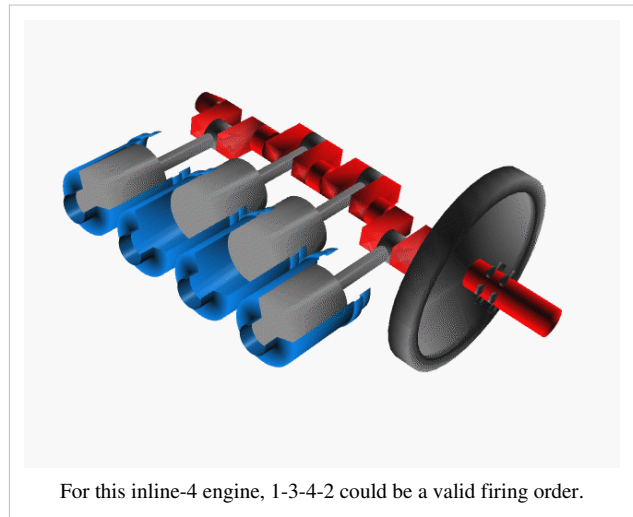


Firing order

The **firing order** is the sequence of power delivery of each cylinder in a multi-cylinder reciprocating engine. This is achieved by sparking of the spark plugs in a gasoline engine in the correct order, or by the sequence of fuel injection in a Diesel engine. When designing an engine, choosing an appropriate firing order is critical to minimizing vibration and achieving smooth running, for long engine fatigue life and user comfort, and heavily influences crankshaft design.

Ignition

In a gasoline engine, the correct firing order is obtained by the correct placement of the spark plug wires on the distributor. In a modern engine with an engine management system and direct ignition, the Engine Control Unit (ECU) takes care of the correct firing sequence. Especially on cars with distributors, the firing order is usually cast on the engine somewhere, most often on the cylinder head, the intake manifold or the valve cover(s).



Various firing orders for different engine layouts

number of cylinders	firing order	example
3	1-2-3 1-3-2	Saab two-stroke engine BMW K75 engine
4	1-3-4-2 1-2-4-3 1-3-2-4 1-4-3-2	Most straight-4s, Ford Taunus V4 engine Some English Ford engines, Ford Kent engine Yamaha R1 crossplane Volkswagen air cooled engine
5	1-2-4-5-3	Straight-5, Volvo 850, Audi 100
6	1-5-3-6-2-4 1-6-5-4-3-2 1-2-3-4-5-6 1-4-2-5-3-6 1-4-5-2-3-6	Straight-6, Opel Omega A GM 3800 engine GM 60-Degree V6 engine Mercedes-Benz M104 engine Chevrolet Corvair
7	1-3-5-7-2-4-6	7-cylinder single row radial engine

8	1-8-4-3-6-5-7-2 1-8-7-2-6-5-4-3 1-3-7-2-6-5-4-8 1-5-4-8-7-2-6-3 1-6-2-5-8-3-7-4 1-8-7-3-6-5-4-2 1-5-4-2-6-3-7-8 1-5-6-3-4-2-7-8 1-5-3-7-4-8-2-6 1-2-7-8-4-5-6-3	1988 Chrysler Fifth Avenue, Chevrolet Small-Block engine GM LS engine, Toyota UZ engine Porsche 928, Ford Modular engine, 5.0 HO BMW S65 Straight-8 Nissan VK engine Ford Windsor engine Cadillac V8 engine 368, 425, 472, 500 only Ferrari Dino V8 (F355) Holden V8
10	1-10-9-4-3-6-5-8-7-2 1-6-5-10-2-7-3-8-4-9	Dodge Viper V10 BMW S85
12	1-7-5-11-3-9-6-12-2-8-4-10	2001 Ferrari 456M GT V12
20	1-12-8-11-7-14-5-16-4-15-3-10-6-9-13-17-19-2-18-20	Cadillac V20 engine

Although the vast majority of automobile engines rotate clockwise as viewed from the front, some engines are designed by the manufacturer to rotate counter-clockwise to accommodate certain mechanical configurations. In these applications, the firing order is shown in a reverse order (though it still starts with 1.) For the most common inline configurations, this gives firing orders of 1-3-2, 1-2-4-3, and 1-4-2-6-3-5. In addition to the reconfiguration of the plug wires or injector tubes, the valve timing must be accordingly modified.

Cylinder numbering and firing order

Notes on left/right and front/rear

When referring to cars, the left-hand side of the car is the side that corresponds with the driver's left, as seen from the driver's seat. It can also be thought of as the side that would be on the left if one was standing directly behind the car looking at it.

When referring to engines, the front of the engine is the part where the pulleys for the accessories (such as the alternator and water pump) are, and the rear of the engine is where the flywheel is, through which the engine connects to the transmission. The front of the engine may point towards the front, side or rear of the car.

In most rear-wheel drive cars, the engine is longitudinally-mounted and the front of the engine also points to the front of the car. In front-wheel drive cars with a transverse engine, the front of the engine usually points towards the right-hand side of the car. One notable exception is Honda, where many models have the front of the engine at the left-hand side of the car.



Saab B engine, "firing order 1342" marked on inlet manifold. #1 is towards the firewall (right side of picture).

In front-wheel drive cars with longitudinally-mounted engines, most often the front of the engine will point towards the front of the car, but some manufacturers (Saab, Citroën, Renault) have at times placed the engine 'backwards', with #1 towards the firewall. One notable car with this layout is the Citroën Traction Avant. This layout is

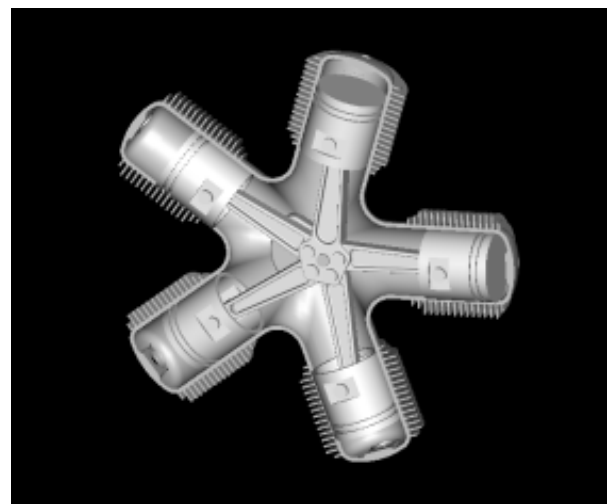
uncommon today.

See also: Automobile layout

Cylinder numbering and firing orders for various engine layouts

In a straight engine the spark plugs (and cylinders) are numbered, starting with #1, usually from the front of the engine to the rear.

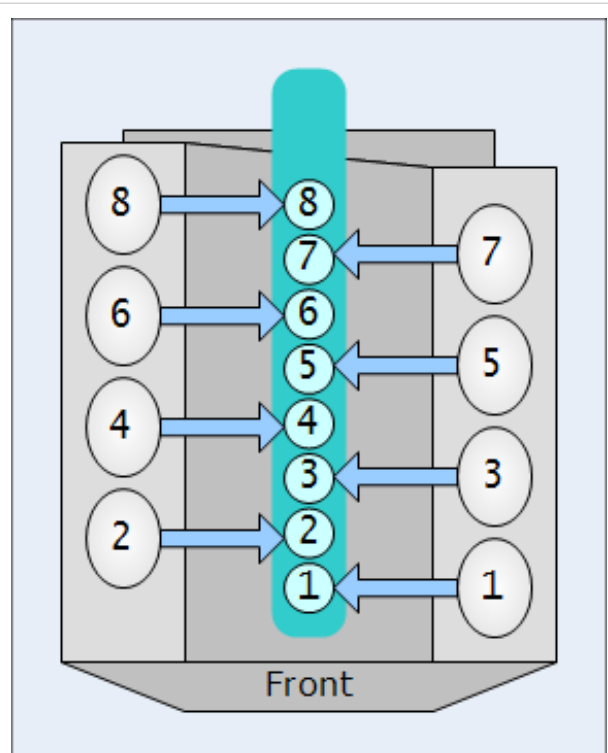
In a radial engine the cylinders are numbered around the circle, with the #1 cylinder at the top. There are always an odd number of cylinders in each bank, as this allows for a constant alternate cylinder firing order: for example, with a single bank of 7 cylinders, the order would be 1-3-5-7-2-4-6. Moreover, unless there is an odd number of cylinders, the ring cam around the nose of the engine would be unable to provide the inlet valve open - exhaust valve open sequence required by the four stroke cycle.



1-3-5-2-4 would be the firing order for this 5 cylinder radial engine.

In a V engine, cylinder numbering varies among manufacturers. Generally speaking, the most forward cylinder is numbered 1, but some manufacturers will then continue numbering along that bank first (so that side of the engine would be 1-2-3-4, and the opposite bank would be 5-6-7-8) while others will number the cylinders from front to back along the crankshaft, so one bank would be 1-3-5-7 and the other bank would be 2-4-6-8. (In this example, a V8 is assumed). To further complicate matters, manufacturers may not have used the same system for all of their engines. It is important to check the numbering system used before comparing firing orders, because the order will vary significantly with crankshaft design (see crossplane).

As an example, the well-known Chevrolet Small-Block engine has cylinders 1-3-5-7 on the left hand side of the car, and 2-4-6-8 on the other side, and uses a firing order of 1-8-4-3-6-5-7-2.^[1] Note that the order alternates irregularly between the left and right banks; this is what causes the famous 'burbling' sound of this type of engine.^[2]



The cylinder numbering scheme used by some manufacturers on their V engines is based on "folding" the engine into an inline type.

In most Audi and Ford V8 engines cylinders 1-2-3-4 are on the right hand side of the car, with 5-6-7-8 are on the left.

This means that GM LS V8 engines and Ford Modular V8s have an identical firing pattern despite having a different firing order.

An interesting exception is the Ford Flathead V8 where the number 1 cylinder is on the right front of the engine(same as other Ford V8's) but this cylinder is NOT the front cylinder of the engine! In this case number 5 is the front cylinder. A similar situation exists with the Pontiac V8's 455 etc. where the cylinders are numbered like a Chevrolet V8 but the right side bank is in front(like a Ford), this puts cylinder number 2 in front of number 1.

V8 Cylinder bank	Audi	Ford	GM & Chrysler	GM (Northstar Only)
Right side of vehicle	1234	1234	2468	1357
Left side of vehicle	5678	5678	1357	2468

Ships

Contrary to most car engines, a ship's engine or a power plant engine is numbered from the flywheel end towards the free end.

In ship and power plant V-type engines the numbering is A1... and B1... where the A-bank is on the left hand side and the B-bank is on the right hand side, looking from the flywheel end.

Trivia

- The neon lights on *Flo's V8 Cafe* in the movie *Cars* flash in the proper firing order for a Ford flathead V8.

See also

- Two stroke cycle
- Four stroke cycle
- Engine configuration

External links

- Firing Orders, Cylinder Numbering and Distributor Rotation for American V8 engines ^[3]
- V8 Engines ^[4] - Analysis of firing orders and cylinder numbering of V8 engines

References

[1] "Boxwrench.net" (http://boxwrench.net/specs_index.htm). . Retrieved 2009-02-04.

[2] Reyenga, Craig. "Craig's website - V8 engines - exhaust sound" (<http://craig.backfire.ca/pages/autos/v8-engines#sound>). . Retrieved 2009-02-04.

[3] http://boxwrench.net/specs_index.htm

[4] <http://craig.backfire.ca/pages/autos/v8-engines>