Wikipedia engine

An engine , or motor , is a machine used to change energy into movement that can be used. The energy can be in any form. Common forms of energy used in engines are electricity , chemical such as petrol or diesel or heat. When a chemical is used to produce energy it is known as fuel. In past centuries motor and and engine meant very different things. This meaning is still often used. Sometimes a thing is called an engine if it creates mechanical energy from heat, and a motor if it creates mechanical energy from other kinds of energy, like electricity. Typical engines in this meaning are steam engine and internal combustion engine , while typical motors are electric motor and hydraulic motor. And sometimes the two words mean the same thing. The word "gin," as in "cotton gin", is short for "engine. Early kinds of engine used heat that was outside of the engine itself to heat up a gas to a high pressure. This was usually steam and the engines are called steam engines. The steam was piped to the engine where it pushed on pistons to bring about motion. These engines were commonly used in old factories, boats and trains. Most cars use a chemical engine that burns fuel inside it. This is called an internal combustion engine. There are many different types of internal combustion engine. They can be grouped by fuel, cycle and configuration. Common fuel types for internal combustion engines are petrol, diesel, autogas and alcohol. There are many other types of fuels. There are 3 different types of cycle. There are lots of different configurations of piston engines. Their cylinders have pistons in them and a crankshaft. Any number of cylinders can be used but 1, 2, 3, 4, 6, 8, 10 and 12 are common. The cylinders can be arranged in many ways, in a straight line, at an angle to each other or in a circle. A Wankel engine has no cylinders and uses a triangle shaped rotor spinning in an oval housing which mimics the movement of a piston. Hot gas can also be made to push a turbine around rather like the way the wind turns a windmill. Most electric power stations use big steam turbines. Others use water or wind turbines. Smaller turbines called gas turbines are used for internal combustion engines , such as the jet engines used in aircraft. A rocket causes movement by shooting jets of gas very fast out of a nozzle. The gas may have been stored under pressure or be a chemical fuel that burns to make a very hot gas. Although they are very simple, rockets are the most powerful engines we know how to make. They will work in space where there is nothing to push against. Electric motors do not use a fuel. The energy is supplied to them by electricity carried along wires. The energy may come from a fuel being burnt somewhere else a long way off. The electricity is used to make powerful magnets inside the motor switch on and off at the right time to turn the shaft of the motor. Electric engine is not a motor, but a railway locomotive which runs on electricity. From Simple English Wikipedia, the free encyclopedia. This article does not have any sources. You can help Wikipedia by finding good sources, and adding them. August Mit Engineering. Retrieved Categories : Machines Basic English words Motors. Hidden categories: Articles lacking sources from August All articles lacking sources Commons category link is on Wikidata. Namespaces Page Talk. Views Read Change Change source View history. Wikimedia Commons. Wikimedia Commons has media related to Engines. The B and RB engines are often referred to as "wedge" engines because they use wedge-shaped combustion chambers ; this differentiates them from Chrysler's Hemi big block engines that are typically referred to as "Hemi" or " Hemi" due to their hemispherical shaped combustion chambers. The would continue in production until the end of the series, albeit only for truck installation. The last 'B-RB' wedge-headed engine was produced in August , ending the era of Chrysler "big-block" engines. The is classified as a big block engine. All parts except for the pistons are fully compatible with the Plymouth called their versions of the early B engine the Commando , variants of which included the Golden Commando and Sonoramic Commando. The would last until the end of the series, albeit for trucks only. In its early years, the horsepower was optional on many vehicles, and standard on, among others, the Dodge The had a fuel injected version in only. The cu in B engine â€" not to be confused with the RB version â€" was essentially a larger bore version of the and , using a 4. This venerable engine was introduced in Dodge's version, the D had a cross-ram induction manifold and dual four-barrel carburetors as options. In some Dodge applications, this engine was labeled as the Magnum , while the Plymouth version was called the Golden Commando. Both came with a dual point distributor in high-performance versions. The became the standard model Mopar performance engine for the next decade. The big bore allowed for larger, 2. The engines featured the same basic ram induction system as the Chrysler F's RB engines named Sonoramic Commando when sold in Plymouth form. The later Magnum starting in used the Magnum heads, camshaft, and exhaust manifolds. Chrysler increased the bore size of the to create the its bore of 4. All parts except for the pistons were interchangeable between the and Crankshafts were of cast iron composition. All three versions used the same 8. The was used in car, truck, and motorhome chassis. Horsepower and torque ratings gradually declined through the years due to the addition of more federally mandated emissions controls, until all Chrysler passenger vehicle big-block production ceased in Due to its large factory bore size, short

compared to RB engines deck height, and bottom end strength that is greater than any other production B or RB engine due to extra material added around the main bearing caps. [4] B engine blocks have become a popular choice for high-performance engine build ups. The RB engines, produced from to , are raised-block taller versions of the B engines. All RB wedge engines share a deck height of Bore center distance is 4. All RBs are oversquare. It was only available in and on the US-built Chrysler Windsors and Saratogas ; one of Trenton Engine's lines had been converted to the new RB engine to make the , and demand for the B engine was too high for the remaining line. The solution was to create a RB to fill the gap until the plant figured out how to quickly switch from one block to the other. It was also used in medium and heavy trucks including truck-tractors such as the C , up until It has a bore of 4. During that period, it powered almost all Chrysler New Yorker and all Imperial models, and was also available on the lesser Chryslers, Dodge Polara , Dodge Monaco , and Plymouth Fury as an alternative to the B-block and the A-block It continued as standard on the G, and remained on the option sheets for Chrysler s through The Wedge served as Chrysler's main performance engine until the introduction of the Hemi. After , it would be used only in Dodges and Plymouths. The Max Wedge was a race-only version of the Wedge engine offered from the factory. Known as the Super Stock Plymouth and Ramcharger Dodge, the Max Wedge featured high-flow cylinder heads developed through state-of-the-art at the time airflow testing. The blocks were a special severe-duty casting with larger oil-feed passages than other RB engines, and the blocks were stress-relieved by the factory. Induction came by means of a cross-ram intake manifold tuned for peak power above rpm and two Carter AFBSA 4-barrel carburetors. The Max Wedge also included high-flow cast-iron exhaust manifolds that, on the later versions, resembled steel tube headers. Before the end of the model year, Chrysler introduced the Stage II Max Wedge with improved combustion chamber design and an improved camshaft. A Street Wedge block was also available in and It bears little relation to the Max Wedge except for basic architecture and dimensions. It was an increased-bore version of the standard New Yorker single 4-barrel engine. It had a light wall construction, precision cast-iron block, with iron heads and a bore of 4. In , changes were made to the horsepower ratings of vehicle engines from gross engine only, without air cleaner, exhaust system, alternator, or other power-consuming components to net with alternator, air cleaner, mufflers, and other vehicle equipment installed. The new rating system produced lower, more realistic numbers for any given engine. At the same time, emissions regulations were demanding cleaner exhaust. Engines including the were made with reduced compression, modified cam timing, and other tuning measures to comply with the newly tightened emissions regulations. It was also available in marine and heavy-duty commercial applications until that year. Chrysler also offers complete new 'crate' engines through its Mopar parts division in various displacements, these engines are built from entirely new parts. From Wikipedia, the free encyclopedia. This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. Motor vehicle engine. Vehicles using the B Vehicles using the RB Retrieved January 4, Archived from the original PDF on 4 March Retrieved 4 January Standard Catalog of Chrysler, Krause Publications. Mopar Performance. S-A Design Publishing. December Editions " ". Collectible Automobile : American Cars â€" World Cars Retrieved July 11, Retrieved June 24, Categories : Chrysler engines V8 engines Gasoline engines by model. Hidden categories: Wikipedia indefinitely semi-protected pages Articles needing additional references from October All articles needing additional references Articles with short description Short description matches Wikidata Commons category link is on Wikidata. Namespaces Article Talk. Views Read View source View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. Wikimedia Commons. Add links. Wikimedia Commons has media related to Chrysler B engine. The fuel-air charge is meant to be ignited by the spark plug only, and at a precise point in the piston's stroke. Knock occurs when the peak of the combustion process no longer occurs at the optimum moment for the four-stroke cycle. The shock wave creates the characteristic metallic "pinging" sound, and cylinder pressure increases dramatically. Effects of engine knocking range from inconsequential to completely destructive. Knocking should not be confused with pre-ignition â€"they are two separate events. However, pre-ignition can be followed by knocking. The phenomenon of detonation was described in November in a letter from Lodge Brothers spark plug manufacturers, and sons of Sir Oliver Lodge settling a discussion regarding the cause of "Konking" or "Pinking" in motorcycles. In the letter they stated that an early ignition can give rise to the gas detonating instead of the usual expansion, and the sound that is produced by the detonation is the same as if the metal parts had been tapped with a hammer. The combustion is started by the spark plug some 10 to 40 crankshaft degrees prior to top dead center TDC , depending on many factors including engine speed and load. This

ignition advance allows time for the combustion process to develop peak pressure at the ideal time for maximum recovery of work from the expanding gases. The spark across the spark plug's electrodes forms a small kernel of flame approximately the size of the spark plug gap. As it grows in size, its heat output increases, which allows it to grow at an accelerating rate, expanding rapidly through the combustion chamber. This growth is due to the travel of the flame front through the combustible fuel air mix itself, and due to turbulence which rapidly stretches the burning zone into a complex of fingers of burning gas that have a much greater surface area than a simple spherical ball of flame would have. Pressure rises smoothly to a peak, as nearly all the available fuel is consumed, then pressure falls as the piston descends. Maximum cylinder pressure is achieved a few crankshaft degrees after the piston passes TDC, so that the force applied on the piston from the increasing pressure applied to the top surface of the piston can give its hardest push precisely when the piston's speed and mechanical advantage on the crank shaft gives the best recovery of force from the expanding gases, thus maximizing torque transferred to the crankshaft. A local shockwave is created around each pocket, and the cylinder pressure will rise sharply â€" and possibly beyond its design limits â€" causing damage. If detonation is allowed to persist under extreme conditions or over many engine cycles, engine parts can be damaged or destroyed. The simplest deleterious effects are typically particle wear caused by moderate knocking, which may further ensue through the engine's oil system and cause wear on other parts before being trapped by the oil filter. Such wear gives the appearance of erosion, abrasion, or a "sandblasted" look, similar to the damage caused by hydraulic cavitation. Severe knocking can lead to catastrophic failure in the form of physical holes melted and pushed through the piston or cylinder head i. Hypereutectic pistons are known to break easily from such shock waves. Because pressure and temperature are strongly linked, knock can also be attenuated by controlling peak combustion chamber temperatures by compression ratio reduction, exhaust gas recirculation , appropriate calibration of the engine's ignition timing schedule, and careful design of the engine's combustion chambers and cooling system as well as controlling the initial air intake temperature. The addition of certain materials such as lead and thallium will suppress detonation extremely well when certain fuels are used. Lead dust added to the intake charge will also reduce knock with various hydrocarbon fuels. Manganese compounds are also used to reduce knock with petrol fuel. Knock is less common in cold climates. As an aftermarket solution, a water injection system can be employed to reduce combustion chamber peak temperatures and thus suppress detonation. Steam water vapor will suppress knock even though no added cooling is supplied. Certain chemical changes must first occur for knock to happen, hence fuels with certain structures tend to knock more easily than others. Branched chain paraffins tend to resist knock while straight chain paraffins knock easily. It has been theorized [citation needed] that lead, steam, and the like interfere with some of the various oxidative changes that occur during combustion and hence reduce knock. Turbulence, as stated, has a very important effect on knock. Engines with good turbulence tend to knock less than engines with poor turbulence. Turbulence occurs not only while the engine is inhaling but also when the mixture is compressed and burned. Many pistons are designed to use "squish" turbulence to violently mix the air and fuel together as they are ignited and burned, which reduces knock greatly by speeding up burning and cooling the unburnt mixture. One example of this is all modern side valve or flathead engines. A considerable portion of the head space is made to come in close proximity to the piston crown, making for much turbulence near TDC. In the early days of side valve heads this was not done and a much lower compression ratio had to be used for any given fuel. Also such engines were sensitive to ignition advance and had less power. Knocking is more or less unavoidable in diesel engines , where fuel is injected into highly compressed air towards the end of the compression stroke. There is a short lag between the fuel being injected and combustion starting. By this time there is already a quantity of fuel in the combustion chamber which will ignite first in areas of greater oxygen density prior to the combustion of the complete charge. This sudden increase in pressure and temperature causes the distinctive diesel 'knock' or 'clatter', some of which must be allowed for in the engine design. Careful design of the injector pump, fuel injector, combustion chamber, piston crown and cylinder head can reduce knocking greatly, and modern engines using electronic common rail injection have very low levels of knock. Engines using indirect injection generally have lower levels of knock than direct injection engines, due to the greater dispersal of oxygen in the combustion chamber and lower injection pressures providing a more complete mixing of fuel and air. Diesels actually do not suffer exactly the same "knock" as gasoline engines since the cause is known to be only the very fast rate of pressure rise, not unstable combustion. Diesel fuels are actually very prone to knock in gasoline engines but in the diesel engine there is no time for knock to occur because the fuel is only oxidized during the expansion cycle. In the

gasoline engine the fuel is slowly oxidizing all the time while it is being compressed before the spark. Due to the large variation in fuel quality, atmospheric pressure and ambient temperature as well as the possibility of a malfunction, every modern combustion engine contains mechanisms to detect and prevent knocking. A control loop is permanently monitoring the signal of one or more knock Sensors commonly piezoelectric sensor which are able to translate vibrations into an electric signal. If the characteristic pressure peak of a knocking combustion is detected the ignition timing is retarded by steps of a few degrees. Modern knock control loop systems are able to adjust ignition timings for every cylinder individually. Depending on the specific engine the boost pressure is regulated simultaneously. This way performance is kept at its optimum while mostly eliminating the risk of engine damage caused by knock e. An early example of this is in turbocharged Saab H engines , where a system called Automatic Performance Control was used to reduce boost pressure if it caused the engine to knock. Since the avoidance of knocking combustion is so important to development engineers, a variety of simulation technologies have been developed which can identify engine design or operating conditions in which knock might be expected to occur. This then enables engineers to design ways to mitigate knocking combustion whilst maintaining a high thermal efficiency. Since the onset of knock is sensitive to the in-cylinder pressure, temperature and autoignition chemistry associated with the local mixture compositions within the combustion chamber, simulations which account for all of these aspects [7] have thus proven most effective in determining knock operating limits and enabling engineers to determine the most appropriate operating strategy. The objective of knock control strategies is to attempt to optimize the trade-off between protecting the engine from damaging knock events and maximizing the engine's output torque. Knock events are an independent random process. A single time history simulation or experiment of knock control methods are not able to provide a repeatable measurement of controller's performance because of the random nature of arriving knock events. Therefore, the desired trade-off must be done in a stochastic framework which could provide a suitable environment for designing and evaluating different knock control strategies performances with rigorous statistical properties. From Wikipedia, the free encyclopedia. For other uses, see Ping disambiguation. Main article: Cool flame. Archived from the original on 18 March Retrieved 16 March Automotive technology: a systems approach. Cengage Learning. Gupta Fundamentals of Internal Combustion Engines. PHI Learning. Popular Science. July Archived from the original on 9 April Retrieved 12 June Peyton; Frey, J. Internal combustion engine. Part of the Automobile series. Engine control unit ECU. Alternator Battery Dynamo Starter motor. Portal Category. Categories : Engine fuel system technology Engine problems Engine sensors. Hidden categories: Use dmy dates from September All articles with unsourced statements Articles with unsourced statements from June Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. The Honda K-series engine is a line of four-cylinder four-stroke car engine introduced in The engines use a coil-on-plug, distributorless ignition system with a coil for each spark plug. This system forgoes the use of a conventional distributor-based ignition timing system in favor of a computer-controlled system that allows the ECU to control ignition timings based on various sensor inputs. The cylinders have cast iron sleeves similar to the B- and F-series engines, as opposed to the FRM cylinders found in the H- and newer F-series engines found only in the Honda S Similar to B series, the K-series car engines have two short blocks with the same design; the only difference between them being the deck height. K20 uses the short block with a deck height of mm where K23 and K24 block has a deck height of The VTEC system on engines like the K20A3 only operate on the intake cam; at low rpm only one intake valve is fully opened, the other opening just slightly to create a swirl effect in the combustion chamber for improved fuel atomization. At high rpm, both intake valves open fully to improve engine breathing. These are gaining a following in the import scene, but also among hot rodders and kit car enthusiasts, because they can be put in longitudinal rear wheel drive layouts. From Wikipedia, the free encyclopedia. This article is about the Honda engine. For the Rover engine series of the same name, see Rover K engine. For the Toyota engine series of the same name, see Toyota K engine. Motor vehicle engine. Further information: Earth Dreams Technology. JDM Spec Engines. Archived from the original on 13 March Retrieved 20 May Archived from the original on 12 May Retrieved 21 April Archived from the original on 6 February Retrieved 15 October Archived from the original on 5 November Archived PDF from the original on Retrieved Headlightmag in Thai. Archived from the original on Honda Thailand in Thai. Los Angeles, CA: Acura. Archived from the original on 27 September Retrieved 23 May Honda Automobiles Newsroom. Torrance, CA: Acura. Retrieved 1 September Honda Motor Company. American Honda Motor Co. Honda Motor Co. Oberg Honda Malaysia Racing Team. Category List Commons. Categories : Honda engines introductions inline-four engines Gasoline engines by

Direct fuel injection. Direct fuel injection Except K20C2. Direct fuel injection K24W [6] Fuel injection other. Circle L. Indy V8. Indy V6. An internal combustion engine ICE is a heat engine in which the combustion of a fuel occurs with an oxidizer usually air in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high- pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons , turbine blades , rotor or a nozzle. This force moves the component over a distance, transforming chemical energy into useful work. This replaced the external combustion engine for applications where weight or size of the engine is important. The term internal combustion engine usually refers to an engine in which combustion is intermittent , such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines , jet engines and most rocket engines , each of which are internal combustion engines on the same principle as previously described. In contrast, in external combustion engines , such as steam or Stirling engines , energy is delivered to a working fluid not consisting of, mixed with, or contaminated by combustion products. Working fluids for external combustion engines include air, hot water, pressurized water or even liquid sodium, heated in a boiler. ICEs are usually powered by energy-dense fuels such as gasoline or diesel fuel, liquids derived from fossil fuels. While there are many stationary applications, most ICEs are used in mobile applications and are the dominant power supply for vehicles such as cars, aircraft and boats. ICEs are typically powered by fossil fuels like natural gas or petroleum products such as gasoline , diesel fuel or fuel oil. Renewable fuels like biodiesel are used in compression ignition CI engines and bioethanol or ETBE ethyl tert-butyl ether produced from bioethanol in spark ignition SI engines. Renewable fuels are commonly blended with fossil fuels. Hydrogen , which is rarely used, can be obtained from either fossil fuels or renewable energy. Various scientists and engineers contributed to the development of internal combustion engines. In , John Barber developed the gas turbine. In Thomas Mead patented a gas engine. Also in , Robert Street patented an internal combustion engine, which was also the first to use liquid fuel , and built an engine around that time. In , John Stevens built the first American internal combustion engine. In , De Rivaz fitted his invention to a primitive working vehicle â€" "the world's first internal combustion powered automobile". In , Samuel Brown patented the first internal combustion engine to be applied industrially. In , Nicolaus Otto patented the first atmospheric gas engine. In , American George Brayton invented the first commercial liquid-fuelled internal combustion engine. In , Nicolaus Otto , working with Gottlieb Daimler and Wilhelm Maybach , patented the compressed charge, four-cycle engine. In , Karl Benz patented a reliable two-stroke gasoline engine. Later, in , Benz began the first commercial production of motor vehicles with the internal combustion engine. In , Rudolf Diesel developed the first compressed charge, compression ignition engine. In , Robert Goddard launched the first liquid-fueled rocket. In , the Heinkel He became the world's first jet aircraft. At one time, the word engine via Old French , from Latin ingenium , "ability" meant any piece of machinery â€"a sense that persists in expressions such as siege engine. A "motor" from Latin motor , "mover" is any machine that produces mechanical power. Traditionally, electric motors are not referred to as "engines"; however, combustion engines are often referred to as "motors". An electric engine refers to a locomotive operated by electricity. In boating, an internal combustion engine that is installed in the hull is referred to as an engine, but the engines that sit on the transom are referred to as motors. Reciprocating piston engines are by far the most common power source for land and water vehicles , including automobiles , motorcycles , ships and to a lesser extent, locomotives some are electrical but most use Diesel engines [11] [12]. Rotary engines of the Wankel design are used in some automobiles, aircraft and motorcycles. These are collectively known as internal-combustion-engine vehicles ICEV Where high power-to-weight ratios are required, internal combustion engines appear in the form of combustion turbines or Wankel engines. Powered aircraft typically uses an ICE which may be a reciprocating engine. Airplanes can instead use jet engines and helicopters can instead employ turboshafts ; both of which are types of turbines. In addition to providing propulsion, airliners may employ a separate ICE as an auxiliary power unit. Wankel engines are fitted to many unmanned aerial vehicles. ICEs drive large electric generators that power electrical grids. Combined cycle power plants use the high temperature exhaust to boil and superheat water steam to run a steam turbine. Thus, the efficiency is higher because more energy is extracted from the fuel than what could be extracted by the combustion engine alone. In a smaller scale, stationary engines like Gas engine or Diesel generators are used for backup or for providing electrical power to areas not connected to an electric grid. The base of a reciprocating internal

combustion engine is the engine block , which is typically made of cast iron or aluminium. The engine block contains the cylinders. In engines with more than one cylinder they are usually arranged either in 1 row straight engine or 2 rows boxer engine or V engine ; 3 rows are occasionally used W engine in contemporary engines, and other engine configurations are possible and have been used. Single cylinder engines are common for motorcycles and in small engines of machinery. Water-cooled engines contain passages in the engine block where cooling fluid circulates the water jacket. Some small engines are air-cooled, and instead of having a water jacket the cylinder block has fins protruding away from it to cool by directly transferring heat to the air. The cylinder walls are usually finished by honing to obtain a cross hatch , which is better able to retain the oil. A too rough surface would quickly harm the engine by excessive wear on the piston. The pistons are short cylindrical parts which seal one end of the cylinder from the high pressure of the compressed air and combustion products and slide continuously within it while the engine is in operation. The top wall of the piston is termed its crown and is typically flat or concave. Some two-stroke engines use pistons with a deflector head. Pistons are open at the bottom and hollow except for an integral reinforcement structure the piston web. When an engine is working, the gas pressure in the combustion chamber exerts a force on the piston crown which is transferred through its web to a gudgeon pin. Each piston has rings fitted around its circumference that mostly prevent the gases from leaking into the crankcase or the oil into the combustion chamber. A ventilation system drives the small amount of gas that escapes past the pistons during normal operation the blow-by gases out of the crankcase so that it does not accumulate contaminating the oil and creating corrosion. In two-stroke gasoline engines the crankcase is part of the airâ€"fuel path and due to the continuous flow of it they do not need a separate crankcase ventilation system. The cylinder head is attached to the engine block by numerous bolts or studs. It has several functions. The cylinder head seals the cylinders on the side opposite to the pistons; it contains short ducts the ports for intake and exhaust and the associated intake valves that open to let the cylinder be filled with fresh air and exhaust valves that open to allow the combustion gases to escape. However, 2-stroke crankcase scavenged engines connect the gas ports directly to the cylinder wall without poppet valves; the piston controls their opening and occlusion instead. The cylinder head also holds the spark plug in the case of spark ignition engines and the injector for engines that use direct injection. All CI engines use fuel injection, usually direct injection but some engines instead use indirect injection. SI engines can use a carburetor or fuel injection as port injection or direct injection. Most SI engines have a single spark plug per cylinder but some have 2. A head gasket prevents the gas from leaking between the cylinder head and the engine block. The opening and closing of the valves is controlled by one or several camshafts and springsâ€"or in some enginesâ€"a desmodromic mechanism that uses no springs. The camshaft may press directly the stem of the valve or may act upon a rocker arm , again, either directly or through a pushrod. The crankcase is sealed at the bottom with a sump that collects the falling oil during normal operation to be cycled again. The cavity created between the cylinder block and the sump houses a crankshaft that converts the reciprocating motion of the pistons to rotational motion. The crankshaft is held in place relative to the engine block by main bearings , which allow it to rotate. Bulkheads in the crankcase form a half of every main bearing; the other half is a detachable cap. In some cases a single main bearing deck is used rather than several smaller caps. A connecting rod is connected to offset sections of the crankshaft the crankpins in one end and to the piston in the other end through the gudgeon pin and thus transfers the force and translates the reciprocating motion of the pistons to the circular motion of the crankshaft. The end of the connecting rod attached to the gudgeon pin is called its small end, and the other end, where it is connected to the crankshaft, the big end. The big end has a detachable half to allow assembly around the crankshaft. It is kept together to the connecting rod by removable bolts. The cylinder head has an intake manifold and an exhaust manifold attached to the corresponding ports. The intake manifold connects to the air filter directly, or to a carburetor when one is present, which is then connected to the air filter. It distributes the air incoming from these devices to the individual cylinders. The exhaust manifold is the first component in the exhaust system. It collects the exhaust gases from the cylinders and drives it to the following component in the path. The exhaust system of an ICE may also include a catalytic converter and muffler. The final section in the path of the exhaust gases is the tailpipe. The top dead center TDC of a piston is the position where it is nearest to the valves; bottom dead center BDC is the opposite position where it is furthest from them. While an engine is in operation, the crankshaft rotates continuously at a nearly constant speed. In a 4-stroke ICE, each piston experiences 2 strokes per crankshaft revolution in the following order. Starting the description at TDC, these are: [16] [17]. The defining characteristic of this kind of engine is that each piston completes a cycle every crankshaft revolution. The 4

processes of intake, compression, power and exhaust take place in only 2 strokes so that it is not possible to dedicate a stroke exclusively for each of them. Starting at TDC the cycle consist of:. While a 4-stroke engine uses the piston as a positive displacement pump to accomplish scavenging taking 2 of the 4 strokes, a 2-stroke engine uses the last part of the power stroke and the first part of the compression stroke for combined intake and exhaust. The work required to displace the charge and exhaust gases comes from either the crankcase or a separate blower. For scavenging, expulsion of burned gas and entry of fresh mix, two main approaches are described: Loop scavenging, and Uniflow scavenging, SAE news published in the s that 'Loop Scavenging' is better under any circumstance than Uniflow Scavenging. Some SI engines are crankcase scavenged and do not use poppet valves. Instead, the crankcase and the part of the cylinder below the piston is used as a pump. The intake port is connected to the crankcase through a reed valve or a rotary disk valve driven by the engine. For each cylinder, a transfer port connects in one end to the crankcase and in the other end to the cylinder wall. The exhaust port is connected directly to the cylinder wall. The transfer and exhaust port are opened and closed by the piston. The reed valve opens when the crankcase pressure is slightly below intake pressure, to let it be filled with a new charge; this happens when the piston is moving upwards. When the piston is moving downwards the pressure in the crankcase increases and the reed valve closes promptly, then the charge in the crankcase is compressed. When the piston is moving upwards, it uncovers the exhaust port and the transfer port and the higher pressure of the charge in the crankcase makes it enter the cylinder through the transfer port, blowing the exhaust gases. Lubrication is accomplished by adding 2-stroke oil to the fuel in small ratios. Petroil refers to the mix of gasoline with the aforesaid oil. This kind of 2-stroke engines has a lower efficiency than comparable 4-strokes engines and release a more polluting exhaust gases for the following conditions:. The main advantage of 2-stroke engines of this type is mechanical simplicity and a higher power-to-weight ratio than their 4-stroke counterparts. Despite having twice as many power strokes per cycle, less than twice the power of a comparable 4-stroke engine is attainable in practice. In the US, 2-stroke engines were banned for road vehicles due to the pollution. Off-road only motorcycles are still often 2-stroke but are rarely road legal. However, many thousands of 2-stroke lawn maintenance engines are in use. Using a separate blower avoids many of the shortcomings of crankcase scavenging, at the expense of increased complexity which means a higher cost and an increase in maintenance requirement. An engine of this type uses ports or valves for intake and valves for exhaust, except opposed piston engines , which may also use ports for exhaust. The blower is usually of the Roots-type but other types have been used too. This design is commonplace in CI engines, and has been occasionally used in SI engines. CI engines that use a blower typically use uniflow scavenging. In this design the cylinder wall contains several intake ports placed uniformly spaced along the circumference just above the position that the piston crown reaches when at BDC. An exhaust valve or several like that of 4-stroke engines is used. The final part of the intake manifold is an air sleeve that feeds the intake ports. The intake ports are placed at a horizontal angle to the cylinder wall I. The largest reciprocating IC are low speed CI engines of this type; they are used for marine propulsion see marine diesel engine or electric power generation and achieve the highest thermal efficiencies among internal combustion engines of any kind. Some Diesel-electric locomotive engines operate on the 2-stroke cycle. The most powerful of them have a brake power of around 4. See the external links for an in-cylinder combustion video in a 2-stroke, optically accessible motorcycle engine. Dugald Clerk developed the first two-cycle engine in It used a separate cylinder which functioned as a pump in order to transfer the fuel mixture to the cylinder. In John Day simplified Clerk's design into the type of 2 cycle engine that is very widely used today. The crankcase and the part of the cylinder below the exhaust port is used as a pump. The carburetor then feeds the fuel mixture into the crankcase through a reed valve or a rotary disk valve driven by the engine. There are cast in ducts from the crankcase to the port in the cylinder to provide for intake and another from the exhaust port to the exhaust pipe. The height of the port in relationship to the length of the cylinder is called the "port timing". On the first upstroke of the engine there would be no fuel inducted into the cylinder as the crankcase was empty. On the downstroke, the piston now compresses the fuel mix, which has lubricated the piston in the cylinder and the bearings due to the fuel mix having oil added to it. As the piston moves downward is first uncovers the exhaust, but on the first stroke there is no burnt fuel to exhaust. As the piston moves downward further, it uncovers the intake port which has a duct that runs to the crankcase. Since the fuel mix in the crankcase is under pressure, the mix moves through the duct and into the cylinder. Because there is no obstruction in the cylinder of the fuel to move directly out of the exhaust port prior to the piston rising far enough to close the port, early engines used a high domed piston to slow down the flow of fuel. Later the fuel was "resonated" back into the cylinder using an expansion

chamber design. When the piston rose close to TDC, a spark ignites the fuel. As the piston is driven downward with power, it first uncovers the exhaust port where the burned fuel is expelled under high pressure and then the intake port where the process has been completed and will keep repeating. Later engines used a type of porting devised by the Deutz company to improve performance. It was called the Schnurle Reverse Flow system. DKW licensed this design for all their motorcycles. Internal combustion engines require ignition of the mixture, either by spark ignition SI or compression ignition CI. Before the invention of reliable electrical methods, hot tube and flame methods were used. Experimental engines with laser ignition have been built. The spark-ignition engine was a refinement of the early engines which used Hot Tube ignition. When Bosch developed the magneto it became the primary system for producing electricity to energize a spark plug. Small engines are started by hand cranking using a recoil starter or hand crank. Prior to Charles F. Kettering of Delco's development of the automotive starter all gasoline engined automobiles used a hand crank. Larger engines typically power their starting motors and ignition systems using the electrical energy stored in a lead–acid battery. The battery's charged state is maintained by an automotive alternator or previously a generator which uses engine power to create electrical energy storage. The battery supplies electrical power for starting when the engine has a starting motor system, and supplies electrical power when the engine is off. The battery also supplies electrical power during rare run conditions where the alternator cannot maintain more than As alternator voltage falls below During virtually all running conditions, including normal idle conditions, the alternator supplies primary electrical power. Some systems disable alternator field rotor power during wide-open throttle conditions. Disabling the field reduces alternator pulley mechanical loading to nearly zero, maximizing crankshaft power. In this case, the battery supplies all primary electrical power. Gasoline engines take in a mixture of air and gasoline and compress it by the movement of the piston from bottom dead center to top dead center when the fuel is at maximum compression. The reduction in the size of the swept area of the cylinder and taking into account the volume of the combustion chamber is described by a ratio. Early engines had compression ratios of 6 to 1. As compression ratios were increased, the efficiency of the engine increased as well. With early induction and ignition systems the compression ratios had to be kept low. With advances in fuel technology and combustion management, high-performance engines can run reliably at ratio. With low octane fuel, a problem would occur as the compression ratio increased as the fuel was igniting due to the rise in temperature that resulted. Charles Kettering developed a lead additive which allowed higher compression ratios, which was progressively abandoned for automotive use from the s onward, partly due to lead poisoning concerns. The fuel mixture is ignited at difference progressions of the piston in the cylinder. At low rpm, the spark is timed to occur close to the piston achieving top dead center. In order to produce more power, as rpm rises the spark is advanced sooner during piston movement. The spark occurs while the fuel is still being compressed progressively more as rpm rises. The necessary high voltage, typically 10, volts, is supplied by an induction coil or transformer. The induction coil is a fly-back system, using interruption of electrical primary system current through some type of synchronized interrupter. The interrupter can be either contact points or a power transistor. The problem with this type of ignition is that as RPM increases the availability of electrical energy decreases. This is especially a problem, since the amount of energy needed to ignite a more dense fuel mixture is higher. The result was often a high RPM misfire. Capacitor discharge ignition was developed. It produces a rising voltage that is sent to the spark plug. CD system voltages can reach 60, volts. The step-up transformer uses energy stored in a capacitance to generate electric spark. With either system, a mechanical or electrical control system provides a carefully timed high-voltage to the proper cylinder. This spark, via the spark plug, ignites the air-fuel mixture in the engine's cylinders. While gasoline internal combustion engines are much easier to start in cold weather than diesel engines, they can still have cold weather starting problems under extreme conditions. For years, the solution was to park the car in heated areas. In some parts of the world, the oil was actually drained and heated overnight and returned to the engine for cold starts. In the early s, the gasoline Gasifier unit was developed, where, on cold weather starts, raw gasoline was diverted to the unit where part of the fuel was burned causing the other part to become a hot vapor sent directly to the intake valve manifold. This unit was quite popular until electric engine block heaters became standard on gasoline engines sold in cold climates. The compression level that occurs is usually twice or more than a gasoline engine. Diesel engines take in air only, and shortly before peak compression, spray a small quantity of diesel fuel into the cylinder via a fuel injector that allows the fuel to instantly ignite. HCCI type engines take in both air and fuel, but continue to rely on an unaided auto-combustion process, due to higher pressures and heat. This is also why diesel and HCCI engines are more susceptible to cold-starting issues, although they run just as well in cold weather once started.

Light duty diesel engines with indirect injection in automobiles and light trucks employ glowplugs or other pre-heating: see Cummins ISB 6BT that pre-heat the combustion chamber just before starting to reduce no-start conditions in cold weather. Most diesels also have a battery and charging system; nevertheless, this system is secondary and is added by manufacturers as a luxury for the ease of starting, turning fuel on and off which can also be done via a switch or mechanical apparatus , and for running auxiliary electrical components and accessories. Most new engines rely on electrical and electronic engine control units ECU that also adjust the combustion process to increase efficiency and reduce emissions. Surfaces in contact and relative motion to other surfaces require lubrication to reduce wear, noise and increase efficiency by reducing the power wasting in overcoming friction , or to make the mechanism work at all. Also, the lubricant used can reduce excess heat and provide additional cooling to components. At the very least, an engine requires lubrication in the following parts:. In 2-stroke crankcase scavenged engines, the interior of the crankcase, and therefore the crankshaft, connecting rod and bottom of the pistons are sprayed by the 2-stroke oil in the air-fuel-oil mixture which is then burned along with the fuel. The valve train may be contained in a compartment flooded with lubricant so that no oil pump is required. In a splash lubrication system no oil pump is used. Instead the crankshaft dips into the oil in the sump and due to its high speed, it splashes the crankshaft, connecting rods and bottom of the pistons. The connecting rod big end caps may have an attached scoop to enhance this effect. The valve train may also be sealed in a flooded compartment, or open to the crankshaft in a way that it receives splashed oil and allows it to drain back to the sump. Splash lubrication is common for small 4-stroke engines. In a forced also called pressurized lubrication system , lubrication is accomplished in a closed-loop which carries motor oil to the surfaces serviced by the system and then returns the oil to a reservoir. The auxiliary equipment of an engine is typically not serviced by this loop; for instance, an alternator may use ball bearings sealed with their own lubricant. The reservoir for the oil is usually the sump, and when this is the case, it is called a wet sump system. When there is a different oil reservoir the crankcase still catches it, but it is continuously drained by a dedicated pump; this is called a dry sump system. On its bottom, the sump contains an oil intake covered by a mesh filter which is connected to an oil pump then to an oil filter outside the crankcase, from there it is diverted to the crankshaft main bearings and valve train. The crankcase contains at least one oil gallery a conduit inside a crankcase wall to which oil is introduced from the oil filter. The main bearings contain a groove through all or half its circumference; the oil enters these grooves from channels connected to the oil gallery. The crankshaft has drillings that take oil from these grooves and deliver it to the big end bearings. All big end bearings are lubricated this way. A single main bearing may provide oil for 0, 1 or 2 big end bearings. A similar system may be used to lubricate the piston, its gudgeon pin and the small end of its connecting rod; in this system, the connecting rod big end has a groove around the crankshaft and a drilling connected to the groove which distributes oil from there to the bottom of the piston and from then to the cylinder. Other systems are also used to lubricate the cylinder and piston. The connecting rod may have a nozzle to throw an oil jet to the cylinder and bottom of the piston. That nozzle is in movement relative to the cylinder it lubricates, but always pointed towards it or the corresponding piston. Typically a forced lubrication systems have a lubricant flow higher than what is required to lubricate satisfactorily, in order to assist with cooling. Specifically, the lubricant system helps to move heat from the hot engine parts to the cooling liquid in water-cooled engines or fins in air-cooled engines which then transfer it to the environment. The lubricant must be designed to be chemically stable and maintain suitable viscosities within the temperature range it encounters in the engine. Common cylinder configurations include the straight or inline configuration , the more compact V configuration , and the wider but smoother flat or boxer configuration. Aircraft engines can also adopt a radial configuration , which allows more effective cooling. More unusual configurations such as the H , U , X , and W have also been used. Multiple cylinder engines have their valve train and crankshaft configured so that pistons are at different parts of their cycle. It is desirable to have the pistons' cycles uniformly spaced this is called even firing especially in forced induction engines; this reduces torque pulsations [29] and makes inline engines with more than 3 cylinders statically balanced in its primary forces. However, some engine configurations require odd firing to achieve better balance than what is possible with even firing. With an even firing pattern, the pistons would move in unison and the associated forces would add. Multiple crankshaft configurations do not necessarily need a cylinder head at all because they can instead have a piston at each end of the cylinder called an opposed piston design. Because fuel inlets and outlets are positioned at opposed ends of the cylinder, one can achieve uniflow scavenging, which, as in the four-stroke engine is efficient over a wide range of engine speeds. Thermal efficiency is improved because of a lack of cylinder heads. This design was used in the

Junkers Jumo diesel aircraft engine, using two crankshafts at either end of a single bank of cylinders, and most remarkably in the Napier Deltic diesel engines. These used three crankshafts to serve three banks of double-ended cylinders arranged in an equilateral triangle with the crankshafts at the corners. It was also used in single-bank locomotive engines , and is still used in marine propulsion engines and marine auxiliary generators. Most truck and automotive diesel engines use a cycle reminiscent of a four-stroke cycle, but with compression heating causing ignition, rather than needing a separate ignition system. This variation is called the diesel cycle. In the diesel cycle, diesel fuel is injected directly into the cylinder so that combustion occurs at constant pressure, as the piston moves. Otto cycle is the typical cycle for most of the cars internal combustion engines, that work using gasoline as a fuel. Otto cycle is exactly the same one that was described for the four-stroke engine. It consists of the same major steps: intake, compression, ignition, expansion and exhaust. In , Nicolaus Otto manufactured and sold a double expansion engine the double and triple expansion principles had ample usage in steam engines , with two small cylinders at both sides of a low-pressure larger cylinder, where a second expansion of exhaust stroke gas took place; the owner returned it, alleging poor performance. In , the concept was incorporated in a car built by EHV Eisenhuth Horseless Vehicle Company ; [30] and in the 21st century Ilmor designed and successfully tested a 5-stroke double expansion internal combustion engine, with high power output and low SFC Specific Fuel Consumption. The six-stroke engine was invented in Four kinds of six-stroke use a regular piston in a regular cylinder Griffin six-stroke, Bajulaz six-stroke, Velozeta six-stroke and Crower six-stroke , firing every three crankshaft revolutions. These systems capture the wasted heat of the four-stroke Otto cycle with an injection of air or water. The Beare Head and "piston charger" engines operate as opposed-piston engines , two pistons in a single cylinder, firing every two revolutions rather more like a regular four-stroke. The very first internal combustion engines did not compress the mixture. The first part of the piston downstroke drew in a fuel-air mixture, then the inlet valve closed and, in the remainder of the down-stroke, the fuel-air mixture fired. The exhaust valve opened for the piston upstroke. These attempts at imitating the principle of a steam engine were very inefficient. There are a number of variations of these cycles, most notably the Atkinson and Miller cycles. The diesel cycle is somewhat different. Split-cycle engines separate the four strokes of intake, compression, combustion and exhaust into two separate but paired cylinders. The first cylinder is used for intake and compression. The compressed air is then transferred through a crossover passage from the compression cylinder into the second cylinder, where combustion and exhaust occur. A split-cycle engine is really an air compressor on one side with a combustion chamber on the other. Previous split-cycle engines have had two major problemsâ€"poor breathing volumetric efficiency and low thermal efficiency. However, new designs are being introduced that seek to address these problems. The Scuderi Engine addresses the breathing problem by reducing the clearance between the piston and the cylinder head through various turbo charging techniques. The Scuderi design requires the use of outwardly opening valves that enable the piston to move very close to the cylinder head without the interference of the valves. Scuderi addresses the low thermal efficiency via firing after top dead centre ATDC. Firing ATDC can be accomplished by using high-pressure air in the transfer passage to create sonic flow and high turbulence in the power cylinder. Jet engines use a number of rows of fan blades to compress air which then enters a combustor where it is mixed with fuel typically JP fuel and then ignited. The burning of the fuel raises the temperature of the air which is then exhausted out of the engine creating thrust. A gas turbine compresses air and uses it to turn a turbine. It is essentially a jet engine which directs its output to a shaft. There are three stages to a turbine: 1 air is drawn through a compressor where the temperature rises due to compression, 2 fuel is added in the combuster , and 3 hot air is exhausted through turbine blades which rotate a shaft connected to the compressor. A gas turbine is a rotary machine similar in principle to a steam turbine and it consists of three main components: a compressor, a combustion chamber, and a turbine. The air, after being compressed in the compressor, is heated by burning fuel in it. The heated air and the products of combustion expand in a turbine, producing work output. Gas Turbines are among the most efficient internal combustion engines. A gas turbine is a rotary machine somewhat similar in principle to a steam turbine. It consists of three main components: compressor, combustion chamber, and turbine. The air is compressed by the compressor where a temperature rise occurs. The compressed air is further heated by combustion of injected fuel in the combustion chamber which expands the air. This energy rotates the turbine which powers the compressor via a mechanical coupling. The hot gases are then exhausted to provide thrust. Gas turbine cycle engines employ a continuous combustion system where compression, combustion, and expansion occur simultaneously at different places in the engineâ€"giving continuous power. Notably, the combustion takes place at constant pressure.

rather than with the Otto cycle, constant volume. The Wankel engine rotary engine does not have piston strokes. It operates with the same separation of phases as the four-stroke engine with the phases taking place in separate locations in the engine. In thermodynamic terms it follows the Otto engine cycle, so may be thought of as a "four-phase" engine. While it is true that three power strokes typically occur per rotor revolution, due to the revolution ratio of the rotor to the eccentric shaft, only one power stroke per shaft revolution actually occurs. The drive eccentric shaft rotates once during every power stroke instead of twice crankshaft , as in the Otto cycle, giving it a greater power-to-weight ratio than piston engines. This type of engine was most notably used in the Mazda RX-8 , the earlier RX-7 , and other vehicle models. The engine is also used in unmanned aerial vehicles, where the small size and weight and the high power-to-weight ratio are advantageous. Forced induction is the process of delivering compressed air to the intake of an internal combustion engine. A forced induction engine uses a gas compressor to increase the pressure, temperature and density of the air. An engine without forced induction is considered a naturally aspirated engine. Forced induction is used in the automotive and aviation industry to increase engine power and efficiency. It particularly helps aviation engines, as they need to operate at high altitude. Forced induction is achieved by a supercharger , where the compressor is directly powered from the engine shaft or, in the turbocharger , from a turbine powered by the engine exhaust. All internal combustion engines depend on combustion of a chemical fuel , typically with oxygen from the air though it is possible to inject nitrous oxide to do more of the same thing and gain a power boost. The combustion process typically results in the production of a great quantity of heat, as well as the production of steam and carbon dioxide and other chemicals at very high temperature; the temperature reached is determined by the chemical make up of the fuel and oxidisers see stoichiometry , as well as by the compression and other factors. The most common modern fuels are made up of hydrocarbons and are derived mostly from fossil fuels petroleum. Fossil fuels include diesel fuel , gasoline and petroleum gas , and the rarer use of propane. Except for the fuel delivery components, most internal combustion engines that are designed for gasoline use can run on natural gas or liquefied petroleum gases without major modifications. Large diesels can run with air mixed with gases and a pilot diesel fuel ignition injection. Liquid and gaseous biofuels , such as ethanol and biodiesel a form of diesel fuel that is produced from crops that yield triglycerides such as soybean oil , can also be used. Engines with appropriate modifications can also run on hydrogen gas, wood gas , or charcoal gas , as well as from so-called producer gas made from other convenient biomass. Experiments have also been conducted using powdered solid fuels, such as the magnesium injection cycle. Even fluidized metal powders and explosives have seen some use. Engines that use gases for fuel are called gas engines and those that use liquid hydrocarbons are called oil engines; however, gasoline engines are also often colloquially referred to as, "gas engines" " petrol engines " outside North America. The main limitations on fuels are that it must be easily transportable through the fuel system to the combustion chamber , and that the fuel releases sufficient energy in the form of heat upon combustion to make practical use of the engine. Diesel engines are generally heavier, noisier, and more powerful at lower speeds than gasoline engines. They are also more fuel-efficient in most circumstances and are used in heavy road vehicles, some automobiles increasingly so for their increased fuel efficiency over gasoline engines , ships, railway locomotives , and light aircraft. Gasoline engines are used in most other road vehicles including most cars, motorcycles , and mopeds. There are also engines that run on hydrogen , methanol , ethanol , liquefied petroleum gas LPG , biodiesel , paraffin and tractor vaporizing oil TVO. Hydrogen could eventually replace conventional fossil fuels in traditional internal combustion engines. Alternatively fuel cell technology may come to deliver its promise and the use of the internal combustion engines could even be phased out. Although there are multiple ways of producing free hydrogen, those methods require converting combustible molecules into hydrogen or consuming electric energy. Unless that electricity is produced from a renewable source—and is not required for other purposes—hydrogen does not solve any energy crisis. In many situations the disadvantage of hydrogen, relative to carbon fuels, is its storage. Liquid hydrogen has extremely low density 14 times lower than water and requires extensive insulation—whilst gaseous hydrogen requires heavy tankage. Even when liquefied, hydrogen has a higher specific energy but the volumetric energetic storage is still roughly five times lower than gasoline. However, the energy density of hydrogen is considerably higher than that of electric batteries, making it a serious contender as an energy carrier to replace fossil fuels. The 'Hydrogen on Demand' process see direct borohydride fuel cell creates hydrogen as needed, but has other issues, such as the high price of the sodium borohydride that is the raw material. Since air is plentiful at the surface of the earth, the oxidizer is typically atmospheric oxygen, which has the advantage of not being stored within the vehicle. This increases the

power-to-weight and power-to-volume ratios. Other materials are used for special purposes, often to increase power output or to allow operation under water or in space. Cooling is required to remove excessive heat—over heating can cause engine failure, usually from wear due to heat-induced failure of lubrication , cracking or warping. Two most common forms of engine cooling are air-cooled and water-cooled. Some engines air or water-cooled also have an oil cooler. In some engines, especially for turbine engine blade cooling and liquid rocket engine cooling , fuel is used as a coolant, as it is simultaneously preheated before injecting it into a combustion chamber. Internal combustion engines must have their cycles started. In reciprocating engines this is accomplished by turning the crankshaft Wankel Rotor Shaft which induces the cycles of intake, compression, combustion, and exhaust. The first engines were started with a turn of their flywheels, while the first vehicle the Daimler Reitwagen was started with a hand crank. All ICE engined automobiles were started with hand cranks until Charles Kettering developed the electric starter for automobiles. As diesel engines have become larger and their mechanisms heavier, air starters have come into use. Air starters work by pumping compressed air into the cylinders of an engine to start it turning. There are also starters where a spring is compressed by a crank motion and then used to start an engine. Some small engines use a pull-rope mechanism called "recoil starting", as the rope rewinds itself after it has been pulled out to start the engine. This method is commonly used in pushed lawn mowers and other settings where only a small amount of torque is needed to turn an engine over. Once ignited and burnt, the combustion products—hot gases—have more available thermal energy than the original compressed fuel-air mixture which had higher chemical energy. The available energy is manifested as high temperature and pressure that can be translated into work by the engine. In a reciprocating engine, the high-pressure gases inside the cylinders drive the engine's pistons. Once the available energy has been removed, the remaining hot gases are vented often by opening a valve or exposing the exhaust outlet and this allows the piston to return to its previous position top dead center, or TDC. The piston can then proceed to the next phase of its cycle, which varies between engines. Any heat that is not translated into work is normally considered a waste product and is removed from the engine either by an air or liquid cooling system. Internal combustion engines are heat engines , and as such their theoretical efficiency can be approximated by idealized thermodynamic cycles. The thermal efficiency of a theoretical cycle cannot exceed that of the Carnot cycle , whose efficiency is determined by the difference between the lower and upper operating temperatures of the engine. The upper operating temperature of an engine is limited by two main factors; the thermal operating limits of the materials, and the auto-ignition resistance of the fuel. All metals and alloys have a thermal operating limit, and there is significant research into ceramic materials that can be made with greater thermal stability and desirable structural properties. Higher thermal stability allows for a greater temperature difference between the lower ambient and upper operating temperatures, hence greater thermodynamic efficiency. Also, as the cylinder temperature rises, the engine becomes more prone to auto-ignition. This is caused when the cylinder temperature nears the flash point of the charge. At this point, ignition can spontaneously occur before the spark plug fires, causing excessive cylinder pressures. Auto-ignition can be mitigated by using fuels with high auto-ignition resistance octane rating , however it still puts an upper bound on the allowable peak cylinder temperature. The thermodynamic limits assume that the engine is operating under ideal conditions: a frictionless world, ideal gases, perfect insulators, and operation for infinite time. Real world applications introduce complexities that reduce efficiency. For example, a real engine runs best at a specific load, termed its power band. The engine in a car cruising on a highway is usually operating significantly below its ideal load, because it is designed for the higher loads required for rapid acceleration. Engine fuel economy is measured in miles per gallon or in liters per kilometres. The volume of hydrocarbon assumes a standard energy content. In general, practical engines are always compromised by trade-offs between different properties such as efficiency, weight, power, heat, response, exhaust emissions, or noise. Sometimes economy also plays a role in not only the cost of manufacturing the engine itself, but also manufacturing and distributing the fuel. Increasing the engine's efficiency brings better fuel economy but only if the fuel cost per energy content is the same. For stationary and shaft engines including propeller engines, fuel consumption is measured by calculating the brake specific fuel consumption , which measures the mass flow rate of fuel consumption divided by the power produced. For internal combustion engines in the form of jet engines, the power output varies drastically with airspeed and a less variable measure is used: thrust specific fuel consumption TSFC , which is the mass of propellant needed to generate impulses that is measured in either pound force-hour or the grams of propellant needed to generate an impulse that measures one kilonewton-second. For rockets, TSFC can be used, but typically other equivalent measures are traditionally used, such as specific impulse and effective exhaust

velocity. Internal combustion engines such as reciprocating internal combustion engines produce air pollution emissions, due to incomplete combustion of carbonaceous fuel. The main derivatives of the process are carbon dioxide CO_2, water and some soot â€"also called particulate matter PM. The effects of inhaling particulate matter have been studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. There are, however, some additional products of the combustion process that include nitrogen oxides and sulfur and some uncombusted hydrocarbons, depending on the operating conditions and the fuel-air ratio. Not all of the fuel is completely consumed by the combustion process. A small amount of fuel is present after combustion, and some of it reacts to form oxygenates, such as formaldehyde or acetaldehyde, or hydrocarbons not originally present in the input fuel mixture. Incomplete combustion usually results from insufficient oxygen to achieve the perfect stoichiometric ratio. The flame is "quenched" by the relatively cool cylinder walls, leaving behind unreacted fuel that is expelled with the exhaust. When running at lower speeds, quenching is commonly observed in diesel compression ignition engines that run on natural gas. Quenching reduces efficiency and increases knocking, sometimes causing the engine to stall. Incomplete combustion also leads to the production of carbon monoxide CO. Further chemicals released are benzene and 1,3-butadiene that are also hazardous air pollutants. Increasing the amount of air in the engine reduces emissions of incomplete combustion products, but also promotes reaction between oxygen and nitrogen in the air to produce nitrogen oxides NO_x. NO_x is hazardous to both plant and animal health, and leads to the production of ozone O_3. Ozone is not emitted directly; rather, it is a secondary air pollutant, produced in the atmosphere by the reaction of NO_x and volatile organic compounds in the presence of sunlight. Ground-level ozone is harmful to human health and the environment. Though the same chemical substance, ground-level ozone should not be confused with stratospheric ozone, or the ozone layer, which protects the earth from harmful ultraviolet rays. Carbon fuels contain sulfur and impurities that eventually produce sulfur monoxides SO and sulfur dioxide SO_2 in the exhaust, which promotes acid rain. In the United States, nitrogen oxides, PM, carbon monoxide, sulphur dioxide, and ozone, are regulated as criteria air pollutants under the Clean Air Act to levels where human health and welfare are protected. Other pollutants, such as benzene and 1,3-butadiene, are regulated as hazardous air pollutants whose emissions must be lowered as much as possible depending on technological and practical considerations. NO_x, carbon monoxide and other pollutants are frequently controlled via exhaust gas recirculation which returns some of the exhaust back into the engine intake, and catalytic converters, which convert exhaust chemicals to harmless chemicals. The emission standards used by many countries have special requirements for non-road engines which are used by equipment and vehicles that are not operated on the public roadways. The standards are separated from the road vehicles. Significant contributions to noise pollution are made by internal combustion engines. Automobile and truck traffic operating on highways and street systems produce noise, as do aircraft flights due to jet noise, particularly supersonic-capable aircraft. Rocket engines create the most intense noise. Internal combustion engines continue to consume fuel and emit pollutants when idling so it is desirable to keep periods of idling to a minimum. Many bus companies now instruct drivers to switch off the engine when the bus is waiting at a terminal. This means that a driver can be ordered " by an authorised person Only a few local authorities have implemented the regulations, one of them being Oxford City Council. In many European countries, idling is, by default, disabled by stop-start systems. From Wikipedia, the free encyclopedia. For the form of water ice, see Ice V. For the high speed train, see ICE V. Engine in which the combustion of a fuel occurs with an oxidizer in a combustion chamber. Main article: History of the internal combustion engine. For rotating-crankcase radial -cylindered engines, see Rotary engine. See also: Diesel engine and Gasoline engine. Main article: 4-stroke engine. Main article: 2-stroke engine. Main article: Spark-ignition engine. Main article: Diesel engine. Main article: Diesel cycle. Main article: Jet engine. Main article: Gas turbine. Main article: Brayton cycle. Main article: Wankel engine. Main article: Forced induction. Main article: Hydrogen internal combustion engine vehicle. Main article: Internal combustion engine cooling. Main article: Starter motor. Play media. See also: Air suction valve. Main article: Idle reduction. Energy portal. Retrieved Engineering Fundamentals of the Internal Combustion Engine. Prentice Hall. The World History of the Automobile. Germany: Society of Automotive Engineers. Retrieved 21 September Biographical Dictionary of the History of Technology. Physics of Energy. A spark of Italian creativity" PDF. World Wide Words. Technology Today and Tomorrow. Extreme Machines on Land. DeLuchi First Hand Info. Archived from the original on Retrieved 26 June Archived from the original PDF on Mitsubishi Heavy Industries Technical Review. I Engine". The Old Motor. Automobile in American Life and Society. University of Michigan-Dearborn. Innovate Motorsports. Popular

Mechanics. Hearst Magazines. January The Romance of Engines. Ilmor Engineering. Intergovernment Panel on Climate Change. General Electric Power Generation. General Electric. US: Bureau of Ordnance. After assembling, the air-flask shall be charged to lbs. US: General Motors. Ingersoll Rand. Motor Authority. Oxford City Council. November Thermodynamic cycles. Without phase change hot air engines. Internal combustion engine. Part of the Automobile series. Engine control unit ECU. Alternator Battery Dynamo Starter motor. Portal Category. Car design. Hot rod Lead sled Lowrider Street rod T-bucket. Compact executive Executive Personal. Compact Mini. Front Mid Rear. Portal Category Template:EC car classification. Heat engines. Beale number West number. Timeline of heat engine technology. Categories : Internal combustion engine Engines Piston engines 17th-century inventions.

Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. Wikimedia Commons. Wikimedia Commons has media related to Internal combustion piston engine lubrication systems. Wikimedia Commons has media related to Internal combustion engines, Thermodynamic cycle. Wiki software also known as a wiki engine or wiki application is collaborative software that runs a wiki , which allows users to create and collaboratively edit pages or entries via a web browser. A wiki system is usually a web application that runs on one or more web servers. The content, including previous revisions, is usually stored in either a file system or a database. Wikis are a type of web content management system , and the most commonly supported off-the-shelf software that web hosting facilities offer. There are dozens of actively maintained wiki engines. They vary in the platforms they run on, the programming language they were developed in, whether they are open-source or proprietary , their support for natural language characters and conventions, and their assumptions about technical versus social control of editing. The first generally recognized "wiki" application, WikiWikiWeb , was created by American computer programmer Ward Cunningham in and launched on c2. Wiki software originated from older version control systems used for documentation and software in the s. By the mids these generally had web browser interfaces. However, they lacked the ability to easily create links between internal pages without writing HTML code. By the time MediaWiki appeared, this convention had been largely abandoned in favor of explicitly marking links in edited source code with double square brackets. Page names thus did not interrupt the flow of English and could follow standard English capitalization convention. Case-sensitivity on the first letter but not subsequent letters supported standard English capitalization conventions and let writers author their pages in ordinary English, with the linking of particular words and phrases afterward. This proved to be the critical change that allowed ordinary authors of English to write wiki pages, and non-technical users to read them. This policy was extended to other natural languages, avoiding the use of unusual-looking text or awkward capitalization that violates the language's own rules. Over the next 10 years, many more wiki applications were written, in a variety of programming languages. After , there began to be a move toward increasing consolidation and standardization: many less-popular wiki applications were gradually abandoned, and fewer new applications were created. Relatively few of the wiki engines currently in use were created after The idea of having wiki functionality is now seen as desirable generally and some aspects of wiki functionality has also been added to existing content management systems , such as Microsoft SharePoint. Some writers have pointed out that SharePoint does not in fact function as a wiki, even with this functionality in use. In general new wiki engines have not followed the data formats of the existing engines, making them of limited use for those who have already invested in large knowledge bases in existing software. As a rule newer wiki projects have not succeeded in attracting large numbers of users from the existing wiki software base. None of these alternatives support the extensions available under standard MediaWiki, some of which extend or alter its data format. There are essentially three types of usage for wiki software: public-facing wikis with a potentially large community of readers and editors, private enterprise wikis for data management by corporations and other organizations, and personal wikis , meant to be used by a single person to manage notes, and usually run on a desktop. Some wiki software is specifically geared for one of the usage types, while other software can be used for all three, but contains functionality, either in its core or through plugins, that help with one or more of the usage types. Public wikis are wikis that can be read by anyone; usually, though not always, the contents can be edited by anyone as well,

though sometimes registration is required. Among public wikis, MediaWiki is the dominant software: it powers the world's most popular as per August, public wiki, [2] Wikipedia free , as well as the most popular wiki farm, Wikia commercial , and it is the most popular software in use on other public wikis as well. Other Internet websites, based on wiki software, include encyclopedies such as Sensei's Library , Parlia , and WikiTree. Enterprise wiki software is software intended to be used in a corporate or organizational context, [4] especially to enhance internal knowledge sharing. It tends to have a greater emphasis on features like access control, integration with other software, and document management. Most proprietary wiki applications specifically market themselves as enterprise solutions, including Socialtext , Jive , Traction TeamPage , Notion , and Nuclino. Increasingly offerings appear which use the name 'wiki' but do not offer basic elements common to established wikis, like Wiki Markup and Link-first workflow Confluence since , [5] or Version Control of Full Text Search Microsoft Teams. In addition, some open source wiki applications also describe themselves as enterprise solutions, including XWiki , Foswiki , [7] TWiki , [8] and BlueSpice. Among the many companies and government organizations that use wikis internally are Adobe Systems , Amazon. Within organizations, wikis may either add to or replace centrally managed content management systems. Their decentralized nature allows them, in principle, to disseminate needed information across an organization more rapidly and more cheaply than a centrally controlled knowledge repository. Wikis can also be used for document management , project management , customer relationship management , enterprise resource planning , and many other kinds of data management. Software that is specifically designed for running personal wikis includes Tomboy , PmWiki , and ConnectedText now discontinued. Other, more general, wiki applications have components geared for individual users, including MoinMoin which offers a "DesktopEdition" [12] , and TiddlyWiki. Most wiki software uses a special syntax, known as wiki markup , for users to format the text, instead of requiring them to enter in HTML. Based on the atomic property of database systems , any edit should be traced. On wiki software, the chronology of edits e. There are a variety of wiki hosting services , otherwise known as wiki farms, that host users' wikis on a server. Some wiki software is only available in hosted form: PBworks , Wetpaint and Wikispaces are all examples of wiki hosting services that run on code that is only available on those sites. Other wiki software is available in both hosted and downloadable form, including Confluence , Socialtext , MediaWiki and XWiki. Wiki software can include features that come with traditional content management systems, such as calendars, to-do lists, blogs and discussion forums. All of these can either be stored via versioned wiki pages, or simply be a separate piece of functionality. Software that supports blogs with wiki-style editing and versioning is sometimes known as "bliki" software. Tiki Wiki CMS Groupware is an example of wiki software that is designed to support such features at its core. Many of the enterprise wiki applications, such as TWiki , Confluence and SharePoint , also support such features, as do open-source applications like MediaWiki and XWiki , via plugins. Some wiki applications let users embed scripting -style calls into wiki pages, which are processed by the wiki's parser and run either when the page is saved or when it is displayed. XWiki and MediaWiki are examples of such applications. Wiki software can let users store data via the wiki, in a way that can be exported via the Semantic Web , or queried internally within the wiki. A wiki that allows such annotation is known as a semantic wiki. Some wiki software have special handling for accessing by mobile devices, such as mobile phones. This is usually done by displaying conservative HTML coding. Various approaches to providing wiki functionality when the user is not online have been tried. For users who need to simply read the wiki's content when offline, a copy of the content can often be made easily; in the case of Wikipedia, CD-ROMs and printed versions have been made of parts of Wikipedia's content. Allowing offline editing, however where the changes are synchronized when the user is back online , is a much more difficult process. One approach to doing this is using a distributed revision control system as a backend of the wiki, in peer-to-peer style. With this approach, there is no central store of the wiki's content; instead, every user keeps a complete copy of the wiki locally, and the software handles merging and propagating of changes when they are made. This is the approach taken by the ikiwiki engine which can use the distributed revision control system Git as its back-end , and Code Co-op a distributed revision control system that includes a wiki component. Wiki software can be distributed. There has also been research done on allowing Wikipedia to be run as a decentralized wiki. From Wikipedia, the free encyclopedia. Collaborative software that runs a wiki. For other uses, see Wiki disambiguation. This article relies too much on references to primary sources. Please improve this by adding secondary or tertiary sources. September Learn how and when to remove this template message. Main article: History of wikis. Retrieved 11 April Applications - XWiki". Concurrency and Computation: Practice and Experience. Personal Medical Semantic Wiki farm. Software Interwiki

links. Software Wiki farms. History Creole. Wiki software. FlexWiki Microsoft SharePoint. Nuclino TiddlyWiki Wiki. Redmine Wagn Gollum. Category Comparison List. AusRegistry CZ. Document management system Wiki software Blog software. Categories : Wiki software Web portals Information technology management Wikis by genre. Hidden categories: Articles with short description Short description matches Wikidata Articles lacking reliable references from September All articles lacking reliable references. Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version. Wikimedia Commons Meta-Wiki. The most commonly used terms are primary balance and secondary balance. Unbalanced forces within the engine can lead to vibrations. Although some components within the engine such as the connecting rods have complex motions, all motions can be separated into reciprocating and rotating components, which assists in the analysis of imbalances. Using the example of an inline engine where the pistons are vertical , the main reciprocating motions are:. The imbalances can be caused by either the static mass of individual components or the cylinder layout of the engine, as detailed in the following sections. If the weightâ€" or the weight distributionâ€" of moving parts is not uniform, their movement can cause out-of-balance forces, leading to vibration. For example, if the weights of pistons or connecting rods are different between cylinders, the reciprocating motion can cause vertical forces. Similarly, the rotation of a crankshaft with uneven web weights or a flywheel with an uneven weight distribution can cause a rotating unbalance. Even with a perfectly balanced weight distribution of the static masses, some cylinder layouts cause imbalance due to the forces from each cylinder not cancelling each other out at all times. For example, an inline-four engine has a vertical vibration at twice the engine speed. These imbalances are inherent in the design and unable to be avoided, therefore the resulting vibration needs to be managed using balance shafts or other NVH -reduction techniques to minimise the vibration that enters the cabin. A reciprocating imbalance is caused when the linear motion of a component such as a piston is not cancelled out by another component moving with equal momentum moving in the opposite direction in the same plane. In engines without overlapping power strokes such as engines with four or fewer cylinders , the pulsations in power delivery vibrates the engine back and forth rotationally on X-axis, similar to a reciprocating imbalance. Torsional vibration is caused when torque is applied at offset distances along a shaft. This occurs along the axis of a crankshaft, since the conrods are usually located a different distances from the resistive torque e. This vibration is not transferred to outside of the engine, however fatigue from the vibration could cause crankshaft failure. Radial engines do not experience torsional imbalance. The primary balance of an engine refers to vibrations which occur at the fundamental frequency first harmonic of the engine speed. A piston travels further during the top half of its motion than during the bottom half of its motion, which results in non-sinusoidal vibrations called secondary vibration. The difference in distance travelled is due to the rotation of the connecting rod. At 90 degrees after top dead centre TDC the crankshaft end of the conrod is exactly at the halfway point of its stroke, however the angle of the conrod ie the left-right movement, when looking down the crankshaft means that the piston end of the conrod must be lower than the halfway point, in order for the conrod to maintain a fixed length. The same also applies at degrees after TDC, therefore the piston end travels a greater distance from degrees to 90 after TDC than it does in the 'bottom half' of the crankshaft rotation cycle 90 degrees to degrees after TDC. In order to travel this greater distance in the same amount of time, the piston end of the connecting rod must experience higher rates of acceleration during the top half of its movement than in the bottom half. This unequal acceleration results in higher inertia force created by the mass of a piston in its acceleration and deceleration during the top half of crankshaft rotation than during the bottom half. In the case of an inline-four engine with a traditional degree crankshaft , the upwards inertia of cylinders 1 and 4 is greater than the downwards inertia of cylinders 2 and 3. Therefore, despite an equal number of cylinders moving in opposite directions at any given time creating perfect primary balance , the engine nonetheless has a non- sinusoidal imbalance. This is referred to as a secondary imbalance. Mathematically, the non-sinusoidal motion of the crank-slider mechanism can be represented as a combination of two sinusoidal motions:. The pistons do not move in exactly this fashion, it is still a useful representation for analyzing its motion. This analysis is also the origin of the terms primary balance and secondary balance , which are now also used outside of academia to describe engine characteristics. The vibration caused by this secondary imbalance is relatively small at lower engine speeds, but it is proportional to the square of the engine speed, potentially causing excessive vibration at high RPM. To reduce these vibrations, some engines use balance shafts. A balance shaft system most commonly consists of two shafts with an identical eccentric weight on each shaft. The shafts rotate at twice the engine speed and in opposite directions to each other, thus producing

a vertical force which is designed to cancel out the force caused by the engine's secondary imbalance. The most common use of balance shafts is V6 engines and large displacement inline-four engines. For engines with more than one cylinder, factors such as the number of pistons in each bank, the V angle and the firing interval usually determine whether reciprocating phase imbalances or torsional imbalances are present. Straight-twin engines most commonly use the following configurations:. V-twin engines have the following characteristics:. V4 engines come in many different configurations in terms of the 'V' angle and crankshaft configurations. Some examples are:. V6 engines are commonly produced in the following configurations:. A 'flat' engine may either be a degree vee engine or a 'boxer' engine. A degree vee engine as used in the Ferrari BB has opposed cylinder pairs whose connecting rods use the same crank throw. Contrary to this, in a 'boxer' engine as applied in BMW motorcycles, each conrod has its own crank throw which is positioned degrees to the crank throw of the opposed cylinder. Flat-four engines typically use a left-right-right-left crankshaft configuration and have the following characteristics:. Flat six engines typically use a boxer configuration and have the following characteristics:. This section is an introduction to the balancing of two steam engines connected by driving wheels and axles as assembled in a railway locomotive. The effects of unbalanced inertias in a locomotive are briefly shown by describing measurements of locomotive motions as well as deflections in steel bridges. These measurements show the need for various balancing methods as well as other design features to reduce vibration amplitudes and damage to the locomotive itself as well as to the rails and bridges. The example locomotive is a simple, non-compound, type with 2 outside cylinders and valve gear, coupled driving wheels and a separate tender. Only basic balancing is covered with no mention of the effects of different cylinder arrangements, crank angles, etc. For example, Dalby's "The Balancing of Engines" covers the treatment of unbalanced forces and couples using polygons. Johnson and Fry both use algebraic calculations. At speed the locomotive will tend to surge fore-and-aft and nose, or sway, from side to side. It will also tend to pitch and rock. This article looks at these motions that originate from unbalanced inertia forces and couples in the 2 steam engines and their coupled wheels some similar motions may be caused by irregularities in the track running surface and stiffness. The first two motions are caused by the reciprocating masses and the last two by the oblique action of the con-rods, or piston thrust, on the guide bars. There are 3 degrees to which balancing may be pursued. The most basic is static balancing of the off-center features on a driving wheel, i. in addition, balancing a proportion of the reciprocating parts can be done with additional revolving weight. This weight is combined with that required for the off-center parts on the wheel and this extra weight causes the wheel to be overbalanced resulting in hammer blow. Dynamic balancing on steam locomotives is known as cross-balancing and is 2-plane balancing with the second plane being in the opposite wheel. A tendency to instability will vary with the design of a particular locomotive class. Relevant factors include its weight and length, the way it is supported on springs and equalizers and how the value of an unbalanced moving mass compares to the unsprung mass and total mass of the locomotive. The way the tender is attached to the locomotive can also modify its behaviour. The resilience of the track in terms of the weight of the rail as well as the stiffness of the roadbed can affect the vibration behaviour of the locomotive. As well as giving poor human ride quality the rough riding incurs maintenance costs for wear and fractures in both locomotive and track components. All the driving wheels have an out-of-balance which is caused by their off-center crank pins and attached components. The main driving wheels have the greatest unbalance since they have the biggest crankpin as well as the revolving portion of the main rod. They also have the valve gear eccentric crank and the back end of the eccentric rod. In common with the linked driving wheels they also have their own portion of the side rod weight. The part of the main rod assigned a revolving motion was originally measured by weighing it supported at each end. A more accurate method became necessary which split the revolving and reciprocating parts based on the position of the center of percussion. This position was measured by swinging the rod as a pendulum. The side rod weights assigned to each crankpin are measured by suspending the rod on as many scales as there are crankpins or by calculation. Their 90 deg separation causes a swaying couple. The whole locomotive tends to move under the influence of unbalanced inertia forces. The horizontal motions for unbalanced locomotives were quantified by M. Le Chatelier in France, around , by suspending them on ropes from the roof of a building. The trace was an elliptical shape formed by the combined action of the fore-and-aft and swaying motions. The effect of vertical out-of-balance, or varying wheel load on the rail, was quantified by Professor Robinson in the U. The residual unbalance in locomotives was assessed in three ways on the Pennsylvania Railroad testing plant. In particular, 8 locomotives were tested at the Louisiana Purchase Exposition in The three measurements were:. Qualitative assessments may be done on a road trip in terms of the riding qualities in the cab. They may

not be a reliable indicator of a requirement for better balance as unrelated factors may cause rough riding, such as stuck wedges, fouled equalizers and slack between the engine and tender. Also the position of an out-of-balance axle relative to the locomotive center of gravity may determine the extent of motion at the cab. Balance weights are installed opposite the parts causing the out-of-balance. The wheel is statically balanced only. A proportion of the reciprocating weight is balanced with the addition of an extra revolving weight in the wheel, i. The overbalance causes what is known as hammer blow or dynamic augment, both terms having the same definition as given in the following references. Hammer blow varies about the static mean, alternately adding to and subtracting from it with each wheel revolution. The term hammer blow does not describe what takes place very well since the force varies continuously and only in extreme cases when the wheel lifts from the rail for an instant is there a true blow when it comes back down. It also has a different form per wheel revolution as described later. As an alternative to adding weights to driving wheels the tender could be attached using a tight coupling that would increase the effective mass and wheelbase of the locomotive. The Prussian State Railways built 2-cylinder engines with no reciprocating balance but with a rigid tender coupling. The crankpin-and-rods weight on the wheels is in a plane outside the wheel plane location for the static balance weight. The second plane used is in the opposite wheel. Up to that time only static balancing was done in America, although builders included cross-balancing for export locomotives when specified. Builders in Europe adopted cross-balancing after Le Chatelier published his theory in Maximum wheel and axle loads are specified for a particular bridge design so the required fatigue life of steel bridges may be achieved. This is neglected in the above calculations for allowable overbalance in each wheel. It may need to be taken into account. Since the rotating force alternately reduces the wheel load as well as augmenting it every revolution the sustainable tractive effort at the contact patch drops off once per wheel revolution and the wheels may slip. Excessive hammer blow from high slipping speeds was a cause of kinked rails with new North American s and s that followed the A. Out-of-balance inertia forces in the wheel can cause different vertical oscillations depending on the track stiffness. The steam engine cross-head sliding surface provides the reaction to the connecting rod force on the crank-pin and varies between zero and a maximum twice during each revolution of the crankshaft. Unlike hammer blow, which alternately adds and subtracts for each revolution of the wheel, piston thrust only adds to the static mean or subtracts from it, twice per revolution, depending on the direction of motion and whether the locomotive is coasting, or drifting. In a double-acting steam engine, as used in a railway locomotive, the direction of the vertical thrust on the slide bar is always upwards when running forward. It varies from nothing at the end of stroke to a maximum at half stroke when the angle between the con-rod and crank are greatest. The position of maximum thrust is shown by the increased wear at the middle of the slide bars. The tendency of the variable force on the upper slide is to

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 lift the machine off its lead springs at half-stroke and ease it down at the ends of stroke. This causes a pitching and, because the maximum up force is not simultaneous for the 2 cylinders it will also tend to roll on the springs. Residual out-of-balance in the assembled rotor is corrected by installing balance weights in 2 planes that are accessible with the engine installed in the aircraft. One plane is at the front of the fan and the other at the last turbine stage. From Wikipedia, the free encyclopedia. For other uses, see Primary balance statistical term. Retrieved 6 August Engineering Explained. Retrieved 20 March Archived from the original PDF on. Retrieved Internal combustion engine. Part of the Automobile series. Engine control unit ECU. Alternator Battery Dynamo Starter motor. Portal Category. Categories : Engine technology. Namespaces Article Talk. Views Read Edit View history. Help Learn to edit Community portal Recent changes Upload file. Download as PDF Printable version.