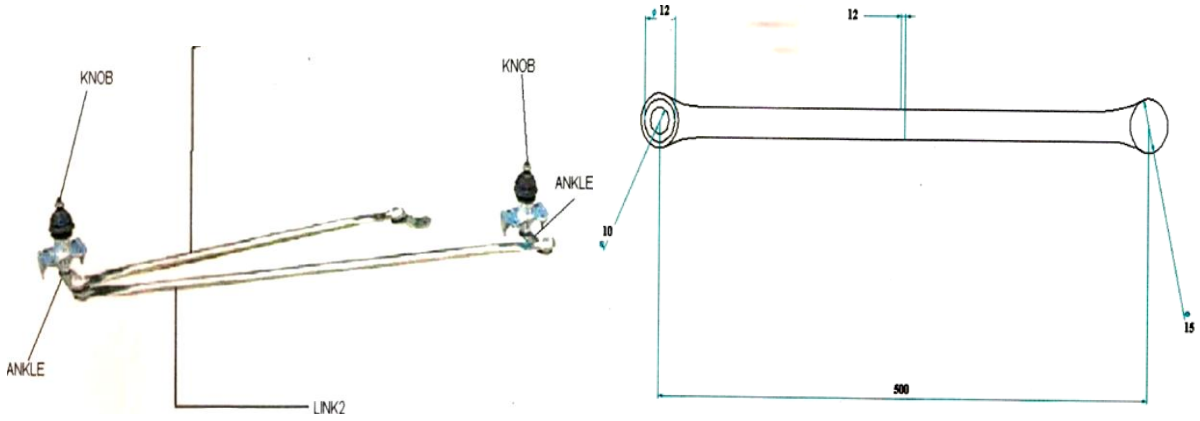


Fig 9.2 Links used for external wiper.

Knob is the one which holds the wiper stick. This gets rotary motion from the linkage, and is transferred to the wiper stick which oscillates in the same angle as that of the linkage.

3.2.2 INTERNAL LINKAGE MECHANISM

Link rods used for the internal wiper actuation has one cylindrical rods of outer diameter 12mm. In the figure shown, one end of the link is connected to the motor. The other end of the link is connected to the ankle, which converts the linear motion of the rod to the rotary motion of the wiper holder

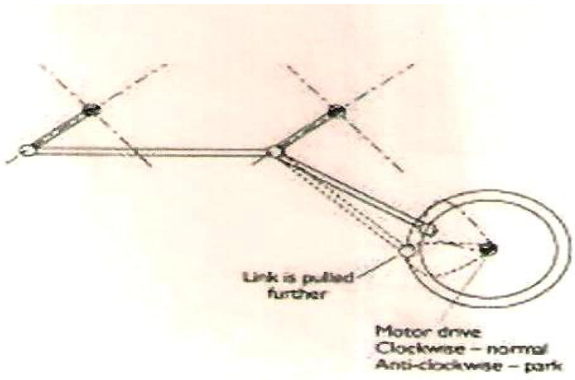


Fig 9.3 Internal wiper linkage

TECHNICAL DETAILS OF AUTOMATIC WIPERS

Torque generated in motor = 1.8Nm Radius of the motor wheel = 25mm Torque generated by the motor wheel T= (Radius of the motor wheel)* (Torque generated in motor) = 1.8*25 = 45 Nm Gear ratio between the worm and the wheel of the motor = 25: 1 Length of the link = 73 mm
The force generated at the end of the link of the motor = (length of the link) / (torque generated by the motor) = 6.5N
Length of the link 1 = 500mm
Ankle length = 45mm
Forced generated at the ankle = 6.5 N
Torque generated at the wiper knob
= (ankle length)*(force generated at the link)
= 6.5 * 45 = 30 Nm

3.2.3 WIPER BLADES

The wiper arms moves the thin rubber strip across the windshield to clear the water on it.
To obtain the key to streak-free operation of wiper, it is necessary to create even pressure over the length of the rubber blades. The position of the motor decides the pressure on the blades. The wiper blades fix on the knob of the linkage by a screw.

VI. CONCLUSION

The concept of Automatic Wipers with Mist Control has been implemented successfully. After the experimental setup the wiper motor was tested for all the following conditions drizzling, heavy rain, medium rain. The test have been conducted under mist on the wind shield. The mist has been removed successfully from the wind shield. By the uses of automatic wipers one can drive the commercial vehicles without any distractions to operate the wipe. Use of internal wipers ensures good visibility to the driver, which in turn prevents the accidents.

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