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## IMPROVEMENT OF ELECTRICAL CIRCUITS SIMULATION WIPER SYSTEM

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### Abstract

The wiper system is an electrical system body which functions as a windshield sweeper with the main goal is to keep the driver's view when the weather is dewy or rainy, the wiper system has 2 electrical circuits namely high speed and low speed plus a washer circuit that functions to spray liquid onto the glass. Because the wiper system electrical circuit simulation trainer is no longer functioning, in this final project the writer fixes the wiper system electrical circuit simulation in the automotive lab to function again. The writer repairs the wiper system electrical circuit simulation so that it can be used again in practice, so that students can more easily understand how the paths of the electrical circuits in the wiper system such as high speed and low speed circuits and washer system circuits. As a result of the electrical circuit simulation repairing of the wiper system, there are components that are missing and damaged, so some components must be replaced. In the wiper system at high speed. It requires a larger supply of electric current than at low speed.

**Keywords:** Electrical Design, Wiper System

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### Introduction

Automotive technology is a field where technological developments always keep up with the times. Development

Automotive technology is based on 3 main things, namely peace, security and safety. A car can be said to be good if it provides three main things, a system that makes a vehicle more comfortable as well as supporting safety, with the body's electrical system where the body's electrical system is all electrical installations that are on the vehicle's body, this system functions as an additional component to complement the functionality of a car. It can be said that the electricity of this body does not have any effect on vehicle performance, but it really supports driving safety. as a result, with the existence of electricity, the car body can function safely and comfortably.

From the background of the problems above, the main problems that the author can take are:

1. Lack of understanding of electrical lines and how the wiper system works.
2. Many argue that it is difficult to handle and maintain the wiper electrical system.
3. How to solve troubleshooting on the wiper system.

The research objectives to be achieved in preparing this final report are:

1. In order to know the electrical circuit of the wiper system.
2. In order to know the mechanism of how the wiper system works.
3. In order to know how to repair the wiper system.
4. In order to make it easier to understand the electrical circuit of the wiper system.

## Theoretical Basis

System *wipers* is one of the devices which is a mechanism in a car vehicle which is very important especially when the car is driving in the rain or in the morning and it is still dewy and foggy.

*wipers* is one of the important components in the car which is very closely related in terms of safety. The wiper functions to ensure that the driver's view is not obstructed by dew, rainwater or anything that sticks to the glass.

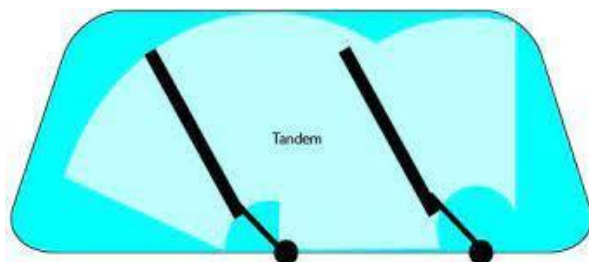
### Types of Wipers.

The progress and development of technology is currently very rapid and there are many inventions that help perfect a technology, one of which is in the automotive field there are many types that have sprung up, including a series of wiper systems that have various types.

The following are the types of wiper systems:

#### a. *Tandem System*

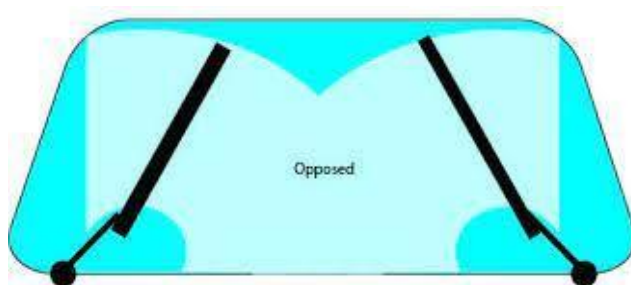
*tandem system* is the most conventional configuration and is commonly used by various types of cars, this type of wiper system uses two rods with directions according to the driving position. If the car is right-handed, it means that the first sweep is also to the right and vice versa, if it is left-hand drive, the rubber will sweep to the left.



Picture1. tandem system

#### b. *Opposed System*

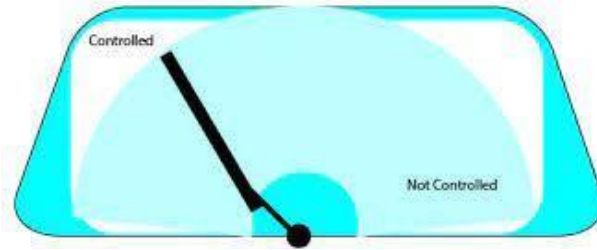
This type is the same as the tandem type but in the reverse position, the wiper rubbers overlap in the middle and when they move both lead to the opposite side.



Picture2. opposed system

c. *Mono Wipers*

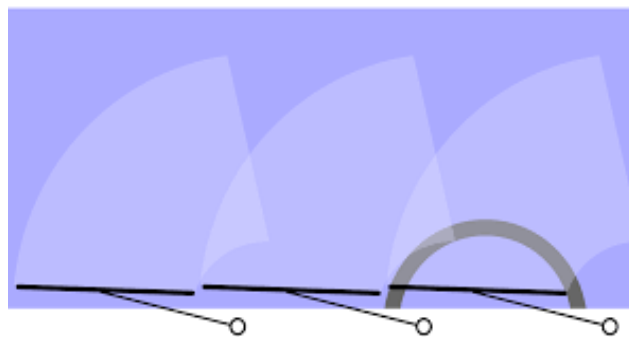
This wiper system has only one wiper arm and the central pedestal moves to direct the wiper blade to reach a wider upper area.



**Picture3.** Mono wiper system

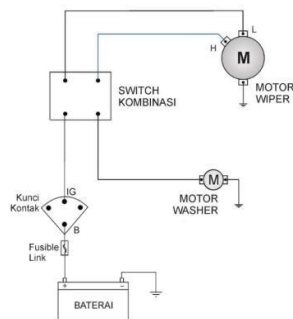
d. *Triple Lever*

the number of wipers has three wiper blades because usually this type of wiper is used on a wide car.



**Picture4.** Triple Lever system

1. **How the Wiper and Washer System Works**



**Picture5.** how the wiper system works

### A. How wipers work

1. When the ignition switch/ignition is ON, the battery current that has been connected to the fuse will be forwarded through the ignition to the wiper switch.
2. The wiper switch functions as a relationship regulator as well as a high speed, low speed, washer, and off regulator. when the ignition is ON, the wiper switch already has current which can later be forwarded to the wiper motor.
3. When the wiper motor which has the function of being the prime mover in the wiper system receives current, the wiper motor will act in sync with the command from the wiper switch, be it low speed or high speed, the wiper motor will rotate and will be forwarded to the wiper link.
4. When the wiper motor moves, the wiper link will transmit power from the wiper motor to the wiper arm while changing the rotary motility of the wiper motor as alternating motion.
5. *Wiper links* move and continue the power through the wiper arm then the wiper blade will move to sweep the windshield.

### B. How the washer works

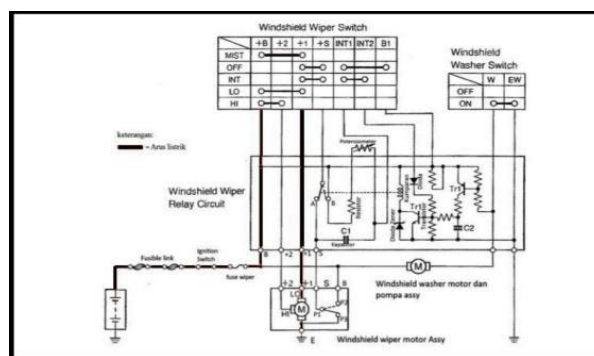
1. When the ignition switch/ignition is ON, the battery current connected to the fuse will be forwarded through the ignition to the combination switch.
2. *Combination switch* which functions as a current breaker and connector in the wiper and washer system will continue the current to the washer motor as the primary driver in the washer system.
3. The washer motor functions as a water pump in the washer tank which will then be forwarded through the hose to the nozzle.
4. *nozzle* which functions as a medium where water will come out towards the glass, then spray water based on the combination switch command.

## 2. Repair of Wiper System Electrical Circuit Simulation

In selecting the title for repairing the wiper system electrical circuit simulation, there were several missing components and quite a lot of damage where many wiring lines had been broken and damaged, and the condition of the switch, the wiper motor connecting cable also had some damage. as a result, in the analysis, the author decided to replace the damaged cable and replace and repair the damaged wiper electrical system components.

In this design, the author makes a new path by imitating the previously damaged cable. so that the wiper circuit can function again.

The following is the wiring of the wiper system electrical circuit:



Picture6. wiring wiper system

## Methodology

In writing this final report the author will discuss the electrical circuit in the wiper system.

The problems that the author faces in the simulation of the wiper system electrical circuit are quite a lot such as the condition of the cables that are not suitable for use, even many cables are damaged because the condition of the system switches and switches has begun to break down, many supporting components of this wiper system are missing.

Therefore the authors carry out an inspection to identify any damage and make repairs by buying the missing components and then checking and repairing the wiper system components.

### 1. Overview of Researched Technology Architecture

The technological architecture studied is an improvement in the simulation of the wiper system electrical circuit applied to the trainer boardstand. In this study, repairs and simulations of the wiper system electrical circuit were carried out in the automotive lab at the Bogor Academy of Technology.

In repairing the wiper system electrical circuit simulation, the author coordinates with the supervisor about the layout of the connectors and what components must be replaced so that the wiper system electrical circuit simulation can run again.

### 2. Analysis of Technology Architecture Boundary

In writing this Final Project report, the object that the author examines is the repair of the wiper system electrical circuit simulation. The author chooses to examine this part of the wiper system electrical circuit where the author improves the wiper system electrical circuit simulation so that the facilities for practice increase again.

In writing the final project report entitled Improvement of Wiper System Electrical Circuits, the author conducted research covering all components of the wiper system such as batteries, fuses, switches, cables, ignition keys, wiper motors, washer motors, wiper blades, wiper arms, nozzles and switches. (combination switch).





With the condition of the wiper system electrical circuit simulation that has been repaired, students will be able to use it for practical courses affiliated with the wiper system, because this wiper system is simulated in the trainer, of course students can easily understand the paths in the wiper system electrical circuit.



### 3. Technology Architecture Needs Analysis

In the development of a technological architecture with the title Repair of the wiper system electrical circuit simulation, the authors need supporting tools to repair the damaged system so that it can work again normally. Therefore the authors need tools and materials to support improvements to this system so that it can work properly.

The following are the supporting tools that the author uses to improve the simulation of the wiper system's electrical circuit:

**Table1.** supporting tools in the repair process

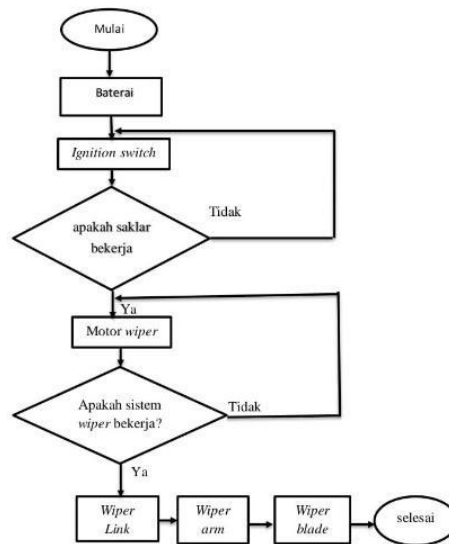
NO	TOOL'S NAME	INFORMATION
1		as a cable peeler so that the cable can be connected to another circuit
2		serves to open the nut in the circuit.
3		serves to find the connection on the combination switch cable
4		serves to check whether the current is connected to the cable
5		serves to unscrew and install bolts on the circuit

		
<p>6</p>		<p>serves to wrap the cable connection to make it more secure.</p>

#### 4. Technology Process Analysis

##### A. Input analysis

Input analysis is the process of input received so that later there is a process that is carried out. The input to this system comes from the control switch/lever. The following is an analysis of the input to the wiper system.

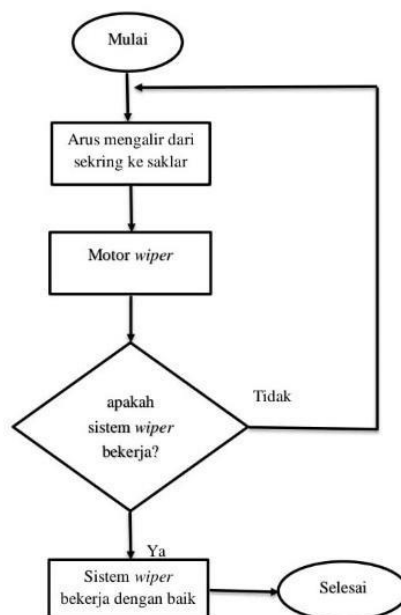


**Picture7.** Process Technology Analysis Flowchart

In the flowchart above it can be observed that when the ignition switch is in the on position, electricity will flow to the switch, when we position the switch to high speed, low speed or washer then electricity will flow past the fuse first, then to the switch then to the wiper motor after the motor the wiper is in good condition, the wiper system will work properly, but if the wiper motor does not rotate, the wiper system will not work.

### B. Output analysis

The output analysis is the result of the output coming from the input received by the system which will later convert electrical energy into motion energy, here is a flowchart analyzing the output of the wiper electrical circuit system.



**Picture8.** Output Analysis Flowchart

In the output analysis flowchart image above, it can be concluded that if the input received is in good condition, the wiper system will work, but if the conditions are not good, the wiper system will not work.

### C. Analysis of the repair process

In repairing the simulation of the wiper system electrical circuit, there are several processes that need to be carried out so that the damage to the wiper system is not getting worse. The following is an analysis of the repair process in the simulation of the wiper system electrical circuit.

1. The author bought a missing wiper system component and then installed it.
2. The author checks all cables using a teslamp so that they know the condition of the existing cables.
3. After all the cables have been checked, the writer focuses on checking the components of the wiper system, it is known that there are several wiper systems that cannot work properly, then the writer fixes them.
4. After the check was completed, it was found that there were several wiper systems that could not work properly.



5. After the components of the wiper system are working properly again, the authors test each cable again using a teslamp to find out whether the current is connected properly.
6. Then the author changed the connector between the cables using a banana jack.
7. After all connectors have been replaced with good ones, the author checks all fuses and cables affiliated with the system.

After re-checking is complete, the authors carry out tests on a simulation of the wiper system electrical circuit, when everything has been repaired and replaced, it is found that the entire wiper system can function again.

### 5. Technological Procedures

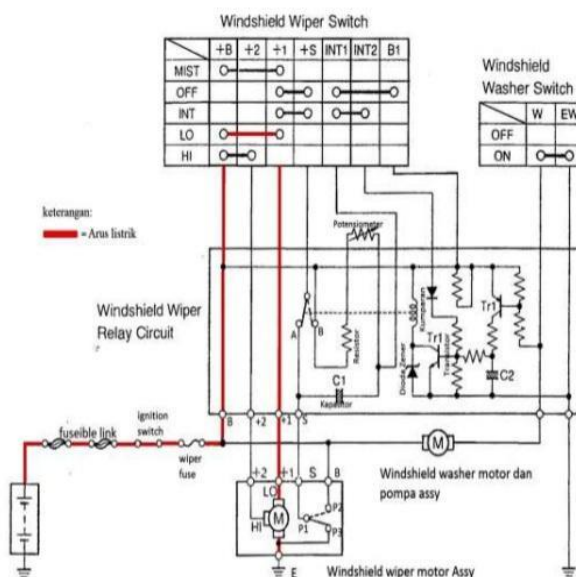
In repairing the electrical circuit simulation, the wiper system has a maintenance procedure where the purpose of the maintenance procedure is to maintain the wiper system so that it is always in good condition.

In the maintenance of the wiper system electrical circuit simulation, there are several procedures that must be carried out so that the wiper system can work properly. The following is the maintenance procedure for simulating the wiper system electrical circuit.

- a) Make sure that the battery condition is always in good condition so that the wiper system electrical circuit always gets good current and voltage.
- b) Always make sure that the charging condition does not occur over charging so that the electricity in the wiper system does not receive current and voltage spikes which result in a short.
- c) Make sure that the condition of the fuse is always in good condition.
- d) Make sure the switch is not exposed to any liquid.
- e) make sure the wiper motor, wiper blade and wiper arm are in good condition.

In the wiper and washer system there are several work steps that occur in the wiper, here are some types of how the wiper system works:

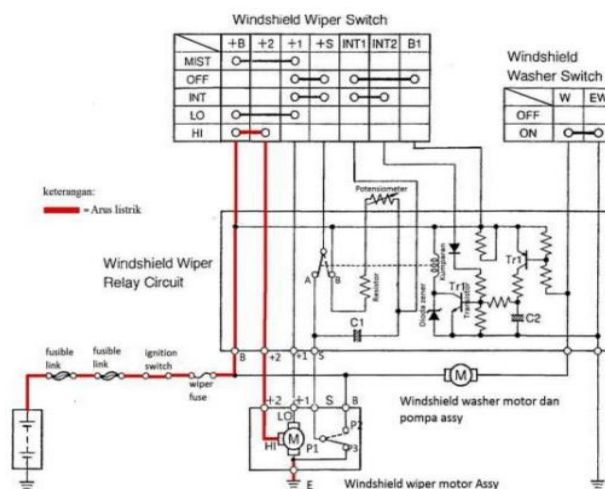
- a. Low speed circuit work steps



Picture 9. Low wiper circuit wiring.

Here are the working steps for the low speed wiper system:

1. The battery positive current flows through the fusebelt then flows into the ignition.
  2. Terminal B of the ignition receives current from the fusebelink. (If the ignition is turned to the ON position then the current flows to the ON terminal of the ignition and then flows to the terminal on the fuse wiper and to terminal B of the switch)
  3. If the wiper switch in the low position is operated, the combination switch will flow current through the +1 wiper switch terminal to the wiper low contact point.
  4. at this time the electric current flows to the wiper motor and consequently the wiper motor rotates relatively slowly.
- b. High speed circuit work steps

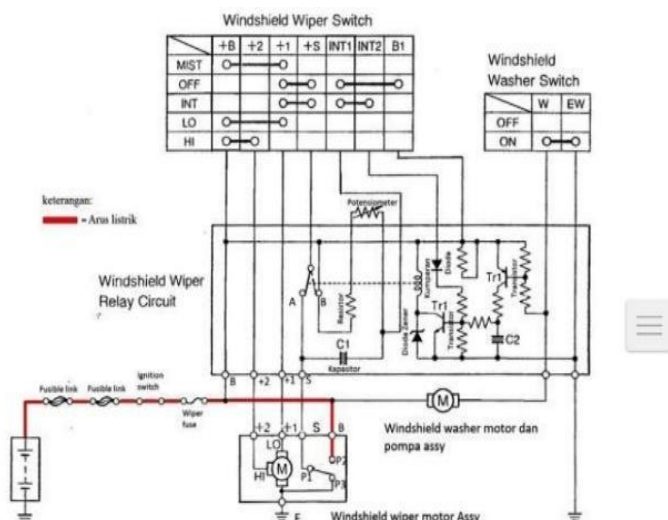


Picture10. Wiring high wiper circuit

Here are the steps for high speed wipers.

1. The battery positive current flows through the fusebelt then flows into the ignition.
2. Terminal B of the ignition receives current from the fusebelin. (If the connection key is turned to the ON position then current will go to the ON terminal of the ignition then to the terminal on the wiper fuse and to terminal B of the switch)
3. The wiper switch in the high position is operated, so the wiper fuse electric current flows through the +2 wiper switch terminal to the wiper relay Hi.
4. at this time the electric current flows to the wiper switch and consequently the wiper motor works with a faster rotation

c. Wiper off step.

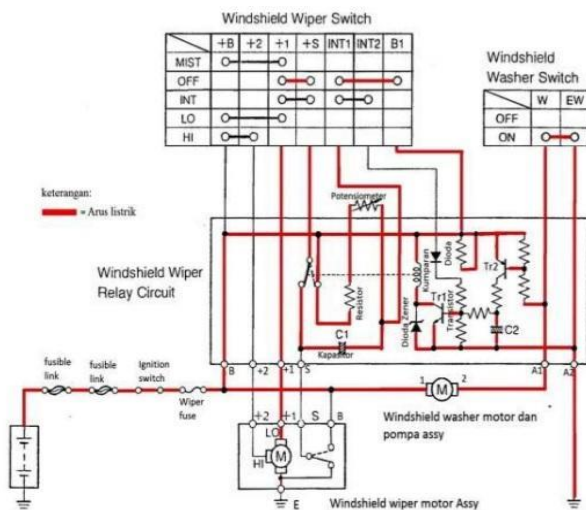


Picture11. Wiring the wiper circuit is in the Off position

Here are the steps for the wiper in the off position:

1. The battery positive current flows through the fusebelt then flows into the ignition.
2. Terminal B of the ignition receives current from the fusebelt. (If the ignition is turned to the ON position then the current flows to the ON terminal of the connection lock and flows to the fuse washer terminal and to terminal B of the switch)
3. from the wiper switch the current will flow to the cam switch point B where the cam switch point is the circuit breaker cam to the s+ terminal.
4. when the wiper is in the stop position, the wiper motor will stop due to the transition of the cam switch point from side B to side A, because the wiper motor does not receive current supply, the current will stop at the wiper motor terminal.

d. Washer work steps



Picture12. Wiring series washer On

Here are the working steps of the washer system:

1. The battery positive current flows through the fuse belt then flows into the ignition.
2. Terminal B of the ignition gets current from the fuse Belin. (When the ignition is turned to the ON position, the current flows to the ON terminal of the ignition and flows to the terminal on the wiper fuse and to terminal B of the switch)
3. Terminal 2 of the washer motor gets current from the ON terminal of the combination washer switch then the current is forwarded to Terminal A1.
4. *washer switch point* receives current from terminal A1 and is connected to terminal A2.

## Results and Discussions

### A. How Technology Objects Work.

The following is how the technological object works from the wiring diagram of the wiper system electrical simulation:

1. How Accu works
  - a. when the positive and negative of the battery have been connected, the battery will supply electrical energy to the fusebox which functions as a safety net, which prevents short circuits and excessive current loads in the electrical circuit of the wiper system.
  - b. Current from the fusebox will flow to the ignition. If the ignition is in the ON position, an electric current will flow to switch A contact and then be forwarded to contact switch B, flowed again to the switch and then to the wiper motor.
  - c. when the electricity is received by the wiper motor, the wiper motor will function properly, namely converting electrical energy into rotary energy which is then forwarded to the wiper lever which converts the rotary energy created by the wiper motor into energy of translational motion up and down.

#### 2. How the fuse works

The fuse will work if there is a short circuit in the electrical circuit so that when a short occurs it will disconnect the battery from the entire circuit.

#### 3. How the ignition works

The connecting terminal in the ignition is the terminal that gets direct supply from the battery, namely terminal B. Then the terminal that is connected to the ignition coil and mass, namely the IG terminal. The ignition has a function as a connector and circuit breaker in the circuit.

#### 4. How the high/low wiper system works

- a. When the combination switch is turned to the low speed position, the low speed wiper relay will be connected, as a result the battery will flow electric current through the relay and then flow to the wiper motor. In the wiper current enters the low speed brush on the wiper motor which causes the wiper to move at a relatively slow speed.
- b. When the combination switch is turned to the high speed position, the current will be cut off from the low speed wiper relay and the current will be connected to the high speed wiper relay. Because

the low speed brush has no current because the current is connected to the high speed brush, the wiper will move at a relatively high speed.

- c. When we turn the wiper switch to the washer position, the combination switch will cut off the flow of the wiper motor and the current is connected to the washer motor.

#### 5. How wiper motors work

The wiper motor is a fixed magnet DC motor whose function is to convert electrical energy into kinetic energy to move the wiper arm. The amount of current flowing to the wiper motor is regulated by *combination switch* as a result the speed of the wiper motor can change based on the amount of power current *switch combination*.

#### 6. How wiper links work

*wiper link* serves as a connecting medium so that the wiper blade can sweep the glass, *wiper link* also has a function as a modifier of the rotation of the motor *wipers* so that *wiper blades* can move back and forth

#### 7. How washers work

if the Combination switch is positioned in the ON Washer position, then the battery flows current through the ignition then goes to the fuse then flows to the washer motor. The washer motor runs and as a result the Nozzel will spray cleaning water onto the glass.

#### 8. How wiper blades work

*Wipers* The blade serves as the primary medium for sweeping and cleaning windshields.

### B. Technology Implementation.

Improved implementation of the wiper system electrical circuit simulation where the cable lines have a relatively good safety factor because they use a banana jack.

The following is a test on the wiring simulation of the wiper system electrical circuit which has the following division:

1. Fuse Testing  
before testing the circuit, check the fuse first whether the fuse is disconnected or not.
2. Ignition Testing  
Turn the ignition key to the On position. When the ignition is connected, there will be a connection between the other terminals such as B, IG, ACC will be connected.
3. Combination Switch Testing.  
Turn the switch to the low position. When the wiper switch is turned to the low position, the battery flows current through the low speed relay and then to the wiper motor, then the current flows to the low speed brush and as a result the wiper moves at a relatively low speed
4. Turn the wiper switch to the high position, when the switch is turned to the high speed position, the current will be cut off from the low speed wiper relay and the current will be connected to the high

speed wiper relay. Because the low speed brush has no current because the current is connected to the high speed brush, the wiper will move at a relatively high speed.

5. Wiper motor testing

Turn the ignition key to the ON position so that current can be connected to the circuit, then press the wiper switch to the ON (low speed) position so that current flows to the wiper motor, then also check the high speed wiper motor to make sure the wiper motor is moving properly.

6. Wiper link testing

When the wiper motor moves the wiper link will transmit power so that the rotary energy from the wiper motor can be converted into alternating energy, make sure the alternating energy works properly which will later be passed on to the wiper arm.

7. Testing the washer system

Press the combination switch to the ON washer position, then the water in the washer tank will be pumped by the washer motor then the water will flow towards the nozzle and will be sprayed on the glass surface.

### C. Technology Testing

#### a. Technology Weaknesses

In repairing the Wiper system electrical circuit simulation, several weaknesses were found, the following are the weaknesses of the wiper system electrical circuit simulation

1. There is no ignition key and fusebox so that the simulation situation for the electrical circuit of the wiper system is totally dead.
2. The old condition of the switch causes electricity to not be channeled properly, which causes the wiper system to not move.
3. Many cable conditions are in poor condition, as a result of increasing the resistance in the circuit.
4. Motorcycle wiper there was a problem that could not turn on but has been fixed
5. The condition of the connectors is that they are no longer functioning, all of them are replaced with banana jacks.

From the technological weaknesses above, there are several ways to identify a damage and how to fix it, here is troubleshooting and how to overcome it:

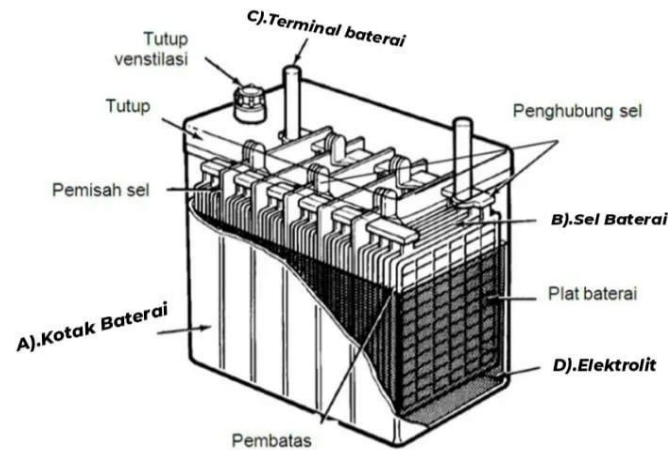
1. Troubleshooting procedure.

The troubleshooting procedure of the wiring diagram for simulating the electrical circuit of the wiper system so that when the wiper system is damaged can quickly identify the damage so that the damage does not spread to other components. The following is a troubleshooting procedure for simulating the wiper system electrical circuit.

2. Battery box

- a. Check the battery box for any damage in the case due to impact or floating due to leaks or the battery is getting too much mains voltage.

- b. Check the cells in the battery whether crystallization occurs, cells fall out or cells float due to vibration, battery life is also poor battery quality.
- c. Check the battery terminals and cable connectors, whether there is corrosion due to heat due to loose connector installation.
- d. Check the electrolyte, on the battery box there is a line per level and the amount of electrolyte must be in the middle of the line. Receiving excess electric voltage on the battery is the main cause of reduced amount of electrolyte.



**Picture13.** accu battery

### 3. *Combination Switch*

*Combination switch* the way to check is to use a multimeter, look for each cable one by one to see if there is a connection by placing one of the probes in terminal B of the combination switch one other probe to look for connections on the connection cable to other switches such as the wiper (low, high or off) and the switch washer.



**Picture14.** Combination switches.

#### 4. *Fuse*

The way to check the blade fuse or implanted fuse that I use in the wiper system electrical circuit simulation is to look at the fuse wire whether the wire is disconnected or not.



**Picture15.** different fuses

Based on the Society of Automotive Engineers (SAE International) standards, there are 4 types of fuses available. The following are the types of fuses:

##### a. Glass tube fuses

Has a cover at both ends made of copper or brass and coated with chrome. This fuse is also transparent and clear and has a tube-like shape.



**Figure 16.** tube fuses



### b. Fuseblades

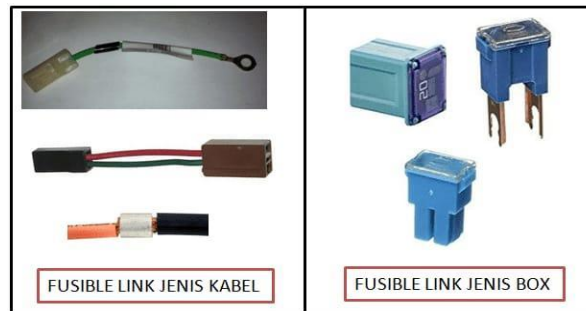
*Fuseit* is made of transparent plastic material and has a wire in the middle of the fuse has a square shape



**Picture17.** fuse blades

### c. Fuse fusible link

*Fuse Fusible Link* It has 2 metal strips that will melt at a certain temperature because the 2 strip points were soldered together.



**Picture18.** fuse type fusible link

### d. Fuse Yazaki

*Fuse Yazaki* can be called the result of an upgrade from Fuse Fusible Link using a simpler design, so that in terms of security it can better protect the wiring on the battery.



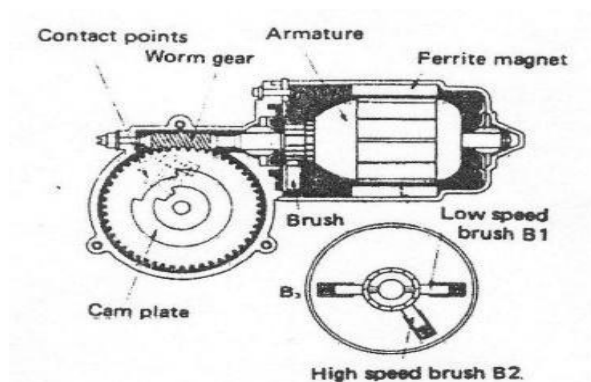
**Picture19.** fuse yazaki

5. The wiper motor does not work

If the wiper motor cannot work the first step that must be taken when the wiper motor cannot rotate is to check the fuse then check whether the cable is loose or if there is a broken cable using a multimeter by looking for current flowing, the next step is to check the combination switch is there a connection to the wiper motor, when everything has been checked and the results are fine then check the wiper motor if the wiper motor is damaged then it must be replaced.

**Table 2.** system testing *wipers* And *washer*

No	System name	Test Position	Test result
1	System <i>wipers</i>	OFF switch, KK OFF	OFF
		KK ON, LOW position switch	ON
		KK ON, Switch HIGH position	ON
2	System <i>washers</i>	OFF switch, KK OFF	ON
		ON switch	ON



**Picture 20.** wiper motors

6. Wiper dynamo

Check the coil whether there is a burn if there is a fire then the wiper dynamo must be replaced.



**Picture21.** wiper dynamo

7. Less washer water spray

Clean the tube where the water washer uses water then shake it so that the dirt in the water tube disappears.



**Picture 22** washer tanks

b. Technology Advantage

The technological advantages of simulating the wiper system electrical circuit:

1. When the cable has been repaired and the current has returned, the wiper motor is working properly.
2. The rubber on the wiper blade is still thick.
3. The washer still sprays hard.
4. The wiper arm binds the wiper blade well.
5. Using a simulation of the wiper system electrical circuit, the mechanism of the wiper system electrical circuit is easier to understand.

**Table3.** Wiper movement testing per minute

No	Wiper Work Steps	Number of Movements Per Minute
1	Low Speed	35 Movement
2	High Speed	58 Movement

**Table4.** Testing the RPM of the wiper motor rotation

No	Wiper Work Steps	Wiper Motor Speed RPM
1	Low Speed	38.5RPM
2	High Speed	66.5RPM

## Conclusions

In the description of writing the Final Project report above, the following conclusions can be drawn:

1. The number of wiring components of the wiper system is damaged and missing components.
2. Lack of maintenance in the simulation of the wiper system electrical circuit where this system cannot function.
3. The condition of the object under study has been stopped for a relatively long time, causing many components to become dusty as a result of which the electric current is not optimal.
4. When the condition of the wiper system is replaced and repaired, the wiper system is still working very well.
5. In the simulation of the wiper system electrical circuit it is very useful for practice because it is more practical to understand than learning directly in the car.
6. Students can use a wiper system electrical circuit simulation for practice.
7. Treatment of objects is an important thing to avoid damage

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