

MAHLE n e w s

A F T E R M A R K E T

MAGAZINE FOR TRADE, WORKSHOP AND ENGINE REPAIR

When the question about the main topic for the next issue of the **MAHLE Aftermarket news** was considered at the last editorial meeting, it soon became clear: this time there will be two. First the commercial vehicle business, whose increasing sales figures can be regarded as a barometer for the industry, has been given the appropriate space in this issue – in the motorsport report, our technology double page and in connection with cabin air filters, the “topic of the season” that is gaining more and more importance in the commercial vehicle sector. In addition, we have news of our own: the

latest acquisitions of the MAHLE Group, in particular the engine component section of the Dana Corporation, which is of special interest for the aftermarket. We report about this in the editorial – and more on page 3. What else have we found out, photographed and illustrated for you? Our engine component experts have investigated the topic “cavitation” for you, our team of reporters has spoken with the Portuguese trading company Auto Delta... and finally, we have looked over the shoulders of our film crew. With this in mind – please enjoy reading the new **MAHLE Aftermarket news!**

2/2007

IT IS HUMMING!

THE COMMERCIAL VEHICLE: ENGINE FOR ECONOMY AND INNOVATION.

More about this, for instance, on pages 4, 7 and 12/13!

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Arnd Franz, General Manager
MAHLE Aftermarket

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MAHLE
Filter



Dear readers



Arnd Franz,
General Manager
MAHLE Aftermarket.

In the past weeks, the MAHLE Group has provided plenty to talk about in the industry – due to a number of acquisitions. These new additions to our group are of relevant importance to our customers in the aftermarket, with their products, technologies and market presence.

With the acquisition of the Dana engine component business, MAHLE Aftermarket has gained additional sales and distribution channels in important markets in the world and has increased the product range in all essential engine component lines, in particular in piston rings and bearing shells. This is complemented by a number of well-known and respected brands such as Perfect Circle®, Clevite® and Glacier Vandervell™.

Part of this acquisition is the distribution centre in Poissy/France, now renamed MAHLE Aftermarket SAS: a highly productive site with an attractive product range – sold in many countries of Europe, North Africa and the Middle East by a team of customer and market-oriented employees with excellent engineering background.

The acquisition of the air filter business of Siemens VDO is initially more of interest for MAHLE original equipment customers. However, in the course of expanding our market position as leading supplier of air management systems for the automotive industry, we are also establishing a clear position in the aftermarket: as suppliers of air filters that meet the quality demands of the respective vehicle and engine manufacturers.

Additional important projects have been the acquisition of two leading valve manufacturers in Argentina and China. These will contribute to our continuous initiative to broaden our engine valve range in South America and Asia as well as complement our range in Europe.

We regard it as our central task, to develop our new activities continuously, to integrate them into our network, to win the confidence of our new customers and to allow all partners of our company to take part in the advancements and synergisms.

Also in the existing spare part business, MAHLE is active with many products. The continuous boom in the commercial vehicle sector, driven by the dynamic world economy and an associated increase in transport requirement, demonstrates the growing importance of our product range in the commercial vehicle sector. The worldwide production of commercial vehicles increased by 4 % or 368,000 units to 10.5 million vehicles from 2005 to 2006 alone. The relevant growth impetus came from Eastern Europe, North America and Asia.

In addition to the broad and well-established product range of engine components for use in commercial vehicles in Europe, MAHLE has significantly boosted the development of filter products for commercial vehicles during the past months – from fuel filters to cabin air filters. This provides our engine component customers also with the suitable filtration solutions in original equipment quality. At the same time, the range of our American and Asian production sites is extended according to the demands of the markets.

Our customers benefit therefore from the growth of the MAHLE Aftermarket due to further expansion of our product range, our enhanced presence and extended service. Uncompromising product quality, supported by a strong brand image will always remain the guideline of our actions.

Please enjoy reading our new **MAHLE Aftermarket news!**

Arnd Franz



A WIDE

PRODUCT RANGE, OPTIMISED LOGISTICS, SHORTER DISTANCES

HOW MAHLE CUSTOMERS BENEFIT FROM THE ACQUISITION OF THE ENGINE COMPONENT SECTION OF THE DANA CORPORATION.

The MAHLE Group: in the top 30 automotive suppliers, one of the leading producers of components and systems for combustion engines and their peripheral equipment, with an international distribution network and renowned brands – such as MAHLE Original, MAHLE Filter and Knecht in the European aftermarket. On an expansion course – with the aim to satisfy the growing demands of its international customers for a wider and wider engine component range.

At the other side: the engine components section of the Dana Corporation – with a total of 39 sites in 10 countries, about 5,000 employees and an aftermarket distribution network for the piston ring brand Perfect Circle® and the bearing brand Glacier Vandervell™ as well as the trade organization Clevite®. With a parent company under bankruptcy proceedings, needing liquid funds – and therefore prepared to dispose of its engine component section.

These were the general conditions early this year – ideal conditions for reaching an agreement about the acquisition of all units of the Dana engine components section worldwide by MAHLE. The acquisition took place in March 2007.

A PERFECT ADDITION

The result is a successful extension of the MAHLE Original product range. This is because Perfect Circle® boasts a range of about 2,400 piston rings in original equipment quality in Europe – in particular for the vehicles of Peugeot,

Citroën and Renault including Renault Trucks. Glacier Vandervell™ comprises about 1,800 bearings in original equipment quality, covering mainly the commercial vehicle applications of Renault Trucks, Iveco, Scania and Volvo.

WHAT WILL CHANGE REGARDING THE BRAND NAMES?

Nothing! The brand names Perfect Circle® and Glacier Vandervell™ will be retained where they are already established – only the packaging will be changed to the international MAHLE packaging design. In addition, piston rings and bearings will gradually also be sold under the brand name MAHLE Original in all countries. MAHLE Original will remain our worldwide brand for engine components – and also for piston rings and bearings.

WHAT ARE THE BENEFITS FOR SALES AND MARKETING?

With this acquisition, MAHLE Aftermarket has two additional efficient logistics centres at its disposal, with ideal locations in the centre of Europe: Poissy/France for Perfect Circle® and Trento/Italy for Glacier Vandervell™. This ensures smooth and even faster delivery and optimum availability of the complete MAHLE Aftermarket range to trade and workshops.



In focus: DAF XF 105, the "International Truck of the Year 2007".

EUROPE'S NEW KING OF THE ROAD

AND THE WINNER IS ...

It took surprisingly little time for the 20-strong jury to agree: the Europe-wide title "International Truck of the Year 2007" has been awarded to the DAF XF 105. And indeed, the truck sets new standards in respect of efficiency, transport capacity, interior trim, ergonomics and handling. A powerhouse – and a worthy king of the road.

EVOLUTION INSTEAD OF REVOLUTION

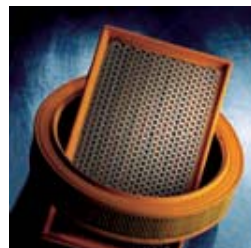
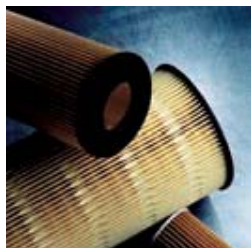
Not to change everything, but to improve many things – this is the basis for the exterior design of the new DAF XF 105. Distinctive stylistic elements of the successful predecessor XF 95 have been retained. However, the more prominent radiator grille that has been integrated in the new steel bumper, the clear styling and the completely newly designed Super Space Cab – equipped with cabin air filters from MAHLE – make the new XF 105 unique.

POWER AND ELEGANCE

The truck gets its power from a newly developed 12.9 l PACCAR-MX engine that is initially available from 300 kW/410 hp to 375 kW/510 hp. The eye-catcher of the engine is the plastic cylinder head cover manufactured by MAHLE. Cylinder liners, valve guides, valve seat inserts and roller tappets from MAHLE help to take care of the necessary driving power.

MAHLE ENGINE COMPONENTS AND MAHLE FILTERS ARE USED IN VEHICLES AND ENGINES OF THE FOLLOWING BRANDS.

Alfa Romeo, Audi, BMW, Case New Holland, Caterpillar, Citroën, Cummins, Daewoo, DAF, Deutz, Ducati, Ferrari, Fiat, Ford, General Motors, Harley Davidson, Hatz, Honda, Hyundai, Isuzu, Iveco, Jaguar, John Deere, Komatsu, Lancia, Land Rover, Mack, Magna Steyr, MAN, Maserati, Mazda, Mercedes-Benz, Mitsubishi, Moto Guzzi, MWM, Nissan, Perkins, Peugeot, Porsche, Renault, RVI, Saab, Scania, Seat, Škoda, Smart, Steyr Daimler Puch, Stihl, Suzuki, Toyota, Volkswagen, Volvo, Zettelmeyer.





1 ŠKODA OCTAVIA SCOUT

It finds its way – also through inhospitable terrain: the new Škoda Octavia Scout. Four wheel drive, 40 mm more ground clearance, under-run guard at front and rear as well as newly designed bumpers front and rear serve only one purpose: to make the new estate from Škoda fit for almost any terrain. Also on board: MAHLE pistons, piston rings and pins, connecting rods, valves, valve guides and air filters.

2 MERCEDES-BENZ C-CLASS

Already at the first glance, looking at the new Mercedes-Benz C-Class is a pleasure: concise styling, wide radiator grille and a distinctive rear section. And as usual, the new version is a little larger than its predecessor: exactly 5.5 cm longer and 4.2 cm wider. A choice of 5 petrol and 3 diesel engines will be available towards the end of the year – on tour with oil filter modules and oil filter elements, carbon canisters, oil mist separators, air filters, camshafts, valves, valve guides and valve seat inserts, pistons, piston pins as well as cylinder liners from MAHLE.

3 VOLVO C 30

A tailgate completely made from glass – that was offered by Volvo once before, at the beginning of the 70s. However, this is all that could be said about any retro aspects of the new Volvo C 30. No wonder, since the manufacturer likes customers to see the compact car as a “choice for individualist with youthful thinking”. This is also reflected in a rather lively engine range – backed-up by oil filter modules, pistons, piston rings and pins, connecting rods, cylinder liners and camshafts made by MAHLE.

4 PEUGEOT EXPERT VAN

Ample room for all passengers – this is only one of the advantages offered by the new Peugeot Expert Van. In addition, a comfortable interior and a powerful engine range are featured. The new family van, which offers space for up to 8 people, is powered by a 2 l petrol engine with 100 kW/136 hp for instance. Also on board are MAHLE pistons, piston rings and piston pins – complemented by camshafts, cylinder liners, fuel filters and oil filter modules from MAHLE.

5 VW CROSS GOLF

The Golf Plus has moved into the all-terrain sector – as Cross Golf. On the rocky road it has been fitted with modified plastic components such as wheel arch widening, a new front apron with a hint of under-run guard, a similar apron at the rear, cladding at the sides as well as prominent roof rails. The engines under the bonnet of the Golf Plus are equipped with pistons, piston rings and piston pins, connecting rods, valves and valve seat inserts, air filters and oil filter modules from MAHLE.

6 AUDI TT ROADSTER

The new Audi TT Roadster is unmistakably a progression from its successful predecessor – but it also sets its own accents with its athletic lateral line, the powerful rear section and a new material combination of aluminium and steel that makes the vehicle lighter. Initially it will be available with a 2 litre TFSI engine with 147 kW/200 hp as well as a 3.2 litre V6 engine with 184 kW/250 hp – backed-up by air intake modules, oil filter modules, oil mist separators, camshafts, valves, valve guides, pistons, piston rings, piston pins and bearings from MAHLE.

7 TOYOTA AURIS

A powerful front, a dynamic shoulder line and only little body overhang – just its visual appearance positions the new Toyota Auris as a powerhouse in the compact car sector. Its unusual name is actually a derivation of the Latin word for gold: “aurum”. Nomen est omen – this might be what the Japanese car manufacturers thought. The Golf competitor is available with a choice of 2 petrol and 2 diesel engines, covering a power range of 71 kW/97 hp to 130 kW/177 hp – and this with MAHLE pistons and piston pins.

8 NISSAN QASHQAI

Unconventional to the last detail – this is how the Nissan Qashqai presents itself: the upper body half is reminiscent of a sporty passenger car and the lower half of an SUV with its distinctive wheel arches and increased ground clearance. A choice of two powerful petrol and diesel engines take care of the relevant driving power. Also here, it is worth looking at the detail: MAHLE connecting rods and valve seat inserts operate in the combustion chambers.

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ALWAYS UP-TO-DATE

The worldwide presence at trade fairs important to the automobile spare part market contributes decisively to the success of MAHLE – as this is where the Who's Who of the automotive industry, the component trade and the motor vehicle trade come together. An exhibition stand provides the optimum platform for active customer care. Here we can inform about market trends, product innovations and the current filter and engine component range as well as give tips for the daily routine in workshop and sales and point out opportunities for sales increases. In addition, trade fairs are ideal settings for building or strengthening contacts with sales partners – and finally for sharpening the whole of the MAHLE brand profile.

Due to globalization, the MAHLE strategists are faced more than ever with a difficult decision: the question of the "where". Participation at certain trade fairs has simply been a must for the industry for years. However, new markets open all the time worldwide – and with that, new sales prospects. In this kind of situation, only companies that can get their names established early on in the region and can build up an effective distribution network can have a real chance of success. Here a selection of the most important international trade fairs from March to May – with background information about the respective markets and their key features.



9-11 MARCH 2007 IN STUTTGART

At the "Retro Classics", one of the most important trade fairs for classic cars in Germany, MAHLE was represented at almost any corner. To be more precise: in the engines of many classic cars. And this exactly with the pistons, cylinders and assemblies that were fitted when the cars left the factory in those days – an important condition if their value needs to be retained. The interest in the MAHLE stand was accordingly large. This is also where the new Special Edition 2007 catalogue was available – with a selected range of MAHLE Original engine components for road registered classic cars, rare sports cars and exotic cars. You want to know which piston fits the Porsche 356 and you don't have the new reference work at hand? Just click on www.mahle-aftermarket.com – the answer will also be provided by the module "Search the online catalog".



2-5 APRIL 2007 IN ALGIERS

The Equip Auto Algeria with an exhibition surface area of more than 10,000 sq. m. is gaining more and more in importance. This is because Algeria

and the region offer new opportunities for the motor vehicle spare part market: thanks to a liberalization of import regulations, increasing buying power, a steadily growing vehicle population and a high average vehicle age – matched by the respective requirement for spare parts. Technical information regarding maintenance and repair of European vehicle models with MAHLE spare parts was especially in demand at the MAHLE stand in Algiers – except from some heavy lorries, only import vehicles can be found on Algerian roads.



9-13 MAY 2007 IN MADRID

More than 2,000 participating companies from 24 countries, 50,000 sq. m. exhibition surface, more than 50,000 trade visitors – an impressive outcome for the last Motortec. The Spanish motor vehicle sector continues on its success course: 2.7 million vehicles produced annually, about 2 million vehicle registrations and a correspondingly high number of workshops (about 48,000). MAHLE will provide information about its complete product range at a stand of 130 sq. m. Key areas will be the extended valve range and the cabin air filter range – important performers for workshops. Will you be there? We look forward to your visit in hall 9, stand H801.



automechanika

MIDDLE EAST

Everything that makes autos move

27-29 MAY 2007 IN DUBAI

The interest in the Automechanika Middle East is growing: already in 2006, the most important motor vehicle trade fair in the region registered record figures – with more than 650 exhibitors from 37 countries and more than 10,000 visitors. Further increases are expected for this year, as this is a market with great potential: the trade volume for motor vehicle spare parts of the Gulf states has been estimated to be more than 12 billion US\$. Dubai alone is worth 5 billion US\$ of this and its ports are today the central place of transshipment for the entire region. Key areas for MAHLE at the Automechanika Middle East will be high-volume engine components and filters for engines and vehicles of the Near East. Everyone who is in Dubai at the end of May is welcome at our stand in the German pavilion!

They are strong, fast – and above all large: the giants of the European Truck Racing Championship. Despite their weight of more than 5 t, they deliver torque of almost 5,000 Nm to the road surface with nearly 1,100 hp. Even Formula 1 racing cars only manage a fraction of this.

Definitely not long-distance driver romanticism: when the armada of trucks is darting over the full width of the road towards the first bend, hardly any spectator remains seated. After Formula 1, the FIA European Truck Racing Championship has become one of the most popular motorsport series in Europe. Almost 800,000 spectators are tempted to the racing tracks every year by this gigantic spectacle. Up to 240,000 enthusiasts make their way to the Truck Grand Prix at the Nürburgring alone every year – and the numbers are rising.

FAST MOVING HISTORY

The beginnings of professional truck racing reach back to the early 80s. In those days, the first truck races were held in the USA. Already in 1986, the first starting signal was given at the Nürburgring for the first Truck Grand Prix. Only 3 years later, the first official European championship took place. The automobile manufacturers soon discovered that truck racing is an excellent testing ground for their new developments: in the beginning – with considerable financial costs – in the “Super Race Truck” class that no longer exists, and now exclusively in the “Race Truck” class with designs close to series vehicle designs. This provides a significantly larger starting field and real competitive fighting – man against man and engine against engine.

MAXIMUM PERFORMANCE BASED ON SERIES PRODUCTION

The closeness of the racing trucks to series vehicle designs makes the racing spectacle particularly attractive to vehicle manufacturers and designers of engine components. It is known from Formula 1 engines, for example, that their pistons have only little in common with series pistons. They are finely worked, weight minimised and optimised for strength – pure high-tech. In contrast, the piston of a racing truck cannot be distinguished from a series piston at first glance. This means that maximum performance has to be delivered based on series development.

AN ACID TEST FOR MAHLE PISTONS

In most of the racing trucks, raw series pistons from MAHLE are used. This is usually done without salt core cooling channels and pin boss bushings, and often even smaller piston pins are used. Even the piston rings are identical to series products – and this at three times higher engine power and maximum



Truck racing is becoming increasingly popular all over the world. Here some impressions from a Brazilian racing track.

ignition pressures of more than 300 bar at times, compared with 180 bar in series engines. An acid test that is only possible as the diesel combustion principle does not allow significant increases in engine speed and therefore does not require special designs in terms of weight reduction. Only the piston clearance has to be adapted to the high thermal loads under racing conditions. Otherwise, piston seizure threatens.

SHORT AND POWERFUL

A decisive difference compared to series production is that MAHLE series pistons are designed for a long service life of more than 1 million km driving distance. In racing operation, pistons only have to run for about 300 km – this, however, under highest loads ...

EUROPEAN TRUCK RACING CHAMPIONSHIP 2007		
31/03 – 01/04	Spain	Barcelona
19/05 – 20/05	Belgium	Zolder
02/06 – 03/06	Spain	Albacete
23/06 – 24/06	France	Nogaro
06/07 – 08/07	Germany	Nürburgring
25/08 – 26/08	Czech Republic	Most
08/09 – 09/09	France	Le Mans
22/09 – 23/09	Italy	Misano
06/10 – 07/10	Spain	Jarama

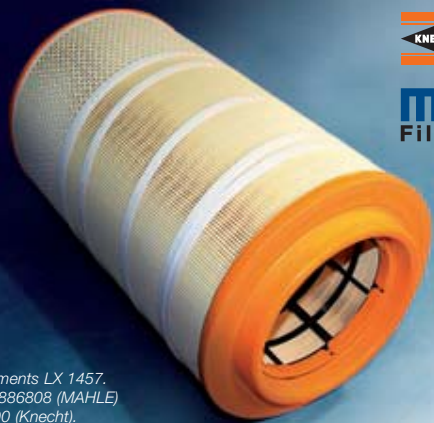
THE BATTLE OF THE GIANTS

The European Truck Racing Championship: this is where trucks without cylinder capacity limitations compete with almost 1,100 hp and up to 5,000 Nm torque.



INNER HOLD

For the DAF 75 CF from model 2001 onwards, a special air filter element is available. A characteristic feature of the LX 1457 is its stable internal support frame made from plastic.



MAHLE
Filter

Air filter elements LX 1457.
Part no. 76886808 (MAHLE)
or 76886790 (Knecht).

COMPLETE PACKAGE

TU 3 JP L 4 is the designation of the Euro 4 engine of Peugeot. This stands for a 4-cylinder in-line engine with 75 hp that is not only used in the 106, 206, 306, 307, Partner and 1007, but also in the Citroën Berlingo, Xsara, C2 and C3. We offer now an assembly to repair this versatile engine: insiders may already be familiar with the cylinder liners with part number 021 WN 26 – the 75 mm small piston with chromium-plated and phosphatized rings in chromium/ceramic coating has now been added.



Pistons for Peugeot TU 3 JP L 4, R4 (75 hp).
Part no. 040 02.



Pistons for Audi BDV, V6 (170 hp).
Part no. 033 18.



SHORT & GOOD

For the repair of the Audi BDV V6, a short piston with a head design optimised for the 5-valve configuration is attached via a keystone connecting rod to the crankshaft. A highly efficient ring set helps to provide the power with a compression ring of only 1.2 mm height and a 2 mm height coil-supported bevelled-edge oil ring, which are located at either side of a central taper-faced Napier ring.

WELL DISTRIBUTED

Atego is the name of the 6–16 tonners from Mercedes-Benz that are used in urban and overland transport: OM 904 is the designation of the 4-cylinder engine and OM 906 for the 6-cylinder version. The driving power is provided from 102 and 279 hp of the 3-valve Euro 2 engines with turbocharging and intercooling. Suitable pistons and cylinder liners (part number 004 WV 18) are available for their repair: two types of pistons are offered depending on the engine number. The detailed spare part range can be found in our Online Catalogue at www.mahle-aftermarket.com.



Pistons for Mercedes-Benz engines
OM 904/906, R4/6 (102–279 hp).
Part no. 003 97 or 003 98.

Fuel filter elements KX120D. Part no. 70342564 (MAHLE)
or 70342562 (Knecht).



MAHLE
Filter

HEART OF STEEL

In the now available fuel filter element KX120D, a metal fabric is used as filter medium. The element is used as pre-filter for the hand fuel-supply pump in the Mercedes-Benz Actros from model 1996 onwards.

X-TRA TIGHT

For the Scania of the series P, R, T from model 10/2005 onwards, we offer the fuel filter element KX182D Eco: its X shaped seal profile takes care of optimum sealing.



Fuel filter elements KX182D Eco.
Part no. 06832281 (MAHLE)
or 06832273 (Knecht).



MAHLE
Filter

Pistons for Volvo engine
TAMD 122 A, R6 (400 hp).
Part no. 038 60.



MARINE POWER

TAMD 122 A – this is the designation of the 12 litre 6-cylinder in-line engine for marine applications from Volvo. Its extremely sound groove insert piston with 130.18 mm diameter has a stable ring set. The molybdenum plated keystone compression ring alone measures more than 4.5 mm in height, the taper-face ring is nearly as strong – and finally the coil-supported bevelled-edge oil ring with chromium plating measures even 4.747 mm. In addition, the matching cylinder liners are available (Part no. 037 WN 25 and 037 WN 30).

CROSS-COUNTRY

Whether Opel, Isuzu or Vauxhall, the all-terrain versions are always called Frontera – and are equipped with the engine type Y22SE – which delivers solid 133 hp from the 2.2 l petrol engine. The matching pistons are now available from MAHLE sales partners.

Pistons for Opel Y22SE, R4 (136 hp).
Part no. 012 26.



MAHLE
ORIGINAL

Cabin air filter elements with
active carbon LAK 154.
Part no. 76833081 (MAHLE)
or 76611941 (Knecht).



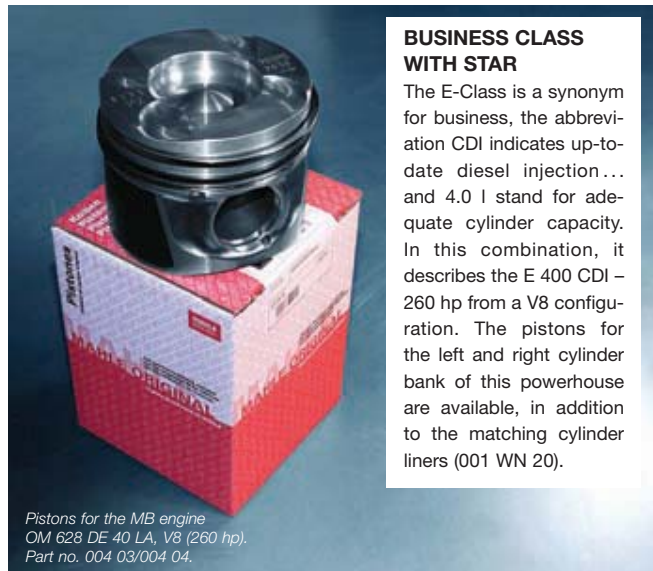
FULL SUPPORT

The cabin air filter element LAK 154 with active carbon is available for expert maintenance of the MAN TGA from model 2000 onwards. Its large panel element has special end-mouldings for optimum support.

**BUSINESS CLASS
WITH STAR**

The E-Class is a synonym for business, the abbreviation CDI indicates up-to-date diesel injection ... and 4.0 l stand for adequate cylinder capacity. In this combination, it describes the E 400 CDI – 260 hp from a V8 configuration. The pistons for the left and right cylinder bank of this powerhouse are available, in addition to the matching cylinder liners (001 WN 20).

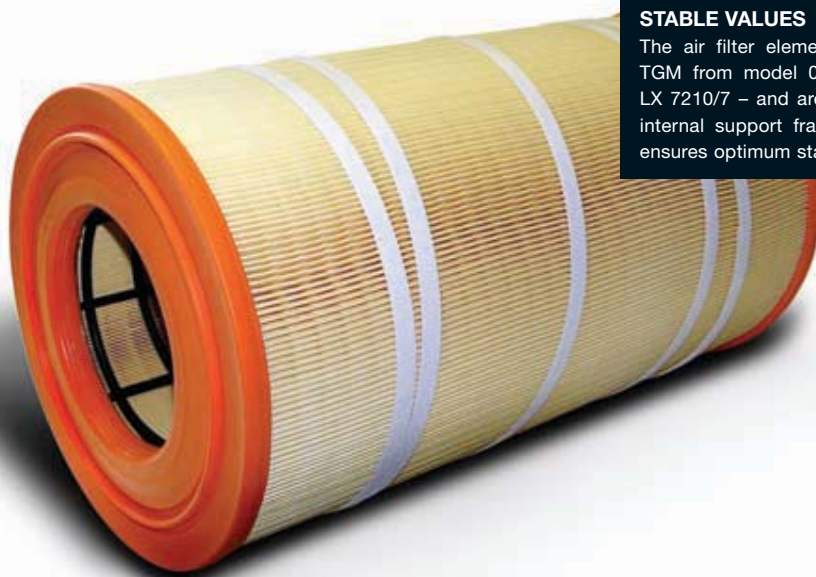
Pistons for the MB engine
OM 628 DE 40 LA, V8 (260 hp).
Part no. 004 03/004 04.



MAHLE
Filter

STABLE VALUES

The air filter elements for the MAN TGL and TGM from model 04/2005 onwards are called LX 7210/7 – and are distinguished by a special internal support frame made from plastic that ensures optimum stability.



Air filter elements LX 7210/7.
Part no. 76832737 (MAHLE)
or 76832729 (Knecht).

← WATER JACKET →



BADLY ERODED

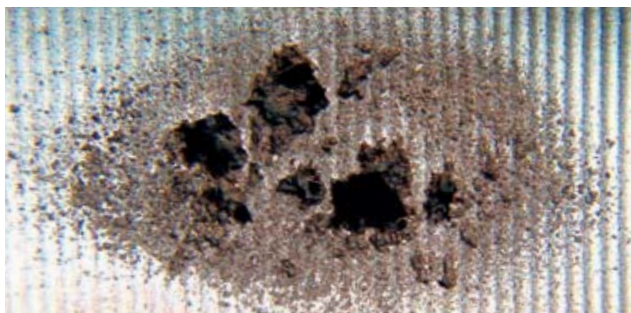
CAVITATION AT CYLINDER LINERS

Again and again, engine repairers are confronted with cylinder liners that are badly eroded at the surface. The diagnosis: cavitation damage – also called pitting. What causes such damage? And what can your customers do to avoid it?

The cylinder liners have one thing in common: they are all so-called "wet" liners (type WN), which have coolant flowing around them during operation. In this design solution, the generated combustion heat is effectively carried away and dissipated via the heat exchanger.

WHAT DOES CAVITATION DAMAGE LOOK LIKE?

For this type of damage, it can be noticed that the pits are mainly found in the upper and lower dead-centre position of the piston. When these typical pits or erosions are present, we speak of cavitation damage.



An accumulation of small pits in the area of the water jacket – indication of cavitation damage.

WHAT EXACTLY IS CAVITATION?

AND HOW IS IT CAUSED AT THE CYLINDER LINER?

Cavitation (lat. cavitare „hollow out“) describes the formation of hollow spaces in (strong flowing) liquids – which mostly dissipate immediately afterwards. This phenomenon is caused by pressure fluctuations that in combustion engines are due to the piston movements. These vibrations are transmitted to the surrounding water jacket, which is then made to vibrate as well. When the cylinder wall moves back during a vibration cycle, a vacuum forms in the coolant and leads to vapour bubbles at that location. When the coolant column vibrates back, these vapour bubbles implode and "blast" individual atoms out of the cylinder liner surface: the result is pitting corrosion.

CAVITATION DAMAGE OR NORMAL CORROSION – HOW TO DIFFERENTIATE

There are two distinctive characteristics of cavitation damage: **1.** the pits are only found at the major or minor thrust side of the liner. **2.** In contrast to normal corrosion, the pits are getting larger towards the inside. This hollowing out (erosion) has the effect that the wall of the cylinder can be perforated completely – until coolant enters the cylinder. Furthermore, when the surface of the cylinder has initially been damaged due to cavitation, further opportunities for more cavitation damage and also corrosion are opened.



Cavities at the cylinder liner: after the liner has been cut open it can clearly be seen that the cavities are becoming larger towards the inside.

PITTING – WHAT ARE THE REASONS?

Insufficient frost protection in the coolant: A common reason for cavitation damage is the composition of the coolant. In many countries of the world, engines are run without antifreeze agent in the cooling water – or with an insufficient proportion.

However, the antifreeze agent does not only protect from frost, but also prevents corrosion in the radiator and engine and lubricates the coolant pump. A suitable antifreeze agent influences the physical and chemical characteristics of the coolant – it lowers the freezing point of the coolant and increases its boiling point. This reduces the tendency to bubble formation and therefore the risk of cavitation damage.

Leakage in the cooling system / insufficient overpressure function:

Under normal operating conditions, an overpressure is formed in the cooling system, which reduces the tendency to vapour bubble formation. However, even just a leaking radiator cap prevents overpressure from developing – and can be the reason for cavitation damage at the cylinder liners. Also defective thermostats or viscous couplings of radiator fans can reduce the temperature level of the engine to such an extent that overpressure cannot develop in the cooling system.

Engine operation in the lower temperature range: cavitation damage has especially been observed in engines that operate in the lower temperature range (50–70 °C). At higher temperatures (90–100 °C), the increased water pressure prevents vaporous cavitation.

Poor quality products: cylinder liners of inferior quality that cannot be fixed correctly to the cylinder block due to excessive manufacturing tolerances will move in the engine. The increased vibrations result here often in cavitation damage. Also low-grade materials can be the reason for cavitation damage.

ENGINE REPAIR AFTER CAVITATION DAMAGE –

TIPS FROM THE PRACTICE

The **seat diameter** of the lower liner area **must not be refaced** when the surface is corroded – unless liners with larger fitting diameter are used.

It is crucial that the **correct piston mounting clearance** is observed – and honing of the liner resulting in increased diameter must be avoided as well as re-fitting of previously used pistons. Instead, either the next oversize should be reached by re-boring (and the relevant oversize piston should be used) or a new assembly should be fitted.

It is essential to use the **permanent antifreeze agent with corrosion protection** that is recommended by the engine manufacturer – even when engines are only used in warm regions without frost or within buildings (e.g. generator drive). Specifications regarding replacement intervals and alternative additives for certain regions must also be observed.

Also the **water quality** is important: the use of distilled, strongly alkaline or acidic water is not suitable.

We recommend to **check** cooling systems, thermostats and radiator fans at regular intervals. The overpressure of the cooling system has to be assured (if necessary replace the radiator cap).

PREVENT CAVITATION DAMAGE – WITH ENGINE COMPONENTS FROM MAHLE

In close cooperation with the engine and automotive industry, MAHLE engineers develop engine components with minimum susceptibility to cavitation damage.

Precondition for long engine life without cavitation damage is a smooth running piston. MAHLE optimizes the piston shape already during the development stage – in many test series at the actual engine. The result is good running smoothness and minimized pulse generation during contact alterations in the cylinder.

MAHLE cylinders ensure optimum functioning, refinement, long service life and reliability of the engine: the most important protection from cylinder liner cavitation is minimising vibration transfer. MAHLE cylinder liners are therefore machined with high accuracy and minimum tolerances – in order to ensure vibration free mounting in the cylinder block and therefore reliable running during the entire lifetime of the engine.



A SUPPLY OF CLEAN AIR

The commercial vehicle market is booming. This will also enhance the sales prospects for cabin air filters in lorries, transporters and building vehicles. Air conditioning systems with suitable filters have become all but standard equipment in the meantime. However, when a vehicle is used with a clogged cabin air filter, severe consequences for heating and air conditioning systems may be the result. The replacement intervals stipulated by the vehicle manufacturers must therefore be strictly observed. Generally this means: about every 12,000 to 15,000 km. For a lorry that travels an annual distance of 250,000, this would be at least every 3 weeks.

While some years ago only passenger cars were equipped with cabin air filters, there is practically no commercial vehicle today that is not fitted with a filter that protects drivers from polluted air entering the cabin. And that is a good development. Without cabin air filters, drivers in their cabins would be subjected to pollutant concentrations 6 times higher than at the roadside. This is mainly due to the so-called tunnel effect, which means that the exhaust fumes of the vehicles in front are directly drawn into the vehicle interior. But also irritant gases such as ozone, toxic gases such as fertilizers and diesel exhaust particulate and other irritants such as pollen and annoying smells would get straight into the interior without cabin air filters. MAHLE Filter and Knecht cabin air filters are both available as particulate and combination filters. Particulate filters protect from fine dust, but also from pollen, industrial fallout and other very fine particulates that can reach the lungs. In addition, active carbon filters absorb smells and gases and reduce up to 99 % of ozone.

THE STRUCTURE OF A CABIN AIR FILTER WITH ACTIVE CARBON

A layer of special active carbon granules is sandwiched between two fleece layers. The unpleasant smells are deposited in the pores of the active carbon. Active carbon consists mainly of carbon (mostly > 90 %) with an extremely porous structure. The pores are interconnected like in a sponge. Just 2 grams of active carbon are roughly equivalent to the surface area of a football pitch – a standard filter containing about 200 g carbon has therefore a filter surface of about 100 football pitches.

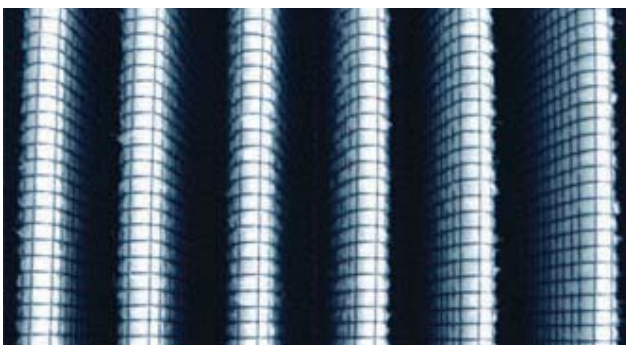
**CABIN AIR FILTERS FOR COMMERCIAL VEHICLES:
THE FINE AND THE COARSE**

In contrast to passenger vehicles, commercial vehicles are often used in dusty environments such as building sites. Their cabin air filters must therefore not only eliminate smallest particulate from the cabin, but also coarse particulate. However, the finer the filtration, the more dirt is removed – and the faster the dirt absorption capacity is exhausted. It is the task of the R&D engineers to combine the required fine filtration with a long service life. When the coarse particulate load is extremely high as, for instance, at a building site or a quarry, the filter must be replaced more often – or there needs to be a way of cleaning it. During the development of the LA 43, the decision was made in favour of cleaning.

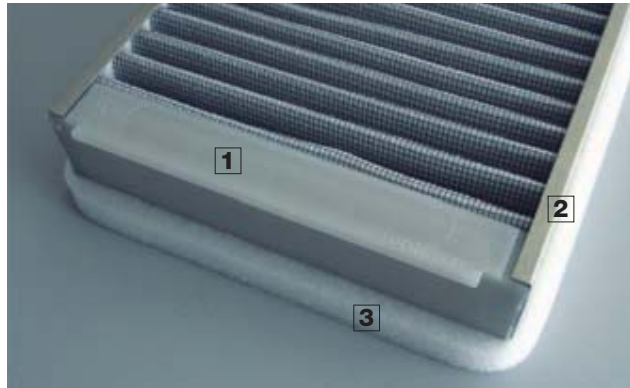
**FOR EXTREME COARSE PARTICULATE LOAD:
THE CLEANABLE MAHLE FILTER**

The higher the degree of air pollution, the sooner the filter will clog. In extremely dusty environments, the cabin air filter can become so dirty in a few hours that the ventilation system practically ceases working. For such extreme situation, MAHLE has developed the filter element LA 43 in cooperation with Mercedes-Benz. The filter can be cleaned by knocking out the dirt manually and is used as original equipment in the building site versions of the Actros and Actros II models.

The design of the filter has been modified to make it resilient to the cleaning process that is required several times daily under extreme dust loads. From the outside, the special filter differs from other MAHLE cabin air filters in its more robust construction, with stable aluminium side members and massive end-mouldings made from plastic. Optimum sealing is achieved with a so-called blade location in the end pleat of the fleece and a plastic foam seal all around. A corrosion-resistant wire grid at both sides supports and protects the filter fleece. The filter medium consists of a synthetic filter fleece that has been designed for a significantly higher dust take-up capacity for this application.



The fleece of the LA 43 is supported and protected by a grid on both sides.



The LA 43: robust design with side members of plastic (1) and aluminium (2) as well as a foam seal all around (3).

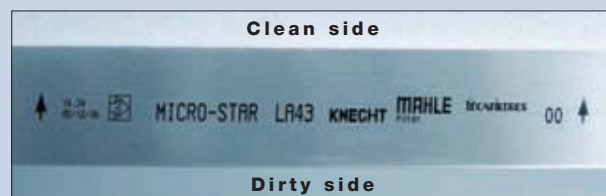
**SERVICE INTERVALS:
ONLY A GUIDELINE**

Cabin air filters are mostly located in front of the vehicle's heating or air conditioning system, where the polluted outside air is drawn in and blown into the vehicle interior after cleaning – this can be up to 150 l air per second when the filter is in optimum condition. For clogged filters, this air volume is reduced. This can be noted clearly, when only a limited amount of air reaches the passenger compartment, although the blower is set to maximum (if in doubt, a visual check of the filter will help). When the filter is clogged, it is high time for replacement, or in case of the LA 43 for cleaning – regardless of the distance covered since the last filter change. If this is not done, expensive consequential damage of heating or air conditioning can result.

The cleaning process for the LA 43 can be repeated up to 80 times. Tests in laboratory and practice have shown that even after 80 cleaning procedures (tapping out and blowing out) the initial conditions of a new filter are almost reached again. However afterwards, the filter should be replaced as the performance can deteriorate rapidly.

KNOCKING OUT THE DIRT: TIPS FOR CLEANING THE LA 43

Pre-cleaning: tapping the filter on an even surface releases most of the dirt located at the dirty side.



Also for the LA 43, the fitting orientation must be observed the same way as for any other filter.

Main cleaning: If compressed air is available, the filter can be blown out afterwards. However, this should only be done from the clean side, which means in opposite direction to the arrows at the outer moulding (see picture). Otherwise, the dust particles are blown through the material and the collection efficiency, especially for smaller particles, is significantly reduced, making the filter useless. Also the choice of air pressure is important: to maintain the long service life of the filter and to avoid damage, the air pressure generally used in workshops should not be applied. Less is better here, in particular in respect of service life. This means: do not hold the air nozzle too close to the filter, but keep a distance of about 10 to 15 cm and blow out the filter with low air pressure (max. 0.5 bar).

If there is no compressed air available, it is quite sufficient to tap the dust out of the filter and at the next opportunity clean it with compressed air as described above. When the filter is installed again, observe the correct fitting orientation – as indicated by the arrows at the side mouldings.

Note: although the cleanable filter is robustly constructed, it should be checked for possible damage before refitting and be changed when in doubt.

„The entire company is like a family“

Auto Delta is one of the most successful trading companies for automotive spare parts and accessories on the Portuguese market. It was founded 30 years ago by Armindo Romão and Catarina Silva and has been family owned to the present day. The company supplies more than 600 customers in the whole of Portugal – and beyond that, in various countries of Africa and Europe.

MAHLE Aftermarket news: Mr. Romão, congratulations! In May, Auto Delta can look back on 30 years of market activities. Do you still remember the year 1977?

Armindo Romão: Of course. At that time, we started as a 2 person enterprise. My wife Catarina Silva was responsible for administration and I for sales. Those days were quite different from now: back then, the customers still used to come to the suppliers. Of course, today it is the other way round. In the meantime, we see ourselves as service partners, visit our customers regularly and inform them about innovations.

MAHLE Aftermarket news: How was it in the early days?

Armindo Romão: Difficult. In the years after the “Revolution of the Carnations” in 1974, import restrictions inhibited the economic development in Portugal. Getting hold of car spare parts was a very complicated business. In order to import products we had to take out credits. It has been hard work but fortunately, we have succeeded.

MAHLE Aftermarket news: And then Portugal joined the European Union ...

Armindo Romão: Yes, this was in 1986. However, at that time, Auto Delta had already gone through major developments: from retail trade to a wholesale trade company. This enabled us to concentrate on new technologies – and allowed us to meet the increased quality standards of the EU. This development continues to the present time. Our company has already prepared for the future, as our children have started to continue our work.

MAHLE Aftermarket news: Auto Delta has remained a family business to this day?

Armindo Romão: Through and through – and this in the widest sense of the word. The entire company works like a large family. My son Marcelo Silva has taken charge of sales management and imports. My daughter Rosália Silva takes care of financial affairs together with my wife. Also our 30 other

employees are part of this “family alliance”. Our entire success is due to this team spirit and the good cooperation.

MAHLE Aftermarket news: Does this also reflect on the relationship with your customers?

Armindo Romão: Of course. Thanks to our low staff turnover, our employees and customers have often known one another for many years. This creates confidence and trust – and in many instances leads to actual friendships.

MAHLE Aftermarket news: These are the so-called soft facts. How about the hard facts at Auto Delta?

Armindo Romão: In 1995, we have moved to new headquarters, where all necessary service sections have been combined on an area of 2,300 sq. m. When a lorry drives today onto our site, it can leave again, fully loaded after 20 minutes. Our product range comprises now any type of automotive spare part and accessories. We have engines, suspension components, steering gear, clutches, brakes, filters and much more in our range. In order to offer solely guaranteed quality, we only work together with first-class manufacturers – such as MAHLE.

MAHLE Aftermarket news: We are pleased to hear this.

Armindo Romão: MAHLE has a very good reputation in Portugal. This cooperation does therefore also strengthen our image. However, I would like to go one step further: I was earlier speaking about our company as a family. In this sense, we are proud to be part of the “MAHLE family”. This is because the business relations with MAHLE are distinguished by that “little bit extra”. You offer absolute quality in every business division. This is an incentive for our own quality management.

MAHLE Aftermarket news: In what way?

Armindo Romão: This year, we will introduce the necessary steps for our quality certification – both on national and international level. We want to show our customers that we are a forward-looking company.

MAHLE Aftermarket news: Mr. Romão, we thank you for the conversation and wish you continuous success – also, and in particular with MAHLE products.



A well-established team: Armindo Romão and his wife Catarina Silva of Auto Delta in conversation with MAHLE Aftermarket news.

A RESORT FOR CLEAR AIR

MAHLE FILTERSYSTEME AUSTRIA PRODUCES CABIN AIR FILTERS AND MECHATRONICS COMPONENTS AT ITS NEW LOCATION WOLFSBERG.

Wolfsberg, situated at the base of the Koralpe in the Austrian state of Carinthia, is a special type of resort: this is where MAHLE Filtersysteme Austria has been producing cabin air filters since the middle of 2005 – and therefore clean air in the figurative sense. Cabin air filters prevent pollen, exhaust fumes and other dust like substances from entering the passenger compartment and does not only provide significant advantages to allergy sufferers. In addition, cabin air filters with active carbon absorb various smells and therefore take care of the greatest possible comfort.

A NEW FACTORY FOR THE FILTER PRODUCTION

The location Wolfsberg is part of the MAHLE filter production St. Michael ob Bleiburg, situated in 40 km distance. With the support of the Austrian state of Carinthia, MAHLE was able to take-over a former shoe factory that went bankrupt and converted it for filter production. After the redevelopment work was finished in 2005, the management in St. Michael relocated the entire cabin filter production in one step from St. Michael to Wolfsberg. At the same time, it was assured that the high productivity and quality standards of the parent factory were adopted.

INNOVATION PROJECT MECHATRONICS

Afterwards, the entire production of mechatronics components as well as the Austrian branch of mechatronics development was positioned in Wolfsberg as part of the innovation project mechatronics. A close cooperation with the "Höheren Technischen Lehranstalt (HTL) Wolfsberg" (Higher

college of engineering) ensures the demand-oriented education and training of the urgently needed mechatronics specialists of tomorrow.

CERTIFIED QUALITY

There are currently 82 employees at the site in Wolfsberg. Especially in the area of mechatronics as well as in the cabin filter production further expansion is planned. Already 731,000 LA filters (cabin air filters without active carbon) and 1,660,000 LAK filter (cabin air filters with active carbon) were produced in 2006. An expansion of this capacity has already been planned. Also the neutral inspectors of the TÜV (German technical inspection association) could verify the high quality at Wolfsberg in the meantime. The production site has been certified according to TS16949 since February 2007 – and complies therefore with the strict demands of this important standard for the automotive industry.

CLEAN AIR IS ALWAYS IN SEASON

The filter production at MAHLE Wolfsberg runs 12 month in the year at full power – because good cabin air filters are in demand all the year round. But what kind of substances must the filter remove from the air at what time of the year? The table provides an overview:

	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MARCH	APR
OZONE												
POLLEN												
						INCREASED AIR HUMIDITY						



Up-to-date production: production takes place on five active carbon lines in two shifts on new knife pleaters as well as a folding and strapping machine.



Plenty of space: the total area adapted for the production is 14,000 m².



Success factor workforce: there are currently 82 employees working at the site in Wolfsberg who produced already 731,000 LA filters and 1,660,000 LAK filters in 2006.



Highest quality standards: since February 2007, the production site has been certified according to TS16949 and complies therefore with this important standard for the automotive industry.



Good SHOOTING

THE DIRECTORS OF THE NEW MAHLE AFTERMARKET FILM ARE ... OUR PRODUCTS

The idea was as simple as it was convincing. „Wherever there are cars, MAHLE is there“ – so let us show this “Wherever”: the countries with their typical landscapes in which vehicles travel that have been fitted in the factories with our engine components and filters – from icy Siberia to the scorching hot deserts – this with the slogan inserted in the language of the country that is shown at the time. Of course, also the workshops and engine repair shops that fit our products as part of their maintenance and repair activities play their part. This accompanied by contrasting music, fade-ins from our international production sites and sequences from research and development – sometimes emerging from literally ice-cold

conditions. And not least, the zoom sequences of the production machines for engine components and filters... and the printing machines that make our packaging.

We have already shown our customers the result of this shooting and cutting work at the Automechanika. Perhaps, you have also seen the film already at one of our sales partners. If not, we recommend a visit to www.mahle-aftermarket.com – from there you can download a data reduced version to your computer. We wish you lots of enjoyment... and good entertainment watching the film!

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