MODULE CONTENT

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| Unit of Competency | **DIAGNOSE AND REPAIR IGNITION SYSTEM** |
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| Module Title | **DIAGNOSING AND REPAIRING IGNITION SYSTEM** |
| Module Descriptor | This unit covers the knowledge, skills and attitudes required to basic diagnosing and repairing the ignition system such as ignition switch, spark plug, high tension wires/cables cables/ignition coil, and distributor. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair ignition system | |
| LO2. Diagnose ignition system | |
| LO3. Repair ignition system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 1**

**PREPARE TO DIAGNOSE AND REPAIR IGNITION SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Prepare to diagnose and repair ignition system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Prepare to diagnose and repair ignition system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Prepare to diagnose and repair ignition system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Prepare to diagnose and repair ignition system | Remember the step-by-step procedure of the Prepare to diagnose and repair ignition system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**PREPARE TO DIAGNOSE AND REPAIR IGNITION SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Determined job requirements
2. Sourced and interpreted diagnostic information.
3. Verified symptoms.
4. Identified hazards associated with the work and managed risks.
5. Selected and checked tools, equipment, and materials.
6. Reported defective and damaged tools and equipment.
7. Checked and reported availability of materials.

**IGNITION SYSTEM**

**INTRODUCTION**

The car’s ignition system produces the high voltage needed to ignite the fuel charges in the cylinders of a petrol engine. The system must create an electric arc across the gaps at the spark plugs. These events must be timed so they happen exactly as each piston nears the top of its compression stroke. The heat of each spark starts combustion and procedures the engine’s power strokes.

In recent years, different types of ignition systems have been developed to improve engine performance, fuel economy, and dependability, fig. 35-1. This chapter compares the older contact point type with more modern electronic and computer-coil (distributorless) ignitions. This should give you a sound knowledge off all automotive ignition systems.

**Fig. 35-1** There are three basic types of automotive ignition systems. A - older contact point. B – Modern electronic type with distributor. C – Latest computer-coil ignition does not use a distributor.

**FUNCTION OF AN IGNITION SYSTEM**

An automotive ignition system has several functions:

1. Provide a method of turning a spark ignition or petrol engine ON and OFF.

2. Be capable of operating on various supply voltages (battery or alternator voltage).

3. Produce a high voltage arc at the spark plug electrodes to start combustion.

4. Distribute high voltage pulses to each spark plug in the correct sequence.

5. Time the spark so that it occurs as the piston nears TDC on the compression stroke.

6. Vary spark timing with engine speeds, load, and other conditions.

Various ignition system parts and designs are used to achieve these functions.

**BASIC IGNITION SYSTEM**

An ignition system must change low battery voltage into very high voltage and then send the high voltage to the spark plugs. The parts needed to do this are shown in Fig. 35-2.

1. BATTERY (provides power for system).

2. IGNITION SWITCH (allows driver to turn ignition and engine on and off).

3. IGNITION COIL (changes battery voltage into 30,000 volts or more).

4. SWITCHING DEVICE (contact points or electronic circuit that operates ignition coil).

5. SPARK PLUG (air gap in combustion chamber for electric arc).

6. IGNITION SYSTEM WIRES (conductors that connect components.

**Fig. 35-2** Basic ignition system for one cylinder engine, battery voltage is stepped up to about 30,000 volts by the coil before it is sent to the spark plug. Switching device times voltage to coil. It can be a set of mechanical breaker points or an electronic switching circuit.

With the ignition switch ON, current flows to the parts of the ignition system. When the switching device is closed (conducting current), current flows through and energises the ignition coil.

When the piston is near DTC on the compression stroke, the switching device opens. This causes high voltage to shoot out of the ignition coil and to the spark plug.

The electrical arc at the plug ignites the fuel mixture. The mixture begins to burn, forming pressure in the cylinder for the engine’s power stroke.

When the ignition key is turned OFF, the battery-to-coil is broken. Without current to the ignition coil, sparks are NOT produced at the spark plugs and the engine stops running.

An actual ignition system is much more complex than one just discussed. Cars have multiple cylinder engines and the timing of the sparks must vary with operating conditions.

**IGNITION SYSTEM SUPPLY VOLTAGE**

The ignition system supply voltage is fed to the ignition system by the battery or alternator. The battery provides electricity when starting the engine. After the engine is running, the alternator supplies a slightly higher voltage to the battery and ignition system.

**Ignition Switch**

The ignition switch is a key-operated switch in the driver’s compartment. A hot wire (voltage supply wire) connects the switch to the battery. Other terminals on the switch are connected to the ignition system, starter solenoid, and other electrical devices.

**Bypass and Resistance Circuits**

An ignition system bypass circuit is sometimes used to supply direct battery voltage to the ignition during starter motor operation.

When the engine is being started, the ignition switch is in the start or fully clockwise position. Shown in Fig. 35-3A, this connects the battery to the starter motor and to the ignition system. The starter motor rotates the engine until the engine begins to run.

The starter motor draws high current and causes battery voltage to drop below 12.6 volts. The bypass circuit assures that there is still enough voltage and current for ignition operation and easy engine starting.

A resistor circuit may be used in the ignition system to limit supply voltage to the ignition during alternator operation. Look at Fig. 35-3B.

**Fig. 35-3** some ignition systems use resistance and bypass circuits to feed current to the ignition coil. A – when cranking, bypass feeds direct battery voltage to coil. B - After starting, resistance circuit feeds controlled voltage to coil.

After the engine starts, the switch causes it to return to the RUN POSITION.

To protect the ignition from damage, a resistor circuit is sometimes placed between the switch and ignition coil to limit current flow.

Either a special resistance wire (wire having internal resistance) or a ballast resistor (heat sensitive resistor that can regulate voltage to ignition coil) is used in the resistance circuit. This circuit assures that a relatively steady voltage of about 9.5 to 10.5 volts is applied to the ignition system.

Note! Many electronic ignition systems do not use bypass or resistance circuits.

**PRIMARY AND SECONDARY**

The two main sections of an ignition system are the primary and secondary circuits.

The primary circuit of the ignition system includes all of the components and wires operating on low voltage (battery or alternator voltage). See Fig. 35-4A.

**Fig. 35-4.** Two major sections of an ignition system. A – Primary circuit includes all parts working on a battery voltage. B – Secondary circuit of parts carrying high coil output voltage.

The secondary circuit of the ignition system is the high voltage (30,000 volt or more) section/ it consists of the wires and parts between the coil output and the spark plug ground, Fig. 35-4B.

The primary circuit of the ignition system uses conventional wire, similar to the wire used in the other electrical systems of the car. The secondary wiring however, must have much THICKER INSULATION to prevent leakage (arcing) of the high voltage.

**Ignition coil**

a ignition coil produces the high voltage (30,000 volts or more) needed to make current jump the gap at the spark plugs. It is a pulse type transformer at the spark plugs. It is a pulse type transformer capable of producing a short burst of high voltage for starting combustion.

As in Fig. 35-4B, coil output voltage usually passes through the coil wire, distributor, plug wire, and spark plug before starting the burning process in the engine.

**Ignition Coil Construction**

Shown in Fig. 35-5, the ignition coil consists of two sets of windings (insulated wire wrapped in circular pattern). The coil has two primary terminals (low voltage connections), an iron core (long piece of iron windings), and a high voltage terminal (output or coil wire connection).

**Fig. 35-5** Cutaway of ignition coil shows basic parts. Primary windings surround secondary windings. Iron core is mounted in centre of windings.

The primary windings of the coil are several hundred turns of heavy wire, wrapped around or near the secondary windings.

The secondary windings are several thousand turns or very fine wire located inside or near the primary windings.

Both windings are wrapped around an iron core and are housed inside the coil case.

**Ignition Coil Operation**

When the battery current flows through the ignition coil primary windings, a strong magnetic field in produced. Look at Fig. 35-6A. the action of the iron core helps concentrate and strengthens the field.

When the current flowing through the coil is broken, the magnetic field COLLAPSES across the secondary windings. See Fig. 35-6B.

**Fig. 35-6** Ignition coil operation. A – With switching device (points or electronic circuit), closed, current flows through ignition coil primary windings. Strong magnetic field builds in coil. B – When switching device opens, current flow stops and magnetic field collapses across secondary windings. This induces high voltage in secondary windings of coil. The spark plug fires.

Since the secondary windings have more turns than the primary, 30,000 volts is induced into the secondary windings. High voltage shoots out of the top terminal and to a spark plu.

There are two common methods used to break current flow and fire the coil: mechanical breaker points or an electronic switching current.

**IGNITION DISTRIBUTORS**

Typically, an ignition distributor, Fig. 35-7, has several functions:

1. It actuates the ON/OFF cycles of current flow through the ignition coil primary windings.

2. It distributes the coil’s high voltage pulses to each spark plug wire.

3. It must cause the spark to occur at each plug earlier on the compression stroke as engine speed increases and vice versa.

4. It changes spark timing with changes in engine load. As more load is placed on the engine, the spark timing must occur later in the compression stroke to prevent spark knock (abnormal combustion).

5. Sometimes, the bottom of the distributor shaft powers the engine oil pump.

6. Some distributors (unities distributors) house the ignition coil and electronic switching circuit. Refer to Fig. 35-8.

**Fig. 35-7.** Ignition distributor is usually driven by engine camshaft. Small gear on cam drives gear on distributor at one-half engine rpm. Main purpose of distributor is to feed coil voltage to spark plugs.

**Fig. 35-8** Modern unitised distributor has ignition coil and amplifier (electronic switching circuit) mounted inside.

**Distributor Types**

An ignition distributor can be a contact point (mechanical) or pickup coil (used with electronic switching circuit) type. A contact point distributor is commonly used on older cars. The pickup coil type distributor is used on many modern automobiles. Note the basic difference between the two in Fig. 35-9.

**Fig. 35-9** Compare distributors. Trigger wheel and pickup coil replace points in modern electronic ignition. A – Contact points distributor. B – Pickup coil distributor for electronic ignition.

A contact point distributor uses mechanical breaker points to interrupt the flow of primary current through the ignition coil. See Fig. 35-10.

**Fig. 35-10.** Compare a contact point and an electronic ignition system. Note that the pickup coil and control unit replace contact points in modern system.

A pickup coil distributor has a trigger wheel and a pickup coil instead of contact points. Wires from the pickup coil are connected to an ECU (electronic control unit). Refer Fig. 35-9 and 35-10 trigger wheel pickup coil, and ECU perform the same function as contact points.

**CONTACT POINT IGNITION SYSTEM**

Before going on to study today’s electronic ignition systems, you should have a basic understanding of contact point systems. The operation of each is similar in many ways. Fig. 35-10 compares the two.

The distributor for each cam is the lobed part on the distributor shaft that opens the contact points. The cam turns with the shaft at one-half engine speed. One lobe is normally provided for each spark plug. See Fig. 35-9.

The contact points, also called breaker points, act like a spring-loaded electrical switch in hte distributor. Small screw hold the contact points on the distributor advance plate. A rubbing block, of fibre material, rides on the distributor cam. Wires from the condenser and ignition coil primary contact to the points.

The condenser or capacitor prevents the contact points from arcing and burning. It also provides a storage place for electricity as the points open. This electricity is fed back into the primary when the points reclose. Refer to Fig. 35-10.

**Contact Point Ignition System Operation**

With the contact running, the distributor shaft and distributor cam rotate. This causes the cam to open and close the points.

Since the points are wired to the primary windings of the ignition coil, the points make and break the ignition coil primary circuit. When the points are closed, a magnetic field builds in the coil. When the points are open, the field collapses and voltage is sent to one of the spark plugs.

With the distributor rotating at one-half engine rpm and with cam lobe per engine cylinder, each spark plug fires once during a complete revolution of the distributor cam.

**Point dwell (Cam Cycle)**

Dwell or cam cycle is the amount of time, given in degrees of distributor rotation, that the points remain closed between each opening. Look at Fig. 35-11.

**Fig. 35-11** Dwell is time points remain closed in degrees of distributor rotation. Points gap is distance between two points in fully open position. Dwell affects point gap and vice versa.

A dwell period is needed to assure that the coil has enough time to build up a strong magnetic field.

Without enough point dwell, a weak spark would be produced. With too much dwell, the point gap (distance between fully open points) would be too narrow. Point arcing and burning could result.

**ELECTRONIC IGNITION SYSTEM**

An electronic ignition system called a solid state or transistor ignition system uses an electronic control circuit and a distributor pickup coil to operate the ignition coil. Refer to Fig. 35-12.

**Fig 35-12.** Amplifier or control module contains switching circuit or transistor that operates ignition coil. Note relationship of parts.

An electronic ignition is more dependable than a contact point type. There are no mechanical breakers to wear or burn. This helps avoid trouble with ignition timing and dwell.

An electronic ignition is also capable of producing much higher secondary voltages. This is an advantage because wider spark plug gaps and higher voltages are needed to ignite lean air-fuel mixtures. Lean mixtures are now used for reduced exhaust emissions and fuel consumption.

**Trigger Wheel**

The trigger wheel, also called reluctor or pole piece, is fastened to the upper end of the distributor shaft. Fig. 35-12. The trigger wheel replaces the distributor cam used in a contact point distributor. One tooth is normally provided on the wheel for each engine cylinder.

**Pickup Coil**

The pickup coil, also termed sensor assembly or sensor coil, produces tiny voltage pulses for the ignition system’s electronic control unit (module or amplifier). Look at Fig. 35-13. The sensor assembly is a small set of windings forming a coil.