



PAGID

BRAKE SYSTEMS

**TWO-PIECE
BRAKE DISCS
IN A VEHICLE**



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Ever since the disc brake system was introduced into cars, the brake disc has been a significant structural component in automobile construction. Together with the brake pad, the brake disc forms a friction pairing subject to wear and, consequently, it has to withstand extreme load conditions.

Heavy-duty or more powerful vehicles require a larger-dimensioned brake system. For this reason the diameter of the brake discs for vehicles of this kind is bigger and so is the thickness of the brake disc chamber.

When subjected to a high level of thermal load, such brake discs are susceptible to deviations like variations in thickness, axial misalignment and in shielding.

In these cases two-piece brake discs, also called composite brake discs, offer distinct advantages. Thanks to the diverse materials and special binding processes used in their manufacturing, these discs allow a decoupling of the heat flow to the wheel hub.



Hella Pagid two-piece brake disc



Joints with stainless steel rivets

MATERIAL AND CONSTRUCTION

When brakes are applied, the brake discs are subjected to a high level of mechanical stresses. Not only do they have to withstand compressive, tractive and centrifugal forces but they are also required to handle thermal load. In order to achieve the best possible results in every kind of braking situation, the material composition of the brake disc has to be tailored to suit the brake system.

Depending on the vehicle type and the area of application, brake discs made of flake graphite (e.g. grey cast iron GG15) are, for the most part, set as a standard in series production. The properties of grey cast iron can be improved by adding the most diverse kinds of alloying elements to this metal. Molybdenum and chrome enhance the hot crack behaviour and the abrasion resistance of the alloy. Thermal absorption is improved by raising the alloy's carbon content.

Two-piece HELLA PAGID brake discs consist of a brake disc chamber made of aluminum and a friction ring out of grey cast iron that has a high carbon content. Both components are secured at the joint with stainless steel rivets in order to guarantee the transferability of relatively high torques and also to ensure that, as the temperature rises, the friction ring can axially expand independently of the disc chamber. The result is that thermal stresses are minimised and any heat cracks appearing at the point of transition from the friction ring to the disc chamber are reduced.

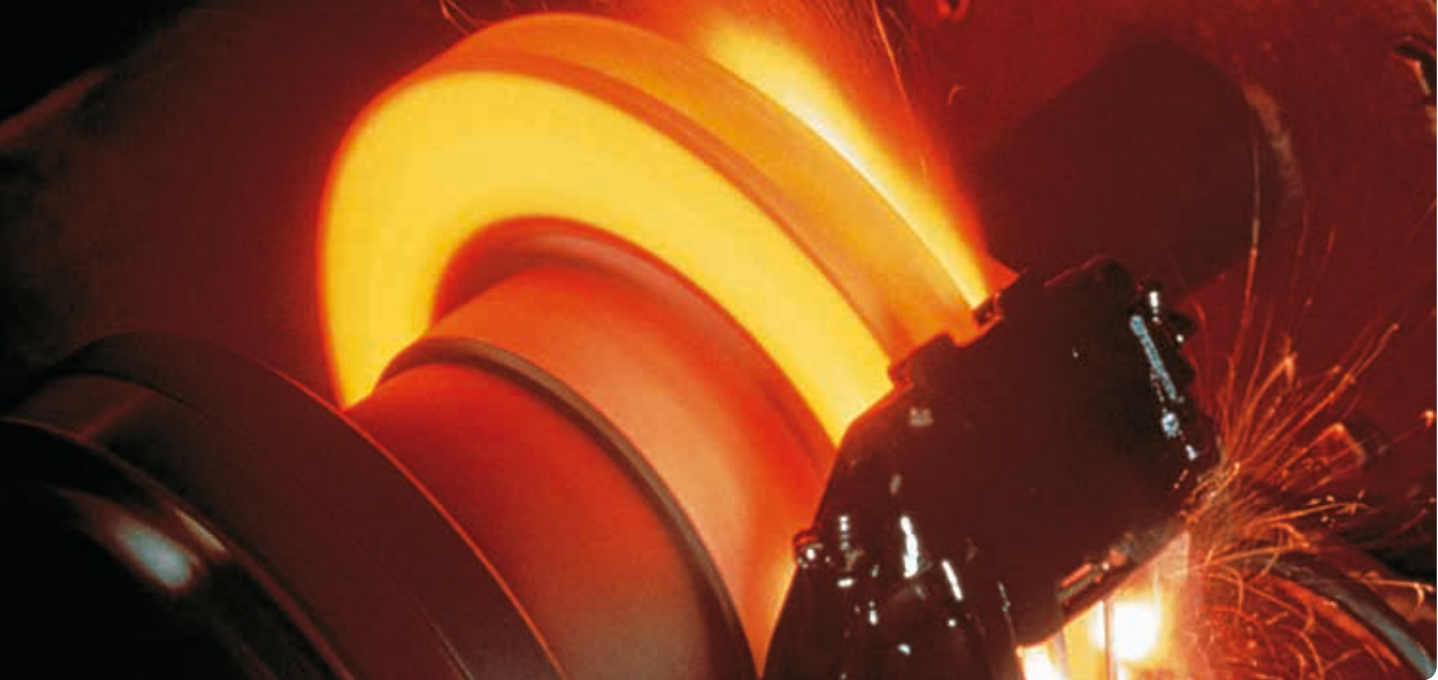
And as a result of using aluminium in the makeup of the brake disc chamber, the weight of the brake disc is additionally reduced by up to 20%.

Apart from the reduction in weight, these brake discs also boast the following advantages:

- Reduction of fuel consumption and therefore verifiable CO2 savings
- Enhanced heat conductivity reduces thermal distortion or warping and minimises brake judder
- Higher load resistance
- Scaling down of noises and/or vibrations as a result of the decoupling of the friction ring and disc chamber
- Ramping up of driving performance thanks to the reduction of unsprung mass of the brake system

By means of an appropriately tailored design, it is possible to significantly improve the efficiency of a brake disc.

The only disadvantage that can be mentioned is the rather complex production process, which is brought about by the performing of various binding processes involving all the diverse materials.



During the braking action, kinetic energy is converted into thermal energy by means of the friction created. Up to 90% of this converted energy is absorbed by the brake disc and then emitted into the ambient air. Thus, under extreme conditions, temperatures reaching as high as 700°C can prevail at the wheel brakes.

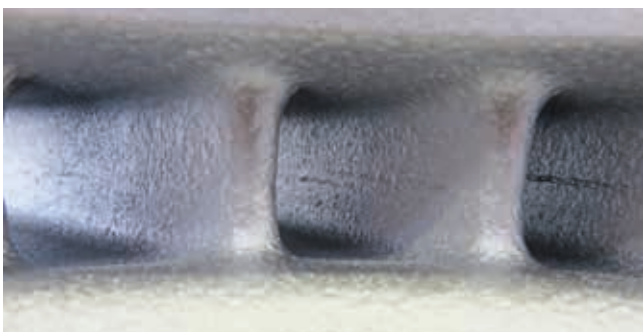
As well as being affected by physical stresses and strains, brake discs are also exposed to environmental influences, to dirt, water and salt. All these issues have to be factored into the equation when structural design is being planned by the manufacturers of brake discs.

The two-piece brake discs are internally ventilated and, therefore, because of their greater mass they possess better heat storage capacity and they also cool down more quickly through the air flow in the channels. These radial channels are located between the two friction rings. The rotation of the brake disc brings about a fan effect, which then creates a permanent air flow throughout the brake disc.

An added feature is that two-piece brake discs can also have slits or grooves or they can be axially perforated. Brake debris, water and dirt gather in the slits or grooves and such material is propelled outwards by the rotary movement.

The axial bores increase heat dissipation, but they are only slightly self-cleaning as brake debris can accumulate in the holes.

In order to combat corrosion, these brake discs are usually given a protective coating. The type of coating given depends on each individual manufacturer but it can entail the spraying on of a non-electrolytic, silver grey dispersion layer. And, at the same time, this means that the optical effect in the exposed rim area of the wheel brake is enhanced. If the brake disc is completely coated, it is recommended that a moderate amount of running in should take place until the brake pad and the disc adjust to each other and the coating on the friction ring has worn away through the friction action.



Radial cooling channels of an internally ventilated brake disc

DIFFERENT VARIANTS

Depending on the vehicle manufacturer, two-piece brake discs can be quite different in design, in their material composition and when it comes to the binding processes used in their production.

The connection between the aluminium disc chamber and the grey, cast iron friction ring can also vary according to the manufacturer. Here it is possible for special casting, bonding or pressing procedures to be used and mechanical connections with rivets, clips, pins or screws can also feature.

On some of its vehicle models, Mercedes Benz uses composite brake discs with a disc chamber made out of sheet steel and a friction ring of cast iron. By means of a special construction, i.e. a toothed design, both components are joined together in a press fit assembly. The toothed profile of the brake disc chamber's outer casing half engages the matching toothed profile on the friction ring in order to bring about torque transmission. The brake disc chamber made of sheet steel is only 2.5 mm thick. A classic brake disc chamber usually has a wall thickness of 7.5 to 9 mm.



BMW composite brake disc with riveted aluminium disc chamber



Mercedes Benz brake disc with splined disc chamber of sheet steel



Audi ceramic brake disc

Brake Discs for Motor Sport

For cost reasons, multi-piece brake discs made of ceramic or carbon are only installed in vehicles intended for motor sport or in highly-priced luxury cars.

Apart from their low weight, long service life and good response behaviour, another one of their advantages is minimum brake fade.

However, because of their less effective heat conductivity, these brake discs require special brake pads which counterbalance this somewhat negative feature.



Testing lateral runout (judder) with a dial gauge

CHECKING WEAR AND TEAR

On account of the high mechanical and thermal load on such components, the state of the composite brake disc - just as is the case with conventional one-piece brake discs - should be checked at regular intervals as stipulated by the manufacturer.

The wear limit of the brake disc is also an issue that is fixed by the manufacturer on the basis of the minimum thickness of the friction ring. This value in millimeters is stated or stamped on the brake disc's outer edge or on the disc chamber.

In addition, the generally applicable testing procedures for brake discs can also be carried out on these occasions. This would include checking radial runout (judder) and thickness deviation (differing disc thicknesses).

The appropriate tolerance values are fixed by each individual vehicle manufacturer and are to be strictly observed.



Indication of the minimum thickness on the edge of the brake disc



Prepared contact surface on the wheel hub

MAINTENANCE HINTS AND TIPS

So as to ensure perfect functioning of the brake system, we recommend the following hints and tips:

- Brake discs should always be replaced in pairs
- Always install new brake discs with new brake pads
- The contact surface of the wheel hub should be flat, burr-free, clean, rust-free and undamaged
- When working with internally ventilated brake discs, observe the direction of movement
- Observe the specified tightening torque
- Because brake discs and brake pads first need to adjust to each other, use the brakes with moderation for a running-in period. Comply with the vehicle manufacturers' run-in instructions
- Pay careful attention to the product-specific instruction leaflet and to the repair and safety instructions supplied by the vehicle manufacturers
- Repair work on the brake system should only be carried out by trained staff

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