

Fuel System Fundamentals

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Fuel System Fundamentals

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Objectives

- Explain the operation of the various carburetor systems
- Compare fuel injection to carburetion
- Identify the different types of fuel injection
- Describe the design and function of electronic fuel injection components
- Understand how a computer feedback system works

Introduction

- Fuel systems
 - Must deliver proper mixture of air and fuel to be burned efficiently
 - Must store enough fuel so the car can complete a trip of a few hundred miles
- This chapter provides an overview of operation, uses, and advantages of different fuel systems

Fuel System

- Fuel delivery system components
 - Storage tank
 - Pump
 - Pressure regulator
 - Filters
 - Fuel lines
 - Hoses
- Fuel induction system
 - Provides correct mixture of burnable air-fuel mixture

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Fuel Tanks

- Fuel tanks: hold 12-20 gallons
 - Corrosive-resistant galvanized steel or plastic
 - Baffle prevents fuel sloshing in tank
 - Fuel pickup tube is installed through a hole in bottom of tank
 - Cluster assembly includes pickup tube, fuel gauge, fuel pump
 - In-tank filter is installed at end of pickup tube
 - Tank has expansion and overflow protection

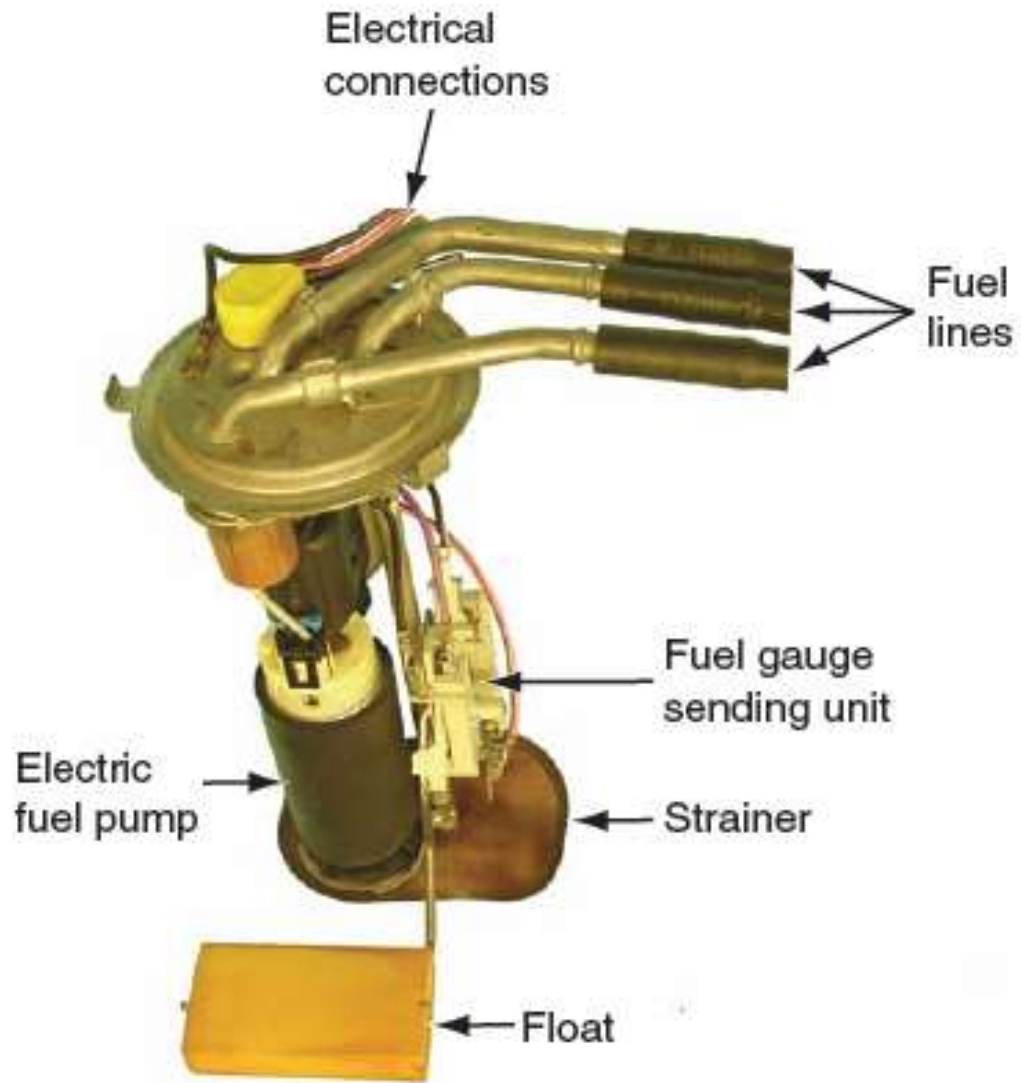


Figure 40.3 Combination electric fuel pump and sending unit.

Fuel Lines, Hoses, and Fittings

- Steel lines made of seamless tubing
 - Run the length of the frame
 - Transport fuel from tank to engine
- Hoses
 - Used for flexible connections

Fuel Pumps

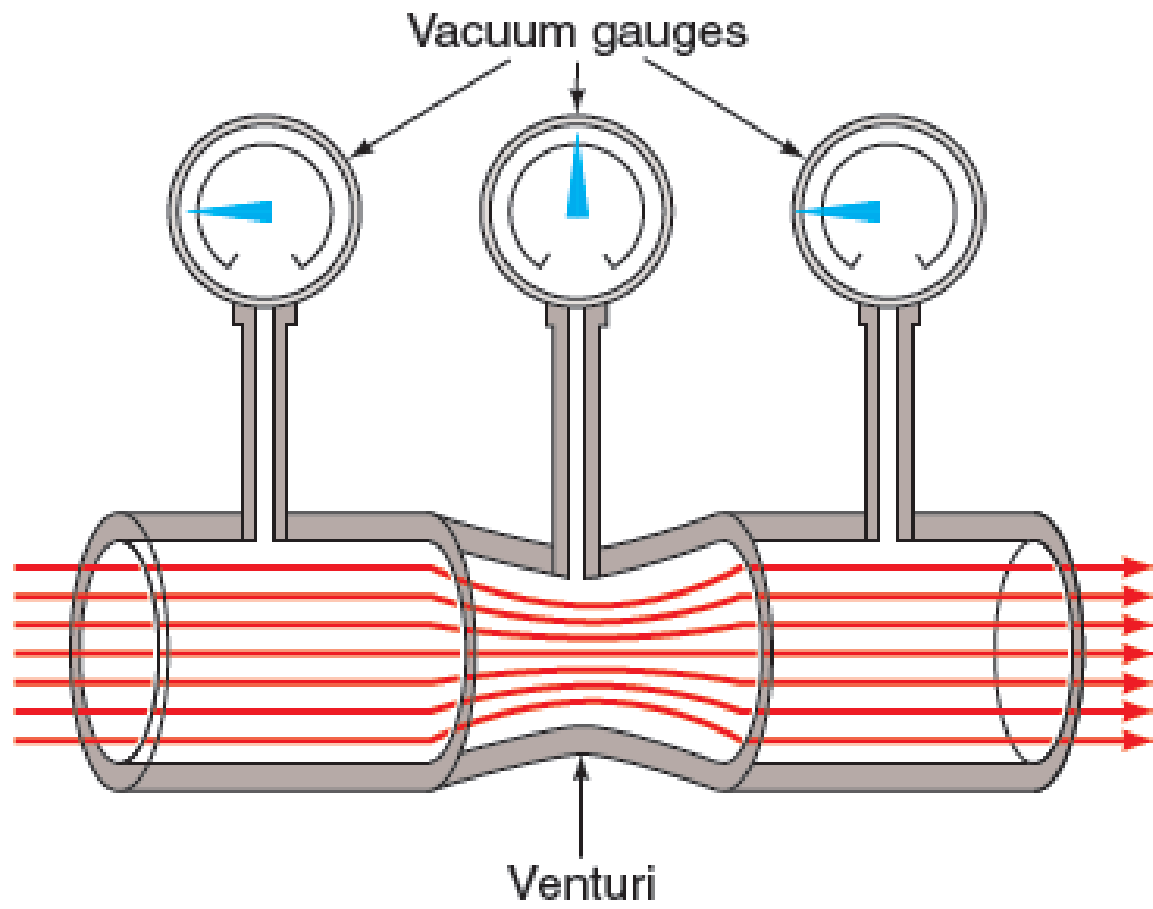
- Fuel from pump flows in a fuel rail loop between engine and fuel tank
 - Pressure regulator controls system pressure
- Electric fuel pump has one-way check valve that maintains pressure when engine is off
 - Submerged in well of fuel so cannot spark
- Fuel pump electrical circuit
 - Electric fuel pumps on modern vehicles: computer controlled
 - Remain on when engine is cranking or running

Fuel Filters

- Located in fuel line or tank
 - Outlet filters: installed on outlet side of fuel pump
- Fuel injection systems
 - Require large, heavy-duty filters
 - Filter out smaller particles of dirt while allowing pump to supply fuel

Fuel Injection and Carburetion

- Atomization: fuel suspended in air in tiny drops
- Vaporization: atomized fuel turns into gas
- Modern vehicles use fuel injections
 - Older vehicles use carburetors
 - Atomize air and fuel
 - Mounted on top of intake manifold
 - Venturi restricts airflow
 - Fuel is drawn into stream of air flowing through the carburetor



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Figure 40.11 The center gauge shows more vacuum (less pressure) in the venturi.

Fuel Injection and Carburetion (cont'd.)

- Airflow is changed by opening the throttle plate
 - Butterfly valve in bottom of carburetor
 - Opens when accelerator depressed
 - Float circuit: works as a toilet does
 - Main jet: provides opening to meter fuel amount
 - Idle port: allows a small amount of air and fuel to be metered into the intake manifold
 - Accelerator pump: provides extra fuel when car is accelerated quickly
 - Power valve: allows extra fuel to bypass main jet
 - Choke: restricts incoming air

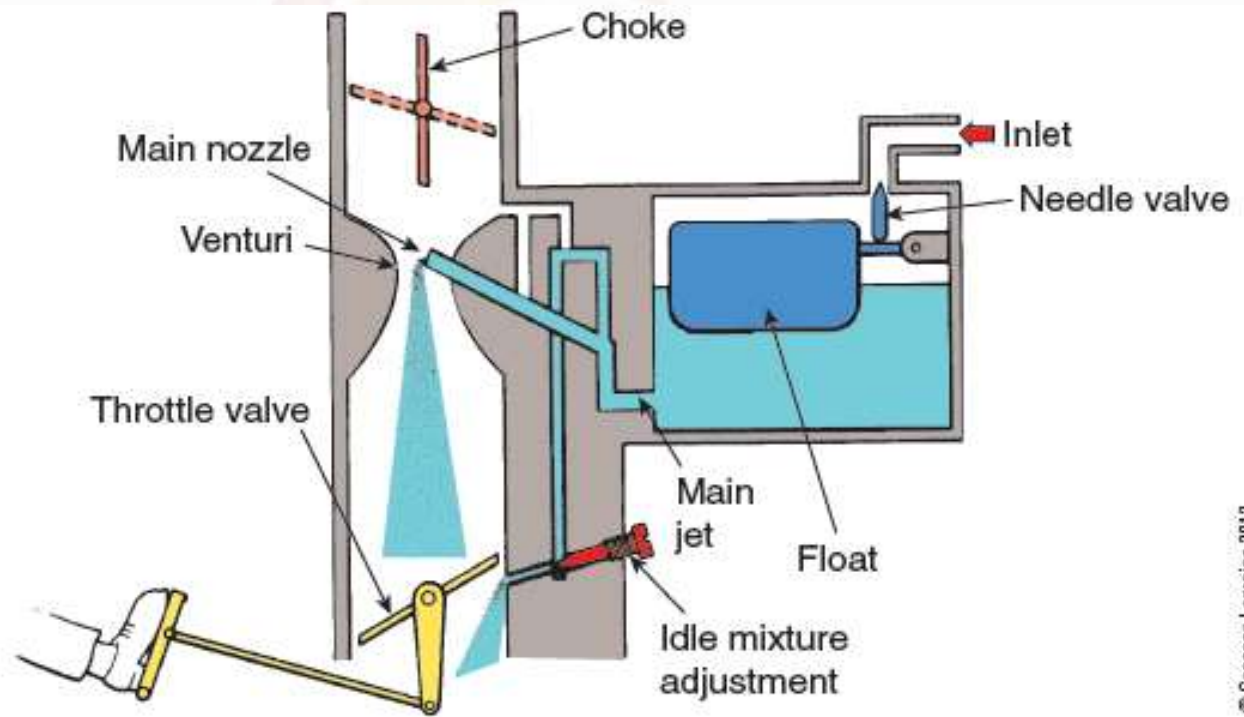


Figure 40.13 Basic parts of a carburetor.

Fuel Injection and Carburetion (cont'd.)

- Feedback carburetors
 - Meter fuel according to how much oxygen is sensed by an oxygen sensor in engine's exhaust
- Fuel injection operation
 - Fuel injection provides a better means of controlling exhaust emissions and fuel economy
- Fuel injection system designs
 - Many types

Fuel Injection and Carburetion (cont'd.)

- Types of fuel injection systems
 - Electronic
 - Mechanical
 - Throttle-body injection (TBI)
 - Central fuel injection (CFI)
 - Port injection
 - Sequential fuel injection
 - Multiport fuel injection (MFI)
 - Central multiport fuel injection (CMFI)

Fuel Injection and Carburetion (cont'd.)

- Port fuel injection systems
 - Fire injectors in different ways
 - Older MFI systems fire injectors in pairs or groups
- Sequential fuel injection (SFI)
 - Opens each injector just before its intake valve opens
 - Each injector has its own computer connection
 - Computer completes the ground for each injector in sequence

Pressure Regulator Operation

- Fuel pressure regulator
 - Controls systems maximum pressure
- Port injectors
 - Exposed to intake manifold vacuum
- Returnless fuel systems
 - Have one fuel line between fuel pump and fuel rail to injectors
 - Fuel does not move through fuel rail
 - Excess fuel returns to tank by way of regulator in fuel gauge sending unit

Electronic Fuel System Operation

- Fuel injectors
 - Electromagnetic solenoid controlled nozzles
 - Each is supplied with power when ignition is on
 - Computer controls the ground or power to complete the circuit
 - Injector plunger is pulled against spring tension by magnetic field
 - Thermal time switch limits the maximum time the injector can operate

Airflow Measurement

- Different ways of determining amount of air flowing into the engine
 - Speed density systems use MAP sensor and engine rpm to calculate air entering engine
 - Airflow density sensors have a sensor that measures volume of air
 - Vane-type mass airflow (MAF) sensor
 - Heated resistor MAF sensor
 - Hot wire MAF sensor

Idle Speed Control

- Idle speed is raised to compensate for cold engine or extra load
 - Raised by allowing more air to bypass throttle plate
 - Auxiliary air valve, air by-pass valve, or idle speed control motor
 - Sensors: throttle position, coolant temperature, air charge temperature
- Drive-by-wire throttle bodies
 - Used in many newer vehicles
 - No throttle linkage is required

Fuel Pump Control Module

- Provides power to fuel pump
 - Uses power transistors
 - Like the ones used to control current flow to an air conditioner blower
 - Power is sent through power transistors in a separate fuel pump driver module

Computer-Controlled Fuel Systems

- Computers meter fuel precisely
- Powertrain control module (PCM)
 - Controls engine performance
 - Includes fuel system
- Automotive ignition and electronics
 - Complex specialty areas
 - This chapter provides a general idea of the operation of the system

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Feedback Fuel Systems

- Computer system components
 - Computer, sensors, and actuators
- Engines with computer feedback
 - Have oxygen sensor in exhaust manifold
- Feedback fuel system
 - Computer makes corrective changes to air-fuel mixture
- Feedback carburetors
 - Used on older cars

Feedback Fuel Systems (cont'd.)

- Open loop
 - Computer does not control the air-fuel mixture
 - Oxygen sensor operates at 600°F
- Closed loop
 - Occurs when engine reaches operating temperature and computer acts on information
- Zirconium oxide works like a small battery
 - Rich mixture generates 0.45 volt or higher
 - Lambda: ratio of air-fuel mixture to ideal mixture
 - Some oxygen sensors are heated

Feedback Fuel Systems (cont'd.)

- Wide range oxygen sensor
 - Accurately detect air-fuel ratios over wider range
 - Two nested zirconia sensors
 - Energy difference determines air-fuel ratio
 - PCM maintains O₂ sensor output at constant voltage
 - Outside sensor measures exhaust oxygen
 - Inside sensor samples outside air

Feedback Fuel Systems (cont'd.)

- Diesel direct injection
 - Common rail connects injectors with diesel fuel under high pressure
 - Atomizes diesel, mixing it with air
- Gasoline direct injection systems
 - Gasoline is injected directly into combustion chamber
 - Runs the engine with a lean mixture
 - Increases fuel economy by as much as 30%
 - Reduces exhaust emissions
 - Require EGR valve to control NOX emissions



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Thank you

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