МИНИСТЕРСТВО ОБРАЗОВАНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«БРЕСТСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Кафедра иностранных языков по техническим специальностям

INTERNAL COMBUSTION ENGINE SYSTEMS and FUEL

Методические указания

по изучающему чтению
для студентов специальностей
«Техническая эксплуатация автотранспорта» и «Автосервис»
на английском языке

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Методические указания составлены в соответствии с требованиями Программы по иностранным языкам для неспециальных факультетов высших учебных заведений для обучения студентов чтению оригинальной литературы по специальности. Тексты подобраны по тематическому принципу и включают описание работы различных систем двигателя, дают представление по вопросам усовершенствования его работы, информируют о различных видах топлива и их особенностях. Контроль понимания прочитанного осуществляется в процессе выполнения послетекстовых заданий.

Предлагаемые методические указания предназначены для аудиторной работы.

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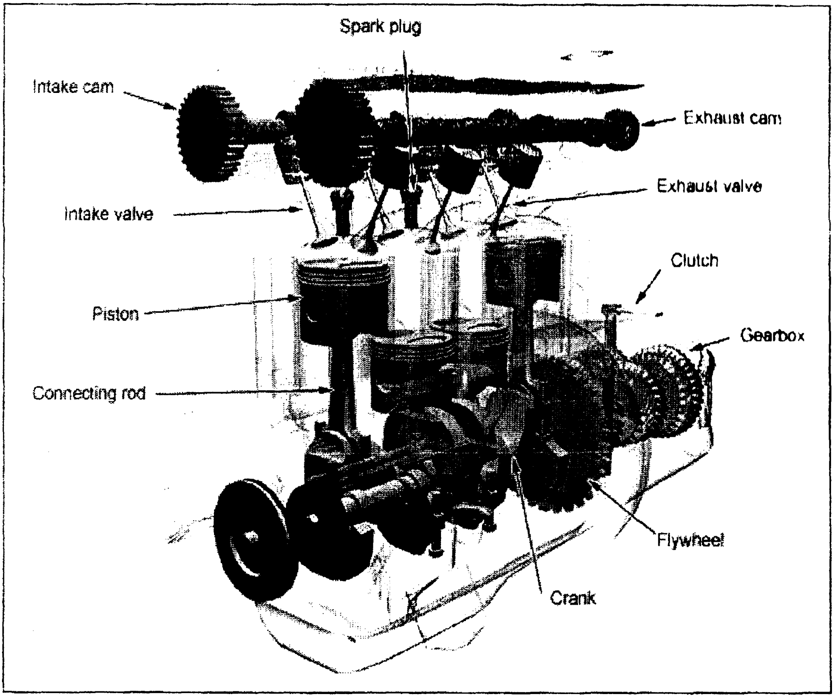
Contents

This booklet gives a common description for how an internal combustion engine works. The basic way all internal combustion engines work is to suck in a mixture of fuel and air, compress it, ignite it either with a spark plug or by self-ignition (in the case of a diesel engine), allow the explosion of combusting gasses to force the piston back down and then expel the exhaust gas. The vertical movement of the piston is converted into rotary motion in the crank via connecting rods. The crank then goes out to the gearbox via a flywheel and clutch, and the gearbox sends the rotary motion to the wheels, driving the vehicle forwards.

The following diagram which shows an inline-4 engine with dual overhead cams is for reference for the technical terms that will further pop out on these pages.



If you want to be pedantic, the suck-squeeze-bang-blow cycle of a 4-stroke engine should be called the Otto Cycle, after its inventor Nikolaus Otto. The development of the internal combustion engine is quite interesting, and enquiring minds can read about it on the following pages.

PART 1

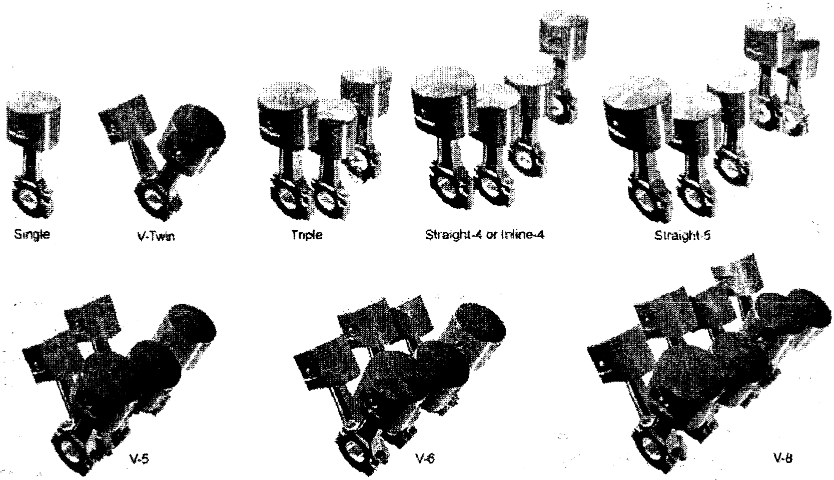
UNIT 1 ENGINE LAYOUTS

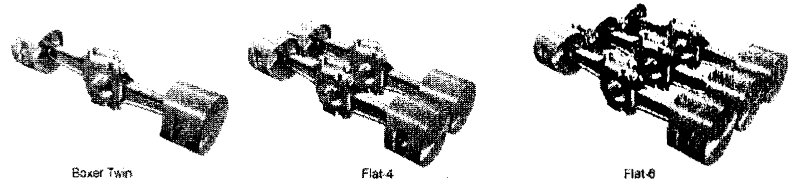
I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Internal combustion engine, mixture of fuel and air, piston, stroke, to find a new home, entire process, to pressurize, reed valve, to suck, camshaft, combustion chamber.

II. Read the text.

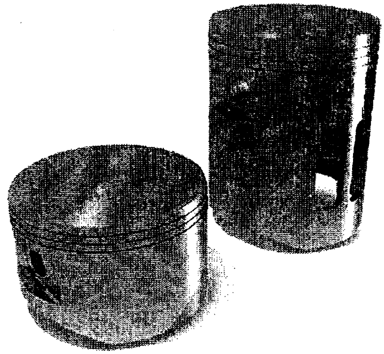
Below are some illustrations of the most common types of cylinder layout you can find in engines today. Singles are typically used in motorbikes, snowblowers, chainsaws etc. V-twins are also found in motorbikes. The triple is almost unique to Triumph motorbikes where they call it the Speed Triple, or the 675. Inline-fours are the mainstay of car engines, as well as being found in some motorbikes too such as the BMW K1200S. Inline fives used to be used a lot in Audis but have found a new home in current Volvos. The V5 is something you'll find in some VWs. The V6 has the benefits of being smoother than an inline-four but without the fuel economy issues of a V8. Boxer engines are found in BMW motorbikes (twins) and Porsches and Subarus (fours and sixes).





The difference between 4-stroke and 2-stroke engines.

First, let's pay attention to some basic concepts — the most common types of internal combustion engine and how they work. It's worth reading and understanding this bit first otherwise the whole section on octane later in the page will seem a bit odd. Almost every car sold today has a 4-stroke engine, so do a lot of motorbikes, lawnmowers, snowblowers and other mechanical equipment. But there are still a lot of 2-stroke engines about in smaller motorbikes, smaller lawnmowers, leaf-blowers, snowblowers and such.



The difference between the two engine types is the number of times the piston moves up and down in the cylinder for a single combustion cycle. A combustion cycle is the entire process of sucking fuel and air into the piston, igniting it and expelling the exhaust.

A 2-stroke engine is different from a 4-stroke engine in two basic ways. First, the combustion cycle is completed within a single piston stroke as oppose to two piston strokes, and second, the lubricating oil for the engine is mixed in with the petrol or fuel. In some cases, such as lawnmowers, you are expected to pre-mix the oil and petrol yourself in a container, then pour it into the fuel tank. In other cases, such as small motorbikes, the bike has a secondary oil tank that you fill with 2-stroke oil and then the engine has a small pump which mixes the oil and petrol together for you.

The simplicity of a 2-stroke engine lies in the reed valve and the design of the piston itself. The picture shows a 4-stroke piston (left) and a 2-stroke piston (right). The 2-stroke piston is generally taller than the 4-stroke version, and it has two slots cut into one side of it. These slots, combined with the reed valve, are what make a 2-stroke engine work the way it does. The following picture shows a 2-stroke combustion cycle. As the piston reaches the top of its stroke, the spark plug ignites the fuel-air-oil mixture. The piston begins to retreat. As it does, the slots cut into the piston on the right begin to align with the bypass port in the cylinder wall. The receding piston pressurizes the crank case which forces the reed or flapper valve to close, and at the same time forces the fuel-air-oil mixture already in the crankcase out through the piston slots and into the bypass port. This effectively routes the mixture up the side of the cylinder and squirts it into the combustion chamber above the piston, forcing the exhaust gas to expel through the exhaust port on the left. Once the piston begins to advance again, it generates a vacuum in the crank case. The reed or flapper valve is sucked open and a fresh charge of fuel-air-oil mix is sucked into the crank case. When the piston reaches the top of its travel, the spark plug ignites the mixture and the cycle begins again.

For the same cylinder capacity, 2-stroke engines are typically more powerful than 4-stroke versions. The downside is the pollutants in the exhaust, because oil is mixed with the petrol, every 2-stroke engine expels burned oil with the exhaust. 2-stroke oils are typically designed to burn cleaner than their 4-stroke counterparts, but nevertheless, the 2-stroke engine can be a smoky device. If you grew up somewhere in Europe where scooters were all the rage for teenagers, then the mere smell of 2-stroke exhaust can bring back fond memories. The other disadvantage of 2-stroke engines is that they are noisy compared to 4-stroke engines. Typically the noise is described as "buzzy".

4-stroke engines are typically much larger capacity than 2-stroke ones, and have a lot more complexity in them. Rather than relying on the simple mechanical concept of reed valves, 4-stroke engines typically have valves at the top of the combustion chamber. The simplest type has one intake and one exhaust valve. More complex engines have two of one and one of the other, or two of each. So when you see "16v" on the badge on the back of a car, it means it's a 4-cylinder engine with 4 valves per cylinder — two intake and two exhaust — thus 16 valves, or "16v". The valves are opened and closed by a rotating camshaft at the top of the engine. The camshaft is driven by either gears directly from the crank, or more commonly by a timing belt.

As the piston retreats on the first stroke, the intake valve (left valve) is opened and the fuel-air mixture is sucked into the combustion chamber. The valve closes as the piston bottoms out. As the piston begins to advance, it compresses the fuel-air mix. As it reaches the top of its stroke, the spark plug ignites the fuel-air mix and it burns. The expanding gasses force the piston back down on its second stroke. At the bottom of this stroke, the exhaust valve (right valve) opens, and as the piston advances for a second time, it forces the spent gasses out of the exhaust port. As the piston begins to retreat again, the cycle starts over, sucking a fresh charge of fuel-air mix into the combustion chamber.

Because of the nature of 4-stroke engines, you won't often find a single-cylinder 4-stroke engine. They do exist in some off-road motorbikes but they have such a thump-thump-thump motion to them that they require some large balancing shafts or counterweights on the crank to try to make the ride smoother. They also take a little longer to start from cold because you need to crank the single piston at least twice before a combustion cycle can start. If there's more than one piston and the engine gets a lot smoother, starts better, and is nowhere near as thumpy. That's one of the advantages of V-6 and V-8 engines. Apart from the increased capacity, more cylinders typically mean a smoother engine because it will be more in balance.

Mercedes-Benz needed to increase the performance of their diesel passenger cars back in the 70's as their market share in the US was increasing. As professionals with big V-8 luxury cars were trading them in for 2.4l diesels, the demand for performance had to be addressed. Mercedes did not want to retool their 114/115 series chassis and there wasn't enough room in the engine bay for a six cylinder diesel. There was, however, room for a straight-5. Benz engineers just hung another cylinder on the back of the 4 cylinder block and the five cylinder engine was born. This engine acquired a lot of status among the high line car owners. When Audi introduced the C2 series cars (the 5000 in America, the 100 in Europe) in 1976, they offered a 5-cylinder petrol engine too. It was basically a 1.8 litre 4-cylinder engine with an extra cylinder. That took it up to 2.0 litres but the fifth piston made such an enormous difference to the smoothness of the engine that it was often mistaken for a V6 or V8. Why only 5 cylinders instead of going for a V6? Partly for the same rationale as Mercedes but primarily because Benz had made the straight-5 configuration fashionable. A straight-5 was also more fuel-efficient than a V6. It's also worth pointing out that nowadays, both Audi and VW have V5 engines with three cylinders in one bank and two in the other. This allows the same smoothness, better gas-mileage.

I. Supply English equivalents to the following Russian words and word combinations.

Двигатель внутреннего сгорания, топливно-воздушная смесь, маховик, сцепление, коробка передач, двухтактный двигатель, топливный бак, выхлопные газы, клапан.

II. Decide whether the sentences are True or False.

1. Today's engines give an idea of the most common types of cylinder lay-out.
2. Most cars and motocycles have a two-stroke engine.
3. The main difference between the two types of engine is in the number of piston movements during a combustion cycle.
4. The simplicity of a two-stroke engine is explained by the reed valve and design of the piston.
5. Having the same cylinder capacity two-stroke engines are more powerful than four-stroke ones.
6. Four-stroke engines have valves in the upper part of the combustion chamber.

III. Finish the sentences according to the contents of the text.

1. A typical two-stroke engine ... . 2. Inline-fours are mainly used ... . 3. A combustion cycle is the process ... . 4. Two slots combined with a reed valve ... . 5. When a piston reaches the top ... . 6. Another advantage of a two-stroke engine ... . 7. The simplest type of a four-stroke engine ... . 8. The nature of a four-stroke engine ... .

IV. Think of the answers to the following questions.

1. What is the basic way an internal combustion engine works? 2. After whom is a four-stroke engine named? 3. Where are used engines of different types of lay-out? 4. What are the basic differences of a two-stroke engine? 5. What are the characteristic features of a four-stroke engine? 6. In what types of machines is most widely used a single-cylinder four-stroke engine? 7. What is the advantage of V-6 and V-8 engines? 8. How did Mercedes-Benz manage to increase the performance of their diesel engine?

V. Translate the following paragraph ("For the same cylinder capacity... commonly by a timing belt") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 2 ENGINE TYPES

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Crank rotation, combustion cycle, intake valve, compression stroke, to be injected directly, pre-igniting, energy content, mileage, to withstand pressure, mist, glow-plug, (non)interference engine.

II. Read the text.

Mechanically, 4-stroke diesel engines work identically to four-stroke petrol engines in terms of piston movement and crank rotation. (To be historically accurate, petrol engines are mechanically similar to diesel engines — diesel engines came first) It's in the combustion cycle where the differences come through. First, during the intake cycle, the engine only sucks *air* into the combustion chamber through the intake valve — not a fuel/air mix. Second, there is no spark plug. Diesel engines work on self-ignition, or detonation. At the top of the compression stroke, the air is highly compressed (over 500psi), and very hot (around 700 °C - 1292°F). The fuel is injected directly into that environment and because of the heat and pressure, it spontaneously combusts (this system is known as direct-injection). This gives the characteristic knocking sound that diesel engines make, and is also why pre-igniting petrol engines are sometimes referred to as 'dieseling'.

Petrol engines typically run compression rations around 10:1, with lower-end engines down as low as 8:1 and sportier engines up near 12:1. Diesel engines on the other hand typically run around 14:1 compression ratio and can go up as high as 25:1. Combined with the higher energy content of diesel fuel (around 147,000 BTU per gallon versus 125,000 BTU for a gallon of petrol), this means that the typical diesel engine is also a lot more efficient than your common or garden petrol engine, hence the much higher gas-mileage ratings.

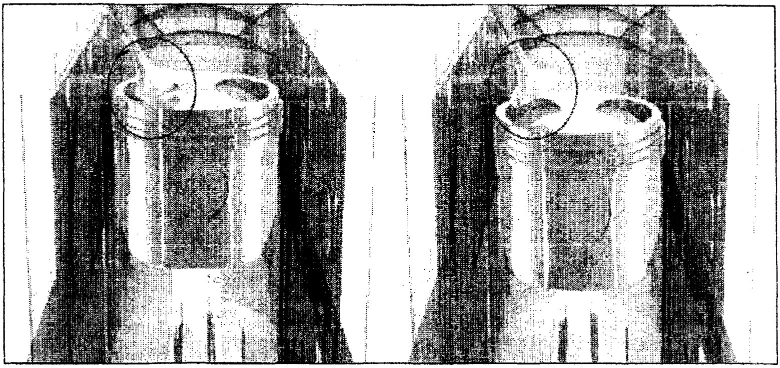
Because of the design of the diesel engine, the injector is the most critical part and has been subjected to literally hundreds of variations in both design and position. It has to be able to withstand massive pressures and temperatures, yet still deliver the fuel in a fine mist. One other component that some diesel engines have is a glow-plug. From cold, some lower-tech engines can't retard the ignition enough, or get the air temperature high enough on start-up for the spontaneous combustion to happen. In those engines, the glow-plug is literally a hot wire in the top of the cylinder designed to increase the temperature of the compressed air to the point where the fuel will combust. These engines typically have a pictograph on the dashboard that looks like a lightbulb. When starting the engine cold, you need to wait for that light to go out — basically you're waiting for the glow-plugs to get up to temperature. In really old diesel designs, this could be as long as 10 seconds. Nowadays it's nearly instantaneous, or in the case of advanced ECM systems, not needed at all.

Would you believe there is such a thing as a 2-stroke diesel engine? The two-stroke cycle described above turns out to be highly beneficial for the diesel model, the major difference being the inclusion of exhaust valves at the top of the cylinder. The burn cycle works similarly too. At the top of the piston travel, the air is hot and compressed, just like in a 4-stroke diesel. And like the 4-stroke, the injector sprays fuel in at that point and it self-combusts. As the gasses expand, the piston is forced downwards and towards the bottom of its stroke, the exhaust valves on the top of the cylinder open. Because the gas is still expanding at this point, the combustion chamber empties itself through the open valves. At the very bottom of the power stroke, the piston uncovers the air intake and pressurized air fills the combustion chamber forcing the last remnants of the exhaust gas out. As the piston begins its compression stroke, the exhaust valves close and the air is compressed and this is what we have — a two-stroke diesel engine. The other difference between a 4-stroke and 2-stroke diesel engine is that the 2-stroke variety must have a turbocharger to fill the cylinder with pressurized air and that doesn't happen by magic.

As with 2-stroke petrol engines, every downward piston stroke is a power stroke, meaning the 2-stroke engine has the potential to product twice as much power as its 4-stroke sibling. Typically you'll find 2-stroke diesels in maritime engines (like those on freighters, tankers and cruise ships) and diesel-electric trains where more power is needed for the same size of engine.

It's worth mentioning the two sub-types of 4-stroke engine at this point. Because the valves always open inwards, into the combustion chamber, they take up some space at the top of the chamber. In an *interference* engine, the position of the piston at the top of its stroke will occupy the same physical space that the open valves do whilst the piston is at the bottom of its stroke. It's important to know if your engine is an interference engine because if the timing belt breaks, at least one set of valves will stop in the open position and the momentum of the engine will ram the piston in that cylinder up into the valves requiring a very expensive engine repair or replacement. In a *non-interference* engine, the valves do not occupy any space that the piston could move into, so if your timing belt snaps on one of these engines, in 99% of cases you won't suffer any valve damage because the piston cannot physically touch the open valves. That is the technical explanation of why it's important to get your timing belt changed at the manufacturer-specified mileage.

The following picture shows the difference between the two types. On the left, circled in red is where the open valve interferes with the position of the piston at the top of its travel. On the right, a non-interference engine shows there is still a gap at the same point.



I. Supply English equivalents to the following Russian words and word combinations.

Работать аналогичным образом, с точки зрения, вращение коленвала, камера сгорания, свеча накала, самовоспламенение, специфический стук, работать (о двигателе), выдерживать большое давление, панель приборов, электролампочка, двухтактный дизельный двигатель, основное различие, расширяться, такт сжатия, турбокомпрессор, одинаковый, ремень газораспределительного механизма.

II. Decide whether the sentences are True or False.

1. From the point of view of piston movement and crank rotation four-stroke diesel and petrol engines work identically.
2. The differences between these two types of engines begin during the combustion cycle.
3. Diesel engines usually have three spark plugs.
4. Like diesel engines, petrol engines work on self-ignition.
5. Compression ratio is much higher in diesel engines.
6. Due to the design of a diesel engine the most critical part of it is the injector.
7. All diesel engines have a glow-plug.
8. Two-stroke diesel engines employ exhaust valves on top of the cylinder.

III. Finish the sentences according to the contents of the text.

1. Mechanically, four-stroke diesel engines ... . 2. Diesel engines work on ... . 3. The fuel is injected ... . 4. Compression ratios of diesel engines ... . 5. The injector has to be able ... . 6. A glow-plug is another ... . 7. Two-stroke diesel engines ... .8. Two-stroke diesels are found ... .9. In an interference engine ... . 10. In a non-interference engine the valves ... .

IV. Think of the answers to the following questions.

1. How can you describe the work of four-stroke diesel and petrol engines from the point of view of piston and crankshaft movement?
2. What are the main differences between these two types of engines?
3. Why do diesels have a characteristic knocking sound?
4. Do petrol and diesel engines differ as far as compression ratios are concerned?
5. What is the most critical part in the diesel engine?
6. Some diesel engines are equipped with a glow-plug, aren't they?
7. What is a glow-plug and what is its role?
8. Where can two-stroke diesels be found?
9. What are the two sub-types of a four-stroke diesel engine?
10. Why is it necessary to change a timing belt as specified by the manufacturer?

V. Translate the following paragraph ("Because of the design... not needed at all") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 3 IGNITION SYSTEM

I. Find in the text the following words and word combinations. read these sentences and translate them into Russian.

To fire a spark plug, to supply voltage, mechanical/electronic trigger, module, crank, coil, to discharge, high voltage system, distributor cap, to time the spark, to cross-reference, intake manifold, loop, pulley, to spin, to point out, gauge.

II. Read the text.

When a piston in an engine reaches the top of its travel, that point is known as Top Dead Centre or TDC. This is important to know because I don't think any engine actually fires the spark plug with the pistons at TDC. More often than not, they fire slightly before TDC. So how does your ignition system work, and what is ignition timing all about? Well generating the spark is the easy part. The electrical system in your car supplies voltage to your coil and ignition unit. The engine will have a trigger for each cylinder, be it a mechanical trigger, electronic module or crank trigger. Whatever it is, at that point, the engine effectively sends a signal to the coil to discharge into the high voltage system. That charge travels into the distributor cap and is routed to the relevant spark plug where it is turned into a spark. The key to this, though, is the timing of the spark in relation to the position of the piston in the cylinder. Hence ignition timing. Having the spark ignite the fuel-air mixture too soon is basically the same as detonation and is bad for all the mechanical components of your engine. Having the spark come along too late will cause it to try to ignite the fuel-air mixture after the piston has already started to recede down the cylinder, which is inefficient and loses power.

Timing the spark nowadays is usually done with the engine management system. It measures airflow, ambient temperature, takes input from knock sensors and literally dozens of sensors all over the engine. It then has an ignition timing map built into its memory and it cross references the input from all the sensors to determine the precise time that it should fire the spark plug, based on the ignition timing map. At 3000rpm, in a 4 cylinder engine, it does this about 100 times a second. In older systems, the spark timing was done using simple mechanical systems which had nowhere near the ability to compensate for the all the variables involved in a running combustion engine. Typically as an engine revolves quicker, the ignition timing needs to advance because the spark needs to get to the cylinder more quickly due to the engine running faster. In modern systems, this is all taken account of in the ignition timing map. On older mechanical system, they used mechanical or vacuum advance systems, so that the more vacuum generated in the intake manifold (due to the engine running quicker), the more advanced the timing became.

Despite the speed that an engine turns, it is possible to be able to check the ignition timing or an engine using (and you'd have never guessed) an ignition timing light. Timing lights are typically strobe lights. They work by being connected to the battery directly and then having an induction coil clamped around one of the spark plug leads — normally the first or last cylinder in the engine depending on the manufacturer. When the engine fires the spark plug for that cylinder, the inductive loop detects the current in the wire and flashes the strobe light once. So if the engine is ticking over at 1100rpm, the strobe will flash 550 times a minute (four stroke engine). So you're now holding a portable rave lighting rig but how does this help you see the timing of an engine? It's simple. You must have seen strobe lights working somewhere — a rave, a stage show —

they're used to effectively freeze the position of something in time and space by illuminating it only at a certain point and for a fraction of a second. Shooting a strobe at someone walking in a dark room will result in you seeing them walk as if they were a flip-book animation on a reel of film. This effect is what's used to visualize the timing of your engine. Somewhere on the front of the engine there will be a notch near one of the timing belt pulleys and stamped into the metal next to it will be timing marks in degrees. On the pulley itself there will be a bump, recess or white-painted blob. When you point the strobe light down towards the timing belt pulley, remember it fires once for each firing of the cylinders. Each time it fires, the white blob on the pulley should be at the same position in its rotation - the strobe fires once for each ignition spark at which point the mark should be in the same place, and the effect to you is that the whole pulley, timing mark and all, are now standing still in the strobe light. The mark on the pulley will line up with one of the degree marks stamped on the engine, so for example if the white dot always aligns with the 10° mark, it means your engine is firing at 10 degrees before TDC. When you revolve the engine, the timing will change so the mark will move closer or further away from the TDC mark depending on how fast the engine is spinning. In some engines, the two marks are simply painted or stamped, and there are no degree markings. In this case, the marks align when the first piston is exactly at TDC.

It's worth pointing out that crank timing marks can be way off so it's worth confirming that your TDC marker is actually TDC before pratting about with the timing. It's not as bad now as it used to be, but in the bad old days, Rover V8's were particularly bad for this, with some being as much as 12° off! So how can you confirm your TDC really is TDC? — With small cameras, a good set of feeler gauges, some cash and someone who knows what they're doing.

The same timing marks exist stamped into the metal near, and on the pulley on the end the camshaft. Essentially these marks are used to line up the cam to the correct position when you're changing the timing belt. You have to make sure the engine is rotated to TDC and that the cams are properly aligned too. If you don't, the cams will spin permanently out-of-synch with the engine crank and the engine will run badly, if at all.

I. Supply English equivalents to the following Russian words and word combinations.

Верхняя мертвая точка, опережение зажигания, подавать напряжение, блок зажигания, распределитель, воспламенять топливно-воздушную смесь, система управления двигателем, способность компенсировать все переменные, зрительно представить, находиться на одной линии, метки для выставления зажигания, вращаться не синхронно.

II. Decide whether the sentences are True or False.

1. The top of the piston travel is called top dead center.
2. The function of the car electrical system is to supply voltage to the coil and ignition unit.

3. A coil discharges the charge which is via the distributor cap routed to a spark plug.
4. The timing of the spark in relation to the position of the piston in cylinder is called ignition timing.
5. In modern cars timing of the spark is usually done with the help of the engine management system.
6. In older systems the spark timing was realized with the help of simple mechanical or vacuum advance systems.
7. It's possible to check the ignition timing using timing (strobe) lights.
8. Checking ignition timing is done with the help of a notch on one of the pulleys and a bump on the pulley itself.

III. Finish the sentences according to the contents of the text.

1. When a piston is at the top ... . 2. The electrical system of a car ... . 3. If the spark ignites the fuel-air mixture too soon ... . 4. In older systems the spark timing ... . 5. It is possible to check the ignition timing ... .6. Each time the strobe light fires ... . 7. Timing marks are placed ... .

IV. Think of the answers to the following questions.

1. What is top dead center? 2. What is the role of the car electrical system? 3. What happens if the spark ignites the fuel-air mixture too soon or too late? 4. What can the engine management system do? 5. What is the principle of work of ignition timing map? 6. How was the spark timing done in older systems? 7. How can ignition timing be realized with timing light? 8. What will happen if timing is not properly adjusted?

V. Translate the following paragraph ("Timing the spark nowadays... the timing became") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

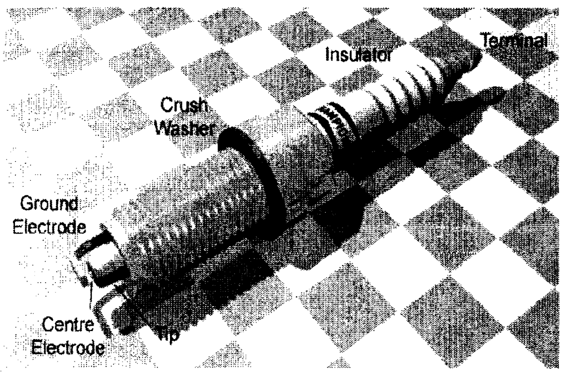
UNIT 4 PLUGS

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

To get to grips with, thermal, core, crush washer, tip, to recess, cellar, brass, steel, to gap a spark plug, tuned engine, fuel gauge, outer electrode, heat range, to dissipate heat, to get rid of heat, to run hot and lean, combustion by-product and build-up, projected nose spark plug.

II. Read the text.

Engine without a spark plug is useless, unless it's a diesel engine in which case it uses a glow-plug instead. If we're talking about regular petrol engines here so the next topic to get to grips with is the spark plug. Not all spark plugs are created equal. Some are more equal than others. They'll all do the job but the more you pay, the better the plug. All spark plugs share the same basic design and construction though.



The high voltage from your vehicle's high-tension electrical system is fed into the terminal at the top of the spark plug. It travels down through the core of the plug (normally via some noise-suppression components to prevent electrical noise) and arrives at the centre electrode at the bottom where it jumps to the ground electrode creating a spark. The crush washer is designed to be crushed by tightening the spark plug down when it's screwed into the cylinder head, and as such, it helps keep the screw threads under tension to stop the spark plug from shaking loose or backing out. The insulator basically keeps the high-tension charge away from the cylinder head so that the spark plug doesn't ground before it gets a chance to generate the spark.

The type of plug which is illustrated here is known as a *projected nose* type plug, because the tip extends below the bottom of the spark plug itself. The other main type of spark plug has the centre electrode recessed into the plug itself and merely grounds to the collar at the bottom. The advantage of the projected nose type is that the spark is better exposed to the fuel-air mixture.

SplitFire and triple-electrode types

There are plenty of different types of grounding electrodes kicking around in spark plug designs nowadays, from 'Y' shaped electrodes (like SplitFire plugs) to grooved electrodes like you'll find on Champion plugs all the way up to triple-electrode plugs like the high-end Bosch items. They're all designed to try to get a better spark, and to that end, you'll now find all sorts of exotic materials turning up too. Titanium plugs, for example, have better electrical conductivity than brass and steel plugs, and the theory is that they'll generate a stronger, more reliable spark.

Gapping a spark plug is the process of ensuring the gap between the two electrodes is correct for the type of engine the plug is going to be used in. If a gap is too large a gap and the spark will be too weak. If too small, the spark might jump across the gap too early. Generally speaking, the factory-set spark plug gap is just fine, but if you're running an older engine, or a highly tuned engine, then you need to pay attention to the gap. Feeler gauges are used to measure the gap, and a gapping tool is used to bend the outer electrode so that the gap is correct.

Something that is often overlooked in spark plugs is their heat rating or heat range. The term "heat range" refers to the relative temperature of the tip of the spark plug when its working. The hot and cold classifications often cause confusion because a 'hot' spark plug is normally used in a 'cold' (low horsepower) engine and vice versa. The term actually refers to the thermal characteristics of the plug itself, specifically its ability to dissipate heat into the cooling system. A cold plug can get rid of heat very quickly and should be used in engines that run hot and lean. A hot plug takes longer to cool down and should be used in lower compression engines where heat needs to be retained to prevent combustion byproduct buildup.

I. Supply English equivalents to the following Russian words and word combinations.

Обычный бензиновый двигатель, одинаковый основной дизайн, подавление шума, затянуть свечу, шататься, электрод «масса», товар, зазор между двумя электродами, заводской зазор у свечи, обращать внимание на зазор, инструмент для выставления зазора, остывать, температурные характеристики.

II. Decide whether the sentences are True or False.

1. All spark plugs share the same basic design and construction. 2. High voltage via the core of the plug jumps to the ground electrode creating a spark. 3. The crush washer helps to stop the spark plug from shaking loose and backing out. 4. The main plug types are a projected nose type and with recessed electrode. 5. Electrode recessed plugs are better exposed to the fuel-air mixture. 6. Nowadays appear spark plugs made of exotic materials. 7. Too large plug gap produces a weak spark. 8. The gap is measured with the help of feeler gauge. 9. To bend the outer electrode one may use a gapping tool. 10. Heat range stands for the temperature at the tip of the spark plug

III. Finish the sentences according to the contents of the text.

1. An engine without a spark ... . 2. Spark plugs are not ... . 3. The high voltage goes to ... . 4. The crush washer is used ... .5. A projected nose type plug ... . 6. Another main type of a spark plug ... . 7. Different types of grounding electrodes ... . 8. To get a better spark ... . 9. If the gap is correct ... . 10. The term "hot range" usually refers to ... .

IV. Think of the answers to the following questions

1. Are there engines without a spark plug? 2. Are spark plugs identical in design and construction? 3. How does a plug work? 4. Why is a crush washer

used with a plug? 5. What is the function of insulator? 6. What are the two main types of spark plugs? 7. Does gapping influence the work of the engine? 8. When must we pay special attention to the gap? 9. What may help to set a proper gapping? 10. How can you define the term "heat range"?

V. Translate the following paragraph ("The type of plug... more reliable spark") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 5 CARBURETTOR

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

To run lean, fouled up spark plug, imprecise, venture, float, miniscule, needle, throttle, cable, to idle, downwind, strainer, contaminant, to pivot, lever, to allow smth in, to restrict, chainsaw, icing, shield, to bog down, to cope with, to maintain, to augment, to choke, emissions, to stall.

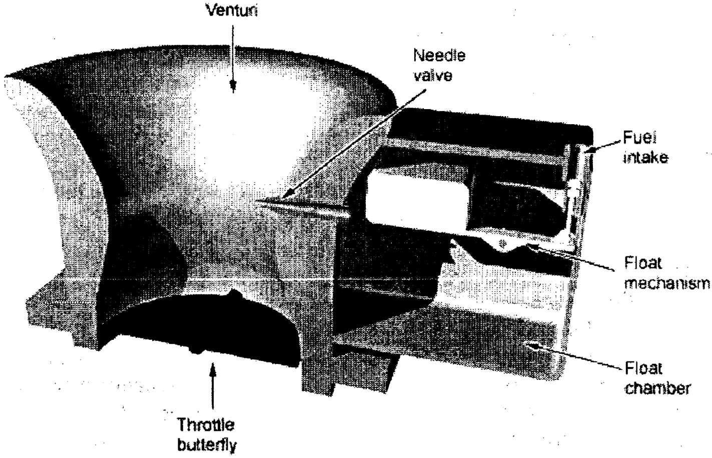
II. Read the text.

When speaking about the fuel-air mix, it is wise to explain how this happens because it is pretty fundamental to the operation of internal combustion engines. The fuel and air are mixed in one of two main ways. The old-school method is to use a carburettor, whilst the new-tech approach is to use fuel injectors. The basic purpose is the same though, and that is to mix the fuel and air together in proportions that keep the engine running. Too little fuel and the engine runs 'lean' which makes it run hot. Too much fuel and it runs 'rich' which conversely makes the engine run cooler. Running rich can also result in fouled up spark plugs, flooded engines and stalling, not to mention wasting fuel. Finding the right balance normally involves about 10 milligrams of petrol for each combustion stroke.

Advantages of carburettors: analogue and very predictable fuelling behaviour, simple and inexpensive to build and maintain.

Disadvantages of arburettors: carburettor icing in the venturi, imprecise fuel metering, float chambers don't work well if they're not the right way up.

A carburettor is basically a shaped tube. The shape of the tube is designed to swirl the incoming air and generate a vacuum in a section called the venturi pipe (or just the venturi). In the side of the venturi is a fuel jet which is basically a tiny hole connected to the float chamber via a pipe. It's normally made of brass and has a miniscule hole at the end of it which determines the flow of fuel through it. In more complex carburettors, this is an adjustable needle valve where a screw on the outside of the carburettor can screw a needle in and out of the valve to give some tuning control over the fuel flow. The fuel is pulled through the jet by the vacuum created in the venturi. At the bottom of the tube is a throttle plate or throttle butterfly which is basically a flat circular plate that pivots along its centreline. It is connected mechanically to the accelerator pedal or twist-grip throttle via the throttle cable. The more you push on the accelerator or twist open the throttle, the more the throttle butterfly opens. This allows more air in which creates more vacuum, which draws more fuel through the fuel jet and gives a larger fuel-air charge to the cylinder, resulting in acceleration.



When the throttle is closed, the throttle butterfly in the carburettor is also closed. This means the engine is trying to suck fuel-air mix and generating a vacuum *behind* the butterfly valve so the regular fuel jet won't work. To allow the engine to idle without shutting off completely, a second fuel jet known as the idle valve is screwed into the venturi downwind of the throttle butterfly. This allows just enough fuel to get into the cylinders to keep the engine ticking over.

To make sure a carburettor has a good, constant supply of fuel to be sucked through the fuel jets, it has a float chamber or float bowl. This is a reservoir of petrol that is constantly topped up from the fuel tank. Petrol goes through an inline filter and a strainer to make sure it's clean of contaminants and is then deposited into the float chamber. A sealed plastic box is pivotted at one end and floats on top of the fuel. This is called the float. A simple lever is connected to the float and controls a valve on the fuel intake line. As the fuel drops in the float chamber, the float drops with it which opens the valve and allows more fuel in. As the level goes up, the float goes up and the valve is restricted. This means that the level in the float chamber is kept constant no matter how much fuel the carburettor is demanding through the fuel jets. The quicker the level tries to drop, the more the intake valve is opened and the more petrol comes in to keep the fuel level up. This is why carburettors don't work too well when they're tipped over — the float chamber leaks or empties out resulting in a fuel spill — something you don't get with injectors. To combat this, another type of chamber is used where carburettors can't be guaranteed to be upright (like in chainsaws). These use diaphragm chambers instead. The principle is more or less the same though. The chamber is full of fuel and has a rubber diaphragm across the top of it with the other side exposed to ambient air pressure. As the fuel level drops in the chamber, the outside air pressure forces the diaphragm down. Because it's connected to an intake valve in the same way that the float is in a float chamber, as the diaphragm is sucked inwards, it opens the intake valve and more fuel is let in to replenish the chamber. Diaphragm chambers are normally spill-proof.

One of the problems with the spinning, compressing, vacuum-generating properties of the venturi is that it cools the air in the process. Whilst this is good for the engine (colder air is denser and burns better in a fuel-air mix), in humid environments, especially cool, humid environments, it can result in carburettor icing. When this happens, water vapour in the air freezes as it cools and sticks to the inside of the venturi. This can result in the opening becoming restricted or cut off completely. When carbs ice up, engines stop. In aircraft engines, there is a control in the cockpit called "carb heat" which either uses electrical heating elements to heat up the venturi to prevent icing, or reroutes hot air from around the exhausts back into the carburettor intakes. In cars, we don't have "carb heat" but instead there's normally a heat shield over the exhaust manifold connected via a pipe to a temperature-controlled valve at the air filter. When its cold, the valve is open and the air filter draws warm air from over the exhaust manifold and feeds it into the carburettor. As the temperature warms up, the valve closes and the carburettor gets cooler air because the risk of icing has reduced. The symptoms of carb icing are pretty easy to diagnose. First, your engine bogs down at high throttle then it loses power and ultimately could stall completely. You'll stop on the side of the road and wait a couple of minutes, then the engine will start and run normally. This is because with the engine off, the heat from the engine starts to warm up the carbs and melts the ice so that when you try to start it up again, everything is fine.

As car engines evolved, carburettors had to evolve to cope with the various demands. It's not unusual to find five-circuit carburettors which have become so complex that they're a nightmare to design, build and maintain. The main circuit is the one which provides day-to-day running capability. It's augmented by accelerator and load (or enrichment) circuits which can vary the fuelling to accomodate sudden acceleration or the need for more power (like driving uphill). The accelerator circuit also adds a second butterfly valve in most cases which only opens at 70 % throttle or more. Then there's the choke circuit designed to provide extra fuel with the throttles closed when the engine is cold, allowing it to start, and finally the idle circuit which does the same thing but when the engine is warm, to keep it going. On top of all this, with the introduction of stricter emissions requirements came catalytic converters, and these expensive boxes of rare metals just don't work well unless the fuel-air ratio is very carefully controlled. And that's something carburettors just couldn't keep up with. Small wonder then that this mechanical tomfoolery gave way to fuel injection......

I. Supply English equivalents to the following Russian words and word combinations.

Работать на богатой (бедной) смеси, струя топлива, регулировочная игла, дроссельная заслонка, работать на холостом ходу, топливная форсунка, герметичная пластиковая коробка, поплавковая камера, пролив топлива, резиновая диафрагма, влажная среда, намерзание карбюратора, подавать дополнительное топливо.

II. Decide whether the sentences are True or False.

1. There are two main ways to mix fuel and air. 2. In both cases the purpose is to get fuel and air mixed in necessary proportions to keep the engine running. 3. The engine runs 'rich' with too much fuel in the mix. 4. It's usually required to have fifteen miligrammes of petrol for each combustion stroke. 5. More complex carburettors have a needle valve to give some tuning control over the fuel flow. 6. Closed throttle produces a vacuum behind the butterfly valve. 7. A second fuel jet in the venture downwind of the throttle butterfly allows the engine to idle. 8. To have a constant supply of fuel the carburettor has a float chamber. 9. Carburettor icing is caused by cooling the air in the venture. 10. To prevent carburettor icing a heat shield is installed, which is connected to a temperature-controlled valve.

III. Finish the sentences according to the contents of the text.

1. The purpose of both carburettor and fuel injector is ... . 2. A carburettor is ... . 3. It is made of ... .4. More complex carburettors have ... . 5. The vacuum created in the venture helps ... . 6. A throttle butterfly ... . 7. Constant supply of fuel to be sucked ... . 8. Carburettors don't work too well when ... .9. In cool humid environments ... .10. The symptoms of carburettor icing ... .

IV. Think of the answers to the following questions.

1. What helps mix fuel and air? 2. What are the advantages and disadvantages of carburettors? 3. How is the shape of the tube in a carburettor designed? 4. What is placed at the bottom of the tube? 5. What connects accelerator pedal and a throttle plate? 6. What is the function of the float chamber? 7. When can't carburettors work well? 8. Why are diaphragm chambers used? 9. What causes carburettor icing? 10. How do car manufacturers overcome the problem of carburettor icing?

V. Translate the following paragraph ("As car engines evolved... way to fuel injection") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 6 INJECTION SYSTEM

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

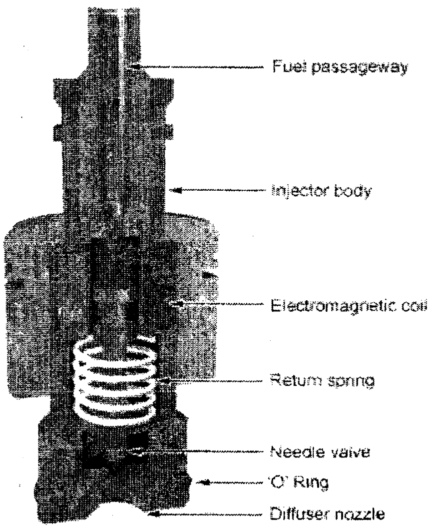
Efficiency, metering, width, twist-grip, current, adjust, spray, crown vortex, cavity, cruise, measure, exhaust, reading, value, to chip, to remap, nozzle, audible, continually, according.

II. Read the text.

Advantages of fuel injection: precise and variable fuel metering, better fuel efficiency and better emissions.

Disadvantages of fuel injection: fairly complex engineering that isn't very user-friendly. Binary on/off functionality at low throttles, which is especially noticeable on motorbikes where the throttle becomes 'snatchy' and it becomes hard to ride smoothly at a low speed.

Compared to carburettors, fuel injectors themselves are incredibly simple. They are basically electro-mechanically operated needle valves. The image on the right shows a crosssection of a representative fuel injector. When a current is passed through the injector electromagnetic coil, the valve opens and the fuel pressure forces petrol through the spray tip and out of the diffuser nozzle, atomising it as it does so. When current is removed, the combination of a spring and fuel back-pressure causes the needle valve to close. This gives an audible 'tick' noise when it happens, which is why even a quiet fuel-injected engine has a soft but rapid tick-tick-tick-tick noise as the injectors fire. This on-off cycle time is known as the pulse width and varying the pulse width determines how much fuel can flow through the injectors. When you ask for more throttle either via the accelerator pedal or twist-grip (on a motorbike) you're opening a butterfly valve similar to the one in a carburettor. This lets more air into the intake system and the position of the throttle is measured with a potentiometer. The engine control unit (ECU) gets a reading from this potentiometer and "sees" that you've opened the throttle. In response the ECU increases the injector pulse width to allow more fuel to be sprayed by the injectors. Downwind of the throttle body is a mass airflow sensor which is normally a heated wire. The more air that

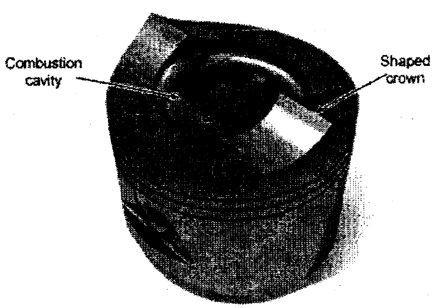


flows past it, the quicker it disappates heat and the more current it needs to remain warm. The ECU can continually measure this current to determine if the fuel-air mix is correct and it can adjust the fuel flow through the injectors accordingly. On top of this, the ECU also looks at data coming from the oxygen (lambda) sensors in the exhaust. These tell the ECU how much oxygen is in the exhaust so it can automatically adjust for rich- or lean-running.

When fuel-injection was first introduced, it was fairly simple and used a single injector in the throttle body. Basically it was a carburettor-derivative but instead of having the induction vacuum suck fuel into the venturi, an injector forced fuel into the airflow. This was known as throttle-body fuel-injection, or single-point fuel-injection.

As engine design advanced, the single-point system was phased out and replaced with multi-point or multi-port fuel-injection. In this design, there is one injector for each cylinder, normally screwed into the intake manifold and aimed right at the intake valve. Because fuel is only sprayed when the intake valve is open, this systems provides more accurate fuel-metering and a quicker throttle response. Typically, multi-point injection systems have one more injector for cold-starting which sprays extra fuel into the intake manifold upstream of the regular injectors, to provide a richer fuel-air mix for cold starting. A coolant temperature sensor feeds information back to the ECU to determine when this extra injector should be used.

As you would expect though, technology marches on with no regard to home mechanics, and the latest technology is direct injection, also known as GDI (gasoline direct injection). This is similar to multi-point injection only the injectors are moved into the combustion chambers themselves rather than the intake manifold. This is nearly identical to the direct injection system used in diesel engines. Essentially, the intake valve only allows air into the combustion chamber and the fuel is sprayed in directly through a high-pressure heat-resistant injector. The fuel and air mix inside the combustion chamber itself due to the positions of the intake valve, injector tip and top of the piston crown. The piston crown in these engines is normally designed to create a swirling vortex to help mix the fuel and air before combustion, as well as having a cavity in it for ultra-lean-burn conditions (picture on the left). The ECU controls the amount of fuel injected based on the airflow into the engine and demand, and will operate a direct injection engine in one of three modes. Full power mode is basically foot-to-the-floor driving. The fuel-air ratio is made richer and the injectors spray the fuel in during the piston intake stroke. In stoichiometric mode the fuel-air ratio is leaned off a little. The fuel is still sprayed in during the piston intake stroke but the burn is a lot cleaner and the ECU chooses this mode when the load on the engine is slightly higher than normal, for example during acceleration from a



stop. Finally, when you're cruising with very little engine load, for example when you're on wide-open motorway with no traffic, the ECU will choose an ultra lean mode. In this mode, the fuel is injected later on in the 4-stroke cycle as the piston is moving up during its compression stroke. This forces the fuel-air charge right up next to the tip of the spark plug for the best burn conditions and the combustion itself takes place partly in the cylinder and partly in the shaped piston crown.

The ECU receives a wide number of sensor readings from all over the engine. Built into the ECU is a fuelling and ignition map which is basically a gigantic table of numbers. It's like a lookup table that the ECU uses to determine injector pulse width, spark timing (and on some engines, the variable valve timing). So the ECU receives a set of values from all its sensors, which it then looks up in the fuelling and ignition map. At the point where all these numbers coincide, there is final number which the ECU then uses to set the injector pulse width. These are the manufacturer's "blessed" fuelling routines, and further on, there's a unit dealing with chipping and remapping, whereby aftermarket tuners can alter these mapping tables to make the engine behave differently.

I. Supply English equivalents to the following Russian words and word combinations.

Впрыск топлива, более эффективное использование топлива, при слегка открытой заслонке, электромагнитная катушка, пружина, нагретая проволока, кислород, впрыскивать топливо, точное измерение топлива, передавать информацию, дополнительный впрыск топлива, головка поршня, нагрузка на двигатель, показания датчика.

II. Decide whether the sentences are True or False.

1. Fuel injection gives precise fuel metering, better fuel efficiency and emissions. 2. In comparison with carburettors fuel injectors are much simple. 3. When the valve opens, the fuel pressure forces petrol out of diffuser nozzle atomizing it. 4. The engine control unit after getting the reading from the potetiometre shows that the throttle is open. 5. Mass air-flow sensor is usually a heated venture. 6. The engine control unit measures the current to determine that the fuel-air mix is correct. 7. When first introduced a carburetor derivative forced fuel into the airflow. 8. With a time the system was replaced with multi-port fuel injection. 9. In direct injection injectors are moved into the combustion chambers. 10. Engine control unit controls the quantity of injected fuel and operates in one of four modes.

III. Finish the sentences according to the contents of the text.

1. In comparison with carburattors ... . 2. When a current passes through the electromagnetic coil ... . 3. The audible 'tick' noise is produced ... .4. The

on/off cycle time ... .5. Opening a butterfly valve allows ... .6. The engine is equipped with a control unit which ... . 7. A mass airflow sensor ... . 8. Initially fuel injection was ... . 9. As the design of the engine advanced, the single point system ... . 10. Engine control unit gets a large number ... .

IV. Think of the answers to the following questions.

1. What are the advantages and disadvantages of fuel injection? 2. How do fuel injectors look like? 3. How does a fuel injector work? 4. What happens if the current stops? 5. What is the pulse width? 6. What does varying the pulse width bring about? 7. What is the function of the engine control unit? 8. How did injector systems develop? 9. How would you define 'direct injection'? 10. What are the three modes in which a direct injection engine can operate?

V. Translate the following paragraph ("When fuel-injection was... injector should be used") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 7 VALVE MECHANISM

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

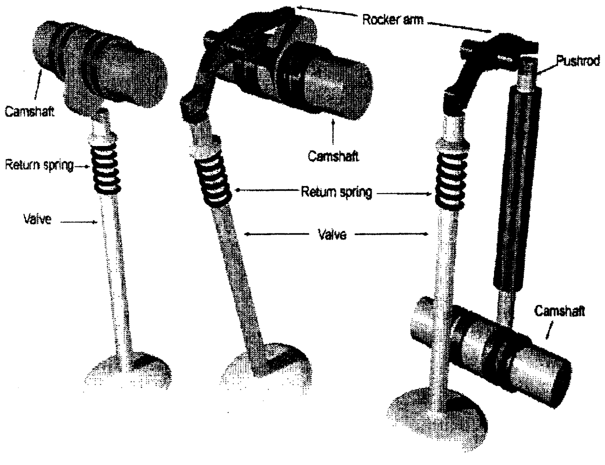
Valve train, premise, rocker, to bounce, to dive, to hit, push rod, bucket, to pressurize, tappet, spring, to swap, to hook, apart from, damage, lobe, to gear.

II. Read the text.

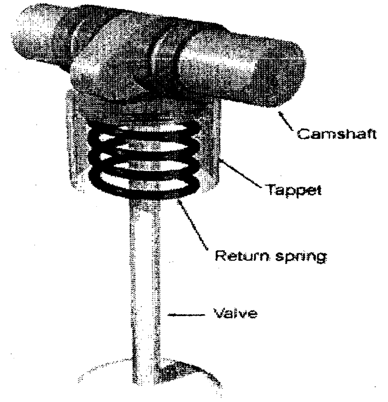
After you've got this far, hopefully you understand that the valves are what let the fuel-air mixture into the cylinder, and let the exhaust out. It seems simple enough, but there are some interesting differences in the various types of valve mechanism.

Spring return valves are about the most commonly used and most basic type of valve-train in engines today. Their operation is simplicity itself and there are only really three variations of the same style. The basic premise here is that the spinning camshaft operates the valves by pushing them open, and valve return springs force them closed. The cam lobes either operate directly on the top of the valve itself, or in some cases, on a rocker arm which pivots and pushes on the top of the valve. The three variations of this type of valve-train are based on the combination of rocker arms and the position of the camshaft.

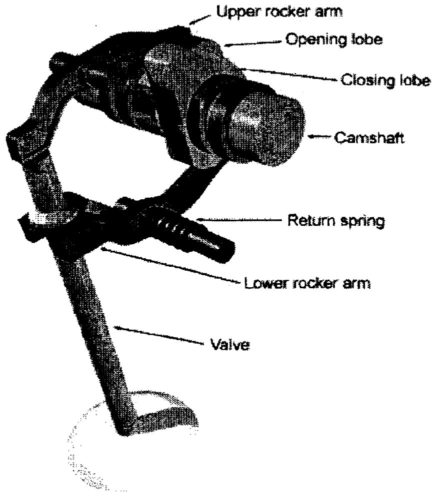
The most basic type has the camshaft at the top of the engine with the cam lobes operating directly on the tops of the valves. The second more complex type still has the camshaft at the top of the engine, but the cam lobes operate rocker arms, which in turn pivot and operate on the tops of the valves. With some of these designs, the rocker arm is pivoted in the middle (as shown below) and with other designed, it's pivoted at one end and the cam lobe operates on it at the midpoint. Think of a fat bloke bouncing in the middle of a diving board whilst the tip of the board hits a swimmer on the head and you'll get the general idea. The third type which you'll find in some motorcycle engines and many boxer engines are pushrod-activated valves. The camshaft is actually directly geared off the crank at the bottom of the engine and the cam lobes push on pushrods which run up the sides of the engine. The top of the pushrod then pushes on a rocker arm, which finally pivots and operates on the top of the valve. The image here shows the three derivatives in their most basic form so you can see the differences between them. The pushrod type shows the camshaft in the wrong place simply for the purpose of getting it into the image. In reality the camshaft in this system is right at the bottom of the engine near the crank. The rocker arms shown here are also called fingers, or followers depending on who you talk to.



Tappet valves aren't really a unique type of valve but a derivative of spring-return valves. For the most part, the direct spring return valve described above wouldn't act directly on the top of the valve itself, but rather on an oil-filled tappet. The tappet is basically an upside-down bucket that covers the top of the valve stem and contains the spring. It's normally filled with oil through a small hole when the engine is pressurized. The purpose of tappets is two-fold. The oil in them helps quiet down the valve-train noise, and the top of the tappet gives a more uniform surface for the cam lobe to work on. From a maintenance point of view, tappets are the items which wear and are a lot easier to swap out than



entire valve assemblies. The image shows a simple tappet valve assembly. The tappet is made slightly transparent so you can see the return spring inside.



Desmodromic valve systems are unique to Ducati motorbikes. From the Ducati website: *The word 'desmodromic' is derived from two Greek roots, desmos (controlled, linked) and dromos (course, track). It refers to the exclusive valve control system used in Ducati engines: both valve movements (opening and closing) are 'operated."* What does it mean? Well in both the above systems, the closure mechanism on the valve relies on mechanical springs or hydraulics. There's nothing to actually *force* the valve to close. With the Ducati Desmodromic system, the camshaft has two lobes per valve, and the only spring is there to take up the slack in the closing system. Ducati valves are forced closed by the camshaft. The marketing people will tell you it's one of the reasons Ducati motorbike engines have been able to revolve much higher than their Japanese counterparts. The idea is that with springs especially, once you get to a certain speed, you're bound by the metallurgy of the spring — it can no longer expand to full length in the time between cylinder strokes and so you get 'valve float' where the valve never truly closes. With Desmodromic valves, that never happens because a second closing rocker arm hooks under the top of the valve stem and jams it upwards to force the valve closed. In fact, the stroke length, rods, and pistons all play their part in valve timing and maximum engine speed — it's not just the springs and valve float. This is why F1 cars use such a small stroke and pneumatic valves springs. In truth, both systems, spring or Desmodromic only work well up to a limit. Newer Japanese bikes have engines that can revolve to the same limit as a Ducati just using spring-return valves.

You can see the basic layout of a desmodromic valve. As the cam spins, the opening lobe hits the upper rocker arm which pivots and pushes the valve down and open. As the cam continues to spin, the closing lobe hits the lower rocker arm which pivots and hooks the valve back up, closing it. The return spring is merely there to hold the valve closed for the next cycle and doesn't provide any springing force to the closing mechanism. This is a fairly simple layout for the purposes of illustration. The real engines have Desmo-due and Desmo-quattro valve systems in them where pairs of valves are opened and closed together via the same mechanism. Quattrovalvole, 16v and the other monikers you'll find on the back of a car.

In the 80's, the buzzword was 16-valve. If you had a 16-valve engine you were happening. In Italy, your engine was a quattrovalvole. So what does all this mean? It's really simple. "Traditional" 4-cylinder in-line engines have two valves per cylinder - one intake and one exhaust. In a 16V engine, you have four per cylinder - two intake and two exhaust. (4 valves) x (4 cylinders) = 16 valves, or 16V. It follows that a 20V engine has 20 valves - 5 per cylinder. Normally three intake and two exhaust. Unless you've got a 5-cylinder Audi or Volvo in which case you've still got 4 valves per cylinder. If you're in America, the thing to have now is 32V - a 32 valve engine. Basically it's a V-8 with 4 valves per cylinder. It's all just basic maths.

And what do all these extra valves get you apart from a lot more damage if they ever go wrong? A better breathing engine. More fuel-air mix in, quicker exhaust. When you get further down the page (and if your wife / husband hasn't come and complained to you about spending so damn long reading this stuff so late at night), you'll find some more information on why this is A Good Thing.

I. Supply English equivalents to the following Russian words and word combinations.

Клапанный механизм, кулачковый вал, коромысло, эксцентрик, коленвал, штанга, палец, возвратный клапан, ряд клапанов, с точки зрения обслуживания, аналог, набрать определенную скорость, клапан-поплавок, хорошо работать до определенного предела, сила вращения, дополнительные клапана, лучше работающий двигатель.

II. Decide whether the sentences are True or False.

1. The valves are devices which let the fuel-air mixture into the cylinder and let the exhaust out. 2. Most widely used are spring return valves. 3. Revolving camshaft operates the valves which return to a closed position with the help of return springs. 4. The cam is usually fixed at the top of the engine. 5. In a more complex type the cam lobes operate rocker arms. 6. The third type of valve mechanism is found in some motocycle engines. 7. Tappet valves cannot be considered a unique type of valve. 8. In terms of maintenance tappet valves are much easier to swap out. 9. In Dicati desmodromic system there are two lobes per valve. 10. Desmodromic valves never bring about 'valve float'.

III. Finish the sentences according to the contents of the text.

1. The valves are used .... 2. Spring return valves .... 3. The operation of spring return valves .... 4. The three variations of valve train .... 5. The most basic type .... 6. The more complex type .... 7. The third type can be .... 8. Tappet valves .... 9. The oil in this valve type helps .... 10. Ducati motobikes are equipped with ....

IV. Think of the answers to the following questions.

1. What is the function of valves? 2. What kinds of valves do you know? 3. Spring valves are most commonly used, aren't they? 4. How many variations of

this valve system can you name? 5. Where is the third type of valves found? 6. How do valve mechanisms of this type work? 7. How can you characterize the operation of tapper valves? 8. For what purpose are they used? 9. Are they easy to change? 10. What is characteristic of desmodromic valves? 11. Where are they usually used?

V. Translate the following paragraph (""With the Ducati Desmodromic system... using spring-return valves") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

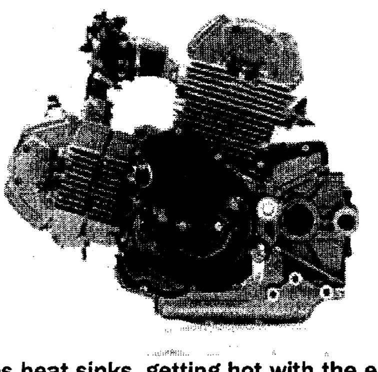
UNIT 8 ENGINE COOLING SYSTEM

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

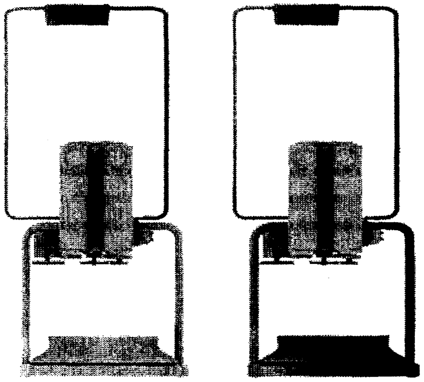
It stands to reason, to explode, lump, rear-engined, fins, weak point, to swing, to angle, to disperse, core, coolant, liquid, expansion, drivability, to re-direct, to alter, sticker, to mess with smth, in-car heating, permulation.

II. Read the text.

It stands to reason that if you fill a metal engine with fuel and air hundreds of times a second and make it explode, the whole thing is going to get pretty hot. To stop it all from melting into a fused lump of steel and aluminium, all engines have some method of keeping them cool.



You don't see this (air cooling) much on car engines at all now. The most famous cars it was used on were rear-engined boxers like the original VW Beetle, Karmann Ghia, and Porsche Roadsters. It is still used a lot on motorbike engines because it's a very simple method of cooling. For air cooling to work, you need two things — fins (lots of them) and good airflow. An air-cooled engine is normally easy to spot because of the fins built into the outside of the cylinders. The idea is simple — the fins act as heat sinks, getting hot with the engine but transferring the heat to the air as the air passes through and between them. Air-cooled engines don't work particularly well in long, hot traffic jams though, because obviously there's very little air passing over the fins. They are good in the winter when the air is coldest, but that illustrates a weak spot in the whole design. Air cooled engines can't regulate the overall temperature of the cylinder heads and engine, so the temperature tends to swing up and down depending on engine load, air temperature and forward speed. A famous problem with air-cooling is associated with V-twin motorcycles. Because the rear cylinder is tucked in the frame behind the front cylinder, its supply of cool, uninterrupted air is extremely limited and so in these designs, the rear cylinder tends to run extremely hot compared to the front. The image on the right is Ducati and shows the engine from the Monster 695 motorbike. It's a good example of modern air-cooled design and you can see the fins on the engine are all angled towards the direction of travel so the air can flow through them freely.



To some extent, *all* engines have oil-cooling. It's one of the functions of the engine oil - to transfer heat away from the moving parts and back to the sump where fins on the outside of the sump can help transfer that heat out into the air. But for some engines, the oil system itself is designed to be a more efficient cooling system. BMW 'R' motorbikes are known for this (their nickname is 'oilheads'). As the oil moves around the engine, at some points it's directed through cooling passageways close to the cylinder bores to pick up heat. From there it goes to an oil radiator placed out in the airflow to disperse the heat into the air before returning into the core of the engine. Actually, in the case of the 'R' motorbikes, they're air- and oil-cooled as they have the air-cooling fins on the cylinders too.

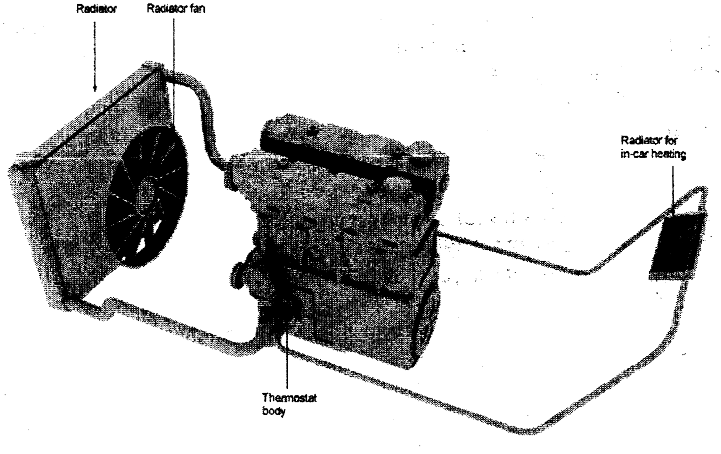
This is by far and away the most common method of cooling an engine down. With water cooling, a coolant mixture is pumped around pipes and passageways inside the engine separate to the oil, before passing out to a radiator. The radiator itself is made of metal, and it forces the coolant to flow through long passageways each of which has lots of metal fins attached to the outside giving a huge surface area. The coolant transfers its heat into the metal of the radiator, which in turn transfers the heat into the surrounding air through the fins - essentially just like the air-cooled engine fins. The coolant itself is normally a mixture of distilled water and an antifreeze component. The water needs to be distilled because if you just use tap water, all the minerals in it will deposit on the inside of the cooling system and mess it up. The antifreeze is in the mix, obviously to stop the liquid from freezing in cold weather. If it froze up, you'd have no cooling at all and the engine would overheat and weld itself together in a matter of minutes. The antifreeze mix normally also has other chemicals in it for corrosion resistance too and when mixed correctly it raises the boiling point of water, so even in the warmer months of the year, a cooling system always needs a water/antifreeze mix in it. The coolant system in a typical car is under pressure once the engine is running, as a byproduct of the water pump and the expansion that water undergoes as it heats up. Because of the coolant mixture, the water in the cooling system can get over 100°C without boiling which is why it's never a good idea to open the radiator cap immediately after you've turned the engine off. If you do, a superheated mixture of steam and coolant will spray out.

Water cooling is the most common method of cooling an engine down, but it's also the most complicated. For example you don't want the coolant flowing through the radiator as soon as you start the engine. If it did, the engine would take a long time to come up to operating temperature which causes issues with the emissions systems, the drivability of the engine and the comfort of the passengers. In truly cold weather, most water cooling systems are so efficient that if the coolant flowed through the radiator at startup, the engine would literally never get warm. So this is where the thermostat comes in to play. The thermostat is a small device that normally sits in the system in-line to the radiator. It is a spring-loaded valve actuated by a bimetallic spring. In layman's terms, the hotter it gets, the wider open the valve is. When you start the engine, the thermostat is cold and so it's closed. This redirects the flow of coolant back into the engine and bypasses the radiator completely but because the cabin heater radiator is on a separate circuit, the coolant *is* allowed to flow through it. It has a much smaller surface area and its cooling effect is nowhere near as great. This allows the engine to build up heat quite quickly. The first of the two diagrams on the right, you can see the representation of the coolant flow in a cold engine.

As the coolant heats up, the thermostat begins to open and the coolant is allowed to pass out to the radiator where it dumps heat out into the air before returning to the engine block. Once the engine is fully hot, the coolant is at operating temperature and the thermostat is permanently open, redirecting almost all the coolant flow through the radiator. (The second of the two diagrams on the right represent the coolant flow in a cold engine.) It's the action of the thermostat that allows a water-cooled engine to better regulate the heat in the engine block. Unlike an air-cooled engine, the thermostat can dynamically alter the flow of coolant depending on engine load and air temperature to maintain an even temperature.

In the good old days, car radiators had belt-driven fans that spun behind the radiator as fast as the engine was spinning. The fan is there to draw the warm air away from the back of the radiator to help it to work efficiently. The only problem with the old way of doing it was that the fan ran all the time the engine was running, and stopped when the engine stopped. This meant that the radiator was having air drawn through it at the same rate in freezing cold conditions as it was on a hot day, and when you parked the car, the radiator basically cooked because it had no airflow while it was cooling down. So nowadays, the radiator fan is electric and is activated by a temperature sensor in the coolant. When the temperature gets above a certain level, the fan comes on and because it's electric, this can happen even once you've stopped the engine. This is why sometimes on a hot day, you can park up, turn off, and hear the radiator fan still going. It's also the reason there are big stickers around it in the engine bay because if you park and open the hood to go and start messing with something, the fan might still come on and damage your fingers.

Most water-cooled car engines actually have a second, smaller radiator that the coolant is allowed to flow through all the time for in-car heating. It's a small heat-exchanger in the air vent system. When you select warm air with the heater controls, you will either be allowing the coolant to flow through that radiator via an inline valve in the cooling system (the old way of doing it) or moving a flap to allow the warm air already coming off that radiator to mix in with the cold air from outside. It's all these combinations and permutations of plumbing in a water-cooled engine that make it so relatively complex. The image below shows the basic elements a water-cooled engine.



I. Supply English equivalents to the following Russian words and word combinations.

Нагреваться, оплавившийся кусок, автомобили с задним расположением двигателя, boxer, ребро, воздушный поток, внешняя сторона цилиндров, переносить тепло, иметь тенденцию к, нагрузка на двигатель, по сравнению с, расположенный под углом, в некоторой степени, движущиеся части, мотоциклы с воздушно-масляным охлаждением, дистиллированная вода, вода из-под крана, осаждаться, противодействие коррозии, побочный продукт, биметаллическая пружина, изменять направление потока охлаждающей жидкости, на той же скорости.

II. Decide whether the sentences are True or False.

1. To prevent the engine from overheating all engines have some way of keeping them cool. 2. Air cooling is not much used nowadays. 3. For air-cooling

two things are needed – fins and a good air-flow. 4. Air-cooled engines are not practical in cities because of traffic jams. 5. In air-cooled engines the temperature tends to go up and down depending on the engine load. 6. The engine oil transfers heat away from moving parts of the engine. 7. In some engines oil passes through an oil radiator and disperses heat into the air. 8. The most common method of cooling down an engine is water cooling system. 9. Tap water can't be used as a coolant because of the minerals contained in it. 10. Water coolant mixture which is under pressure in the cooling system can have over a hundred degrees without boiling.

III. Finish the sentences according to the contents of the text.

1. Air-cooled engines ... .2. For air cooling to work ... .3. One can easily distinguish an air-cooled engine ... . 4. Air-cooled engines don't work well ... .5. An important problem with air cooling ... .6. In BMW motobikes oil ... .7. The most common method of cooling ... . 8. The coolant itself is ... . 9. The anti-freeze mix usually has ... . 10. The thermostat is ... . 11. As the coolant heats up, the thermostat ... . 12. The role of the radiator fan is to ... . 13. Nowadays the radiator fan ... .

IV. Think of the answers to the following questions.

1. Is the cooling system widely used on modern car engines? 2. Where is it still used? 3. Why is it easy to spot an air cooled engine? 4. Where are the weak points of air cooled engines clearly seen? 5. How does an oil cooling system work? 6. What is the most effective method of cooling down an engine? 7. Why can't tap water be used as a coolant? 8. What normally is the coolant? 9. Why can the water in the cooling system get over a hundred degrees? 10. What are the complexities of the water cooling? 11. Why is nowadays the radiator fan electric? 12. How is the cabin heated?

V. Translate the following paragraph ("Water cooling is the most... heat quite quickly") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 9 HYBRID CARS

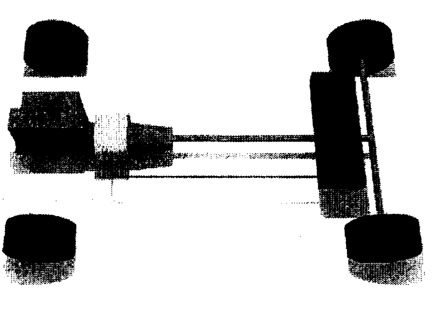
I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Hybrid, vehicle, to draw, braking, on-board system, mainstream, to champion, gearbox, load, weight, to coast, conversely, cold-start, emergency, implement, transmission, planetary, to freewheel, cluster, fascination, conducive, chart, score, benefit, in terms of, to impact, torque, bell-housing.

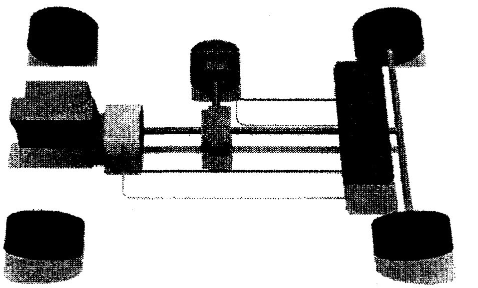
II. Read the text.

You've no doubt heard of hybrid cars by now, most likely the Toyota Prius. More manufacturers are jumping on the hybrid bandwagon, but just what is a hybrid vehicle? Simply put, it's a vehicle that uses a combination of two technologies to drive it. The most common hybrids are petrol-electric, like the Prius. Hybrid petrol-electric cars use a normal petrol engine, just like you'd find in any other car, but in addition, there are two high-torque electric motor-generators. The motor-generators draw power from a bunch of car batteries stored either in the floor-pan of the car (for a low centre of gravity) or in the rear (for convenience). With power supplied to the motor-generator, it behaves as an electric motor. When no power is supplied but the shaft is turning, it becomes a generator to create power. In this mode, you get regenerative braking, where the energy required to slow the vehicle down is all taken up in the motor-generator to re-charge the battery packs. Both the petrol engine and the motor-generator(s) are connected to an onboard computer system which has been programmed to work as efficiently as possible. There are three mainstream technologies in the hybrid market so far, each championed by a different company or group of companies.

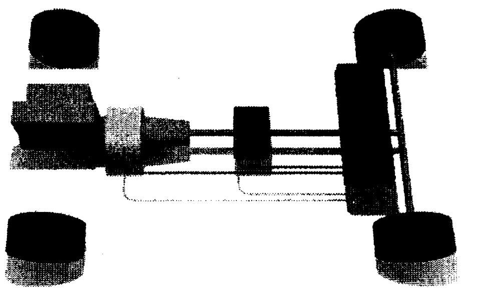
The motor-generator (electric motor and regenerative generator) is in-line with the petrol engine, typically built into the bell-housing in front of the gearbox. The motor-generator is used to assist the petrol engine, thus reducing the load on it and allowing it to be smaller than it would otherwise be for a vehicle of the same weight. For example the Civic hybrid uses a 1.3l engine where the non-hybrid uses a 1.8l engine. The motor-generator cannot turn without turning the petrol engine too. First-generation systems didn't have enough power to be able to run the car on electricity alone. Current generation ones do through higher powered motors and the ability to shut off the petrol engine when coasting. Because the motor-generator is in-line, the regenerative braking works very simply — as you start to brake, the motor becomes the generator. Conversely it is also used as the primary starter motor for spinning the petrol engine up quickly after it has been turned off, for example at traffic lights. There is also a back-up 'regular' starter motor for cold-starts and emergencies. Of the three mainstream hybrid technologies, IMA is by far the simplest to implement, maintain and repair. In the following images you may see the main components of suchlike design: the battery pack, motor-generator 1 and motor-generator 2.



Toyota's take on hybrid drive has a pair of motor-generators, one in-line like the Honda IMA design, one not. The key to its success is the compound planetary gear-set in the transmission. In the Toyota system, the petrol engine and one motor-generator are connected to one of the inputs, the second motor-generator to the second input and the wheels to the third. Through a clever use of electronics, the planetary gearbox can be locked and unlocked in various configurations dependent on what is required. For example, under modest acceleration, the petrol engine drives the planetary gearbox as well as the first motor-generator. The output from that is fed to the second motor-generator along with the output from the gearbox to drive the wheels. In pure electric mode, the first motor-generator freewheels, the petrol engine is turned off and all the electric power is fed to the second motor-generator. Under regenerative braking the second motor-generator becomes the generator as it does in the IMA system above. The difference is that if the battery pack is full, the energy derived from the second motor-generator is redirected to the first motor-generator which in turn uses it to induce drag in the petrol engine to slow the vehicle down. As a result, the actual brakes in a Toyota Hybrid vehicle do not wear very quickly at all because most of the braking is provided by the motor-generators. Only in severe cases do the brake pads actually engage the brake rotors. This is all made possible by the central engine computer and throttle-by-wire / brake-by-wire system.



The third hybrid system comes from GM and has two operating modes as oppose to the single mode of IMA or HSD. It again uses two motor-generators. In first and second gears, the first motor-generator sends power to the second motor-generator, and that coupled with the petrol engine provide the power to the wheels. In higher gears or under heavier loads, the petrol engine always runs (as oppose to the IMA and HSD systems where it can be turned off or have cylinders deactivated). The difference is in how the motor-generators work in cooperation with it. As speed increases, the first motor-generator gets to the point where it's providing no useable input to the drive-train. At this point it begins to freewheel and the second motor-generator begins to act as a generator. As speed increases further, the first motor-generator begins to act as a generator again and at this point its power is once again fed to the second motor-generator which now becomes a motor. Coupled with variable intake timing, direct common-rail injection and a host of other technologies, these all come together to give GM's take on hybrid technology.



Most hybrids have an energy display screen mounted either in the instrument cluster or in the centre console. This is a small LCD which gives the driver, information about what mode you're driving in, and where the power is going. Again, the most recognizable and famous of these displays to date is that from the Toyota Prius (see above). The only real problem with these displays is the fascination they provide to the novice hybrid driver. Watching the animations spin around and the energy arrows scroll here and there as you drive is certainly informative but not really conducive to safe driving. One benefit however is the constantly-updated gas-mileage chart. Many Prius owners report that this spurs them to attempt to get videogame-like high scores in their cars, driving them in such a fashion as to get the highest recorded mpg from their cars. If nothing else, the energy display affects most drivers in terms of educating them as to how their driving style directly impacts their gas-mileage.

I. Supply English equivalents to the following Russian words and word combinations.

Гибридный автомобиль, бензиново-электрический, вырабатывать ток, торможение, заряжать, облегчать работу бензинового двигателя, уменьшать нагрузку, в противном случае, одинаковый вес, система первого поколения, светофор, ключ к успеху, когда батарея питания заряжена, работать в сотрудничестве, переменный, экран.

II. Decide whether the sentences are True or False.

1. The Toyota Prius comes to mind when speaking about hybrid cars. 2. The most common hybrids are petrol-diesel. 3. When power is supplied to the motor generator, it behaves as an electric motor. 4. Each of the three mainstream technologies is championed by a company or group of companies. 5. The motor-generator is used to assist the petrol engine. 6. First generation cars don't have enough power to run a car on electricity alone. 7. Through clever use of electronics the planetary gear box can be switched on and off. 8. The brake pad actually engage the brake rotors only in severe cases. 9. The third hybrid GM system has two operating modes. 10. In higher gears or with heavier loads the petrol engine always runs. 11. One benefit of hybrids is the constantly updated gas-mileage chart.

III. Finish the sentences according to the contents of the text.

1. A hybrid vehicle is ... . 2. The most common hybrids ... . 3. The motor-generator draws power ... .4. When the shaft is turning but no power is supplied ... . 5. There are four mainstream technologies ... . 6. The motor-generator assists ... . 7. IUA technology ... . 8. In the Toyota system ... . 9. The planetary gear box ... . 10. The third hybrid system ... .

IV. Think of the answers to the following questions.

1. What is a hybrid car? 2. What are the most common hybrids? 3. What happens if no power is supplied to the motor-generator? 4. What are the petrol

engine and the motor-generator connected to? 5. How many mainstream technologies are there in the hybrid market? 6. Where is the petrol engine generally placed? 7. Can the petrol engine be shut off when coasting? 8. What key to success with hybrids has Toyota found? 9. In what way is the GM hybrid system different from the IMA one? 10. What happens if speed further increases?

V. Translate the following paragraph ("Simply put, it's a... group of companies") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 10 FUEL

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

To refine, carcinogenic, spontaneously, vapour, to evaporate, detonation, pre-ignition, to foul up, to counteract, precise, to squeeze, to combust, apparent, imprecise, to simulate, mean, to affect, to advance, to retard, multiple, mileage, to badmouth, gratification, publicity.

II. Read the text.

Petrol (or gasoline in American) is a distilled and refined oil product made up of hydrogen and carbons — a hydrocarbon, a long-chain hydrocarbon to be exact (don't get it on your skin — its carcinogenic). It's designed to be *relatively* safe to handle, if you're careful, i.e. it doesn't spontaneously combust without extreme provocation. When you have a petrol fire, it's not the petrol itself that is burning, it's the vapour, and this is the key to fueling an engine. The carburettor or fuel injectors spray petrol into an air stream. The tiny particles of petrol evaporate into a vapour extremely quickly, and combined in a cloud with the air, it becomes extremely combustible. The smaller the particles from the carburettor jet or fuel injector, the more efficiently the mixture burns.

Petrol doesn't spontaneously combust. It can if the conditions are right, and the conditions are extreme heat and pressure — exactly the conditions you find in the combustion chamber. When this happens, it's called detonation or pre-ignition. Diesel engines rely on this process because they don't have a spark plug in the traditional sense of the word. However in petrol engines, when this happens (also known as dieseling), it's a Very Bad Thing. Engines are designed to have the fuel-air mix burn at a fixed point in the cycle, not explode randomly. Whilst it might look like an explosion, if you could film it on a super high-speed camera, you'd see the mixture actually burns up very quickly rather than exploding. The in-cylinder picture of the 4-stroke combustion cycle is as follows:

the intake valve is on the right, the exhaust valve on the left. Detonation, dieseling or pre-ignition are all terms for what happens when the fuel-air mix spontaneously explodes rather than burning. Normally this happens when the mixture is all fouled up, and the engine is running hot. The temperature and pressure build up too quickly in the combustion chamber and before the piston can reach the top of its travel, the mixture explodes. This explosion tries to counteract the advancing piston and puts an enormous amount of stress on the piston, the cylinder walls and the connecting rod. From the outside of the engine, you'll hear it as a knocking or pinging sound. The precise sound is very hard to describe because every engine sounds slightly different when it happens. But the best way to describe it is a constant 'toc-toc-toc' type knocking sound.

The compression ratio of an engine is the measurement of the ratio between the combined volume of a cylinder and a combustion chamber when the piston is at the bottom of its stroke, and the same volume when the it's at the top of its stroke. The higher the compression ratio, the more mechanical energy an engine can squeeze from its air-fuel mixture. Similarly, the higher the compression ratio, the greater the liklihood of detonation.

You know that a fuel-air mix, given the right conditions, *can* spontaneously combust. In order to control this property, all petrols have chemicals mixed in with them to control how quickly the fuel burns. This is known as the octane rating of the fuel. The higher the rating, the slower and more controlled the fuel burns.

Octane is measured relative to a mixture of isooctane (2,2,4-trimethylpentane, an isomer of octane) and n-heptane. An 87-octane gasoline has the same knock resistance as a mixture of 87% isooctane and 13% n-heptane. The octane value of a fuel used to be controlled by the amount of tetraethyl lead in it, but in the 70s and 80s when it became apparent that lead was pretty harmful, lead-free petrol appeared and other substances were introduced to control octane instead.

So you know, the octane number is actually an imprecise measure of the maximum compression ratio at which a particular fuel can be burned in an engine without detonation. There are actually two numbers - RON (Research octane number) and MON (Motor Octane Number). The RON simulates fuel performance under low severity engine operation. The MON simulates more severe operation that might be incurred at high speed or high load and can be as much as 10 points lower than the RON. In Europe, what you'll see on the petrol pumps is the RON. However, in America, what you'll see on the petrol pump is usually the "mean" octane number - notified as (R+M)/2 — the average of both the RON and MON. This is why there is an apparent discrepancy between the octane values of petrol in America versus the rest of the world. Euro95 unleaded in Europe is 95 octane but it's the equivalent of American (R+M)/2 89 octane. In America, low altitude petrol stations typically sell three grades of petrol with octane ratings of 87, 89 and 91. High altitude stations typically also sell three grades, but with lower values - 85, 87 and 89.

There's a bunch of things that can affect how likely an engine is to have detonation problems. The common ones are ambient air temperature, humidity, altitude, your engine's ability to stay cool (i.e. the cooling system) and spark timing. Fortunately, nowadays the engine management system of modern cars can compensate for almost all of these by advancing and retarding the ignition timing. This is where the computer slightly adjusts the point in the ignition cycle at which the spark is generated at the spark plug. With older engines that used mechanical points to send current to the spark plugs, adjusting the timing was a manual affair that involved adjusting the distributor cap orientation.

Most modern cars have knock sensors screwed into the engine at multiple places. These actually detect the vibration or shock caused by detonation (rather than trying to detect the sound) and can signal the engine management system to change the ignition timing to reduce or eliminate the problem.

I. Supply English equivalents to the following Russian words and word combinations.

Очищенное масло, безопасный в обращении, чрезвычайно горючий, распылять топливо, мельчайшие частицы, в произвольном порядке, быть похожим, температура растет, степень сжатия, среднее октановое число, посылать ток, соотношение «топливо – пробег», изменение времени зажигания, терять мощность двигателя.

II. Decide whether the sentences are True or False.

1. Petrol is a distilled and refined gasoline product. 2. Tiny particles of petrol combined with air become extremely combustible. 3. Engines are designed to have the fuel-air mix burn at a fixed point in the cycle. 4. The compression is the ratio between the combined volume of a cylinder and a combustion chamber with the piston at the bottom. 5. All rinds of petrol contain chemicals to control how quickly the fuel burns. 6. Octane is calculated relative to the mixture of isooctane and n-heptane. 7. Octane number is an incorrect calculation of the maximum compression ratio at which a particular fuel burns without detonation. 8. In Europe RON indicates fuel performance under low severity engine operation. 9. Ambient air temperature, humidity, altitude, a cooling system and spark timing can affect how likely an engine can have detonation problems. 10. Octane can affect gas mileage.

III. Finish the sentences according to the contents of the text.

1. Petrol is ... .2. Tiny particles of petrol ... . 3. Petrol can combust ... . 4. Engines are designed ... . 5. Detonation happens ... . 6. The compression ratio of an engine ... .7. The higher the compression ratio ... . 8. In order to control spontaneous combustion ... . 9. The octane number is ... . 10. Several factors may affect ... . 11. Octane number can ... . 12. If you run fuel which is not recommended ... . 13. The car manufacturers are interested ... .

IV. Think of the answers to the following questions.

1. What is petrol? 2. What are its properties? 3. Why is it necessary to transform fuel into tiny particles? 4. What is called detonation? 5. What are the

engines designed for? 6. How is compression measured? 7. How is combustion controlled? 8. How is octane number defined? 9. What are RON and MON? Which is used un European countries? 10. What factors affect detonation? 11. What is the relation between octane and gas mileage? Prove with the examples from the text.

V. Translate the following paragraph ("Engines are designed to... type knocking sound") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 11 OCTANE BOOSTERS

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Booster, deposits, level, attempt, mis-educated, claim, unleaded, contamination, driveline, susceptible, to lubricate, mainstream, to reject, detergent, lumpy, substitute, genuine, discounted, gallon.

II. Read the text.

In some extreme cases, the highest octane fuel available might not solve a knocking or detonation problem. That's normally a symptom of a deeper problem in the engine involving carbon deposits on the cylinder heads, bad spark timing, faulty engine management systems or similar. In these cases, some people choose to add octane booster to their petrol. Basically you fill the tank as normal, then put in a measured amount of octane booster and it further raises the octane level in an attempt to stop the detonation. One of the downsides of this is that it can make the engine harder to start from cold, because the octane booster has made the fuel so much less volatile that it's hard to get it to ignite on the first couple of strokes. Products like Klotz and Redex octane boosters are readily available over the counter in most auto parts stores. Octane boosters are typically used by mis-educated motorcyclists who believe the myth (explained above) that high octane equals to more power.

To try to lay the myth about octane boosters giving more power to bed for once and for all, in 2007 the UK TV show *Fifth Gear* picked four likely candidates and subjected them to rigorous testing. They picked Nitro Hot Shot, NOS Race Only Octane Booster, Wynn's Power Booster and STP Power Booster. All four products make the usual wild claims about increased gas mileage, more bhp and so on and so forth. They took the products to Oxford Brooks University's engine testing lab. The engine was static-mounted so measurements were made at the flywheel. The throttle was computer controlled so they could reproduce the same scenario over and over again. They first did a baseline test to find out peak bhp with regular unleaded petrol. This involved various constant-throttle settings as well as acceleration and deceleration testing, and a 1-hour constant-speed run to emulate driving on a motorway in clear traffic. Each product was tested using the identical setup, with a 15 minute 'pure' petrol flush being used in between each test to ensure there was no cross-contamination. The results were interesting. Nitrox Hot Shot, NOS Race Only Octane Booster and Wynn's Octane Booster all reduced the overall power by 2bhp. STP Power Booster reduced it by 6%. Now remember this was measured at the flywheel so by the time you induce all the drag of the gearbox and driveline into that equation, you'd likely be looking at a 5% to 10% drop at the wheels. Impressive results for products that claim to *increase* your engine's power.

In England, octane boosters are typically also sold as "lead replacements" or "4 star additive". A lot of European cars relied on the lead in 4-star petrol for the increased octane. Lower octane unleaded fuels caused a lot of problems when they first appeared, especially with cars that didn't have engine management systems. Knocking and detonation became evident in a lot of cars and for some reason French and German engines were more susceptible than most. Dumping a shot of octane booster in the tank when filling up solved the problem by raising the RON a few points to make it the equivalent of what old leaded petrol had been. Eventually, by the late 90s, most English and European petrol stations introduced LRP (lead replacement petrol) and the problem sort of went away.

Whilst LRP solved the problem of lower octane unleaded petrol, it introduced a new problem. The lead in leaded petrol also had a secondary function and that was to lubricate the valve seats - the top of the engine block where the valves "park" when not being opened by the cams. With the advent of LRP, detonation went away but the chemicals used to increase octane didn't have any lubricating function. Some older engines started to suffer from increased wear to the valve seats, to the point where the valves could no longer properly close and seal the intake and exhaust ports.

During the 90s, in England, supermarkets started a price war with the mainstream fuel vendors by opening their own petrol stations and undercutting the Esso's and Shell's of the world by as much as 5%. People flocked to these cheap outlets without doing any proper research and after a couple of years, a lot of vehicles began to suffer as a result. There's an old saying that begins *"if it's too good to be true....."* In the case of supermarket petrol, there was an obvious reason why it was cheaper — it was the lower grade fuel that the mainstream outlets wouldn't take. Stuff which had been rejected in quality control, or had less additives and detergents than what you might get from Texaco or Philips66. As a result, engines started clogging up and failing emissions test. Gas mileage went down. Engines became lumpy and rough running and eventually the supermarkets were forced to fall in line with the Big Boys, so much so that nowadays they're normally less than 1% cheaper.

Skip forwards to 2005 and the first summer of high fuel prices in America. Supermarkets started to sprout petrol stations and a lot of people were in the same "cheap fuel" euphoria that the English were in 10 years previously. The

American market did it slightly differently though. Whereas in England, they started out with utterly sub-standard petrol, in the US it seems to be down to the additive and detergent blends (the same system used in the UK now). Typically, pipeline companies pipe in and store the petrol for distribution by filling up the various trucks that deliver to the various petrol stations. So branded and unbranded trucks are filled from the same supply. The difference is that when a truck from one of the majors fills up, they stop at the small company pump where that company's special detergent and additive mix is then pumped into the truck prior to the main fill-up. I'm not entirely clear on the percentages here, but there are e-mails from some readers claiming that it's as little as half a gallon of branded additive for each 9000 gallon truck (0.0028% additive).

This raises an interesting question then — are you better off to go branded, or to use the cheapest stuff you can find and then every couple of months, get a bottle of Chevron Techron additive (or whatever) and run that through your car? As a substitute for genuinely cheaper fuel, a lot of European supermarket chains now offer cheaper fuel at a price. The catch is that you have to shop with them. Once you buy a certain amount of stuff from their store, they'll knock off a percentage of the price of petrol if you buy it from them. The fuel isn't the cheap and nasty sub-standard stuff of yesterday that they used to use - it's good, mainstream product. But they can hide the price drop in the cost of the groceries and other items you buy in store. From your perspective, you save £2 a tank when filling up. From the store's perspective, you just spent £100 in shopping so giving you £2 back on your tank of gas is pocket change. In America, some of the big-box chains, like CostCo and Sam's Club are now doing the same thing. Rather than go the "dodgy crappy petrol" route, they're offering discounted petrol for shopping in their stores, discounting the petrol by a couple of cents per gallon as long as you've bought more than $50 of products from them.

I. Supply English equivalents to the following Russian words and word combinations.

Неправильно выставленное зажигание, средство повышения октанового числа, нижняя сторона, превращать в газообразное состояние, пятая передача, развенчать миф, подвергать неподвижно установить, провести проверку, неэтилированный бензин, промывка бензином, общая мощность, увеличенное октановое число, седло клапана, появление, увеличившийся износ, закрывать отверстие, ценовая война, основные продавцы топлива, заправочная станция, топливо низшего сорта, забиваться, не пройти проверку на вредные выбросы, соответствовать чему-либо, заменитель дешевого топлива, уловка, скрыть снижение цены, сеть супермаркетов.

II. Decide whether the sentences are True or False.

1. In extreme cases even the highest octane fuel cannot solve a knocking/detonation problem. 2. The only way out for some people is the use of octane booster. 3. Adding the booster can make it more difficult to start the

engine. 4. Octane boosters are mainly used by motocyclists. 5. Four kinds of boosters were tested. 6. Experiments were held at Oxford Brooks University engine tasting laboratory. 7. The results showed the reduction of overall power by up to six per cent. 8. At the wheels the drop of power could reach ten percent. 9. In Great Britain alone boosters are sold as lead replacements. 10. Lead replacement petrol drought a problem with lubricating the valve seats. 11. A price war in the 90-ies between the supermarkets and fuel vendors brought new problems for car users. 12. In America cheap fuel euphoria started in 2005. 13. The reduction of new prices is now hidden in the cost of groceries in many European supermakets.

III. Finish the sentences according to the contents of the text.

1. Even the highest octane fuel ... . 2. A deeper problem ... .3. People add octane booster ... .4. One of the downsides ... . 5. Octane boosters are mainly ... .6. British TV show "Fifth Gear" ... . 7. Oxford Brooks University engine tasting lab ... . 8. The results of the testing showed ... . 9. In England octane boosters ... . 10. French and German engines... . 11. In late 90-ies....12. During the 90-ies in Great Britain ... . 13. After using a lower grade fuel... . 14. Cheap fuel euphoria ... . 15. A lot of European supermarket chains ... .

IV. Think of the answers to the following questions.

1. Can a knocking or detonation problem be solved by using octane boosters? 2. What does the presence of this problem mean? 3. Why do some people choose to add octane booster? 4. What may the use of octane booster result in? 5. Who mainly uses octane boosters? 6. What did "Fifth Gear" decide to do? 7. Where were the experiments held? 8. What did the tests show? 9. How are octane boosters sold in England? 10. How does LRP affect the valve seats? 11. What happened in England during the 90-ies? 12. What did supermarkets do in 2005 in America? 13. What innovation did European supermarket chains introduce?

V. Translate the following paragraph ("They took the products... your engine's power") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

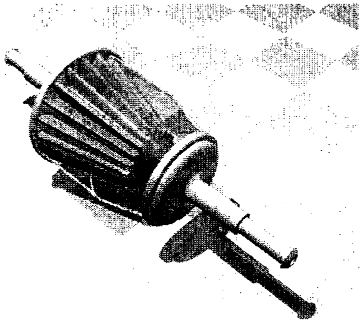
UNIT 12 FUEL FILTERS

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

To bring up, bit to rust, grit, grime, petrol station, in-line, pad, pump, to anodize, fine material, debris, to atomize, grain, slur, priority, jerry, clutter, gimmick, particle, dodgy, worth, nozzle.

II. Read the text.

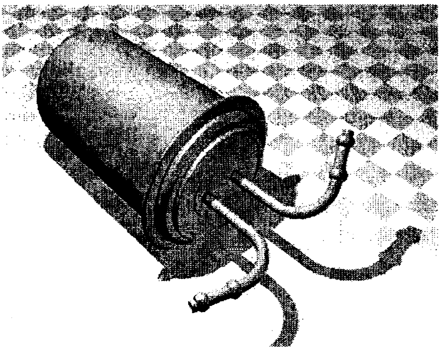
As all this information about petrol and gasoline is starting to run out of your ears, it's worth bringing up the topic of fuel filters. Without fuel filters, none of this information on petrol is worth anything. In an ideal world, every time you



fill your tank, the petrol would come from brand new underground tanks, through brand new hoses and nozzles, down a pristeen filler tube into a brand new gas tank. However, back in the real world, that simply isn't the case. Tiny bits of metal flake off components. Things rust. Grit and grime gets into the fuel through many different sources. For the most part, this sediment settles at the bottom of the underground tanks in a petrol station, and at the bottom of the petrol tank in your car. If you're unlucky enough to fill up just after the petrol station has received a load of fuel from a tanker though, all that sediment will be nicely mixed into the petrol, and you'll get a petrol-sediment mix in your petrol tank. Similarly, if you insist on running your petrol tank down to the 'E' mark on the fuel gauge, you'll be sucking up petrol-sediment mix from the bottom of your own tank. It's a good job then that the men in lab coats decided to put in-line fuel filters in your car. These are relatively simple little devices that come in two basic flavours.

These are the plastic in-line fuel filters. They look like a little plastic container with a wavy yellow pad in them. They're typically designed to have the fuel sucked through them via a mechanical crank-driven fuel pump up near the carburettor. In some tuner vehicles you'll find this has been replaced with a tasty little aluminium item, usually anodised in a nice colour, designed to make it nearly impossible to find.

These are the metal cannister-type fuel filters that are normally buried



under the car somewhere. They're designed to have the fuel pushed through them by an electric high-pressure fuel pump, and so the pressure in the fuel line is much higher. This is why they're made of metal. Internally, the filter material is normally finer too.

Generally speaking, unless it's metal filings, then yes, most debris that you'd find in a fuel system would burn during combustion but that's not the problem. The problem is getting the fuel into the engine in the first place. Further back up this booklet you (hopefully) learned about carburettors and fuel injectors. The one thing common to both is the tiny hole at the end of the line where the fuel is finally atomized into the air. A good sized grain of sand would be all it took to block that tiny hole and once that happens, it doesn't matter how clever your engine is, it won't be getting any petrol. That is why you have to filter fuel — to keep particulates from clogging areas of the fuel system vital to its operation.

Most manufacturers will tell you that fuel filters are sealed-for-life, or lifetime-of-the-car items. To put it mildly, that's total bollocks. In normal operating conditions, in 'first-world' countries, you should change your fuel filter every 75,000 miles (120,000km) or so. If you're into extreme motoring, like round-the-world touring, or working in 'third-world' countries, your fuel filter might need changing as much as every 5,000 miles. That's not a slur on those countries, it's just a fact that the cleanliness of petrol station holding and delivery systems isn't really a hot priority in those countries. Plus, if you're involved in that sort of driving, chances are most of your petrol will come from a rusty metal jerry can.

The job of an in-line fuel filter is to filter out sediment and particulates in the petrol that might otherwise cause problems further down the line in the engine. If you think about it, the average car probably has 40 to 50 litres of petrol go through the fuel filter every week. It stands to reason then that eventually the filter is going to become clogged with debris. Once your filter gets clogged, you start to get all sorts of followon problems. In carburettor cars, you'll get sporadic and weak fuel supply which will lead to a stuttering engine, or an engine that seems to have no power under acceleration. In a fuel injection system where the fuel line pressures are much greater, a clogged filter can lead to a burned out petrol pump or a blown fuel line connection on top of the fuel starvation problems. One just has to bear it in mind when you get to around 75,000 miles. If you're doing your own servicing, change the filter. If you're using a dealer, insist it gets changed despite their protests.

You might as well to explain to you Unified Field Theory here. Locating the fuel filter on any vehicle is a dark art known only to the robot that put your car together. The filter can literally be anywhere in between the tank and the engine. For carburettor engines it's most likely to be in the engine bay, probably with 50cm of where the fuel line comes up from under the car, and clipped to some other tube or cable. For injection filters, it's most likely to be attached to the chassis or a suspension component underneath the car at the back axle, close to the fuel pump and petrol tank.

More often than not, there will be a mesh 'sock' on the pickup tube inside the petrol tank itself. This is a much trickier filter to change as it's a sort of pre-filter to catch the really large stuff. For the most part, these mesh filters don't block easily - anything sucked up against them will normally wash off with the natural movement of the petrol in the tank. Where it's possible to change the external filters yourself, doing the internal one is probably a job best left to a decent mechanic.

Some carburettors have a last line of defence in the form of a metal gause filter just inside the fuel intake. If you take the fuel line off a carburettor and peer inside, that's the most likely place for this to be if there is one. It's worth knowing about this little joy because if you go to all the trouble of changing your other in-line filter(s) and still have a fuel starvation problem, it could be this last little bugger that's blocked.

Some experts are skeptical about the magnet-on-your-fuel-line gimmick. Generally speaking, these are a complete scam, trying to tempt you with wild claims of increased gas mileage and more power. That being said, there is one manufacturer who sells a product which entirely makes sense. FilterMAG do magnetic sleeves for engine oil filters they now also do the same sort of sleeve for fuel filters. The idea is really simple - stick a bunch of powerful rare-earth magnets on the outside of your fuel filters, and any metal particles in your fuel system will end up stuck to the inside of the filter because of the magnets outside. The experience shows that FilterMAG's oil filter product works a charm, so there's no reason to believe their petrol filter magnet would work any differently. The advice — if you're serious about the cleanliness of your fuel, or you know you're going to be taking your car or bike somewhere where the fuel supply might be dodgy, grab one of these FilterMAG products and stuff it on your in-line fuel filter for peace of mind.

I. Supply English equivalents to the following Russian words and word combinations.

Топливный фильтр, совершенно новый, оседать, хорошо перемешанный, топливный насос, вращаемый коленвалом, алюминиевый предмет, которого практически невозможно обнаружить, электрический топливный насос, высокого давления, сделанный из металла, металлические опилки, песчинка, засорять топливную систему, экстремальное вождение, отсек двигателя, присоединенный к трубе.

II. Decide whether the sentences are True or False.

1. In the real world petrol isn't that clean as we might expect it to be. 2. Sediment settles at the bottom of underground tanks and the petrol tank in your car. 3. Equally it is not advised to run your petrol tank down to the E mark on the fuel gauge. 4. Carburettor engine fuel filters are designed to have the fuel sucked through them. 5. Fuel injection filters are made of metal because of the pressure in the fuel line. 6. Fuel must be filtered to take away metal filings from it. 7. In normal operating conditions fuel filter must be changed every ninety thousand miles. 8. In extreme motoring conditions the filter must be changed every five thousand miles. 9. If the filter is clogged, one may get sporadic fuel supply with no power under acceleration. 10. Locating a fuel filter is a rather difficult task. 11. The 'sock' filter is installed on the pick-up tube inside the petrol tank. 12. On some carburettors there's an internal filter just inside the fuel intake.

III. Finish the sentences according to the contents of the text.

1. Without fuel filters ... . 2. But in the real world ... . 3. If you fill up right after the petrol station has received ... . 4. Carburettor engine fuel filters ... . 5.

Fuel injection filters are made ... . 6. It's necessary to filter fuel ... . 7. A good sized grain of sand ... .8. In normal driving conditions ... . 9. In extreme driving ... .10. The filter must be changed ... . 11. A clogged filter ... .12. The location of the filter ... . 13. Inside a petrol tank ... . 14. The carburetor internal filter ... .

IV. Think of the answers to the following questions.

1. Why is the filter considered a very important component of fuel system? 2. What happens if one fills up after petrol has just been received by the petrol station? 3. Why is it not advised to run your petrol tank down to the E mark? 4. What are carburetor engine fuel filters made of? 5. How is the fuel pumped through fuel injection filters? 6. Why are they made of metal? 7. Why is the fuel to be filtered? 8. When must fuel filters be changed? What does it depend on? 9. What does a clogged filter lead to? 10. Where is the fuel filter usually installed on a vehicle? 11. What is the 'sock' filter? 12. What is the function of the carburetor internal filter? 13. How does Filter MAG work?

V. Translate the following paragraph ("Most manufacturers will tell... fuel starvation problems") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 13 BIOFUEL

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Terror, bullet, ethanol, alternative, hoopla, to crop up, time and again, renewable, crude oil, wheat, barley, sugarcane, , biofuel, impact, cure, heal, to expand, pesticides, to back up, amount, liquid, to be unheard of, butane, propane.

II. Read the text.

With the spiraling cost of fuel prices brought on by George Bush's "War On Terror", people are looking at everything to get cheaper fuel, and one of the silver bullets seems to be E85 Ethanol-blend gasoline. We use 'seems to be' because once you do some research, which is what you're doing right here by reading this, you'll learn it's not quite the magic solution everyone would have you believe. E85 is a blend of regular unleaded petrol with between 70% and 83% ethanol depending on the geographic location and time of year. Simply blending ethanol and petrol normally results in a product with a too low vapour pressure, especially in the winter, which is why it is a process best left to people in white labcoats in refineries. It's designed for so-called Flexible Fuel vehicles, and as such has been classified by the US Department of Energy as an alternative fuel. The facts on E85 are a little hard to come by, the attempt has been made to collect together and put as many as possible right here so that a reader can try to cut to the chase. So what is a flexible fuel vehicle (FFV)? Well, it's a vehicle with an engine and emissions system designed to be able to run on a blend of unleaded petrol and ethanol up to a maximum of 85% ethanol. If E85 isn't available, you can run them on just plain old petrol though. If you read all the hoopla surrounding E85, you'll see this statement crop up time and time again: "It is a renewable source of energy and reduces the crude oil imports needed to fuel America's transportation system. Ethanol is a clean, environmentally friendly fuel". Well, yes. But more specifically, "sort of". It's true that it is partly based on a renewable source of energy - ethanol is basically distilled corn oil (or wheat, barley, or potatoes. Brazil, the world's largest ethanol producer, makes the fuel from sugarcane), and yes, it's a cleaner and slightly more environmentally friendly fuel. There're a few 'buts' to go with all this. First, there isn't enough farmland to grow enough corn to produce enough ethanol to meet gasoline demands, and it wouldn't be a good use of it even if there was. Second, there's a huge hidden cost in water — it takes 10 tons of water to process 1 ton of grain for ethanol. Third, in 2007, in a report on the impact of biofuels, the Organization for Economic Cooperation and Development (OECD) said biofuels may "offer a cure that is worse than the disease they seek to heal". "The current push to expand the use of biofuels is creating unsustainable tensions that will disrupt markets without generating significant environmental benefits," the OECD said. "When acidification, fertiliser use, biodiversity loss and toxicity of agricultural pesticides are taken into account, the overall environmental impacts of ethanol and biodiesel can very easily exceed those of petrol and mineral diesel," it added. And finally, the important part of this paragraph.

What does this mean to you? Well it means you'll need a lot more of it for a start. Sure it may be cheaper than regular petrol, but there's a reason — it's a terrible way to run a vehicle. Even the governments own figures back that statement up. Check out one of their lists of flexible-fueled vehicles for yourself. On average, putting E85 in a flexible fuel vehicle will return a nauseating 25% worse gas mileage. E85 doesn't burn as efficiently as regular petrol because it contains less energy per volume — 75,760btu per gallon as opposed to 115,400btu per gallon for plain old petrol. This accounts for the 30% increase in the amount of fuel required in the fuel-air mix during combustion, and the corresponding drop in gas mileage. All this comes with an average drop of only 10% in greenhouse gas emissions. If you go by historical precedent, and assume we all move to FFV's, the income from regular petrol will drop so the oil companies will simply increase the cost of E85. At that point, you're getting terrible gas mileage but paying what you used to for just plain vanilla unleaded petrol. Nothing is free. Of course this doesn't need to be the case. E85's higher octane can allow the use of higher compression, more efficient engines (if optimized for use on it). Look at the race car teams — a lot of racing engines run on pure ethanol. And when engineered to take advantage of it, high-compression, high-efficiency engines can reduce the gas-mileage deficit to about 10% less than their petrol counterparts, which is much closer. But for ethanol to be successful it must be priced below petrol so that the cents per mile cost is favorable taking into account the drop in economy.

In Europe, LPG (Liquid Petroleum Gas/Liquid Natural Gas) has been an option for drivers for years. In Australia, it's been around since the 60's. In England, it's still bubbling under and in America it's virtually unheard of. So what is it? Well, put simply, it's petroleum or natural gas compressed to the point where it becomes a liquid. The liquified gas is contained in a pressure vessel inside the car somewhere — normally a tank in the boot (or trunk if you're American). There's a feed line from there to the fuel injection system or carburettor and a solenoid switch connected to a fuel-cutoff switch, both of which are controlled from a button or switch on the dashboard. In one position, the LPG line is closed and the petrol line is open and the car works just like every other car on the road. In the other position, the petrol line is cut off and the LPG line is opened up. Liquid gas under pressure shoots up the line and out of an injector nozzle either screwed into the side of the carburettor, or integrated into the fuel injection system. As the gas expands out of the nozzle it cools down and becomes a gas. The gas is highly combustible and when mixed with the air going into the engine, creates a perfectly useable fuel-air mix for the engine to run on. So, it's very simple. The gas itself is normally some derivative of butane or propane, or a combination of the two. LPG is manufactured during the process or refining crude oil, and LNG is manufactured during the refining process of extracting natural gas from the ground. Once the gas is compressed, it becomes a liquid, and this is what is carried around in the tank in the back of your car.

LPG is popular because for the most part, it's cheaper than petrol and it gives a pretty good gas-mileage. There are three key issues that bother most people considering LPG conversions. The first is the tank - it takes up a lot of space in your car. For some this isn't an issue, but for others, they need the space and they don't like the idea of an ugly pressure tank up on the roof of the car. The second issue is availability. On mainland Europe this isn't a problem but in most of the rest of the world, you'd be more likely to win the lottery than just stumble across an LPG filling station. The good news though is that by flicking the switch on the dashboard, you can go back to regular petrol (as long as you've got some in the tank) and keep filling up like that until you do come across another LPG station. The third issue is cost. It costs a fair amount to get an LPG conversion done. LPG is cheaper and in the long run you'll recover the costs and start saving money, but that can take 50,000km or more. Another issue which some people don't like is the idea of the pressurization system. To fill up an LPG tank, you need to hook on a pressurized hose to a special filler cap on the outside of the car. It's easy enough to do, and it holds itself in place whilst you're refueling, but for some, they just don't like it. The tank itself will normally be fitted with an automatic fill limiter which looks a lot like a toilet bowl float. When the tank is nearly full, the float operates a lever which severely restricts the flow of gas into the tank. This causes enough backpressure for the pump to realize that it's time to cut off the flow.

I. Supply English equivalents to the following Russian words and word combinations.

Рост цен, получать более дешевое топливо, сказочные решения, смешивание этанола и бензина, возобновляемый источник энергии, экологическое топливо, превосходить, минеральное дизельное топливо, поддерживать утверждение, среднее снижение, работать на чистом этаноле, сжиженный газ, производное от бутана или пропана, сырая нефть.

II. Decide whether the sentences are True or False.

1. Ethanol-blend gasoline is a way to get cheaper fuel. 2. Blending ethanol and petrol results in a product with a low vapour pressure. 3. This fuel is designed for flexible fuel vehicles according to US classification. 4. A flexible fuel vehicle can run on a mix of unleaded petrol and ethanol or pure petrol. 5. Ethanol is clean, environmentally friendly fuel. 6. Ethanol is a distilled corn oil.7. Ethanol-blend fuel has a bad gas mileage. 8. Ethanol doesn't burn efficiently and contains less energy per volume. 9. A lot of racing engines run on pure ethanol. 10. LPG has been an option for drivers in all countries. 11. Gas is highly combustible and when mixed with air it produces a useable mix for the engine? 12. Liquid gas is carried in the tank in the back of one's car.

III. Finish the sentences according to the contents of the text.

1. People are trying ... .2. The way out seems to ... .3. E85 is ... . 4. E85 is designed ... . 5. A flexible fuel vehicle ... . 6. The maximum quantity ... .7. Ethanol is ... .8. It is distilled from ... .9. Ethanol blend fuel ... . 10. As for running a vehicle on an ethanol-blend fuel ... . 11. An average drop of ten per cent ... . 12. The race car teams ... . 13. Ethanol may be successful ... . 14. Liquid petrol gas ... .

IV. Think of the answers to the following questions.

1. What is one of the ways to get a cheaper fuel? 2. What is E85? 3. What kind of product does blending ethanol and petrol give? 4. For what vehicles is ethanol designed? 5. What is a flexible fuel vehicle? 6. Is ethanol a clean? Environmentally friendly fuel? 7. From what is it produced? 8. What reasons restrict its production? 9. Does this blend give a good gas mileage? 10. Why doesn't E85 burn as efficiently as petrol? 11. Why can more efficient engines run on E85? 12. What is LPG? 13. Why do drivers choose LPG instead of petrol? 15. Yow does a vehicle with LPG system work?

V. Translate the following paragraph ("E85 Ethanol-blend fuel has... increase the cost of E85") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

UNIT 14 TUNING THE ENGINE

I. Find in the text the following words and word combinations, read these sentences and translate them into Russian.

Modification, chipping, to tune, to smooth out, curve, remapping, laptop, software, limiter, response, horsepower, tuner house, steed, bias, performance, expertise, void, warranty, to adjust, to respond to, to perfect, issue, to invalidate, to upgrade, belt-on.

II. Read the text.

In England and the US, horsepower means *Imperial* horsepower. The technical definition of this is *"the power a horse exerts in moving 550 pounds of cargo a distance of one foot in one second."* This calculation can include just the horse and its own weight. Horsepower can be defined many ways. One horsepower equals 746 watts, and as such, proper SI units are normally used instead. The term *horsepower* is more a legacy term than anything else.

The term 'brake horsepower' came about because of an apparatus called a water brake that can be used to measure horsepower. Today all manner of brakes are used from hydraulic to electrical. They all perform the same function though, and that is to load up the engine and measure the torque with strain gauges. BHP figures can be calculated from the measured torque values to determine the power of the engine at any given rotation. If bhp figures are published without any other data, you've got to assume they're measured at the crank. The problem is that once you add on clutches, flywheels, gears, driveshafts and all the other components between the engine and the wheels, the actual power at the wheel is often noticeably less. So sometimes you'll see bhp figures noted as "at the wheel". This means the torque has been measured with the wheel being turned through all the above connections to give a more accurate power reading.

In the old days, bhp readings would be taken with the engine running in "optimum" condition, i.e. with no oil or water pumps attached, direct cold-air injection, super-cooled coolant, no exhaust back pressure or catalytic converters and so on and so forth. Fortunately today there are standards that have to be maintained. Most recently, in 2005 the SAE made some changes to the test procedures to eliminate some of the 'slop' in power measurements, and for car manufacturers to be able to make valid SAE-certified bhp claims, their tests must now be monitored by SAE representatives. The results of this change were interesting if only because the bhp values for engines changed without the engines themselves being modified. For example the Honda Element engine remained exactly the same, but its bhp rating dropped from 170bhp to 165bhp, simply because of the new procedures. It's worth pointing out that whilst the rest of the world used bhp or kW (kilowatts) to publish power figures for engines, in America they typically used to use hp(SAE) instead, meaning the rated power of the engine *as installed in the vehicle*, ie including all the engine components, pumps, drivetrain etc. Having said that, even today, all hp(SAE) or SAE-certified bhp figures are taken at the flywheel and thus still don't really tell you how much power is getting to the wheels. The only way to know that is to put your car on a dynomometer (a dyno) and get true at-the-wheel readings.

The formula to calculate bhp from a given torque reading is as follows:

$$bhp = \frac{(2\pi \times torque \times RPS)}{550}$$

Pi is obviously 3.14159, the torque value should be in pounds-feet and RPS is revolutions per second - RPM/60. So do a little elementary maths and you can massively simplify the formula down to this:

$$bhp = \frac{(torque \times rpm)}{5252.11}$$

The formula to calculate regular horsepower from a given torque reading is as follows:

$$hp = \frac{(2\pi \times torque \times rpm \times 1.34 \times 10^{-3})}{60}$$

Pi is still 3.14159, but this time the torque value should be in newton-metres. Again, simplified the formula becomes:

$$hp = \frac{(torque \times rpm)}{7126.34}$$

Not satisfied with the power your lump is giving you? There are solutions, and of course they depend almost entirely on how deep your pockets are. Almost any engine in any car can be adjusted, tweaked, modified and tuned to give more power. The more money you have to spend, the quicker your car will go.

About The simplest and easiest modification to most modern engines is called chipping. When it was first introduced, it involved removing the chip that contains the ignition map from the engine management system, and replacing it with one with a modified map. The new chip was designed for better torque, increased power, or just smoothing out flat spots in the power or torque curve of the engine. Nowadays, chipping should be more accurately referred to as *Remapping*. Gone are the days when you could just a whip a chip out of the ECU. That's so 90's. Today, when you cough up your hard earned cash at a tuner house, they'll plug a laptop in to your engine diagnostics port and upload new software which changes all manner of things from turbo control, fuelling maps, engine load and torque limiters all the way up to throttle-by-wire response (where applicable). They write their own software after studying (read: reverse-engineering) the car's ECU parameters using a rolling road and a laptop hooked to the diagnostics port. From there they can re-write the engine management software to do what they want rather than what the manufacturer wanted. Petrol cars respond well to remapping, but for some reason, diesels respond much better, especially VW diesels. It's not uncommon for a remapped VW ECU to generate 30% more power and torque after it's been breathed on. Add a turbo to that and you can see even wilder gains. Realistically though you ought to expect around a 5-7% increase in horsepower from a chip or remapping operation. Getting your car remapped will take a couple of hours if you go to a reputable tuner house. They'll pop your steed on a rolling road and hook it up to a dyno to get it right. In some cases, you can get a remapping module which sits in-line with the factory-fitted ECU, and then you can download or create your own mappings and upload them to the unit yourself. Power Commander are one of the more notable manufacturers of this sort of system, although theirs is predominantly designed for motorbikes.

But how can this work? More torque and horsepower without changing anything in the engine? Well bear in mind that from the factory, most cars are sold to be more economy and comfort biased than performance biased. Most engines have a lot of slack for generating more power or torque, it's just a question of having the expertise to find it. A lot of work does go into these chips and remapping programs which is why they can cost upwards of $400 for a quality branded product. Whilst it might only be 5% by the numbers, you likely will notice some of the other effects, like smoother acceleration due to flat-spots in the torque curve being ironed out. Everyone who has chipped their vehicles has enjoyed the modification, and relative to what you *can* do to a car, it's a pretty cheap modification.

Chipping or remapping your car will likely void any warranty you have on it because you're messing with the onboard computer which in turn is going to adjust the running of the engine to be "different" from factory spec. And by "different", the manufacturer normally means "no warranty". Having said that, some tuner houses have perfected their software to the point where manufacturers own diagnostics computers can't tell that an engine has been remapped. In that case it becomes a moral issue for you - is it invalidating the warranty if they can't tell?

Some manufacturers do bolt-on upgrades to their vehicles. For example Dodge introduced a bolt-on upgrade to their SRT-4 Neon in 2003. The kit comes with a modified engine management computer (the whole thing, not just the chip) along with high-flow fuel injectors. The nice thing about doing a factory upgrade is that you know for 100% certain that the parts are going to fit, and are going to work together with each other as well as your car. Since that original upgrade, Mopar have produced a veritable treasure trove of bolt-on upgrades for Dodge vehicles, and with most of them you can maintain some of the factory warranty. Factory upgrades are starting to include chips too now, competing with the aftermarket chipping business. That was a move to counter the warranty problems that some kits caused. Either way, factory bolt-ons are A Good Thing. If you want improved performance but are nervous about third-party products, getting something direct from Dodge, Ford, Toyota, Mazda etc. is a good way to go.

Engine as a breathing machine needs to breathe in fuel and air, and it needs to breath out exhaust gasses. Anything that gets in the way of that process is going to impede its ability to breathe. In reality of course, there are plenty of things in the way from air filters and flow sensors in the intake system, to catalysers and bizarre kinks and curves in the exhaust system. By eliminating or reducing these constrictions, you can allow your engine to breathe more easily. Sort of like Nyquil or NightNurse for an engine. By far the easiest and cheapest thing to start with is the air filter. From the factory, air filters are designed to be a compromise of filtering the guck out whilst letting the air through. Aftermarket manufacturers such as K&N and Jamex have been making high-flow air filters for years. The design of the filters is slightly different and they allow more air to pass through the filter whilst still stopping the majority of harmful particles. Again, like all these things, the claims of increased power can be hugely exaggerated. In truth, simply changing the air filter will probably add another 2 or 3hp to your engine. More air going in more easily means the engine management system will adjust the fuelling accordingly and you'll get a better fuel-air charge in the cylinder, resulting in a slight increase in power.

As with most bolt-on performance parts, the box will *always* be optimistic with their claims of power increase. A reader sent me a link to this YouTube video testing a VW Golf Mk3, 1.8 litre engine with a stock OEM air filter versus a conical high-flow filter. The filter manufacturer makes the claim that their product will increase the power of your engine by 10%. In this particular test, the horsepower went from 91.9hp with the OEM filter up to 93.6hp with the high-flow filter - a difference of 1.7hp or 1.8%. This is basically an inconclusive result given the measurement and fault tolerance of a rolling-road dyno which is normally in the 3%-5% range. It's certainly not the 10% promised on the box and is closer the 2hp-3hp I would expect from such a filter.

I. Supply English equivalents to the following Russian words and word combinations.

Решение, удаление чипа, перенастройка, подключить ноутбук, писать свою собственную программу, хорошо откликаться на, бегущая дорога, ориентированный на экономию, более плавное ускорение, сглаживать кривую крутящего момента, лишиться гарантии, заводские установки, модернизация, сохранить заводскую гарантию, противодействовать, в(ы)дыхать.

II. Decide whether the sentences are True or False.

1. Tuning the engine is connected with how much you can afford. 2. The easiest way of modifying most modern engines is chipping. 3. Initially this process meant removing the chip and substituting it for another with a modified map. 4. Introduction of a new chip increased power, produced better torque. 5. Modern chipping is defined as remapping. 6. A new uploaded software completely changes the way the engine works. 7. Petrol cars better respond to remapping than diesel cars. 8. Remapped VW can generate thirty percent more power than before. 9. Having the car remapped takes several hours. 10. Most cars are produced to be more economy and comfort biased than performance biased. 11. Chipping or remapping involves loss of warranty. 12. In some cases even manufacturers' own diagnostic equipment can't show the engine has been remapped. 13. With a factory upgrade you are completely sure the parts

will fit each other. 14. Changing air filter for a high flow one may give another two-three horse powers to your engine.

III. Finish the sentences according to the contents of the text.

1. Tuning the engine ... . 2. The desire to improve the engine performance ... . 3. The simplest modification ... .4. A new chip ... . 5. Today's chipping ... . 6. At a tuner house ... . 7. Petrol cars ... .8. VW diesels ... . 9. Realistically one may expect ... .10. Remapping takes ... . 11. Most car manufacturers ... .12. On average the cost of ... . 13. Chipping or remapping leads to ... . 14. Some manufacturers produce kits ... .15. High flow filters ... .

IV. Think of the answers to the following questions.

1. What can tuning help to achieve? 2. What can a desire to tune the engine be limited by? 3. What do they call modification in modern engines? 4. What did modification involve in nineties? 5. How is chipping done today? 6. What car engines are better tuned? 7. How may the work of a remapped engine change? 8. How log does remapping usually take? 9. How much on average does it cost to remap programmes? 10. Does chipping or remapping necessarily mean the loss of warranty? 11. Are some manufacturers also engaged in upgrading their vehicles? 12. How can the performance of the engine increase with a new high flow filter?

V. Translate the following paragraph ("In old days, bhp readings... at-the-wheel readings") in writing.

VI. Make up a plan (with key words and expressions, if necessary) and summarize the contents of the text.

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