



D

Dampening

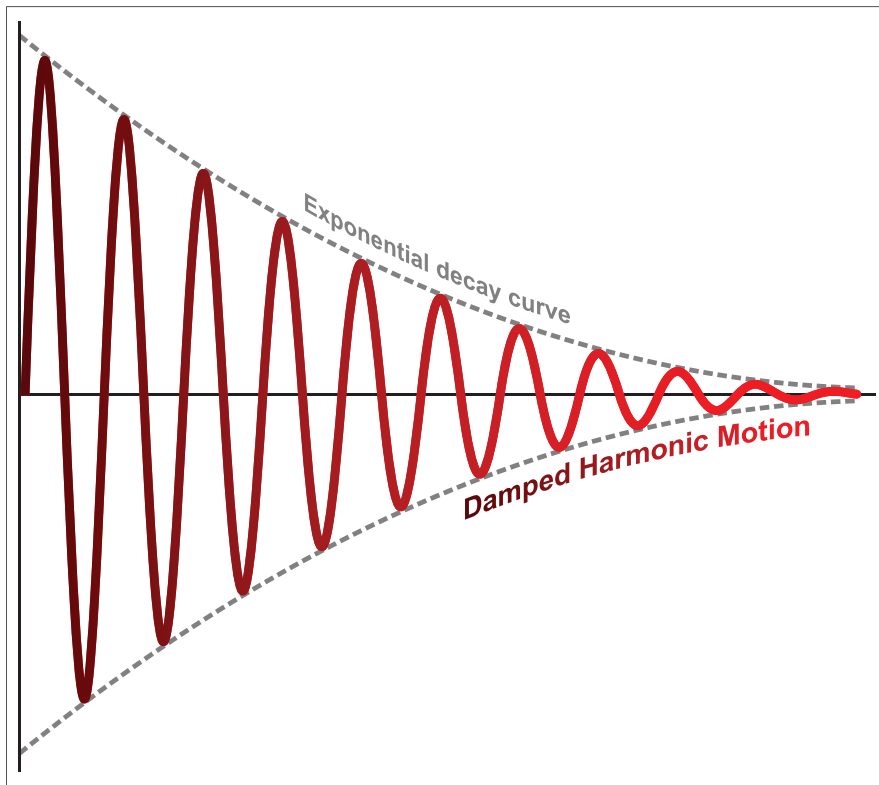
Reducing movement or vibration such as a shock absorber dampening the oscillation of a spring. For more information on this, see **J3152_202005** [1].

Damper

See **Harmonic Balancer**.

Damping

Ability of an object or material to dissipate or absorb vibration. The automotive shock absorber is a good example. The function of the shock absorber is to absorb or dampen the oscillations of the suspension springs and up and down movement. For more information on this, see **J3152_202005** [1].

FIGURE D.1 Ability of an object or material to dissipate or absorb vibration.

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Data

Information from a vehicle computer used for mechanical or electronic computation.

Data Bus Communication

The ICE management computer receives information from other vehicle systems, such as the transmission and cruise control, and body computer module and provides important information to other vehicle systems. The computer transmits critical information such as engine speed, throttle position, and engine temperature. The data bus system functions to reduce the amount of wiring needed for the computer to communicate with other vehicle computers. The data bus may be either a single wire or, on older vehicles, a two-wire system. Similar to personal computer systems, the data bus used on today's vehicles becomes faster, uses even less wires, and performs more functions with each

passing year. The data bus is also referred to as multiplexing or a controller area network (CAN). For more information on this, see **J1939/21_2021** [2].

Data Stream

The serial data in an automotive engine management computer-controlled vehicle system that can be extracted by a scan tool computer or electronic service tools. For more information on this, see **J1930DA_202105** [3].

Datum Plane

Datum means a basis on which other measurements can be based. The datum plane is the horizontal plane.

DC (Direct Current)

When a steady-state electrical potential is applied to a circuit, the resulting current flows in one direction, which is called direct current, or DC.

DC Generator

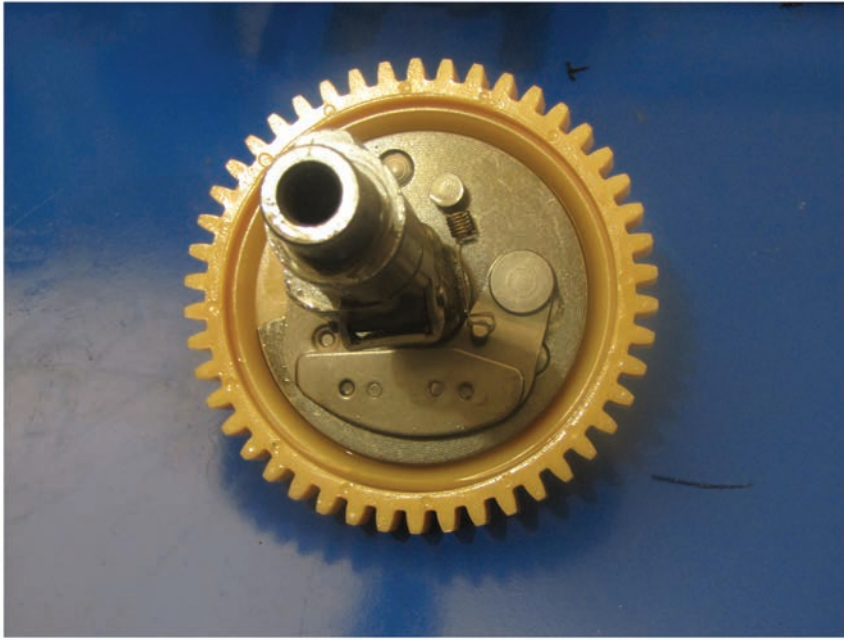
A DC generator uses the principle of electromagnetic induction to produce a DC. When the magnetic lines of force cross or cut a conductor (wire loop), it induces a voltage in that conductor. The DC generator uses an iron core or laminated iron sheets to create an electromagnet. When current flows through this coil, a magnetic field or flux is created between the pole pieces. Permanent magnets could be used. A single wire loop is between the north and south poles. When this wire loop turns into a magnetic field, it cuts off the lines of force and induces a voltage. When there is a complete circuit from the wire loop, current will flow.

Decimal

(1) Refers to or denotes a system of numbers and arithmetic that supports quantity in ten, tenth parts, and powers of ten. (2) A fraction whose denominator can be a power of ten and whose numerator is expressed as numbers placed to the right as a percentage point. (3) The amount system that uses the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Decompressor

A mechanical device used on single- or twin-cylinder air-cooled ICEs that momentarily opens an exhaust valve on the compression stroke of the piston to partly vent the combustion chamber for easy starting.

FIGURE D.2 Decompressor from Honda V2 industrial engine.

Courtesy of John F. Kershaw Ed.D.

De Dion Rear Axle (Dead Axle)

A form of non-independent suspension, different from a swing axle, Hotchkiss drive, or live axle. It does not transmit power to the drive wheels, it is also called a dead axle.

Deep-Cycle Battery

An SLA (sealed lead-acid) battery that provides sustained power over a long period and runs reliably until it is 80% discharged or more, at which point it needs to be recharged. They can be discharged up to 80%, but most battery manufacturers recommend not discharging below 45%.

DEF (Diesel Exhaust Fluid)

DEF (also called reductant and urea) is a reductant. It is composed of urea and purified water and is injected in small amounts into the exhaust where it works with a catalyst to convert NO_x into nitrogen and water vapor. DEF is a non-toxic, odorless, and safe solution composed of:

- 67.5% purified water
- 32.5% automotive-grade urea

Urea is produced from natural gas and other sources and is commonly used in fertilizer and industrial applications including emissions control at power plants. It is certified by the API (American Petroleum Institute). Urea is used in Europe where it is known as AdBlue. The following are determined DEF facts:

- DEF freezes at approximately 12°F.
- DEF thaws with no degradation.
- DEF tank and lines are heated for cold weather operation.
- No impact on cold weather engine operation.
- DEF has a 1-year shelf life.
- DEF will degrade at temperatures above 86°F or in direct sunlight for an extended period; it is not an issue if DEF stock is rotated within a year.
- DEF containers have a date stamp.
- On-board warning systems advise the driver when the DEF level is low or of inferior quality.
- The tank includes a filter and screen.
- Anticipated DEF usage of 1–1.25% of diesel fuel usage.

Deflection Rate

Distance an automotive suspension spring bends under a given load or pressure.

Defogger

An automotive device that blows dry air over the front glass and rear backlight to clear away any condensation.

Defroster

A heating grid placed in the rear window glass or backlight in that when heated will defrost the rear window. See **Heated Rear Window Defroster**.

Deglazing

Repair procedure that you use only when both the cylinder walls and the pistons themselves are in good condition. Deglazing roughens the surface of the cylinders without significantly changing their overall diameter.

Delta-Wound Stator

The two basic stator winding designs are delta wound and wye (Y) style. Delta wound are easily identifiable by their shape, as they are triangular.

These windings yield a high current flow at lower RPM. Wye windings produce higher voltage than delta stators at even lower RPM.

Depth

The distance from the top or surface of something to its bottom or the distance from the nearest to the farthest point of something or from the front to the back.

Detergent Additives

These additives fight varnish deposits. Detergents clean piston ring grooves and keep the rings free to seal with maximum effectiveness.

Detonation

An ICE combustion that takes place when an expanding combustion flame front compresses and heats a portion of the air-fuel mixture in a corner of the combustion chamber that is already at a very high temperature. A portion of the air-fuel mixture explodes before the flame front can get to it. This explosion creates a second pressure wave in the combustion chamber that causes the cylinder pressures to rise at an uncontrolled rate, raising the cylinder temperatures above acceptable limits.

DEX-COOL

General Motors (GM) brand name used for organic acid technology (OAT) antifreeze/coolant that does not contain silicates or phosphates. Usually orange in color (may be pink as well), it absolutely was first developed by Havoline and employed in GM vehicles. This extended-life coolant encompasses a longer service interval than the green, ethylene glycol-based coolants.

DI (Direct Ignition)

The DIS, or direct/distributorless ignition system, uses a control module that is part of the coil assembly and connecting wires to replace the ignition distributor. In a waste-spark system, as it is commonly called, a spark plug is attached to each end of the induction coil secondary winding. Each coil of the system fires two plugs at the same time in two companion cylinders. The pistons in these cylinders will reach top dead center (TDC) at the same time. The cylinder at TDC on the compression stroke is the event cylinder, while the cylinder at TDC on the exhaust stroke or TDC overlap is the waste cylinder. When the

coil fires, both spark plugs fire at the same time to complete the electric circuit. For more information on this, see **J139_202002** [13].

DI (Direct Injection)

Combustion chamber designs come in two distinct groups: open combustion chamber or DI systems and IDI (indirect Injection) systems. In the DI system, fuel injection and subsequent combustion takes place within the actual working chamber or cylinder of the engine. Fuel is injected directly into the space between the cylinder head and the top of the piston. This is also referred to as an open chamber design. The piston often contains a bowl or has a specially shaped crown to aid in the mixing process for good combustion.

DI (Distributor Ignition)

Distributor ignition (DI) is a term specified by the Society of Automotive Engineers (SAE) J1930 standard for an ignition system that uses a distributor. For more information on this, see **J139_202002** [4].

Diagnostic Chart

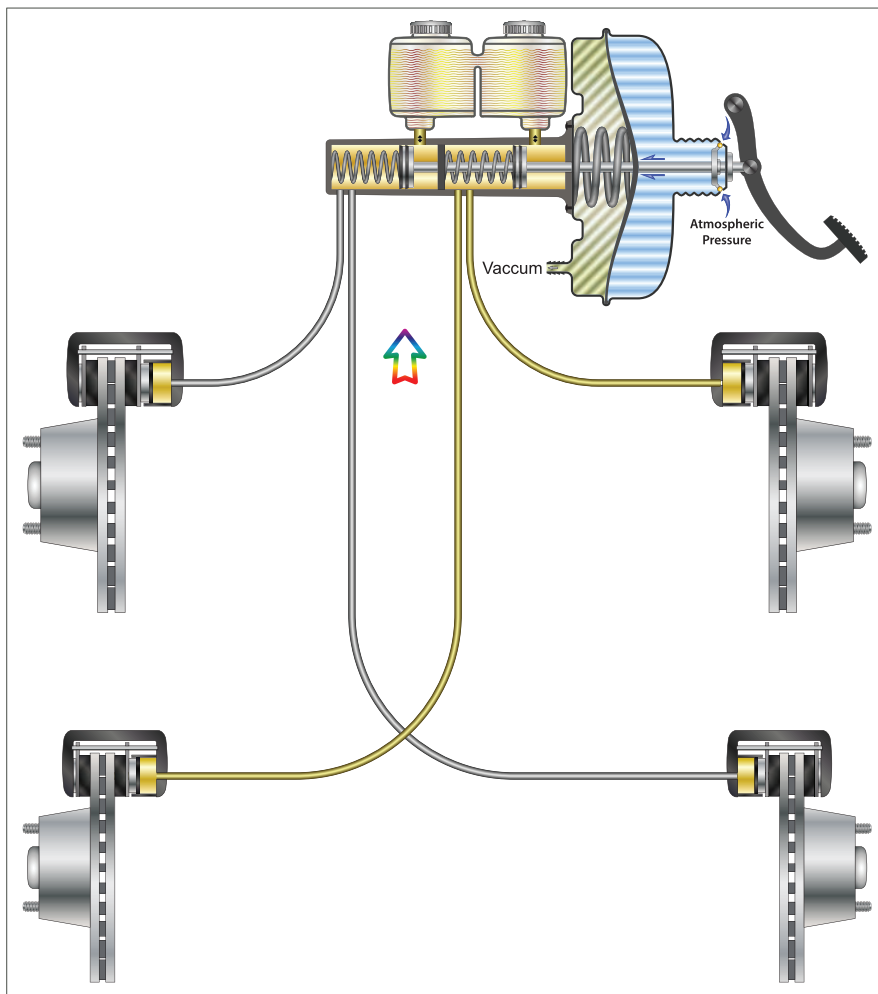
A chart that gives logical steps for finding and correcting problems.

Diagnostic Executive

On computer-managed engine management in an OBD-II (On-Board Diagnostics Generation II) systems, the engine management computer uses a special type of software to manage the vehicle system monitors. On Ford and GM systems, this software is called the diagnostic executive. For more information on this, see **J1930DA_202105** [3].

Diagonal Braking System

In a diagonal split brake system, the right-front and left-rear brakes are on the same hydraulic circuit. The left-front and right-rear brakes are on a separate hydraulic circuit. This type of system is found in FWD (front-wheel-drive) and AWD (all-wheel-drive) vehicles. This system offers an advantage of continued performance even when there is a hydraulic failure in half of the system. Brake pressure can be applied to one driven wheel and the opposite rear wheel in order to maintain directional stability.

FIGURE D.3 Automotive diagonal braking system found in FWD and AWD vehicles.

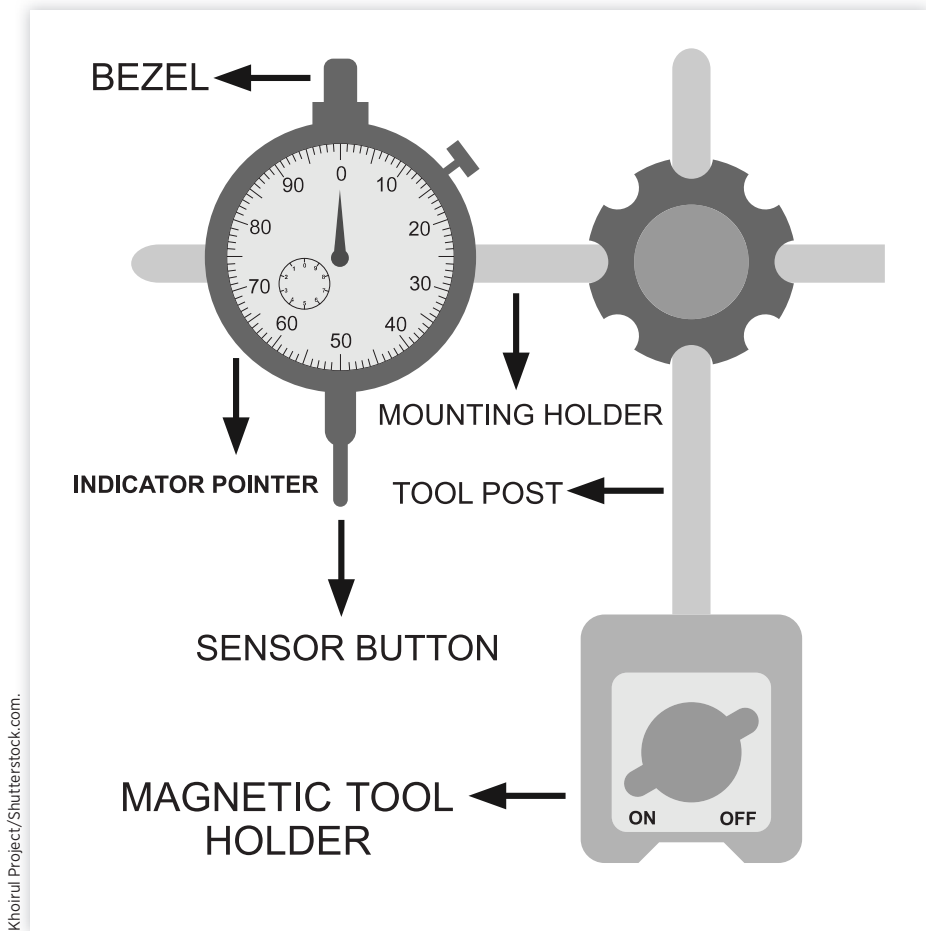
Fouad A. Saad/Shutterstock.com.

Dial Bore Gauge

Special measuring instrument for measuring cylinder and main bearing bores for taper and out of round.

Dial Indicator

The dial indicator is a mechanical device that uses a pin attached to a lever which moves a gear to turn a needle, like a clock, to measure up and down linear travel or rotary movement. It is used to measure endplay, runout, and warpage.

FIGURE D.4 Dial indicator measuring tool.

Diameter

The distance between one side of a circular object to the other side straight across and passing through the center.

Diamond-Shaped Frame

Takes place when one frame rail is pushed rearward in relation to the opposite frame rail. Vehicle tracking is affected by this condition. The following causes can result in a diamond: collision, towing, or being towed with the chain attached to only one side of the frame.

Diaphragm

A thin flexible wall separating two cavities, such as the diaphragm in a vacuum advance unit.

Diaphragm Spring

The diaphragm spring is found in automotive clutches. It is a conical or cone-shaped spring instead of a coil spring for producing adequate pressure to engage the clutch. The clutch cover is fastened to the ICE flywheel and the outer rim of the diaphragm spring is in contact with the pressure plate to hold the clutch disc to the ICE flywheel.

DIC (Driver Information Center)

A vehicle communication system that uses messages, audible noises, and haptic impulses to inform the driver of vehicle conditions. The system uses numerous sensor inputs to the engine and powertrain management computers in addition to vehicle mileage to accurately calculate when the oil needs changing. The software uses temperature, highway or city driving, extreme ambient temperatures, and other factors in making the decision. An oil change indicator tells the driver that an oil change is needed.

Die Grinder

A die grinder is a cutting wheel or stone that will easily remove a damaged bolt head.

Dielectric

The insulating material between the two conductive plates of a capacitor.

Dielectric Grease

Special grease that blocks moisture and helps prevent corrosion without affecting electrical conduction.

Dielectric Strength

Dielectric strength is the resistance to electrical penetration.

Diesel Engine

The diesel engine operates on a different principle than the gas engine since fuel is not mixed with air entering the cylinder during the intake stroke. Air alone is compressed during the compression stroke and the diesel fuel is injected

or sprayed into the cylinder at the end of the compression stroke. The compression ratio is much higher and provides compressed air temperatures as high as 1,000°F. The temperature at this instant is high enough to ignite spontaneously when the injector sprays or injects fuel into the cylinder. Combustion of the fuel is controlled by the speed at which the fuel is injected into the cylinder. Thus, in the diesel engine, the combustion is not a rapid burning of the fuel already present in the cylinder, as in a gas engine, but a slower burning that produces an even increase in pressure. The diesel operates with a stratified air-fuel mixture in the cylinder, and combustion occurs as the fuel mixes with the air. The inlet throttle becomes unnecessary.

FIGURE D.5 Diesel engine.



Sergey Ryzhov/Shutterstock.com.

Diesel Fuel

A mixture of hydrocarbons (hydrogen and carbon) extracted from fossil fuel through a process called distillation. Diesel is a middle distillate with more energy per unit of volume. It is less complicated to refine than gasoline. Diesel fuel contains higher quantities of sulfur which end in harmful exhaust emissions. The distillation process is primarily accustomed to refine fuel. Fossil

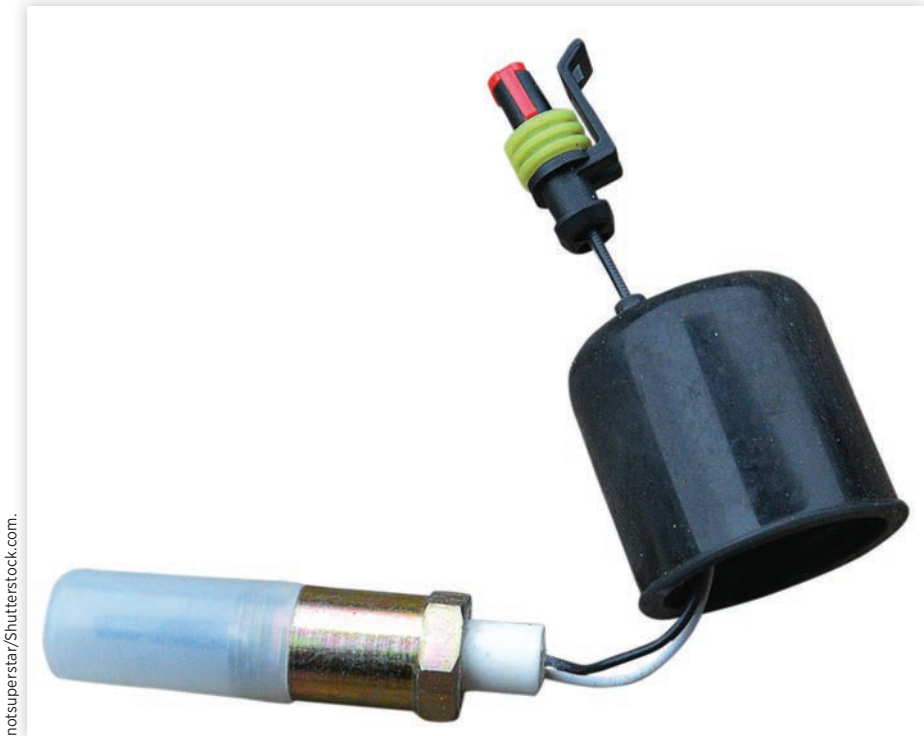
crude is subjected to high heat, and its parts are separated out by vaporization as they reach their individual boiling points. The hydrocarbons within the fossil fuel have different boiling points, so if some fossil oil is placed in a very container and heated, the hydrocarbons with very low boiling points are vaporized first, while the others have higher boiling points.

Diesel fuels are processed from that a part of the oil that boils between 350 and 750°F. Automotive/locomotive diesel fuels are derived from refinery products which are commonly observed as middle distillates. Middle distillates represent products which have a better boiling range than gasoline and are obtained from fractionation of the petroleum or from streams from other refining processes. Finished diesel fuel blends represent blends of middle distillates and should contain other blending components of substantially non-petroleum origin, like biodiesel fuel blend stock, and/or middle distillates from non-traditional refining processes, like gas-to-liquid processes. The properties of economic distillate diesel fuels rely upon the refinery practices employed and also the nature of the crude oils from which they are derived. Thus, they will differ both with and within the region in which they are manufactured. Such fuels generally boil, at gas pressure, over a variety of temperature between 130 and 400°C (approximately 270 to 750°F).

Diesel fuel makeup can represent various combinations of volatility, ignition quality, viscosity, sulfur level, density, and other characteristics. Additives are used to impart specific properties to the finished fuel. Diesel fuel accounts for roughly 20% of all crude consumed within the USA. The oil, automobile, and fuel additive industries have worked together for several decades to work out the composition and properties of diesel fuels required to supply satisfactory vehicle operation. This work is ongoing. Since the late 1960s, environmental concerns have led to federal and state regulations to scale back emissions from vehicles and from petroleum storage and transportation facilities. For more information on this see **J313_201706**, which discusses the characteristics of diesel fuels, common standard test methods, specifications developed by ASTM International, and government regulations [5].

Diesel Fuel Heater

Fuel heaters use electric current or warm coolant to heat fuel. Electric inline heaters are placed in line just before fuel enters the filter housing. Other electric heaters use heating elements located within fuel water separators to warm fuel and prevent icing of water contained by fuel. Coolant-type heaters provide greater temperature increases but only after the engine has coolant has warmed up. Some class 8 trucks use a solid-state electric fuel heater that is actually constructed within the fuel line from the fuel tank to the filter assembly.

FIGURE D.6 Diesel low-pressure fuel heater.

Diesel Fuel #1

1D, or #1 diesel, is the most refined diesel fuel among the two primary grades, and it is the most volatile. Number 1 diesel is intended for use in high-RPM engines that experience frequent changes in speed and load.

Diesel Fuel #2

2D, or #2 diesel, is the grade most commonly used in diesel vehicles, especially in warm to moderate climates.

Diesel Knock

In the process of diesel engine combustion, the first fuel burns very rapidly. This rapid burning causes a sudden rise in pressure. This sudden rise causes a highly localized pressure that causes an audible noise known as diesel knock. This diesel knock noise level hinges on pressure rise velocity. This knock occurs in the beginning of the combustion cycle where knock or detonation in a spark-ignited gasoline-fueled engine takes place at the end of the combustion cycle.

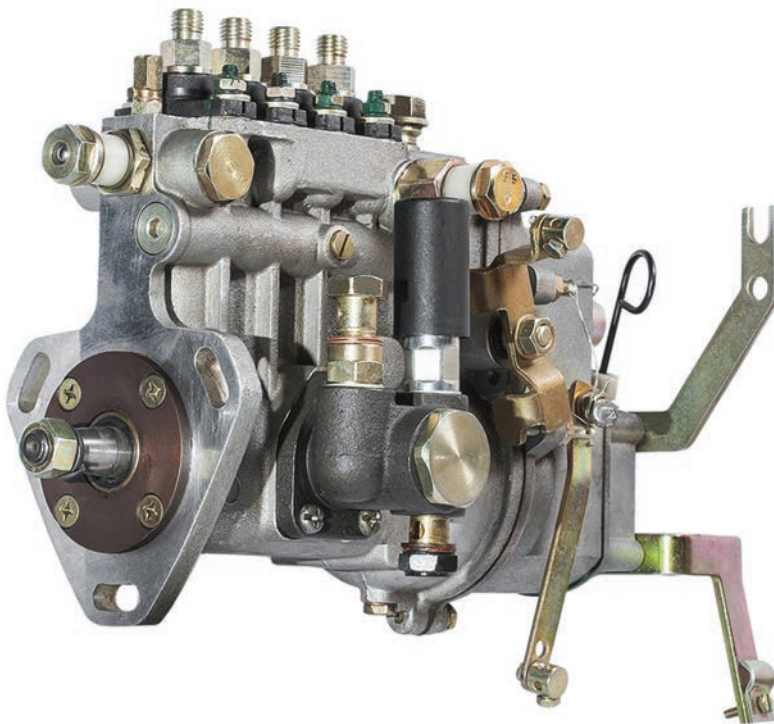
Diesel Particulate Filter

See **DPF**.

Diesel Plunger Pump

When individual pumps are contained in an exceedingly single housing with their high-pressure fuel outlets arranged in each line, the assembly is said as a PLN (pump-line-nozzle) system inline fuel injection system pump. They are called PE models (P for “pump” and the E for enclosed camshaft) since they are mounted lengthwise within the bottom of the pump housing and driven from the engine gear train. These pumps may be mounted in one of three ways: base, cradle, or flange. The mounting is set by the drive end of the pump. When an inline pump is flange mounted, a third letter, S, is added to the designation, with the pump designated as a PES unit. Inline pumps are cited by their physical size, which relates to the pumping plunger diameter, the proportion of the fuel they deliver (quantity), and the pressure they’ deliver to the nozzle. These pump sizes are M, A, MW, and P.

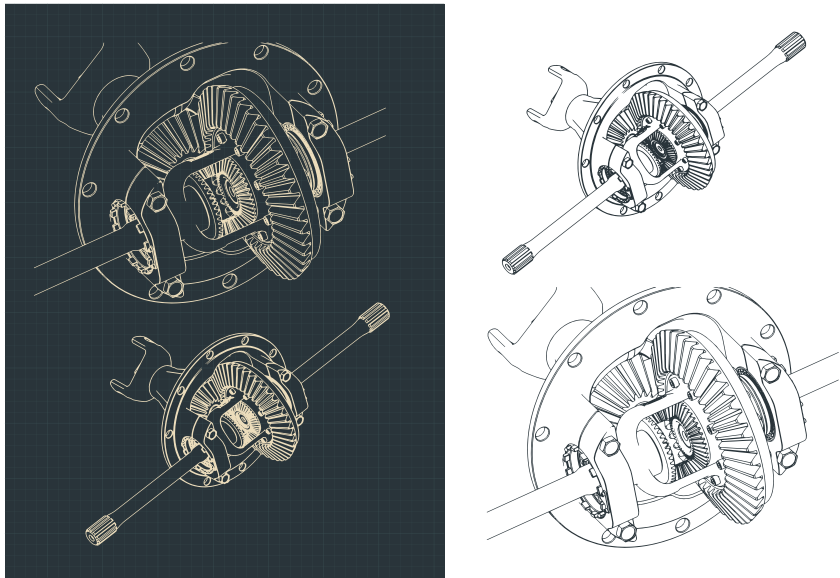
FIGURE D.7 Bosch line pump.



Differential

A gearset within the center of the final drive ring and pinion of a vehicle that permits different wheel speeds at the ultimate drive to permit the vehicle to complete a turn without scuffing the rear tires. The speed of every driven wheel must be allowed to vary slightly as they are going over paved surface irregularities. The open differential consists of several components: differential case, pinion (spider) shaft and gears, and two side (axle end) gears. Torque flows through the ultimate drive to the axles. The method is also lessened into four steps: the drive pinion gear drives the ring gear. A ring gear, bolted to the differential plate, turns the case. The case rotates the differential pinion gear shaft and therefore the pinion gears. The pinion gears drive the side gears, splined to the axle ends, which drive the axles and wheels. For more information on *Nomenclature and Terminology for Truck and Bus Drive Axles*, see J923_201207 [12].

FIGURE D.8 Automotive final drive differential unit.



Andrii Stepaniuk/Shutterstock.com.

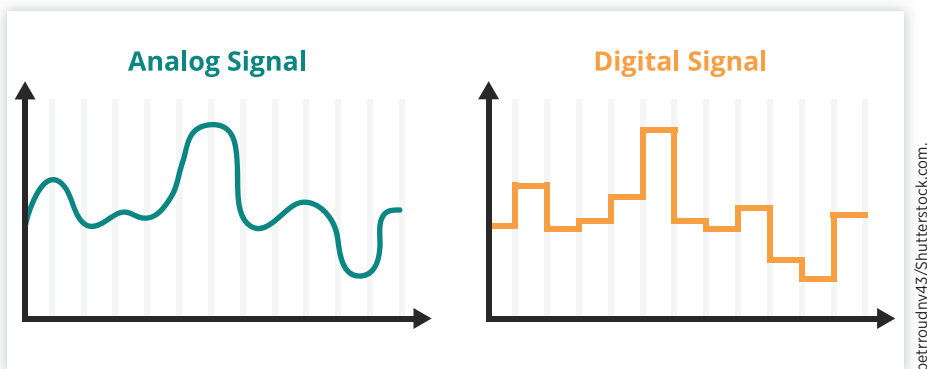
Digital Radio

A radio that uses an electromagnetic signal that broadcasts binary numbers or on/off signals to represent sounds.

Digital Signal

An electronic signal that uses only two voltage levels: on or off.

FIGURE D.9 Analog and digital signal waveform.



Digital Thermometer

An electronic device for measuring temperature. Also called a temperature probe.

Dilution Differential Ratio

The ratio of a specimen to total parts of the solution. A ratio is expressed as parts mixture or specimen to parts diluent.

Diode

A solid-state electronic component that allows current to flow in one direction and is blocked in the other direction.

Diode Trio

A solid-state electronic component that supplies current to the rotor through the electronic regulator.

Dip Stick

A measuring stick to measure the level of oil in an engine or transmission, that is graduated in quarts.

Direct Drive

This action occurs when two meshed gears are the same size and have the same number of teeth, they will turn at the same speed. When the drive gear turns once every revolution of the driven gear, the gear ratio is 1:1, and called direct drive. When a transmission is in direct drive, the engine and transmission turn at the same speed.

FIGURE D.10 Two gears in direct drive with the same number of teeth on each gear.



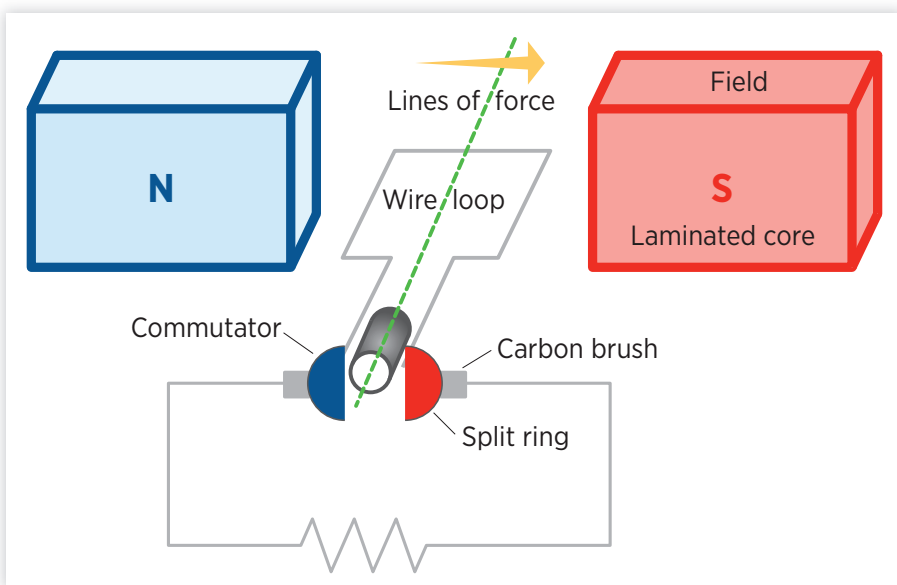
Syntesi fotografia/Shutterstock.com.

Directional Tires

Tires designed to turn in only one direction to improve wet-road traction by providing more surface contact on the outer edge of the tire with the road.

Directional Wheels

Some vehicles are equipped with directional wheels. The hub location where the wheel nuts are installed shows a casting indicating which location the tire belongs on for some directional wheels. Directional wheels can also be indicated by an arrow around the outer section of the wheel. Directional wheels (with arrows) should always be mounted with the arrow pointing in the direction of rotation. Directional wheels are designed to improve brake cooling with the center section acting as a fan to increase air flow over brake components.

FIGURE D.11 DC Generator.

Courtesy of John F. Kershaw Ed.D.

DIS (Distributorless Ignition System)

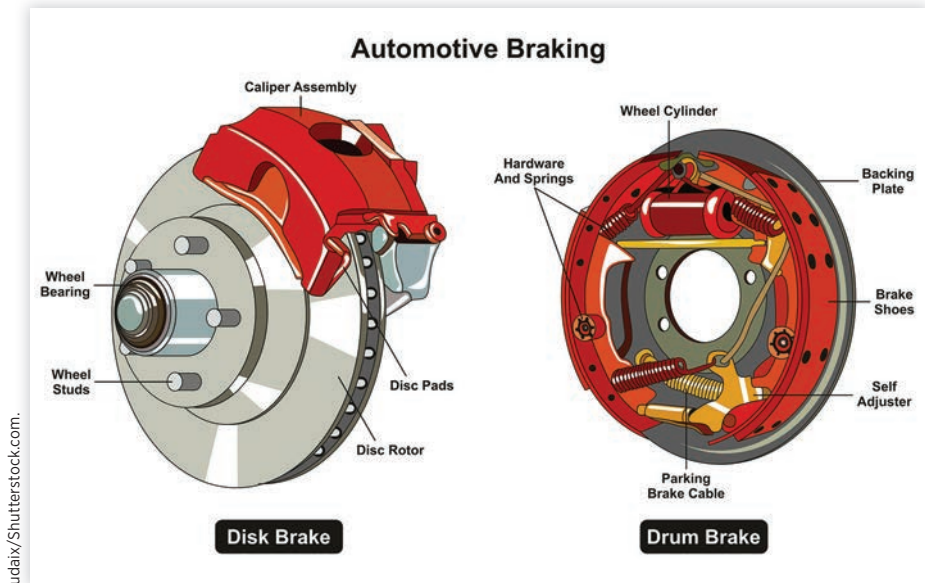
See **Waste-Spark Ignition**.

Disc Brakes

Disc brake assembly includes the caliper assembly, piston, piston seal, dust seal, bleeder screw, brake pads, and special hardware like anti-rattle springs, and wear indicators. Disc brakes on an automobile add the identical manner. Disc brakes include a rotor between two pads on either side of the rotor. The rotor is attached to the wheel and rotates with it. When the motive force applies the brakes, pressure is applied to the stationary pads; also the pads rub against the edges of the rotor, slowing or stopping its rotation. Disc brakes have advantages over drum brakes:

- Dissipate heat more effectively than drum brakes.
- Apply braking force quicker than drums.
- Disperse water more effectively.

FIGURE D.12 Disc brake assembly on the left and a duo-servo brake assembly on the right.



Discrete Device

A complete, separately manufactured, individual component with wire leads for connection into a circuit. It is termed discrete because it is not controlled or recognized by the vehicle management computer.

Dispersants

An engine oil additive that reduces sludge formation by keeping the contaminants suspended in the engine oil.

Displacement

Total swept volume of space inside the cylinders of an internal combustion engine (ICE) occupied and then evacuated (swept) by all of the pistons of that ICE. Volume is the measure of how much something holds. The more volume that an engine cylinder has, the more power it can develop. The total piston displacement is found using this formula:

$$V_d = 0.7854d^2 \times s \quad (\text{D.1})$$

where

d is the piston diameter

s is the stroke

V is cylinder volume

Distributor

Electromechanical component driven by the engine camshaft used to create and distribute the high voltage necessary for spark ignition.

Distributor Indexing

A positive distributor position notch or clamp that permits the distributor to be placed in only one position.

Distributor-Type Diesel Injection Pump

A single, gear-driven pump produces high pressure and a rotating distributor valve routes fuel to the appropriate injection nozzle. The distributor-type fuel injection pump pressurizes and distributes a metered amount of fuel to each cylinder nozzle at the proper time based on the calibrated needs of the engine. This pump uses one pump barrel and a set of plungers to supply all cylinders in a distributing rotation. The pumping element operates eight times because it is used on an eight-cylinder diesel engine and is provided with a distributor or means of connecting the pump delivery to each of the injection nozzles in turn. Some parts have surfaces with machining tolerances measured in microns and require extreme cleanliness during any service. Fuel quantity and timing may be controlled mechanically using a metering valve and speed limiting governor or by an engine management computer.

FIGURE D.13 Distributor-type mechanical diesel fuel injection pump.

Aleksandar Dickov/Shutterstock.com.

Division

A specific segment of an oscilloscope waveform as defined by the grid on the display.

DLC (Data Link Connector)

Connection used in computer-managed systems on cars and trucks to connect the scan tool computer or electronic service tools to the vehicle computers. This device was originally designed for use in a vehicle assembly plant to make sure that all emission-related components were connected and functioning, and was called an ALDL (assembly line diagnostic link) or ALCL (assembly line computer link). For more information on this, see **J1930DA_202105** [3].

DOC (Diesel Oxidation Catalyst)

Causes O_2 (oxygen) to chemically combine with an HC (hydrocarbon) and CO (carbon monoxide) noxious emissions at lower temperatures. The HC and CO are converted to harmless CO_2 (carbon dioxide) and water. Oxidation of these emissions releases heat and takes place without any combustion inside the

converter. This design is still used in spark-ignition, gasoline-fueled engines, and they are called two-way converters. Diesel exhaust, oxidation converters can also oxidize black carbon soot to decrease the mass of diesel particulate matter, or PM, emissions to between 5% and 90%.

Dog Clutch

Dog clutches are used where slip is undesirable and/or the clutch does not manage torque. Without slippage, dog clutches are not plagued by wear in the same way that friction clutches are. Dog clutches are used in some manual transmissions and differentials to lock different gears to the rotating input and output shafts. Dog clutches are commonly utilized in racecars.

Dog Tracking

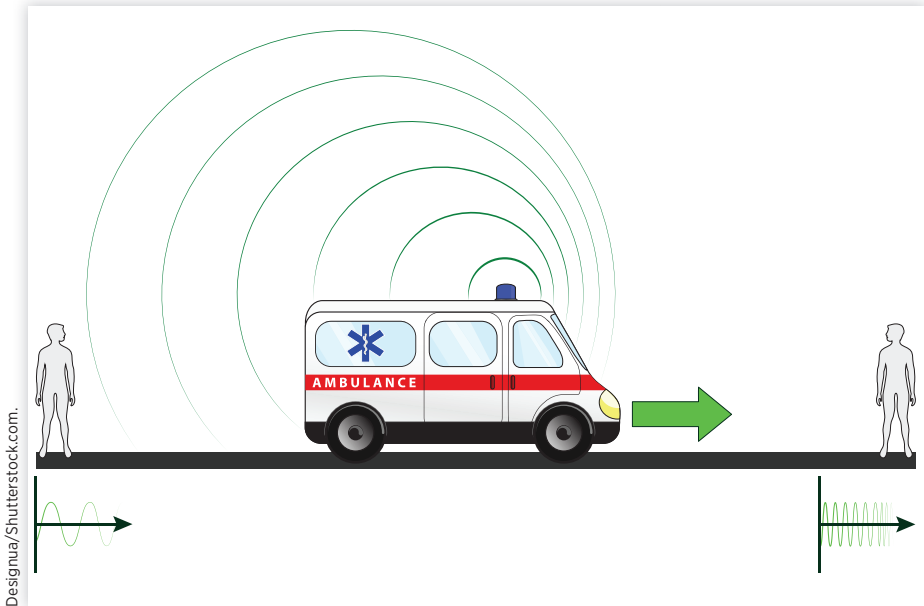
A term accustomed to describe the condition where the rear wheels do not follow directly behind the front wheels; named after the way some dogs run with their rear paws offset toward one side in order that they are going to not hit the front paws while running.

Dolly

Platform on wheels with two axles and four wheels in total, one on each corner. This term is used for a trailer hauling device when a fifth wheel is mounted on a truck axle and uses the fifth wheel to attach to a trailer that is connected to a different trucking rig.

Doppler Effect

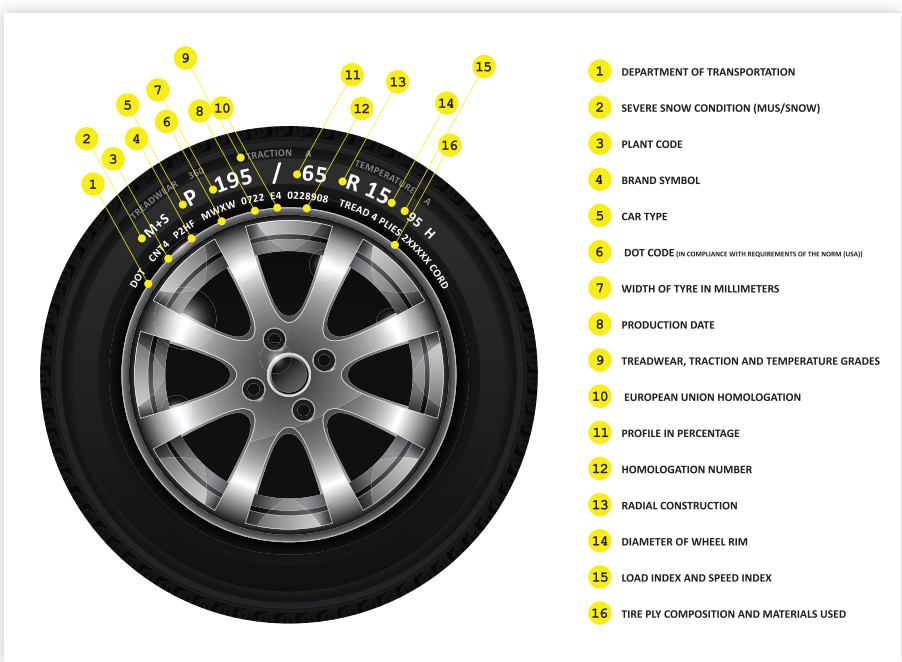
The difference between the observed frequency and therefore the emitted frequency of a wave for an observer moving relative to the source of the waves. It is commonly heard when a vehicle sounding a siren approaches, passes, and recedes from an observer. The emitted signal toward the car is reflected back with a variation of frequency that relies on the speed away/toward the radar. This can be only a component of the important speed.

FIGURE D.14 Doppler effect.

DOT Tire Certification Codes

DOT certification codes are a series of numbers and letters located on the inner sidewall of the tire. It indicates the compliance of a tire and certification with Department of Transportation (DOT) safety standards and may be required for warranty purposes. This label designates the manufacturer, size, and production date of a tire. The production date is a three- or four-digit number; the first two digits signify the week, and the last digit or two digits indicate the year of manufacture. For more information on this, see **J2047_201911** [7].

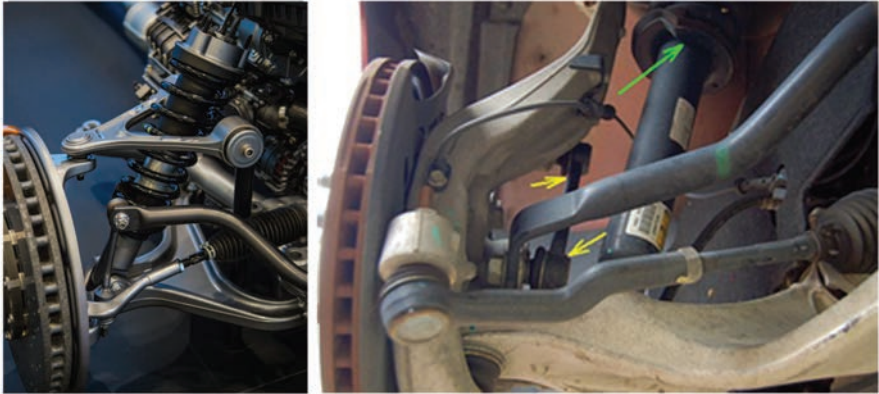
FIGURE D.15 DOT tire certification codes.



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Double-Wishbone Modified Strut Suspension

The double-wishbone modified strut suspension uses a high-mount upper arm. It uses a coil over the shock absorber (green arrow) damper where the upper end of the stabilizer link (yellow arrow) attaches to an aluminum hub carrier (steering knuckle or upright) for a 1:1 motion ratio. Links at the white arrow connect the lower frame to the stabilizer bar. The 1:1 ratio means this is a direct-acting stabilizer; as the bar offers everything it has, it is often smaller and lighter and the suspension is more responsive.

FIGURE D.16 Double-wishbone modified strut suspension.

patruccio/Shutterstock.com.

Courtesy of John F. Kershaw Ed.D.

Downdraft Carburetor

The carburetor is located above the engine intake and the draft or pull is downward from the low pressure created during the intake stroke. Early systems relied on gravity to deliver fuel to the cylinders.

DMM (Digital Multimeter)

A multimeter that uses a vacuum fluorescent or liquid crystal display to provide a digital readout to measure volts, ohms, frequency, and amperes. For more information on this, see **J1930DA_202105** [3].

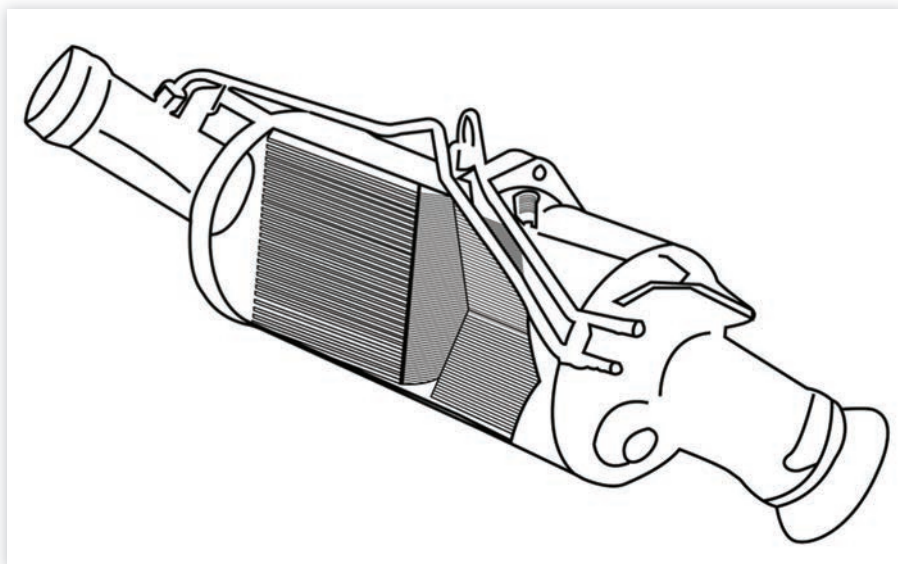
DMS (Driver Monitoring System)

This safety system uses an infrared camera mounted on the steering column and infrared illumination provided by infrared light emitting diodes (LEDs) embedded within the wheel to observe the driving force and provides an estimate of the driver's attention state to the Active Safety Control Module. The resultant image of the motive force is not visible to the driving force. The motive force monitoring system is employed as an input to enable/disable the cruise system; therefore, the driver monitoring system should only move when its function is requested by the Active Safety Control Module. The motive force monitoring system infrared LEDs could also be visible as a dim red glow when the system is active.

DPF (Diesel Particulate Filter)

A filter that collects particulate matter (PM) discharged from the engine. When enough PM is accumulated in the filter, regeneration is performed. Passive or automatic regeneration last about 9 to 40 min and occurs in 100–500 miles of driving. After Stage 1, PM consisting of small particles of carbon remaining after combustion are retained from the exhaust gas by the large surface area of the DPF. For more information on this, see **J1145_201109** [6].

FIGURE D.17 Diesel particulate filter (DPF).



Kanan Shabanov/Shutterstock.com.

Drag

Due to the fact that air flows over the body of a car or truck, it causes a drag on free vehicle movement. A semi-empirical model was developed to represent this drag effect. Aerodynamic drag is demonstrated by the equation:

$$D_A = \frac{1}{2} V^2 C_D A \quad (\text{D.2})$$

where

D_A is the aerodynamic drag

C_D is the aerodynamic drag coefficient

A is the frontal area of the vehicle

Drag Coefficient

Dimensionless quantity accustomed to quantify the drag or resistance of an object in an exceedingly fluid environment, like air or water. It is utilized in the drag equation in which a lower coefficient of drag indicates the article will have less aerodynamic or hydrodynamic drag. The coefficient is usually related to a specific area. For information on this, see **J1594_201007** [8].

Drag Link

A drag link is sometimes used in an automotive steering system to convert rotary motion from a crank arm to a second bell crank. Trucks use a drag link to connect the steering arm that connects to a cross shaft to the opposite steering arm to the pitman arm of the steering gear. Also called a centerlink or relay rod. Drag links are a variation of the centerlink and are used on many modern-day trucks and sport utility vehicles.

FIGURE D.18 Drag link.



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Drift

A controlled lateral sliding of a vehicle.

Drivability

The general evaluation of an ICE operating that includes idle smoothness, cold and hot starting, throttle response, and power delivery.

Driveline

Components like universal joint and the propeller shaft or driveshaft that connect the transmission with the driving axles of a vehicle. See **Drivetrain**.

Driveline Angle Phasing

To reduce vibration in a single cardan U-joint, make sure the driving and driven yokes are in phase with one another, which means they are able to cancel out vibration. To check driveline phasing on a vehicle, place the transmission in neutral and raise it on a lift on jack stands. Rotate the rear wheels until the output yoke attached to the transmission output shaft has its ears pointed at the 12 o'clock and 6 o'clock positions. The input yoke attached to the input shaft of the differential should also be in the 12 o'clock and 6 o'clock positions, which is in-phase with the front yoke. Another way to look at this is to observe the yoke ears on the driveline itself. They should be in the same position on both ends of the driveline.

FIGURE D.19 Driveshaft or propeller shaft yokes in phase.



Driveshaft (Propeller Shaft)

All RWD (rear-wheel-drive) cars and light-, medium-, and heavy-duty trucks have a driveshaft that is a balanced tubular type. A splined slip joint is provided in each driveline system on a non-tandem axle arrangement. The slip joint is at the forward end of the rear shaft. All driveshafts are designed and built with the yoke lugs (ears) in line with one another. This condition is termed phasing. The shaft will absorb the vibration from the speeding up and slowing down anytime the coupler rotates. Mark the driveshafts when disassembling to assure proper assembly alignment. Some driveshafts use alignment arrows stamped on them at the time of production for correct alignment.

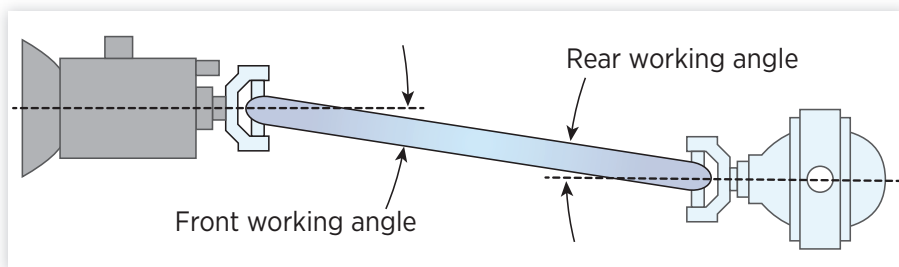
FIGURE D.20 Automotive driveshaft also called a propeller shaft.



Driveshaft (Propeller Shaft) Angles Measuring

To measure U-joint and driveshaft angles, the vehicle must be lifted using an axle contact or drive-on lift. You can also lift the vehicle and place the axles on jack stands. This preserves the actual, loaded driveshaft angles. The working angles of the two U-joints on a drive should be within 0.5° of one another to cancel out vibration. To measure the working angle of a U-joint, do the following:

- Place an inclinometer on the front U-joint bearing cap to measure the transmission angle. Let us suppose the transmission angle is 10° .
- Rotate the driveshaft 90° and read the angle of the driveshaft.
- Subtract the larger angle from the smaller angle, which, in this case, is $13^\circ - 10^\circ$, which gives you the working angle of the front joint, which is 3° .
- Repeat the same procedure to calculate the working angle of the rear joint, which is shown as 16° .

FIGURE D.21 Measuring driveline angle.

Courtesy of John F. Kershaw Ed.D.

In this example, the working angles are the same, or within 0.5° , and no adjustment is necessary. If the difference between the two working angles is greater than 0.5° ; however, shims can be added to bring the working angles closer together. The angle of the rear joint can be adjusted by installing a tapered shim between the leaf spring and the axle. The angle of the front joint can be adjusted by adding or removing shims from the mount under the transmission or by replacing the rear transmission mount.

Driveshaft (Propeller Shaft) Balancing

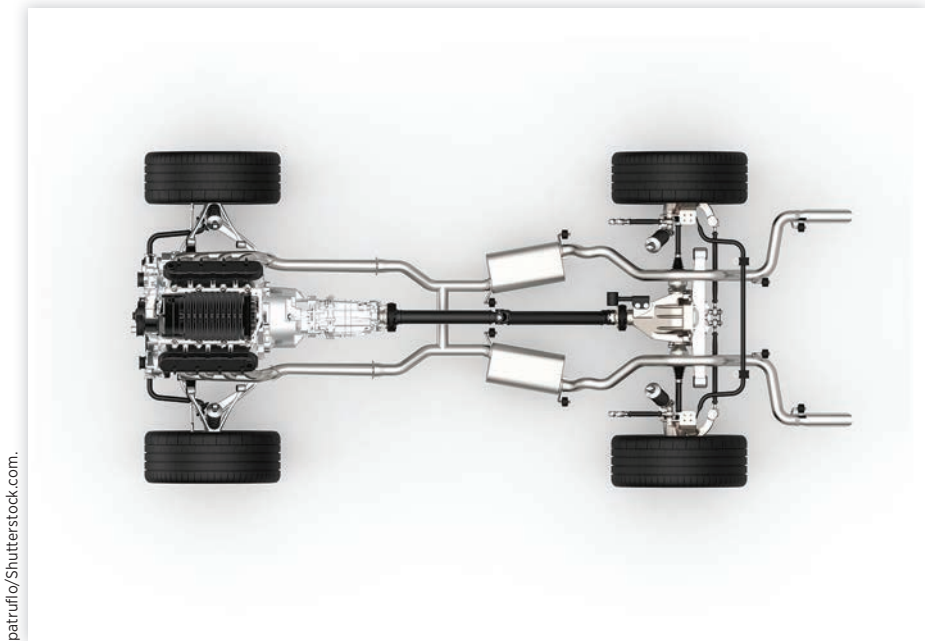
If the propeller shaft (driveshaft) runout is within specification and a vibration still exists, the balance of the shaft should be checked and fixed. The procedure for testing driveshaft balance using a strobe balancer: Raise the vehicle and mark the propeller shaft with four equally spaced marks around its circumference. Label each mark with the numbers 1, 2, 3, and 4. Attach the strobe balancer sensor to the bottom of the differential housing as close to the companion flange as possible. With the vehicle securely lifted and the drive wheels off the ground, start the engine and put the transmission into gear to allow the drive wheels to rotate. Hold the strobe light close to the marks on the propeller shaft. If the light does not flash, the propeller shaft is balanced and no corrective action is necessary. If the light does flash, observe what number mark is shown by the flashing light. Apply hose clamps so that the screw portion of the clamp(s) is opposite the number seen with the strobe light. The screw portion of the hose

clamp is the corrective weight. Remember the strobe light sensor was mounted to the bottom of the differential housing. The strobe light flashes when the heavy part of the propeller shaft is facing downward. If the heavy part of the propeller shaft is down, then corrective weight must be added to the opposite side of the propeller shaft.

Drivetrain

Transfers torque, or a twisting force produced by an engine, to the drive wheels. This system allows the driver to vary the torque and speed of the drive wheels according to driving conditions to disengage engine power from the drive wheels while the engine runs and to select a forward or reverse direction of vehicle travel. In addition, the drivetrain allows the driven wheels to make turns without causing excessive tire and gear wear.

FIGURE D.22 Automotive drivetrain.



Driving Automation—Driver Assistance

At Level 1, the bottom rung of automation, a vehicle has a minimum of one driver web that has steering assistance, or braking and acceleration assistance. The driving force remains liable for driving the vehicle and must be prepared to require control at any time and for any reason. Adaptive controller is an example of Level 1 driver assistance technology. It maintains a secure

following distance between your vehicle and traffic ahead with no intervention by the driving force. A steering assistance feature, like lane-centering assistance or lane-following assistance, would also qualify as Level 1 autonomy. However, a vehicle with both of those features working together qualifies as Level 2 driving automation. For more information on this, see **J3016_202104** [9].

Dropping Point

The temperature where grease passes from a semisolid to a liquid state under conditions specified by the ASTM (American Society for Testing and Materials).

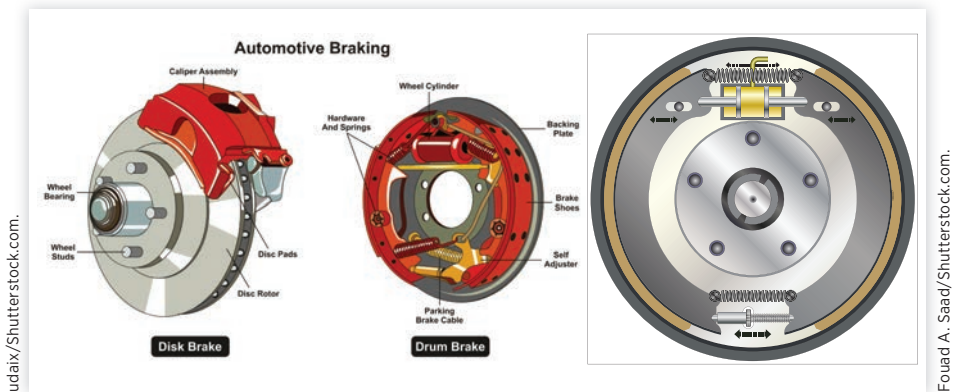
Drum Brakes

Drum brakes use a drum that is attached to, and rotates with, the wheel. Inside the drum is a pair of stationary brake shoes that spread apart and rub against the inside of the drum when the brakes are applied. In all current vehicles that use rear wheel drum brakes, they are used only on the rear wheels. There are two basic types of drum brakes: leading-trailing and duo-servo. Drum brakes use the same principles as disc brakes. However, drum brakes have a drum that surrounds the brake shoes and wheel cylinder. The backing plate holds the shoes, springs, and wheel cylinder inside the brake drum. The backing plate bolts to the axle housing or spindle, and also helps keep dirt and water off the brakes. The wheel cylinders use master cylinder pressure to force the brake shoes against the drums. The boots keep water and dirt out of the cylinder. Special rubber seals prevent fluid from leaking past the pistons. Springs hold the rubber cups against the pistons when the pistons are not pressurized. The bleeder screw threads into the wheel cylinder.

Hydraulic pressure can be used to force air and fluid out of the system through the bleeder screw. Return springs pull the brake shoes away from the brake drums, which also forces the wheel cylinder pistons toward the center of their bores. One end of the return spring fits into a hole in the brake shoe. The other end attaches either to the other brake shoe or to an anchor pin on the backing plate. Leading-trailing brakes have the brake wheel cylinder attached to the top of the backing plate and an anchor point at the bottom. The brake shoe at the front is called the “leading” shoe, while the shoe toward the rear of the vehicle is the “trailing” shoe. Duo-servo brakes have a fixed anchor point at the top of the backing plate, above the wheel cylinder. The self-adjuster connects the two brake shoes at the bottom. In the duo-servo system, the front brake shoe is called the primary shoe, while the rear is called the secondary shoe.

When the vehicle is moving forward, and the brake pedal is applied, the primary shoe is forced against the rotating brake drum. Like the leading shoe (leading-trailing type), friction forces the shoe to move more tightly against the drum, causing self-energizing action. There is no fixed anchor point at the bottom of the backing plate, so the primary shoe transfers rotation to the secondary shoe. Since the secondary shoe is held by the anchor point at the top of the backing plate, the bottom of the shoe pivots into the brake drum. This transfers the thrust of the primary shoe to the secondary shoe, causing it to self-energize as well.

FIGURE D.23 Duo-servo drum brake (left) and a leading drum brake (right).



Drum Brakes Duo-Servo Incremental Self-Adjuster

Duo-servo brakes use a similar type of self-adjusting mechanism as the leading-trailing brakes. The duo-servo uses a two-piece adjuster assembly with a star wheel screw to increase and decrease its length. An adjuster lever is used to rotate the star wheel and allow the brakes to automatically adjust themselves as the vehicle is operated in reverse.

Drum Brakes Leading-Trailing Incremental Self-Adjuster

An incremental self-adjuster rides between the brake shoes slightly below the wheel cylinder. This self-adjuster consists of an adjuster screw retracting spring, adjuster lever, and a two-piece adjuster assembly with a star wheel. The star wheel is part of a threaded screw, which, when turned, increases or

decreases the length of the adjuster assembly. This type of self-adjuster is actuated when the driver moves the vehicle forward for about ten feet and then reverses and applies the brake until the vehicle is completely stopped. This action causes the adjuster screw retracting spring to tug the adjusting lever up over the tip of the tooth of the star wheel. When the linings have worn a particular amount, the adjuster lever engages the star wheel tooth because it tries to maneuver past it. When you take your foot off the brake pedal, the adjuster assembly pushes the adjuster lever out. The lever pivots downward, rotating the star wheel and lengthening the adjuster assembly. Because the adjuster assembly lengthens, it spreads the brake shoes and moves the linings closer to the cylinder.

Dry Manifold

No integral coolant passages are cast into the intake manifold.

Dry Park Test

A test of steering and/or suspension components with the wheels in the straight-ahead position and the vehicle on level ground. The steering wheel is turned while all steering and suspension components are inspected for any looseness.

Dry Sump Lubrication System

An ICE lubrication system that uses two or more oil pumps and a separate oil reservoir, as opposed to a wet-sump system that only has the oil pan sump under the crankcase and a single oil pump. The dry sump system is found on race and off-road applications that make hard turns that could result in loss of oil suction.

Dry Weight

The weight or mass of a weight excluding the weight of all consumables, such as fuel and oils.

DSO (Digital Storage Oscilloscope)

An oscilloscope that samples and stores waveforms in a digital format, but not in real time. It can miss glitches that may occur between samples, so a DSO with a high "sampling rate" is preferred. DSOs have the ability to data log scope traces.

FIGURE D.24 Digital storage oscilloscope.

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DSRC (Dedicated Short-Range Communications)

One-way or two-way short-range to medium-range wireless communication channels specifically designed for automotive use with a corresponding set of protocols and standards. Under this proposed rule, vehicles would broadcast an outlined data packet, the BSM (basic safety message) up to ten times per second, indicating vehicle location, heading, and speed. In March 2017, General Motors (GM) became the primary United States (US) automaker to produce DSRC as standard equipment on a production automobile, the Cadillac CTS. The USA also has appropriate standards—IEEE (Institute of Electrical and Electronics Engineers) 802.11p and frequency rules in situ. In Europe a frequency harmonized for transport safety and a harmonized standard, called ETSI ITS-G5, is in situ.

DTC (Diagnostic Trouble Code)

Alphanumeric or numeric sequence, indicating a fault in a vehicle operating system. For more information on this, see **J1930DA_202105** [3].

Dual-Mass Flywheel

At low speeds the power strokes are far enough apart to cause speed fluctuations at the flywheel. All, but an excessively heavy, flywheel might allow these fluctuations to reach the driveline as torsion vibrations. These oscillations can produce rattling and other noises in the transmission and driveline due to gear backlash and necessary running clearances. Torsion vibration may even cause the driveline to resonate. A flywheel that is heavy enough to eliminate all low-speed oscillations would add too much mass to the crankshaft, hindering the acceleration ability of the engine. To compensate, a dual mass flywheel may be used to absorb most of the irregular oscillations before they reach the transmission. A dual-mass flywheel may also change the resonant speed of the driveline vibrations. It lowers the resonant speed below any speed at which the vehicle operates, such as below the normal idle speed.

Dual Master Cylinder

A dual master cylinder contains a primary and secondary piston; they sit one behind the other in the master cylinder bore. When the brake pedal is depressed, both pistons are forced down the bore. Each piston draws fluid from a separate reservoir and applies two wheel cylinders. The path the fluid takes is different, depending on whether the brake system is a vertical split or diagonal split. If one system fails, the other system will have partial braking ability to stop the vehicle.

Dual Motor-Generator Hybrid

A hybrid vehicle that uses two separate motor-generators located at different locations within the drivetrain. The two motor generators are usually located inside the transmission or transaxle. For more information on this, see **J1715/2_202108** [10].

Duration

Number of crankshaft degrees that the valve is open during crankshaft rotation. At the top of every stroke, the piston is either at top dead center (TDC) or bottom dead center (BDC). A stroke requires one-half of a crankshaft rotation, or 180°. Duration is measured from zero lift just before valve opening to zero lift just after valve closure. However, since it is important to require up valve train slack and lift together with closing the valve gently lightly, therefore the lobe moves the valve very slowly at the start and end of its cycle. This also makes it very difficult to work out or measure precisely when the

valve begins to open or close. To resolve this issue, camshaft manufacturers now measure duration at specific points within the valve lift. The foremost popular specific point is 0.050 in. This measuring point makes it easy to live, and this offers an accurate point at which to start out and stop measuring duration. The upper the lift at which the duration measurement begins and ends, the less rated duration a camshaft will have. The duration of a cam lobe measured between the 0.050-in. lift points is over 50°, but that is measured between the particular opening and shutting points. For more information on this, see **J604_201108** [11].

Durometer

A standardized way to measure the hardness of materials like rubber, elastomers, and plastics. Durometer measurement scales range from 0 to 100. It is a dimensionless measurement.

Duty Cycle

The amount of time (given as a percentage) that current is fed to an ignition coil.

Dwell

The amount of time, recorded on a dwell meter in degrees, which voltage passes through a closed switch also called ignition points. For more information on this, see **J139_202002** [4].

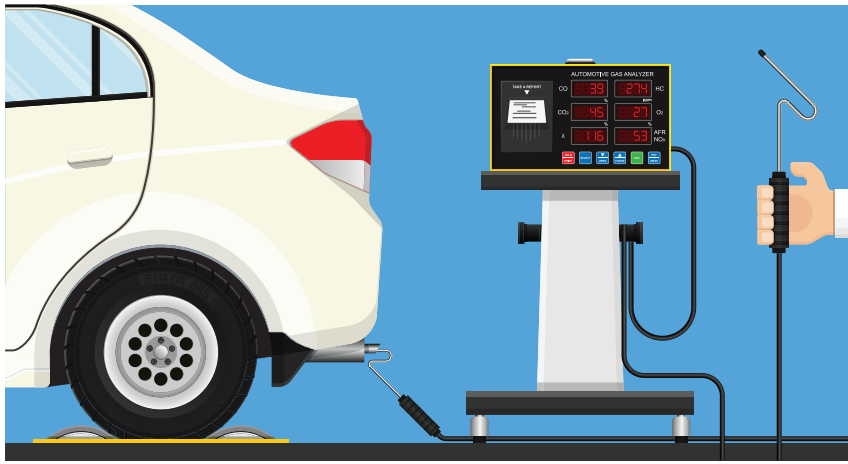
Dwell Section

Dwell is the amount of your time that the current is charging the coil from the transistor-on point to the transistor-off point. The tip of the dwell section marks the start of the following firing line. This time is termed “transistor off” and indicates that the first current of the coil is stopped, leading to a high-voltage spark out of the coil. A part of a secondary scope pattern that starts when the ignition module conducts primary current through the induction coil. For more information on this, see **J139_202002** [4].

Dynamometer (Dyno)

Measures ICE power output and performance. By loading the engine, the dynamometer can check engine acceleration, maximum power output, and on-the-road performance characteristics. This may be used for just the ICE on an engine dynamometer or the entire vehicle on a chassis dynamometer.

FIGURE D.25 Chassis dynamometer.



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