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AN INCREDIBLE DRIVING SCHOOL

Not only do the cast of the *Fast & Furious* franchise have to fulfill their task by acting in front of the cameras; the majority of them have also had to show that they have the ability to drive cars as if they were experienced drivers. They do a lot of action scenes themselves, something that makes this franchise unique.

When the actress Jordana Brewster was offered the part of Mia Toretto in *The Fast and the Furious*, she was delighted. She liked the script, her character, and the possibility of working with actors like Vin Diesel, Paul Walker and Michelle Rodriguez. As soon as the director Rob Cohen explained to her the concept he had in mind for making the movie, she got even more excited. There was just one stumbling block that worried her a bit: in the script, there was a sequence in which, after having a romantic dinner with Brian O'Conner, her character tried to impress him by driving at top speed around the streets of Los Angeles. And this was a bit of a problem for her, as she had never driven a car in her life.

ESSENTIAL: HAVING A DRIVER'S LICENSE

Jordana thought that Rob Cohen might resort to a stunt performer to film this scene, or perhaps everything could be resolved with special effects. When she found out that the director wanted the stars of the film to get behind the wheel of their cars themselves, she turned pale. "As I'm from New York," the actress says, "I had never learned to drive and I had to get my license to be able to do the movie."

For the cast it was very clear that there were two essential requirements for taking part in *The Fast and the Furious*: being good actors and having a driver's license. But that wasn't all. Director Rob Cohen was not going to be satisfied with accepting that his actors knew how to park a car correctly. He also wanted them to be able to control a car at high speed and even do a few spectacular maneuvers, something that is not usually taught in a conventional driving school. But it is in a specialist one.

PUPILS ON WHEELS

Some weeks before filming began, Rob Cohen sent the main members of the cast to the Grand Prix racing

Before shooting *The Fast & the Furious*: All members of the artistic team had to undergo intensive training to familiarise themselves with the handling of the fastest cars.

PHILIP G. ATWELL

Born in 1974, Philip G. Atwell is a well-known American director who has worked for most of his career on advertising and music videos. He began his career in 1999, with the fantastic video that he shot for Eminem of his well-known song *My Name Is*. After that he remained closely associated with the career of this popular rapper, and he also worked with other artists like Snoop Dogg, Ice Cube and 50 Cent. In 2003 he was given the job of making *Turbo-Charged Prelude*, a short film that would act as a link between the feature-length *The Fast and the Furious* and the sequel, *2 Fast 2 Furious*. The short told the story of what Brian O'Conner did after the first film. So we saw him set off on a journey to different places in the USA after quitting the Los Angeles Police Department. Along the way Brian successfully took part in various street races until fate brought him to the city of Miami, where the second film in the franchise would begin. After this contact with the world of *Fast & Furious* Philip Atwell wanted to continue in the movies, and he worked as second unit director on *National Treasure* (2004) and its sequel, *National Treasure: Book of Secrets* (2007). Not long afterwards, he made his debut as a director, in *War* (2007), an action thriller starring Jason Statham and Jet Li, to date the only film he has directed.



CONTROL THE DRIFT

school, in the outskirts of Las Vegas. The aim was for them to be able to appear before the cameras as experienced drivers. Vin Diesel and Paul Walker, great fans of cars and driving, were the ones who most enjoyed the experience, and also the ones who got the most out of their lessons. Their instructors showed them the importance of coming off a bend at the right angle, or how to do a skid at full speed and avoid turning the car over, actions for which conventional drivers are usually unprepared.

Perhaps because she was the one least familiar with driving and cars, Jordana Brewster enjoyed the classes the most. It was all new to her. Among many other things, she learned the feeling of excitement that driving round a closed racetrack at almost 130 km/h gave her. Along with her colleagues, she also did several exercises to improve her reflexes. For example, their instructors made them drive round a track divided into three lanes, each of them marked with a traffic light. Initially, only one lane had a green light, while the other two remained on red to indicate that they couldn't drive in them. Then, the green light in another lane lit up to force them to change quickly.

Of course, the people who instructed the course at the Grand Prix racing school were real specialists. They showed them that driving on a racetrack requires great intelligence. It's not just a case of stepping on the accelerator. They shared all the secrets of their profession with the actors and they moreover taught them the technical jargon used every day on the tracks.

IMPORTANT DIFFERENCES

Both those who were more accustomed to driving and those who had spent little time behind the wheel understood immediately that there were clear differences between driving a car in the streets of the city and doing it on a closed track. The actor Rick Yune, who plays Johnny Tran in *The Fast and the Furious*, learned these big differences straight away. "On a racetrack you go in a straight line and then you get to the bend and have to turn hard right. Depending on how you take that bend, or how you use the space, you can win or lose a race."

Starting at seven o'clock in the morning, and for several days, the actors threw themselves body and soul into training to become racing drivers, holding competitions, simulations, and acquiring technical knowledge about how racing cars work. It was an absolutely unforgettable experience.

THE MOST COMPLICATED LESSON

For the cast of *The Fast and the Furious*, the main obstacle came when they had to learn to skid. They had to take a bend and let the car slide for some meters before braking fully. "There was a moment," says Yune, "when we were all skidding out of control. It's a bit tricky because you have to brake at the same time as you turn, so it's difficult to explain."

After repeating the maneuver over and over, the actors got the hang of it and in the end, they were able to meet their marks and stop a skid on cue.

READY TO FILM

"We decided that Las Vegas was the best place to learn this," Doug Claybourne, the executive producer of the movie, remembers. "Everyone who was going to have to drive this kind of vehicle, in front of or behind the camera, had to be familiar with their special features. It was educational and real fun. The two actresses from the east coast, Jordana and Michelle, barely knew how to drive but by the end they had mastered the art of doing stunts with their cars."

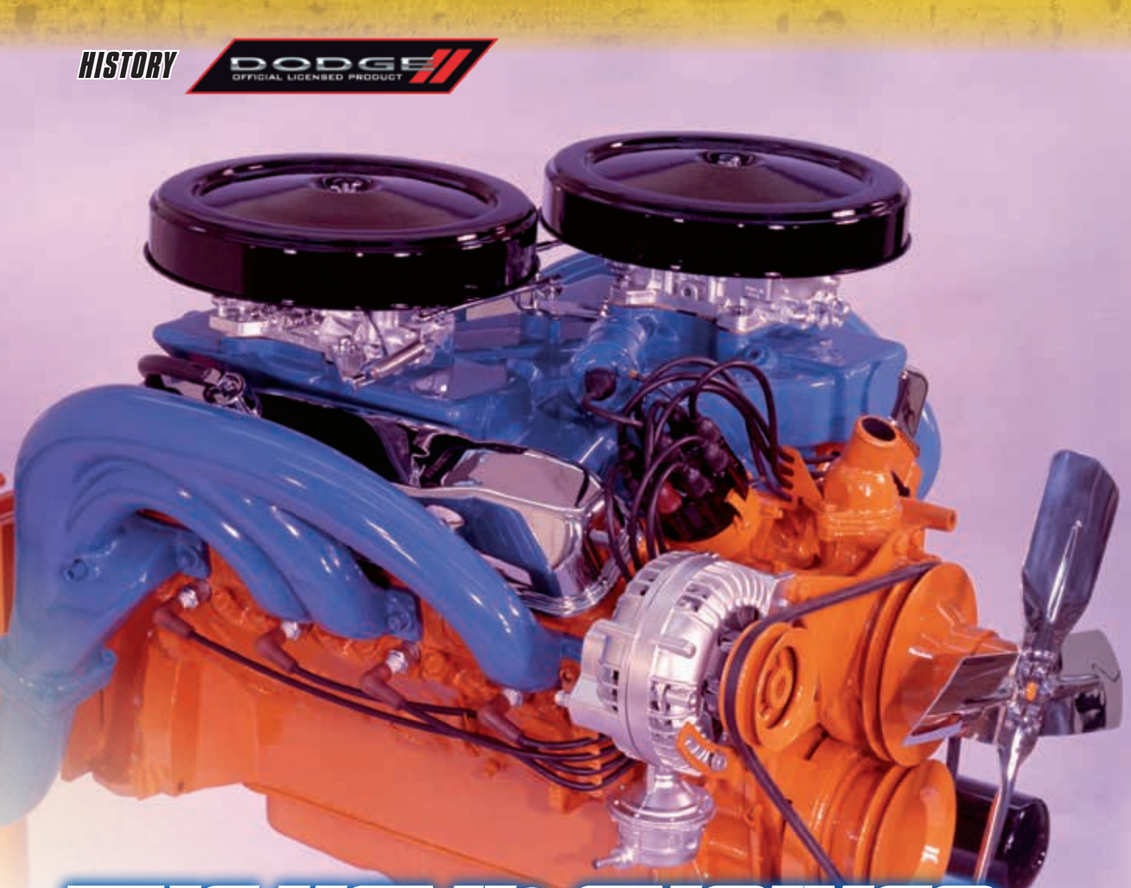
The cast of The Fast and the Furious arrived absolutely ready to film. Thanks to everything they had learned, they were able to get behind the wheel and do all the action scenes that the director, Rob Cohen, needed them to.



The driving lessons were given by a group of specialists in the surroundings of the Grand Prix driving school, located near to Las Vegas.



Actor Sung Kang, who plays Han in the series, also had to practice to be able to portray an experienced driver on the screen.



THE HEMI® ENGINES

Engines with a domed cylinder head are not exclusive to Dodge in particular or to the Chrysler Group in general, but nobody has managed to make them as popular as Chrysler did. Known by the name of HEMI®, these engines, built originally for racing, have always been one of the hallmarks of the most powerful Dodge cars.

The second generation of HEMI® engines was easy to recognise because of the block painted orange that betrayed its origins as a racing engine.

A domed cylinder head, namely, one in which the tops of the cylinders (where the sparkplugs go) are hemispherical, has some advantages with respect to flat cylinder heads. These include the possibility of mounting larger valves, which allow the engine to breathe more. They are housed in the cylinder head and they provide better combustion, distributing the heat inside the cylinder better. For this reason, they are able to offer greater power. Chrysler built its first HEMI® engine, which it nicknamed FirePower, in 1951. It was a 5.4-liter V8 engine to which it applied some of the experience picked up in the construction of aircraft engines during World War II. The second generation of HEMI® engines, already known by this name, dates from 1964 and it is without doubt the most famous one. With 7 liters of cylinder capacity and the block painted orange, these engines were initially developed for racing before they were fitted in many of the group's models, all of them sports cars. In the days of the muscle car, vehicles like the Dodge Coronet, Charger, Challenger, Dart Super Stock and Super Bee had HEMI® engines, just like the ones in the Plymouth Barracuda, Road Runner and GTX. In its road version it gave 450 SAE gross HP (about 350 net HP) and weighed 382 kilos. In 2003, Chrysler launched a new engine with a domed cylinder head that enabled it to recover the name HEMI®. It is available in different cylinder capacities and is still used, for example, in the Dodge Challenger.



The current Dodge Challenger HEMI® has an engine with domed cylinder heads. One of the problems with this kind of engine is that it cannot have four valves per cylinder.



ASSEMBLING THE ENGINE BLOCK (VI)

In this assembly session, we will show you how to mount the header tubes onto the left side of the engine, corresponding to cylinders 1, 3, 5 and 7. Follow the instructions and the illustrations carefully.

Editor's note: The parts shown here may differ slightly from the parts supplied with this issue. This does not affect the quality or the assembly instructions in any way.

PIECES FOR THIS STAGE



















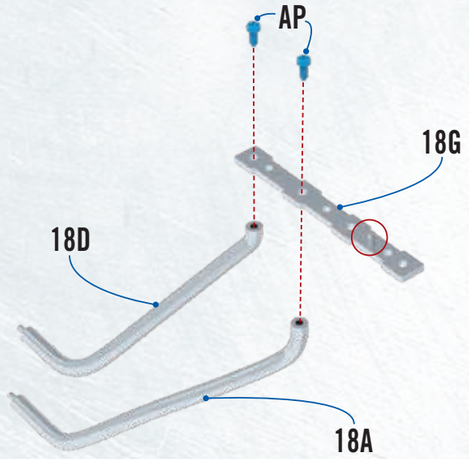
18A Header tube cylinder 5
18B Header tube cylinder 1
18C Header tube cylinder 3
18D Header tube cylinder 7
18E Tube connector
18F Exhaust collector
18G Left bank manifold gasket
AP Screws 1,7 × 4 mm, (x 6)*
CM Screws 1,7 × 3 mm, (x 4)*

* Some of the parts are spares.

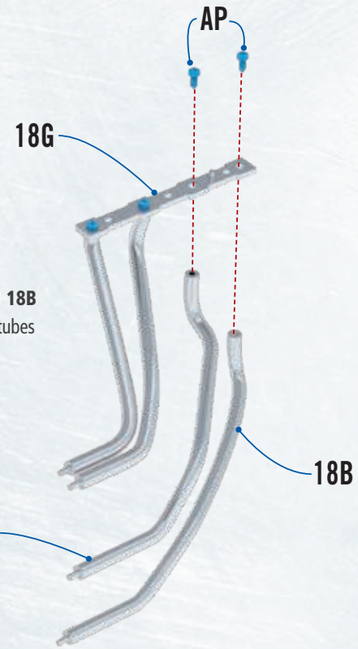
ASSEMBLY AREA



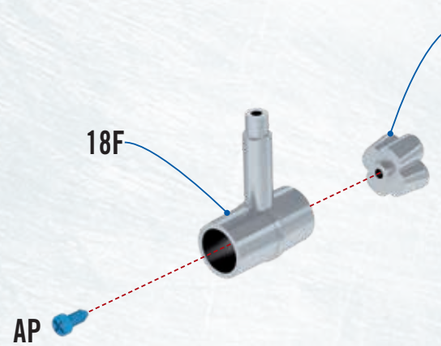
ENGINE BLOCK



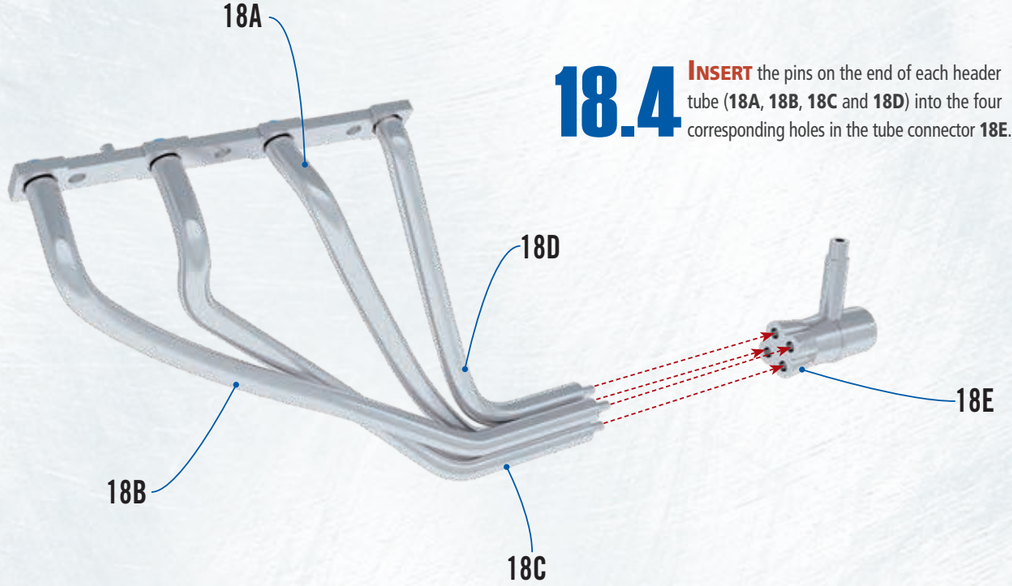
18.1 **TAKE** the manifold gasket **18G** and position it as shown in the illustration (the small pin indicated with the red circle should be facing upwards). Attach the header tube for cylinder 7 **18D** and the header tube for cylinder 5 **18A** to the gasket, using two **AP** screws. ◄



18.2 **ATTACH** the header tube for cylinder 3 **18C** and the header tube for cylinder 1 **18B** to the header gasket **18G** in the same way. The free ends of the two header tubes should be facing the same way. ►

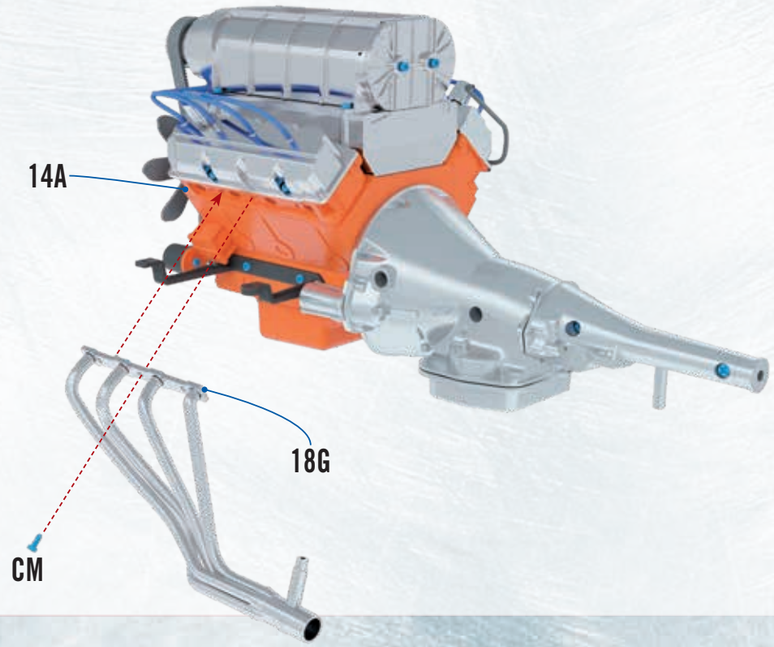


18.3 **WITH** the pieces facing the same way as those shown in the illustration, join the tube connector **18E** to the exhaust collector **18F**. Use an **AP** screw to fix in place. ◄

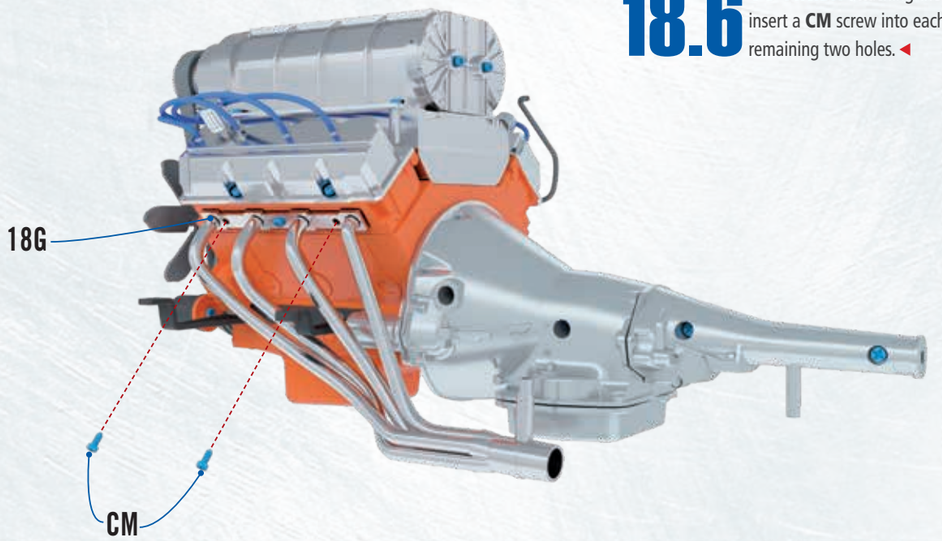


18.4 **INSERT** the pins on the end of each header tube (**18A**, **18B**, **18C** and **18D**) into the four corresponding holes in the tube connector **18E**. ◄

18.5 **POSITION** the left bank manifold gasket **18G** onto the left cylinder head, just underneath the valve cover. The small pin on the gasket must be inserted into the corresponding hole in the left cylinder head. To join the pieces together, insert a **CM** screw into the middle hole in the gasket. ▼



18.6 **To finish** attaching the gasket, insert a **CM** screw into each of the remaining two holes. ◄



STAGE 18 FINAL RESULT



You have now installed the header tubes onto the left bank cylinder head. Put what you have built in a safe place.

THE PISTON, HEART OF THE ENGINE



The piston is one of the most important components of any engine. In a car, its purpose is to transfer the force from explosively expanding gas in the cylinder to the crankshaft via a connecting rod, and from there to the gearbox and the wheels.

Pistons do not have a comfortable life. They are subject to enormously powerful thermal and mechanical pressures. The cylindrical pieces of aluminium inside your engine live in a fiery hell. At 6000rpm, a piston in a petrol/gasoline engine can be subjected to nearly 10 tons of force every 0.02 seconds as repeated explosions heat the metal to more than 600 degrees Fahrenheit (315°C). Its shape is more complicated than it seems, and its structure is very sophisticated. In general, pistons are not designed and manufactured by carmakers themselves, but by specialised companies who develop and produce components for internal combustion engines. Compared to the pistons that used to power even racing cars during the last

The design of a piston head has an impact on its performance. When an engine is tuned correctly, consideration should be given to the pistons.

The piston, heart of the engine

century, today's versions are very high-tech pieces of equipment. They are designed using the latest computerised design technology and tested in simulated operating conditions before they ever become a reality.

THE PISTON STRUCTURE

A piston is not a single piece of technology. It is made up of several different components. Each one has been carefully designed to perform optimally, according to the type of engine in which it is used. The body of the piston is made as a single piece, and is divided into different sections:

The top, or crown of the piston, can be smooth and flat, or it can have different shapes moulded into it. Sophisticated computer modelling and more precise manufacturing methods enable more-complex shapes. Bowls, domes, and valve indents needed for clearance can be included in the design, as well as shapes that aim to achieve a particular compression ratio. Turn the piston upside down and notice the sides, or skirt, of the piston. The walls are surprisingly thin and are made with very fine tolerances, scarcely more than 0.1 inches thick.

Thin walls demand a perfect understanding of the thermal expansion of an object that sometimes has to warm from below freezing to several hundred degrees in a matter of seconds. The piston is not tightly fitted inside the cylinder but has a certain amount of play that is taken up by the piston rings. The head of the piston has grooves around the top of the skirt. This is where the piston rings slot in, and act as a gas seal between the piston head and the walls of the cylinder. Their job is to minimise pressure leaks between the combustion chamber and the crankshaft area.

The rings fit loosely into the grooves, and they are not a complete circle but have a small gap in the circumference. The gap allows the ring to flex slightly, acting like a spring that keeps it tight against the cylinder walls.

There are essentially two types of piston ring – the upper rings have solid faces and provide gas sealing – they are called "compression rings". Lower rings have narrow edges and a U-shaped profile. They act as oil scrapers which control the amount of oil on the cylinder wall. There are many proprietary design features associated with piston rings.

In most cases, mass-produced pistons are made of molten aluminium which is poured into a cast-iron mould. Sports pistons, on the other hand, are usually forged.





THE HEAD

The head of the piston is the "moving floor" of the combustion chamber. Therefore its geometry is of fundamental importance in ensuring maximum performance. The cylinder sleeve guides the piston vertically inside the cylinder barrel, but there is also a small amount of lateral movement derived from the inclination that the connecting rod adopts during the rotation of the crankshaft. This is another function of the loose-fitting piston rings that have enough lateral movement to contain the compression at all times.

In the crown of pistons intended for higher-performance engines, there are often indentations that correspond to the position of the inlet and exhaust valves. They can be seen with the naked eye. As the piston and the valves approach each other at high speed and with tiny margins for error, the grooves always keep a safe distance between the two. A collision would be catastrophic. This sometimes happens when the timing belt, that controls the movement of the camshaft and the valves, breaks and the proper timing is lost. Pistons can smash into valves at high speed, causing expensive damage to the engine. Some people like to tune their car engines by modifying the camshafts to make the valves open and close more efficiently. In this case, they would probably install special pistons with milled or moulded crowns that allow increased clearance. The piston head is connected to the crankshaft by a connecting rod shaft or "con rod". Together with the crank, the connecting rod converts the reciprocating motion of the piston into the rotation of the crankshaft. The connecting rod is required to transmit the compressive and tensile forces from the piston, and rotate at both ends.

A connecting rod for an internal combustion engine consists of the "big end", and "small end". The small end attaches to the gudgeon pin (also called "piston pin" or "wrist pin"), which swivels inside the piston head.

The big end connects to the crankshaft using a plain bushing to reduce friction.

During each rotation of the crankshaft, a connecting rod is subject to powerful and repetitive forces. There are shear forces due to the angle between the piston and the crankshaft, and compression forces as the piston moves downwards. Failure of a connecting rod, often called "throwing a rod", is one of the most common causes of catastrophic engine failure in cars. Sometimes the broken rod can perforate the side of the crankcase, thereby rendering the engine irreparable.

Excessive wear on the big-end bearings can cause the typical "knocking" noise heard in many old engines.



The image shows how the forged pistons of sports models have a lower height to width ratio compared to those used by mass-produced cars.

THE LATEST DEVELOPMENTS

In line with modern trends, the relationship between the height and diameter of the piston head is becoming smaller, which means a reduction in mass and friction. Today, a series-built engine for a high-performance model can even have a lower ratio than that used for pistons in a racing car just a few years ago. If years ago the piston had the classic shape of an inverted cup, today the material around the gudgeon pin has been reduced to the point that the skirt is often reduced to two simple guide shoes. Additionally, the width of the gudgeon pin guides has been reduced, resulting in a much shorter pin. This has the twin advantages of reducing weight and also creating a much stiffer connection. Formula 1 engines are the most extreme example: since the turbo era, ultra-lowered pistons are used, whose height-to-diameter ratio is below 0.32, while in a super sports car, for example, it is usually 0.70.

Forged versus cast

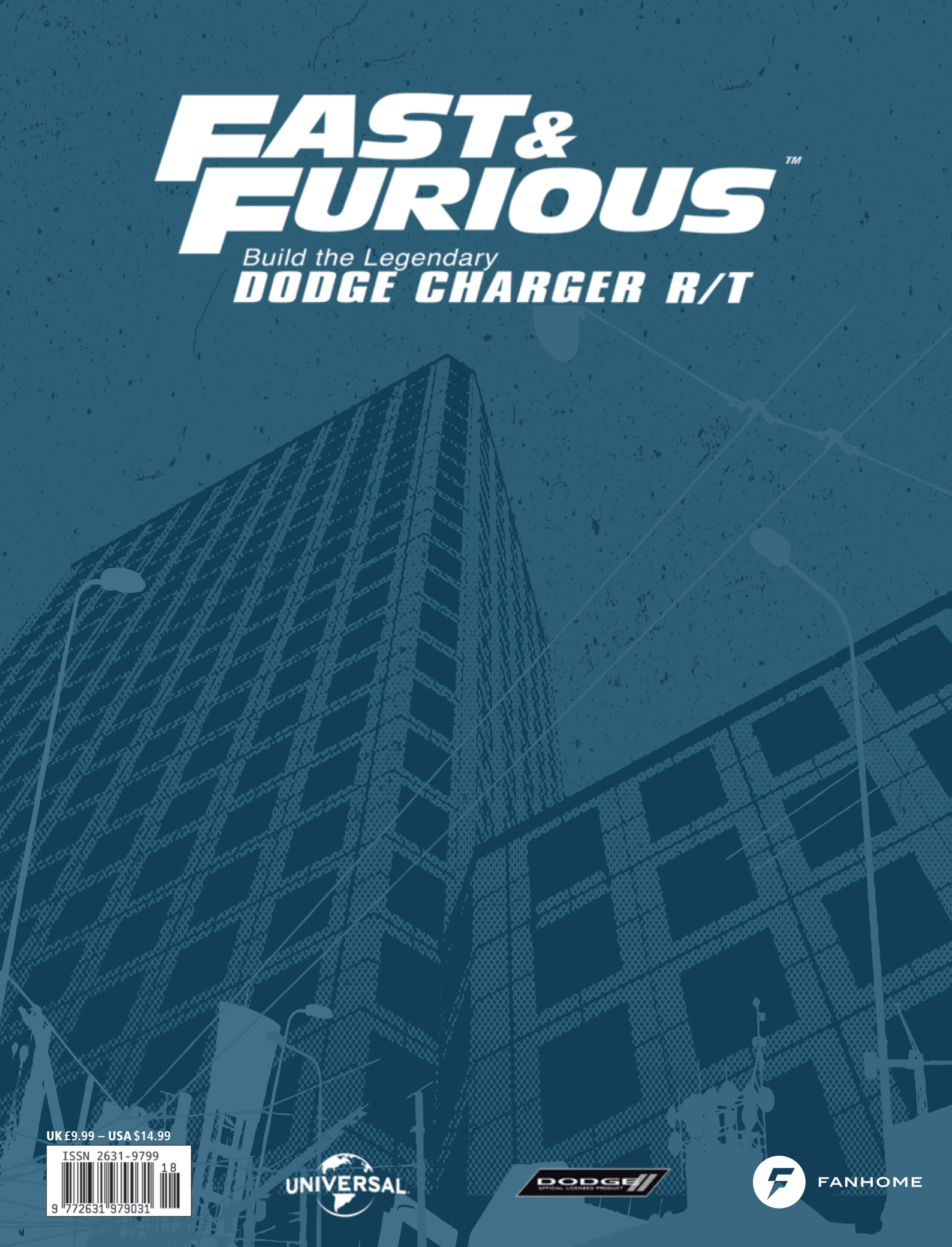
The strength of the pistons depends on both the design and the characteristics of the material. Today, low-density aluminium alloys are used, which allows the manufacture of lighter parts with high thermal conductivity – a significant factor. Not all alloys are the same and may differ in their characteristics: For the production of pistons, alloys incorporating silicon and other elements are often used. Different production methods create different types of pistons. Pistons intended for standard engines are cast. Metal, in a liquid state, is poured into a mould. It is a simple and economical process and allows for cheaper pistons (photo 1). In contrast, pistons intended for racing engines are stamped out from a single block of aluminium (photo 2). This more expensive procedure makes lighter pistons that are stronger.

Hypereutectic pistons are a mid-level compromise between cast and forged pistons. During the casting process, a silicon mix is added to the molten aluminium before cooling. This silicon gives the pistons increased strength and improved thermal characteristics, so there is not as much thermal expansion during engine operation. As you can see, making the right choice is vital if you are tuning an engine designed for high performance. This is why piston manufacturers recommend the use of forged pistons for cars that will be subjected to extreme conditions.



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