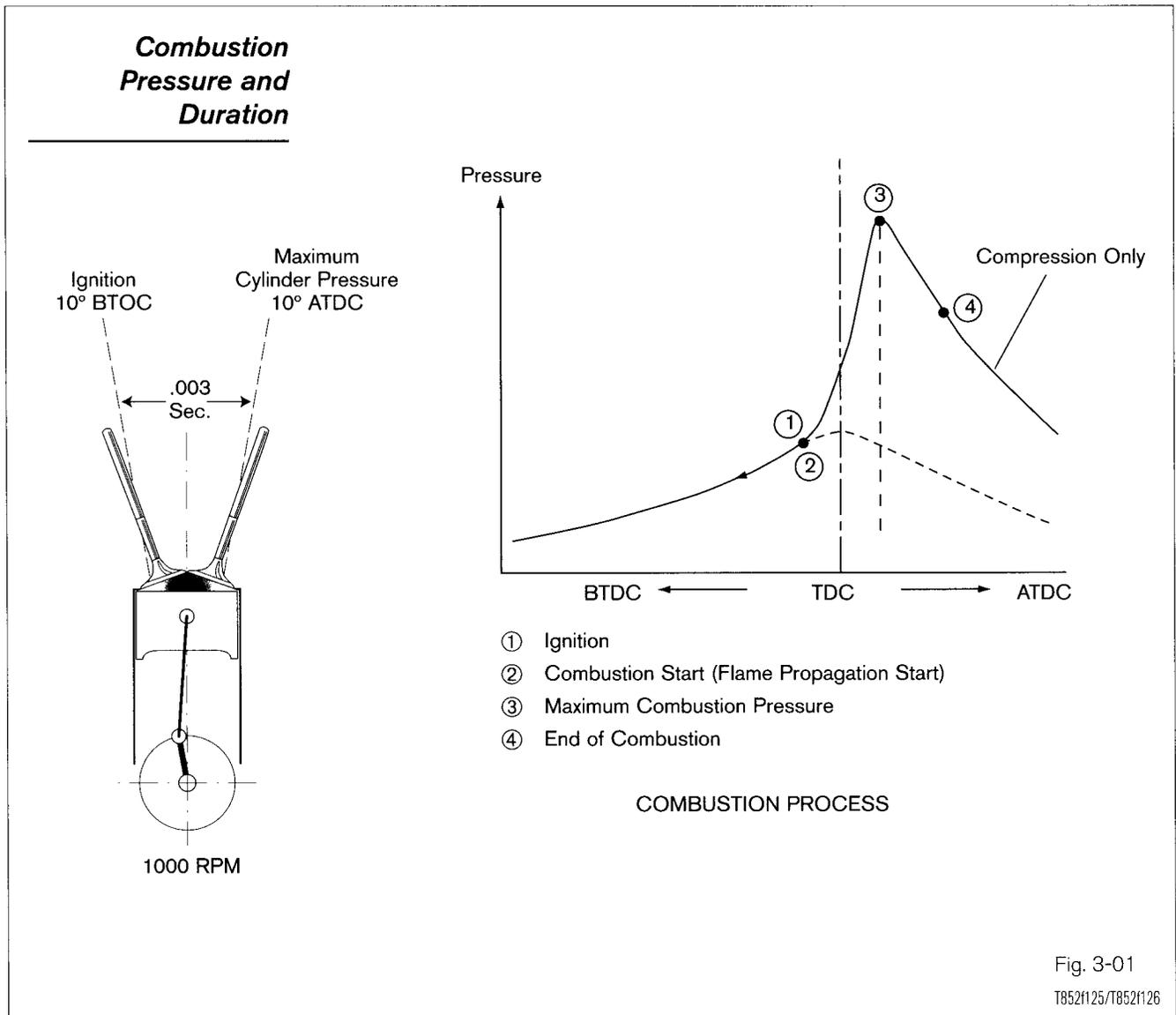


Ignition System Overview

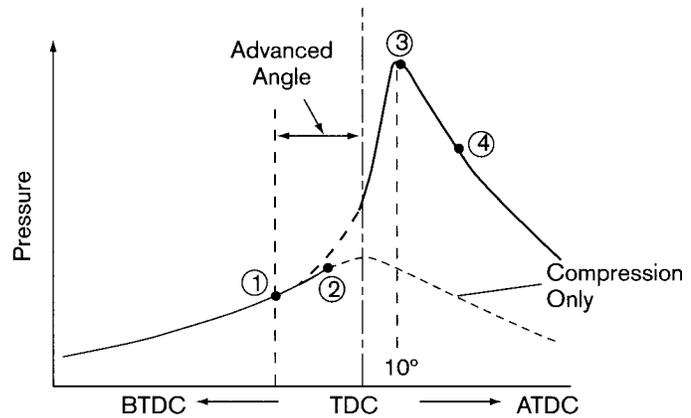
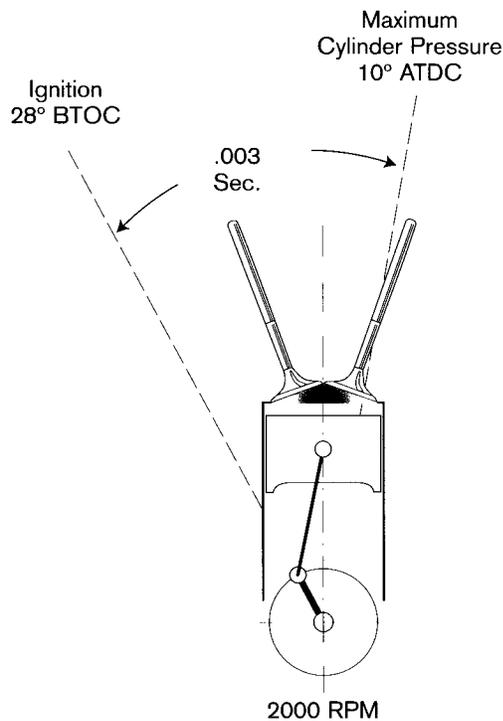
The purpose of the ignition system is to ignite the air/fuel mixture in the combustion chamber at the proper time. In order to maximize engine output efficiency, the air-fuel mixture must be ignited so that maximum combustion pressure occurs at about 10° after top dead center (TDC).

However, the time from ignition of the air-fuel mixture to the development of maximum combustion pressure varies depending on the engine speed and the manifold pressure; ignition must occur earlier when the engine speed is higher and later when it is lower.



Ignition Advance

Ignition must occur earlier so that the cylinder achieves maximum cylinder pressure when engine RPMs increase.



- ① Ignition
- ② Combustion Start (Flame Propagation Start)
- ③ Maximum Combustion Pressure
- ④ End Of Combustion

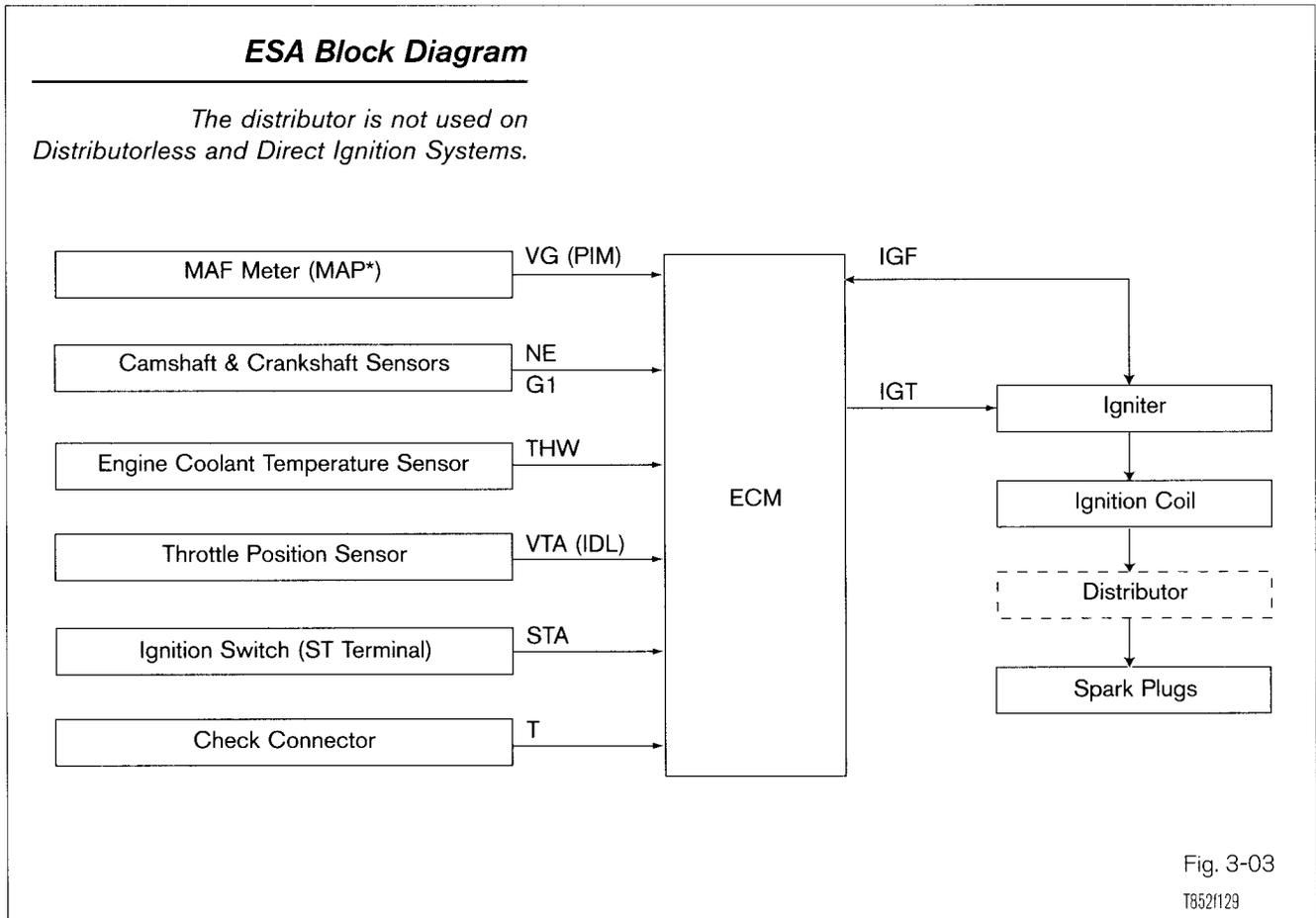
COMBUSTION PROCESS

Fig. 3-02

T852f127/T852f128

In early systems, the timing is advanced and retarded by a governor advancer in the distributor.

Furthermore, ignition must also be advanced when the manifold pressure is low (i.e. when there is a strong vacuum). However, optimal ignition timing is also affected by a number of other factors besides engine speed and intake air volume, such as the shape of the combustion chamber, the temperature inside the combustion chamber, etc. For these reasons, electronic control provides the ideal ignition timing for the engine.



Electronic Spark Advance Overview

In the Electronic Spark Advance (ESA) system, the engine is provided with nearly ideal ignition timing characteristics. The ECM determines ignition timing based sensor inputs and on its internal memory, which contains the optimal ignition timing data for each engine running condition. After determining the ignition timing, the ECM sends the ignition Timing signal (IGT) to the igniter. When the IGT signal goes off, the Igniter will turn on shut off primary current flow in the ignition coil producing a high voltage spark (7kV - 35kV) in the cylinder.

Since the ESA always ensures optimal ignition timing, emissions are lowered and both fuel efficiency and engine power output are maintained at optimal levels.

Types of Ignition Systems

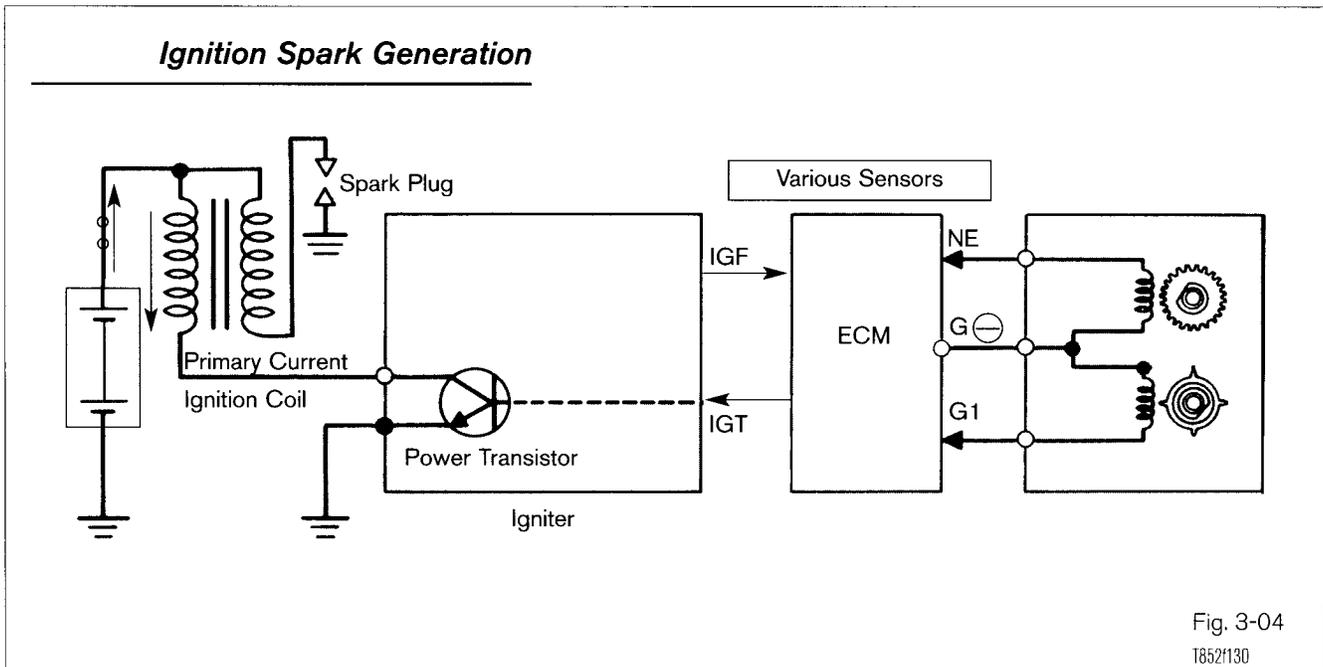
Ignition systems are divided into three basic categories:

- Distributor.
- Distributorless Ignition System (DLI) Electronic Ignition.
- Direct Ignition System (DIS).

Essential Ignition System Components

Regardless of type the essential components are:

- Crankshaft sensor (Ne signal).
- Camshaft sensor (also called Variable Valve Timing sensor) (G signal).
- Igniter.
- Ignition coil(s), harness, spark plugs.
- ECM and inputs.

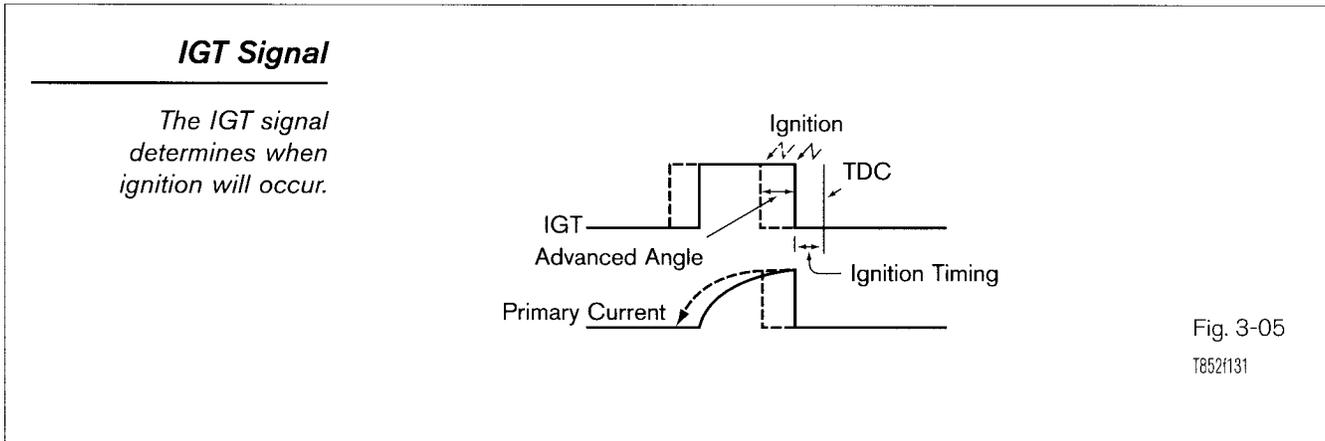


Ignition Spark Generation

The ignition coil must generate enough power to produce the spark needed to ignite the air/fuel mixture. To produce this power, a strong magnetic field is needed. This magnetic field is created by the current flowing in the primary coil. The primary coil has a very low resistance (approximately 1-4 ohms) allowing current flow. The more current, the stronger the magnetic field. The power transistor in the igniter handles the high current needed by the primary coil.

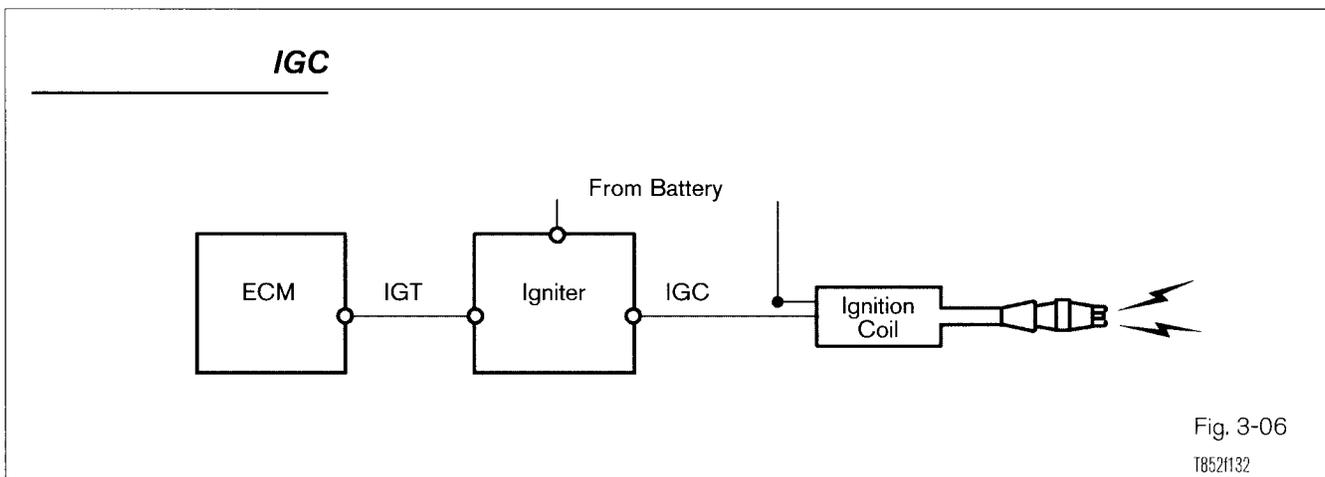
Another requirement to produce high voltages is that the current flow in the primary coil must be turned off quickly. When the transistor in the igniter turns off, current flow momentarily stops and the magnetic field collapses. As the rapidly collapsing magnetic field passes through the secondary winding, voltage (electrical pressure) is created. If sufficient voltage is created to overcome the resistance in the secondary circuit, there will be current flow and a spark generated.

NOTE: The higher the resistance in the secondary circuit, the more voltage that will be needed to get the current to flow and the shorter spark duration. This is important when observing the ignition spark pattern.



IGT Signal

The primary coil current flow is controlled by the ECM through the Ignition Timing (IGT) signal. The IGT signal is a voltage signal that turns on/off the main transistor in the igniter. When IGT signal voltage drops to 0 volts, the transistor in the igniter turns off. When the current in the primary coil is turned off, the rapidly collapsing magnetic field induces a high voltage in the secondary coil. If the voltage is high enough to overcome the resistance in the secondary circuit, there will be a spark at the spark plug.



IGC

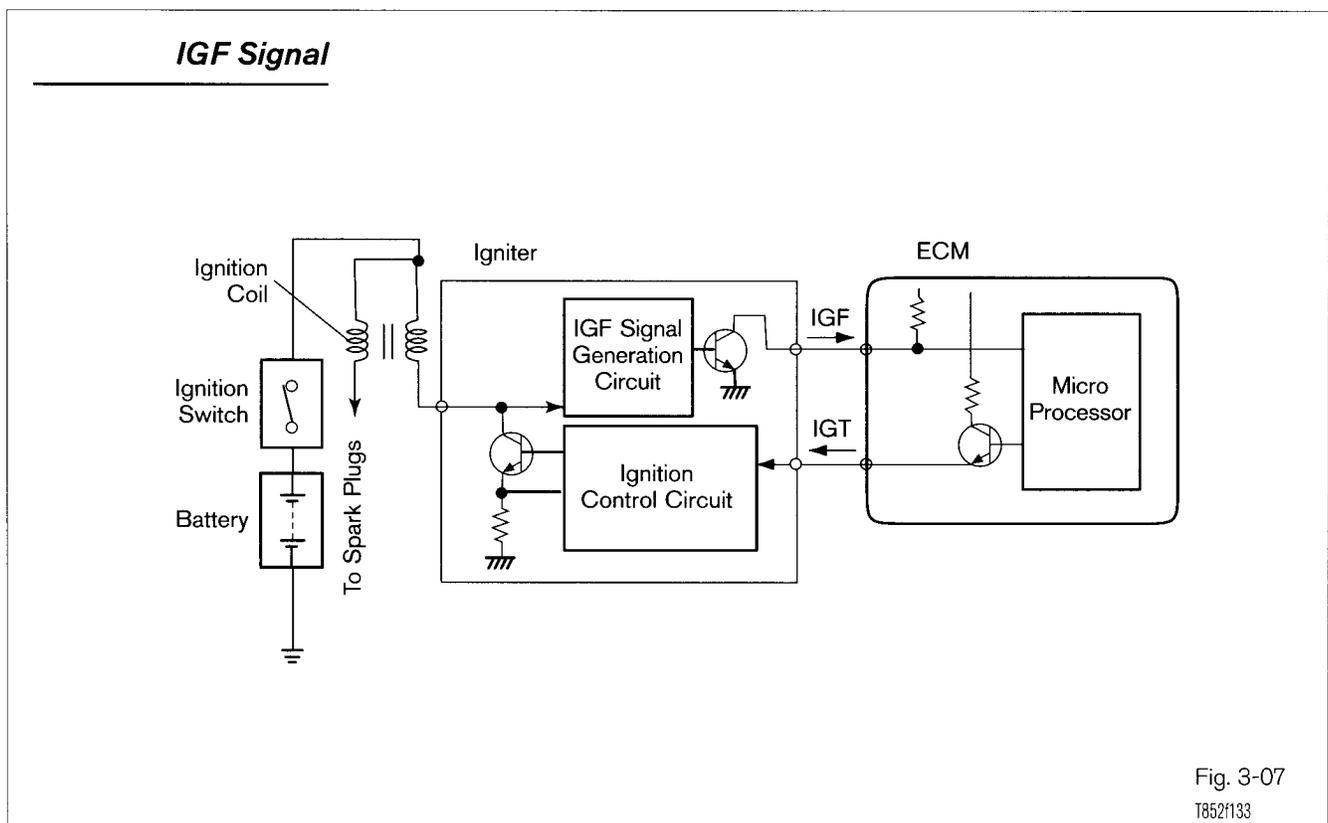
On some ignition systems, the circuit that carries the primary coil current is called IGC. IGC is turned on and off by the igniter based on the IGT signal.

Igniter

The primary function of the igniter is to turn on and off the primary coil current based on the IGT signal received from the ECM. The igniter or ECM may perform the following functions:

- Ignition Confirmation (IGF) signal generation unit.
- Dwell angle control.
- Lock prevention circuit.
- Over voltage prevention circuit.
- Current limiting control.
- Tachometer signal.

It is critical that the proper igniter is used when replacing an igniter. The igniters are matched to the type of ignition coil and ECM.



IGF Signal

The IGF signal is used by the ECM to determine if the ignition system is working. Based on IGF, the ECM will keep power supplied to the fuel pump and injectors on most ignition systems. Without IGF, the vehicle will start momentarily, then stall. However, with some Direct Ignition Systems with the igniter in the coil, the engine will run.

IGF Signal Detection Using CEMF

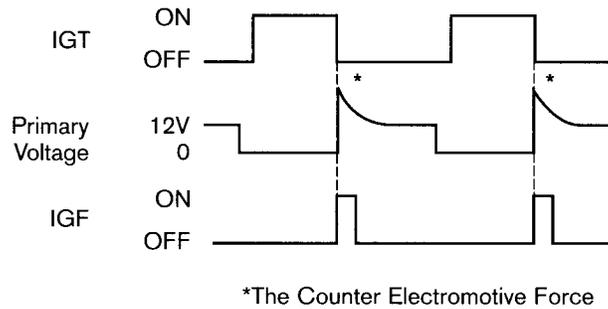
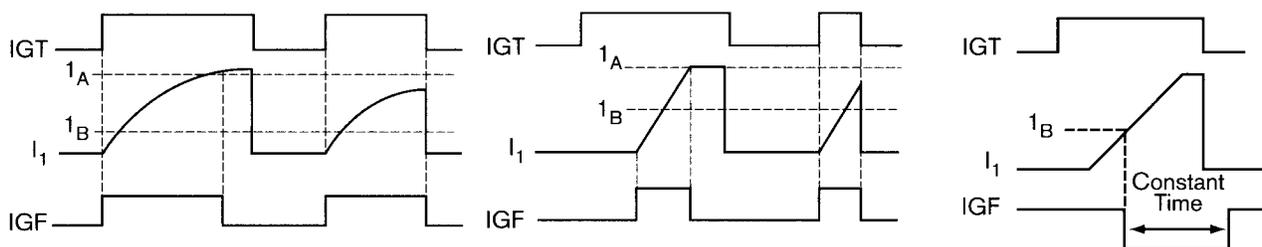


Fig. 3-08
T8521134

IGF Signal Detection using CEMF

There are two basic methods of detecting IGF. Early systems used the Counter Electromotive Force (CEMF) created in the primary coil and circuit for generating the IGF signal. The collapsing magnetic field produces a CEMF in the primary coil. When CEMF is detected by the igniter, the igniter sends a signal to the ECM. This method is no longer used.

IGF Detection through Primary Current



- I_1 Primary current
- I_A Maximum current level for successful spark generation
- I_B Minimum current level for successful spark generation

Fig. 3-09
T8521135/T8521136
T8521137

IGF Detection Using Primary Current Method

The primary current level method measures the current level in the primary circuit. The minimum and maximum current levels are used to turn the IGF signal on and off. The levels will vary with different ignition systems. Regardless of method, the Repair Manual shows the scope

pattern or provides you with the necessary voltage reading to confirm that the igniter is producing the IGF signal.

Lack of an IGF on many ignition systems will produce a DTC. On some ignition systems, the ECM is able to identify which coil did not produce an IGF signal and this can be accomplished by two methods.

The first method uses an IGF line for each coil.

With the second method, the IGF signal is carried back to the ECM on a common line with the other coil(s). The ECM is able to distinguish which coil is not operating based on when the IGF signal is received. Since the ECM knows when each cylinder needs to be ignited, it knows from which coil to expect the IGF signal.

IGF Circuit (8 Cylinder Engine)

Note that there are only two IGF lines for eight cylinders. Because the ECM knows when the coil is triggered, it knows when to expect the IGF signal. This capability allows the ECM to correctly identify the cylinder and set the appropriate DTC.

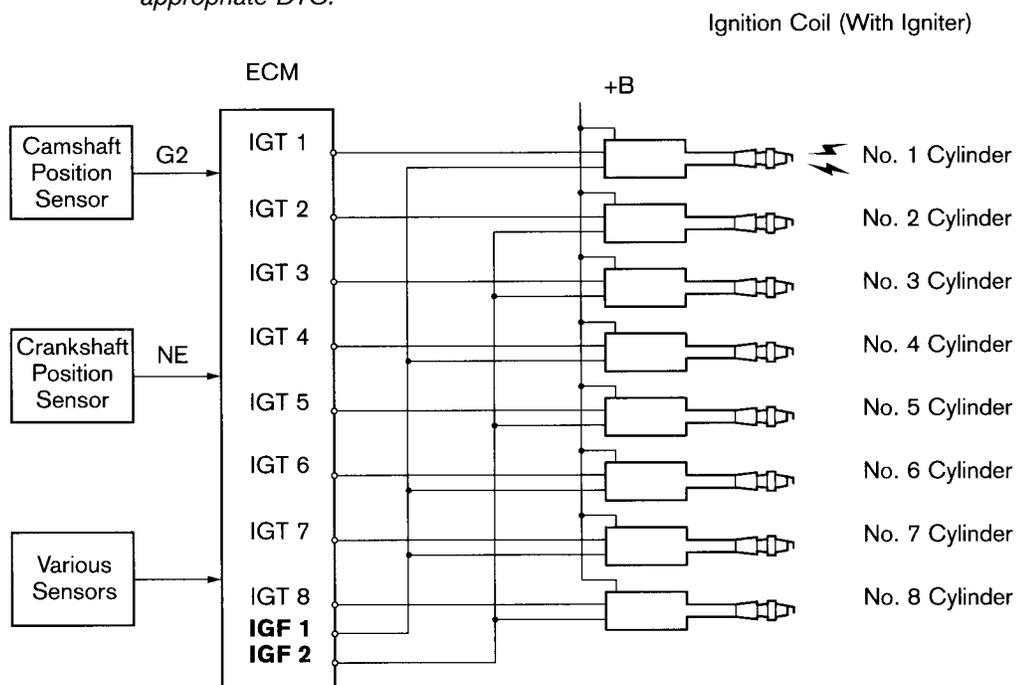
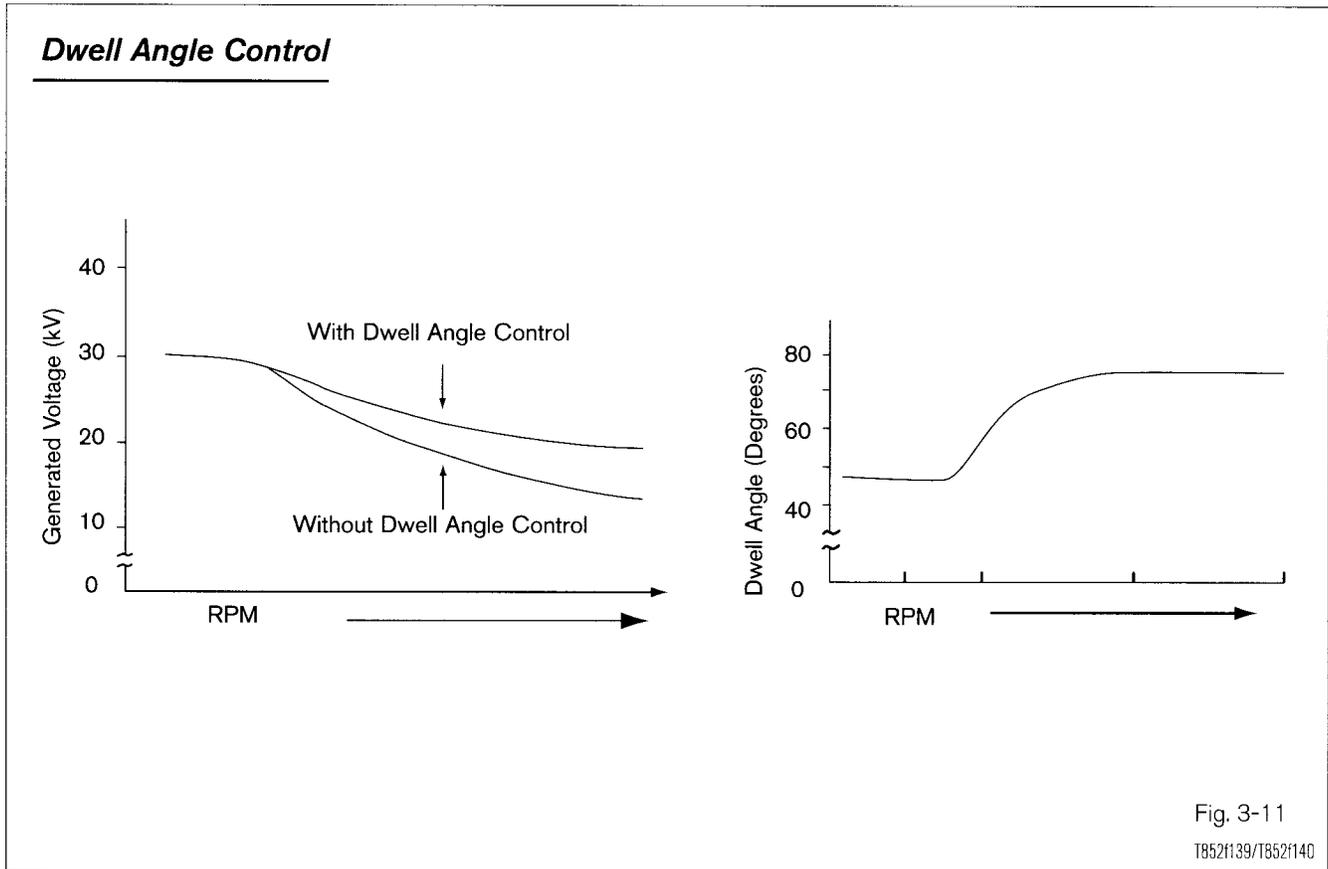


Fig. 3-10

T852f138



Dwell Angle Control

This circuit controls the length of time the power transistor (current flow through the primary circuit) is turned on.

The length of time during which current flows through the primary coil generally decreases as the engine speed rises, so the induced voltage in the secondary coil decreases.

Dwell angle control refers to electronic control of the length of time during which primary current flows through the ignition coil (that is, the dwell angle) in accordance with distributor shaft rotational speed.

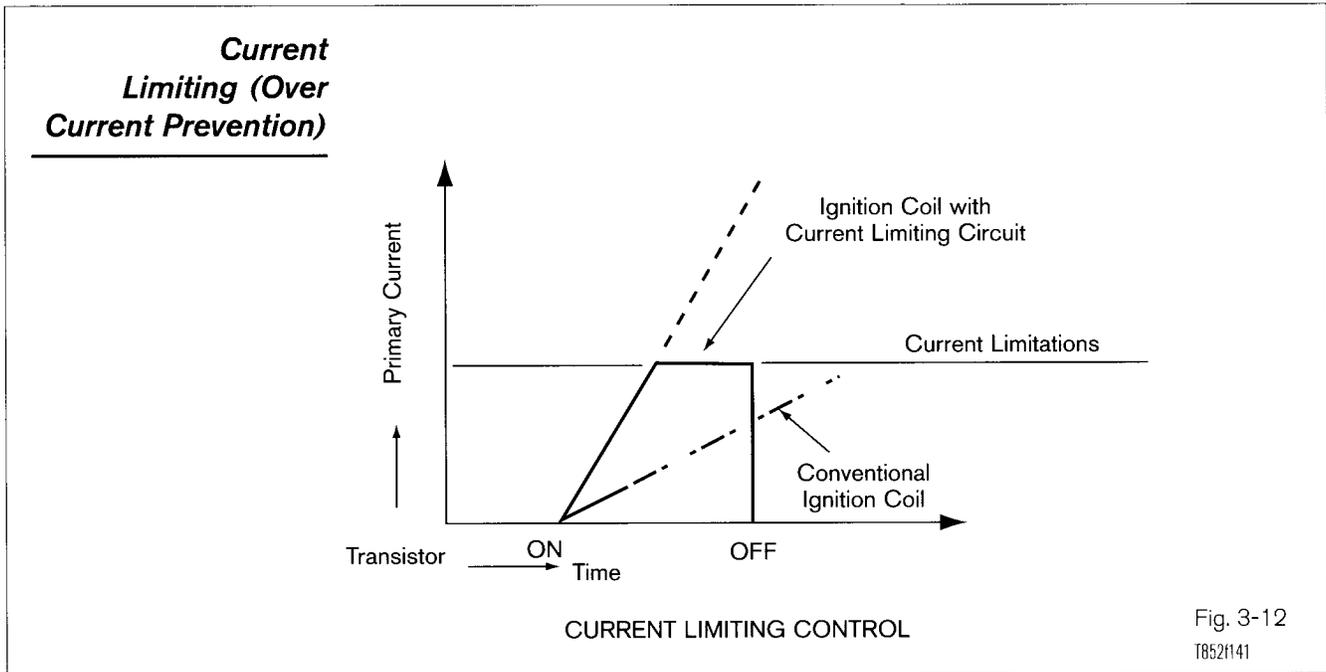
Lock Prevention Circuit

At low speeds, the dwell angle is reduced to prevent excessive primary current flow, and increased as the rotational speed increases to prevent the primary current from decreasing.

This circuit forces the power transistor to turn off if it locks up (if current flows continuously for a period longer than specified), to protect the ignition coil and the power transistor.

Over Voltage Prevention Circuit

This circuit shuts off the power transistor(s) if the power supply voltage becomes too high, to protect the ignition coil and the power transistor.



Current Limiting (Over Current Prevention)

Current limiting control is a system that improves the rise of the flow of current in the primary coil, ensuring that a constant primary current is flowing at all times, from the low speed to the high speed range, and thus making it possible to obtain a high secondary voltage.

The coil's primary resistance is reduced improving the current rise performance, and this will increase the current flow. But without the current limiting circuit, the coil or the power transistor will burn out. For this reason, after the primary current has reached a fixed value, it is controlled electronically by the igniter so that a larger current will not flow.

Since the current-limiting control limits the maximum primary current, no external resistor is needed for the ignition coil.

NOTE: Since igniters are manufactured to match ignition coil characteristics, the function and construction of each type are different. For this reason, if any igniter and coil other than those specified are combined, the igniter or coil may be damaged. Therefore, always use the correct parts specified for the vehicle.

Tachometer Signal

On some systems the Tach signal is generated in the igniter.

NE Signal and G Signal

Though there are different types of ignition systems, the use of the NE and G signals is consistent. The NE signal indicates crankshaft position and engine RPM.

The G signal (also called VVT signal) provides cylinder identification. By comparing the G signal to the NE signal, the ECM is able to identify the cylinder on compression. This is necessary to calculate crankshaft angle (initial ignition timing angle), identify which coil to trigger on Direct Ignition System (independent ignition), and which injector to energize on sequential fuel injection systems.

As ignition systems and engines evolved, there have been modifications to the NE and G signal. Timing rotors have different numbers of teeth. For some G signal sensors, a notch is used instead of a tooth to generate a signal. Regardless, you can determine what style is used by visually examining the timing rotor or consulting the Repair Manual. Many of the different styles are represented with their respective ignition system.

ASSIGNMENT

NAME: _____

1. What is Electronic Spark Advance?

2. List the three types of ignition systems:

3. List the five essential ignition system components:

4. Explain the detail the function of the igniter:

5. Explain in detail the function and purpose of both the IGT, IGF, and IGC signals:

6. Define the term Dwell Angle Control”:

7. Explain in detail the function and purpose of both the NE and G signals: