

🔧 Engine parts

- ✓ **Engine block:** the main structure, holding the cylinders, pistons and crankshaft
- ✓ **Cylinder:** where combustion happens; one piston in each
- ✓ **Piston:** a metal plunger the expanding gases drive down
- ✓ **Connecting rod:** joins the piston to the crankshaft
- ✓ **Crankshaft:** turns the pistons' up-and-down motion into rotation; **RPM** is its turns per minute
- ✓ **Cylinder head:** sits on the block and seals the cylinders
- ✓ **Spark plug:** at the top of the cylinder; its spark ignites the fuel-air mixture
- ✓ **Intake and exhaust ports:** the passages in and out of the cylinder
- ✓ **Valves:** open to let the mixture in and the exhaust out; closed, they seal the cylinder
- ✓ **Camshaft:** its raised **cams** push the valves open; springs close them
- ✓ **Timing belt:** links the crankshaft to the camshaft's cam gear so pistons and valves stay in step

🏠 Cylinder layouts

- ✓ **In-line:** one row on one crankshaft; simple, cheap and easy to maintain: trucks, generators
- ✓ **V-type:** two banks angled in a V, often for six or more cylinders; shorter and lighter: tanks
- ✓ **Boxer (flat):** pistons in pairs moving in and out together; low vibration, low center of gravity
- ✓ **Radial:** in a circle around the crankshaft: older aircraft, World War II tanks

🛢 Diesel engines

- ✓ **No spark plug:** compressing the air heats it until injected fuel ignites on its own
- ✓ More torque at low RPM, for towing and hauling
- ✓ Diesel's higher flash point makes it less flammable and safer to store
- ✓ **2-stroke:** a power stroke every turn; lighter, less efficient, more emissions: large ships
- ✓ **4-stroke:** a power stroke every second turn; more efficient, cleaner: most military vehicles

🔄 The four-stroke cycle

Stroke	Piston	Valves	What happens
1. Intake	Down	Intake open	Draws the fuel-air mixture in
2. Compression	Up	Both closed	Squeezes the mixture
3. Power	Down	Both closed	The spark ignites it; the expanding gas drives the piston
4. Exhaust	Up	Exhaust open	Pushes the spent gas out

Each stroke is one move of the piston; one power stroke every two turns of the crankshaft

⚡ Other ways to power a vehicle

- ✓ **Nuclear:** fission heats water to steam, which drives turbines: submarines, aircraft carriers
- ✓ **Electric:** quiet, no exhaust, instant torque; limited by battery range and charging; damaged lithium-ion batteries can catch fire
- ✓ **Hybrid:** a combustion engine with an electric motor and battery, for range and fuel economy