Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Launch of new engine 276 E30 DEH LA

General

As of the E-Class facelift in 04/2013 a new 6-cylinder gasoline engine M276 E30 DEH LA with turbocharging will be added to the engine line-up.

The advanced engine will be available as E400 in the sedan and in the wagon with and without 4MATIC.

The turbocharging in the engine 276 variant with 3 liter displacement has enabled significant increases to be made in torque and output.

Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Brief Description

New features

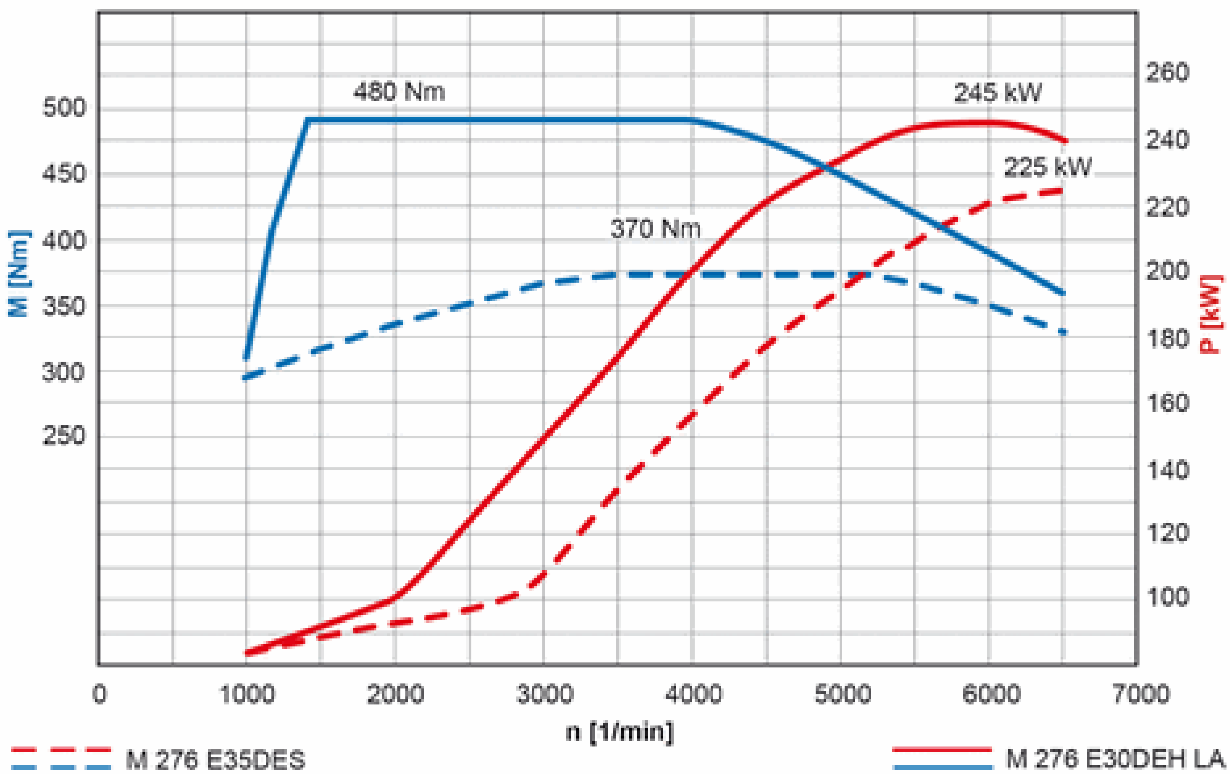
- Reduction of total engine displacement to 2996 cm3
- Increase of rated torque to 480 Nm at 1400 to 4000 rpm
- Increase of rated output to 245 kW at 5500 rpm
- Rigid crankcase made of solid aluminum
- Cylinder liners with innovative "Nanoslide" coating, made in twin-wire arc spray coating process (TWAS coating) and the resulting weight reduction and reduction in friction losses
- Spontaneously responsive turbocharger with wastegate control for each cylinder bank
- Exhaust manifold and turbine housing designed as compact cast steel component
- Compact water-air charge air cooler with separate expansion reservoir mounted on engine for optimum cooling of charge air and excellent thermodynamic efficiency rate
- Adaptation of activated charcoal filter purging to turbocharging requirements through introduction of wide open throttle-purging
- Two-stage engine ventilation system with rotating radial separation and downstream high-volume fine separation for optimum cleaning of the blow-by-gases
- Adaptation of line configuration for high pressure injection system to meet increased engine requirements and use of more powerful fuel system high pressure pump from V8 engines
- Fulfillment of more stringent emissions standard EU6

Tried and tested

- Four valves per cylinder
- Two camshaft adjusters each for inlet and exhaust side ensure optimized development of engine torque and improved exhaust characteristics
- Low-noise chain-drive system with silent chains (timing chain drive made up of three individual chain drives, which can be adjusted using a separate chain tensioner)
- Compact vane-type oil pump with demand-oriented flow control and two compression stages
- Performance-optimized oil and coolant pump drive
- 3rd generation gasoline direct injection with 200 bar fuel pressure, piezo injection nozzles and spray guided multiple injection
- Multiple injection with up to five injections per working cycle
- Multiple-spark ignition system for optimum ignition and combustion (multispark mode)

Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

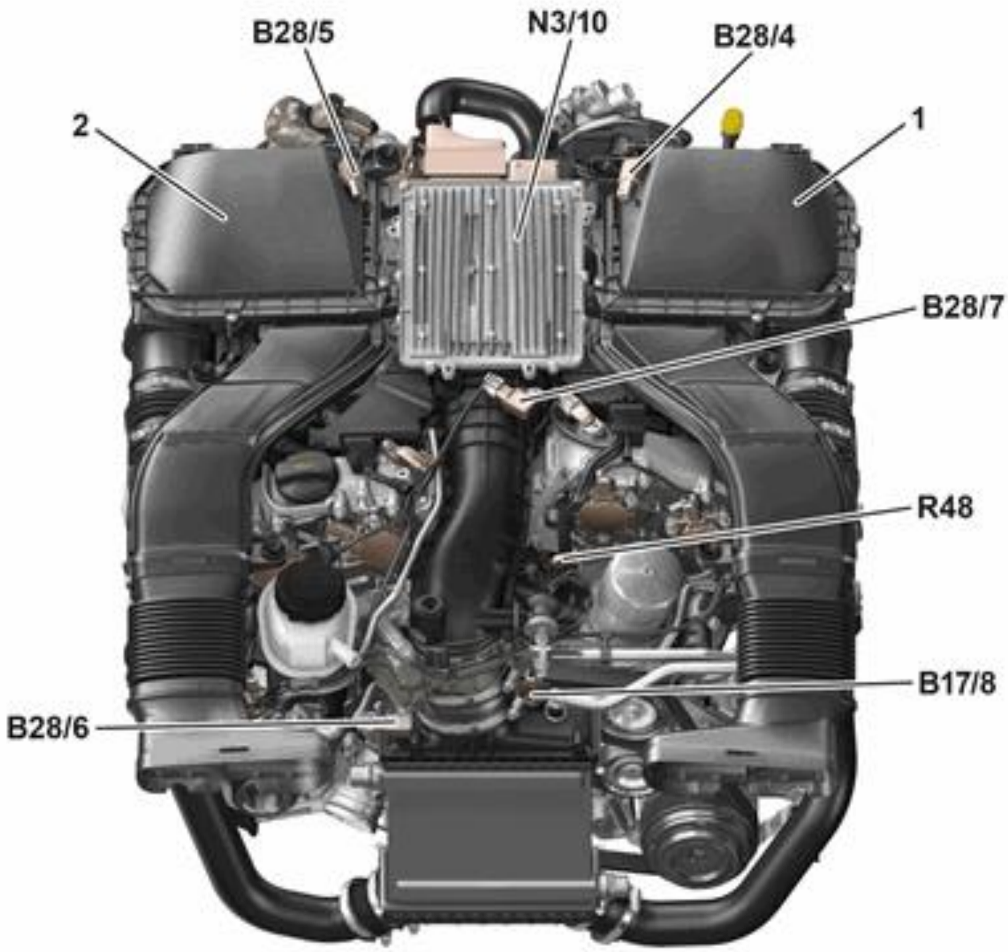
Comparison of torque and power curve on engine 276 E35 DES and engine 276 E30 DEH LA



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of the engine from above

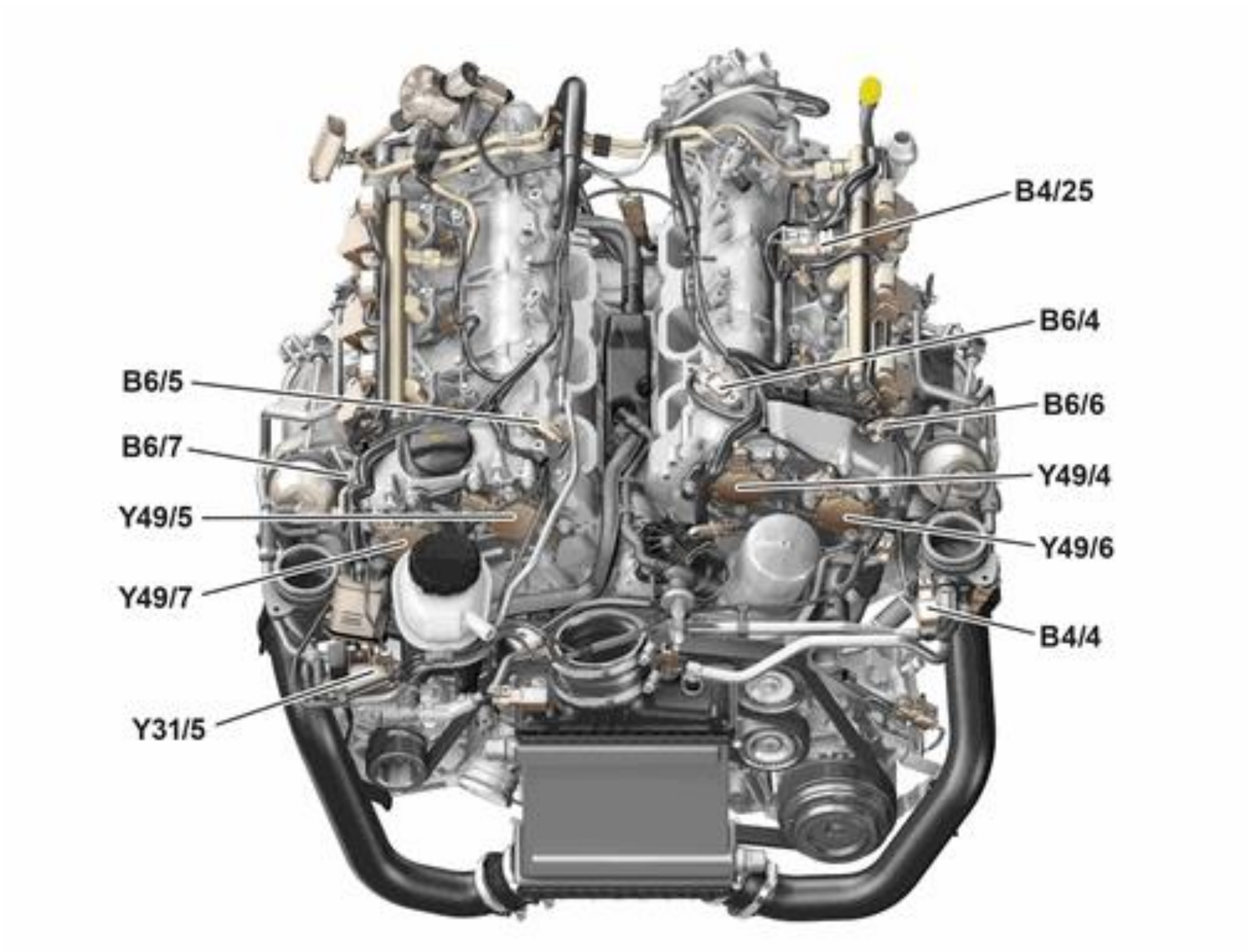
1	*Left air filter housing*
2	*Right air filter housing*
B17/8	*Charge air temperature sensor*
B28/4	*Pressure sensor downstream of left cylinder bank air filter*
B28/5	*Pressure sensor downstream of air filter*
B28/6	*Pressure sensor upstream of throttle valve*
B28/7	*Pressure sensor downstream of throttle valve*
R48	*Coolant thermostat heating element*
N3/10	*ME-SFI [ME] control unit*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of the engine from above

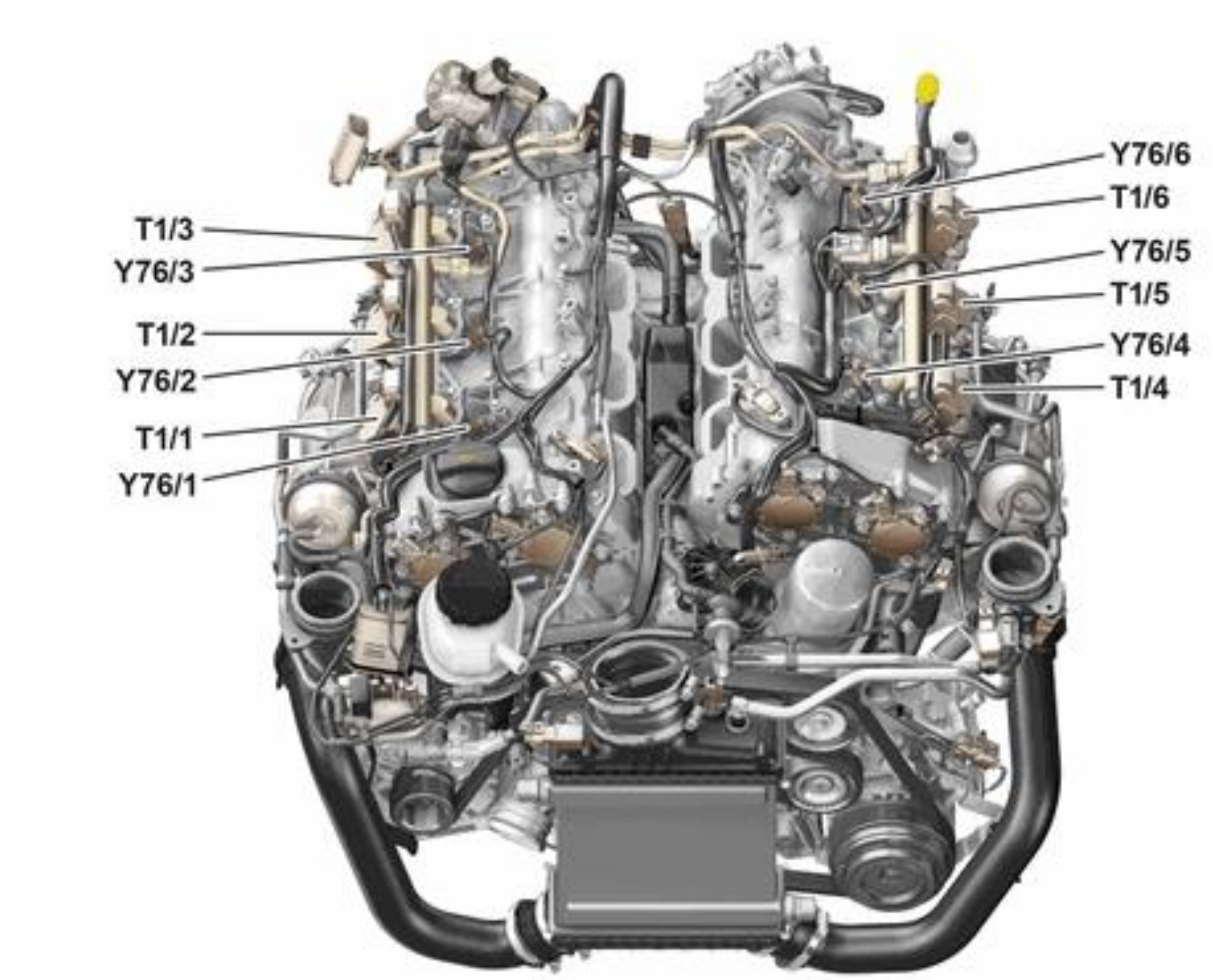
B4/25	*Fuel pressure and temperature sensor*
B4/4	*Purging pressure sensor*
B6/4	*Left intake camshaft Hall sensor*
B6/5	*Right intake camshaft Hall sensor*
B6/6	*Left exhaust camshaft Hall sensor*
B6/7	*Right exhaust camshaft Hall sensor*
Y31/5	*Boost pressure control pressure transducer*
Y49/4	*Left intake camshaft solenoid*
Y49/5	*Right intake camshaft solenoid*
Y49/6	*Left exhaust camshaft solenoid*
Y49/7	*Right exhaust camshaft solenoid*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of the engine from above

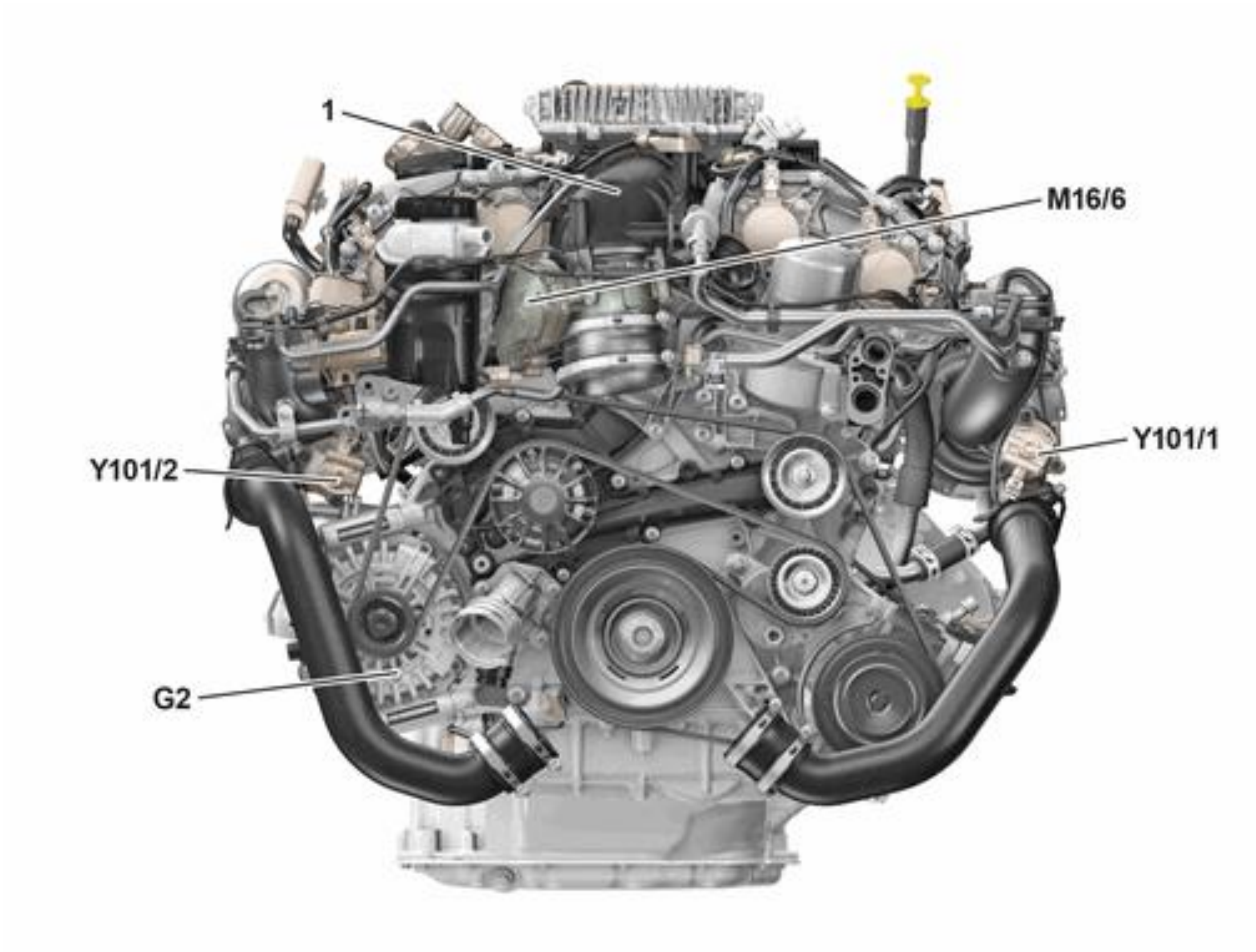
T1/1	*Cylinder 1 ignition coil*	*Y76/1*	*Cylinder 1 fuel injector*
T1/2	*Cylinder 2 ignition coil*	*Y76/2*	*Cylinder 2 fuel injector*
T1/3	*Cylinder 3 ignition coil*	*Y76/3*	*Cylinder 3 fuel injector*
T1/4	*Cylinder 4 ignition coil*	*Y76/4*	*Cylinder 4 fuel injector*
T1/5	*Cylinder 5 ignition coil*	*Y76/5*	*Cylinder 5 fuel injector*
T1/6	*Cylinder 6 ignition coil*	*Y76/6*	*Cylinder 6 fuel injector*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of the engine from the front

1	*Charge air distribution pipe*	*Y101/1*	*Left bypass air switchover valve*
G2	*Alternator*	*Y101/2*	*Right bypass air switchover valve*
M16/6	*Throttle valve actuator*		



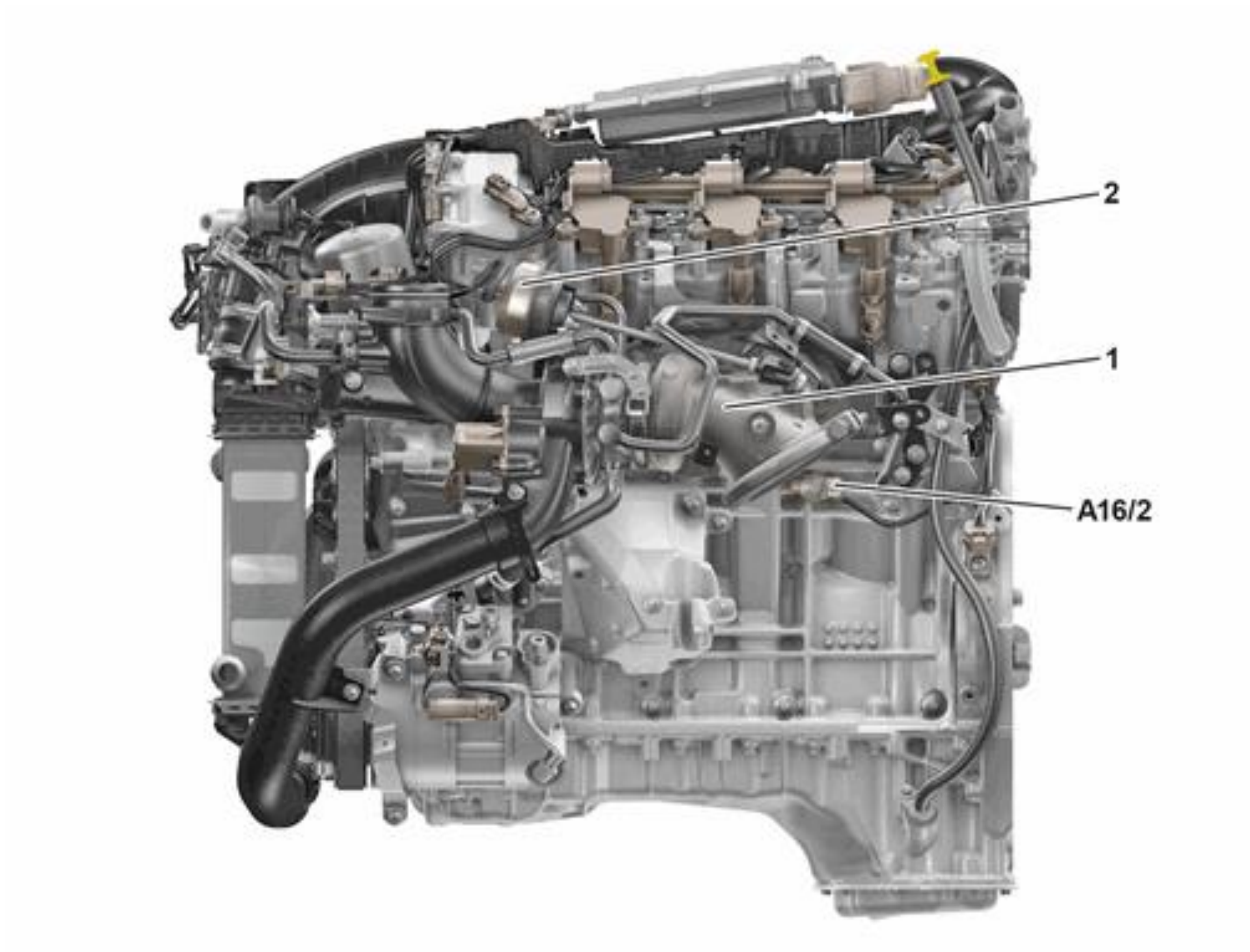
Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of engine from left

1 *Left turbocharger*

2 *Left boost pressure control flap vacuum unit*

A16/2 Left knock sensor



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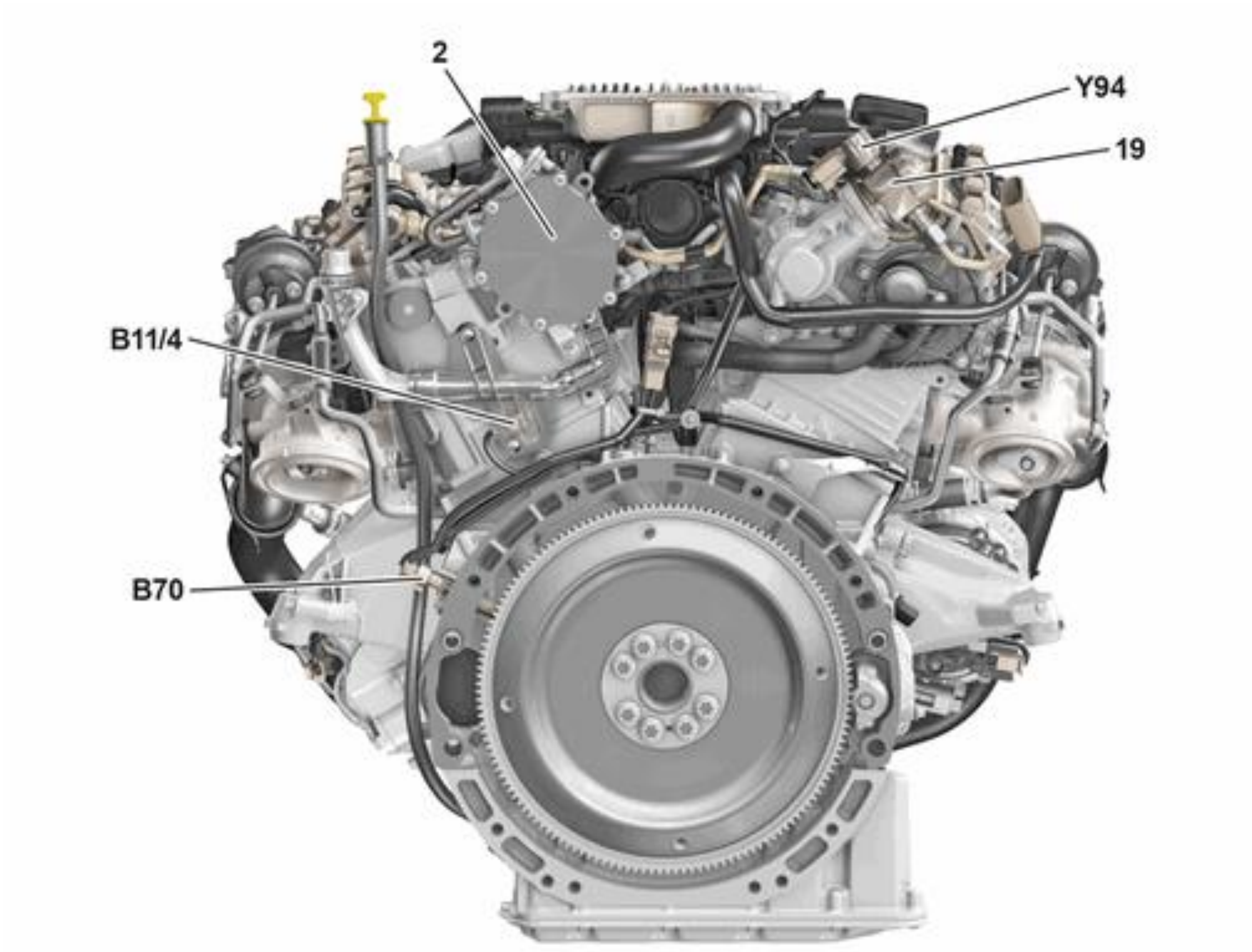
Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of the engine from the rear

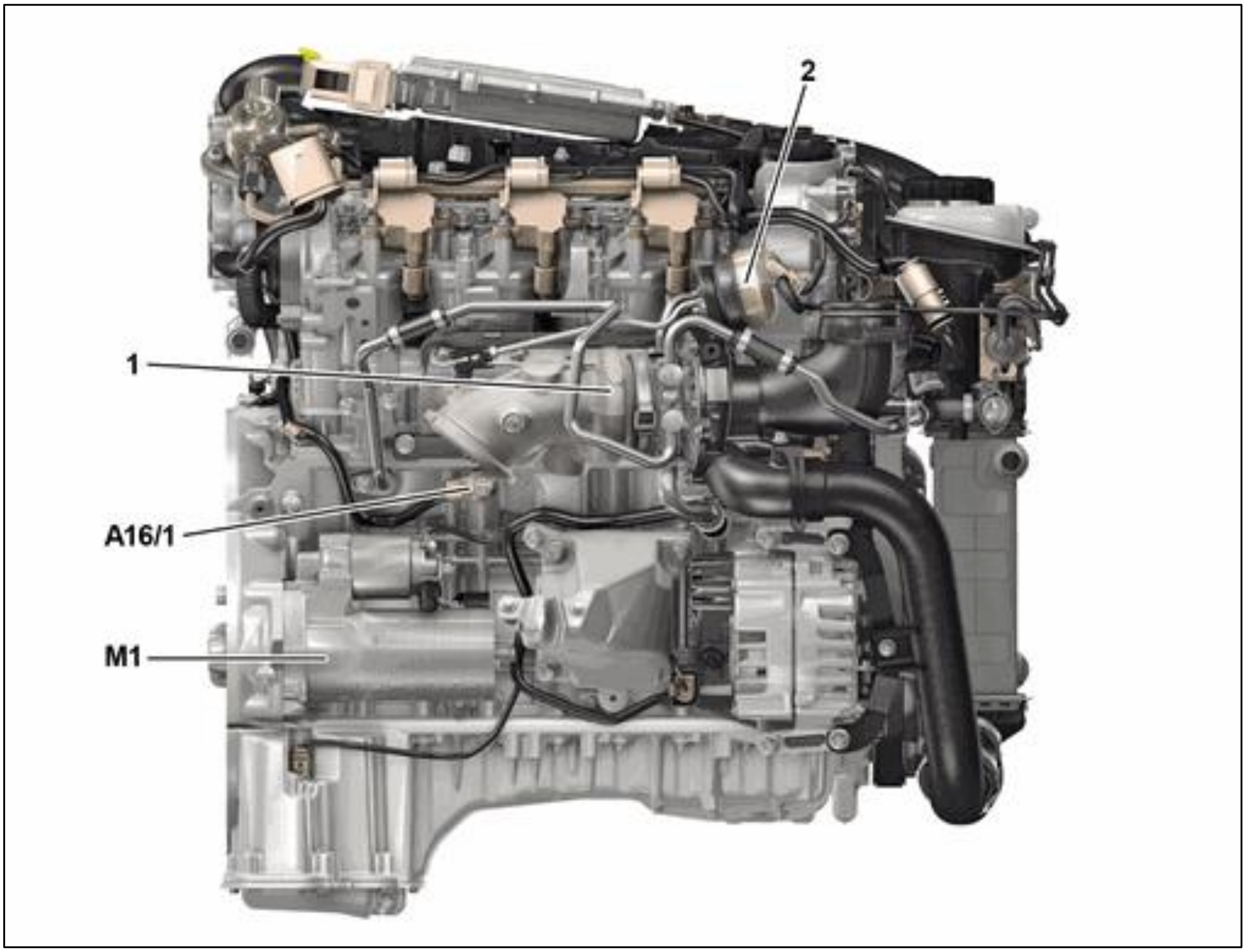
2	*Vacuum pump*	*B70*	*Crankshaft Hall sensor*
19	*Fuel system high pressure pump*	*Y94*	*Quantity control valve*
B11/4	*Coolant temperature sensor*		



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of engine from right

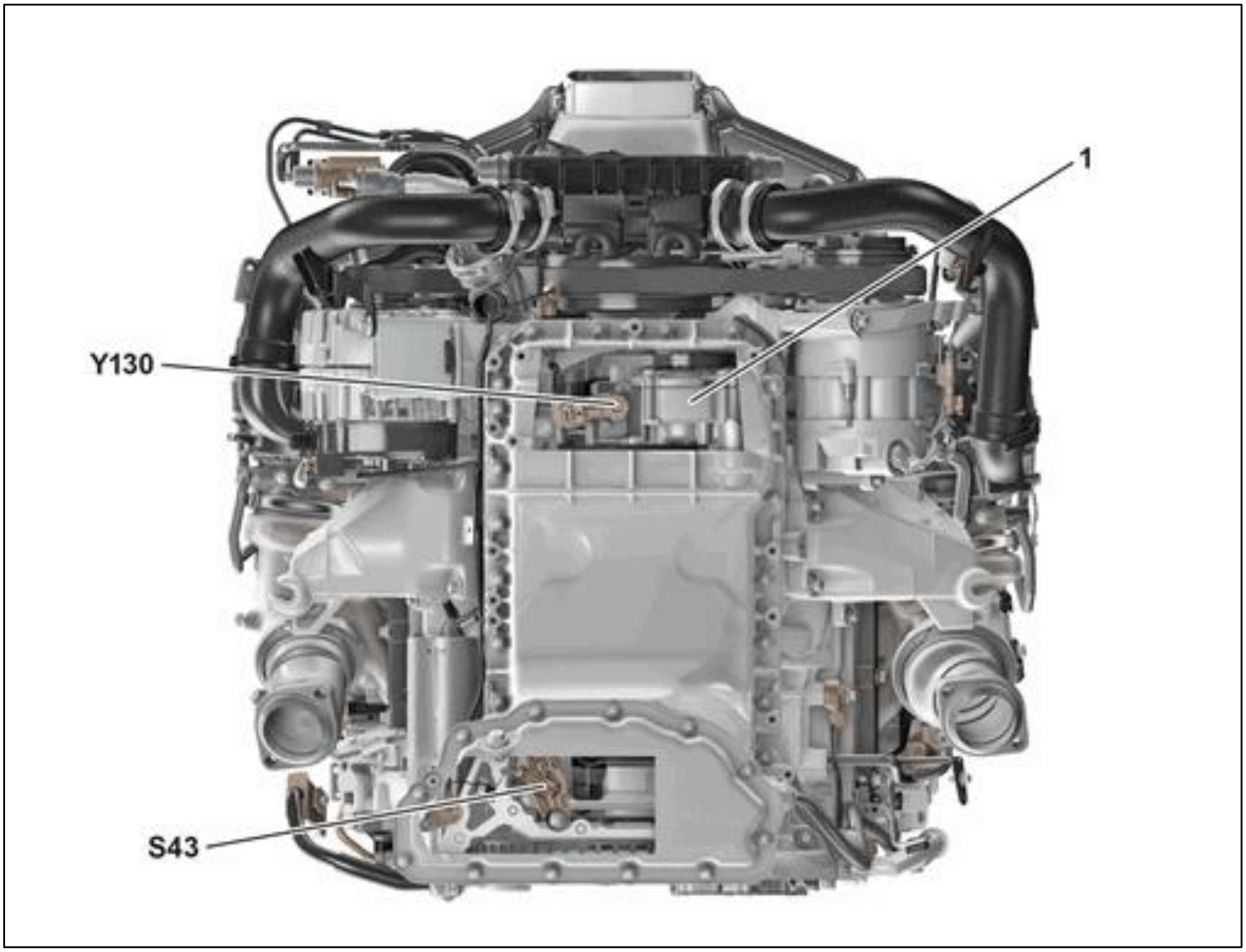
1	*Right turbocharger*
2	*Right boost pressure control flap vacuum unit*
A16/1	*Right knock sensor*
M1	*Starter*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Engine view from below

1 *Engine oil pump*
S43 *Oil level check switch*
Y130 *Engine oil pump valve*



Turbocharging

Each cylinder bank comes with a compact, spontaneously responsive turbocharger with wastegate control. Turbocharging enables a significant improvement to be achieved in the cylinder fill level, thereby boosting delivered output, while simultaneously reducing displacement. Together with state-of-the-art direct injection, a small reduction in specific consumption was also achieved.

These measures enabled the initiated downsizing and systematic modularization in the V6 engines to be successfully continued.

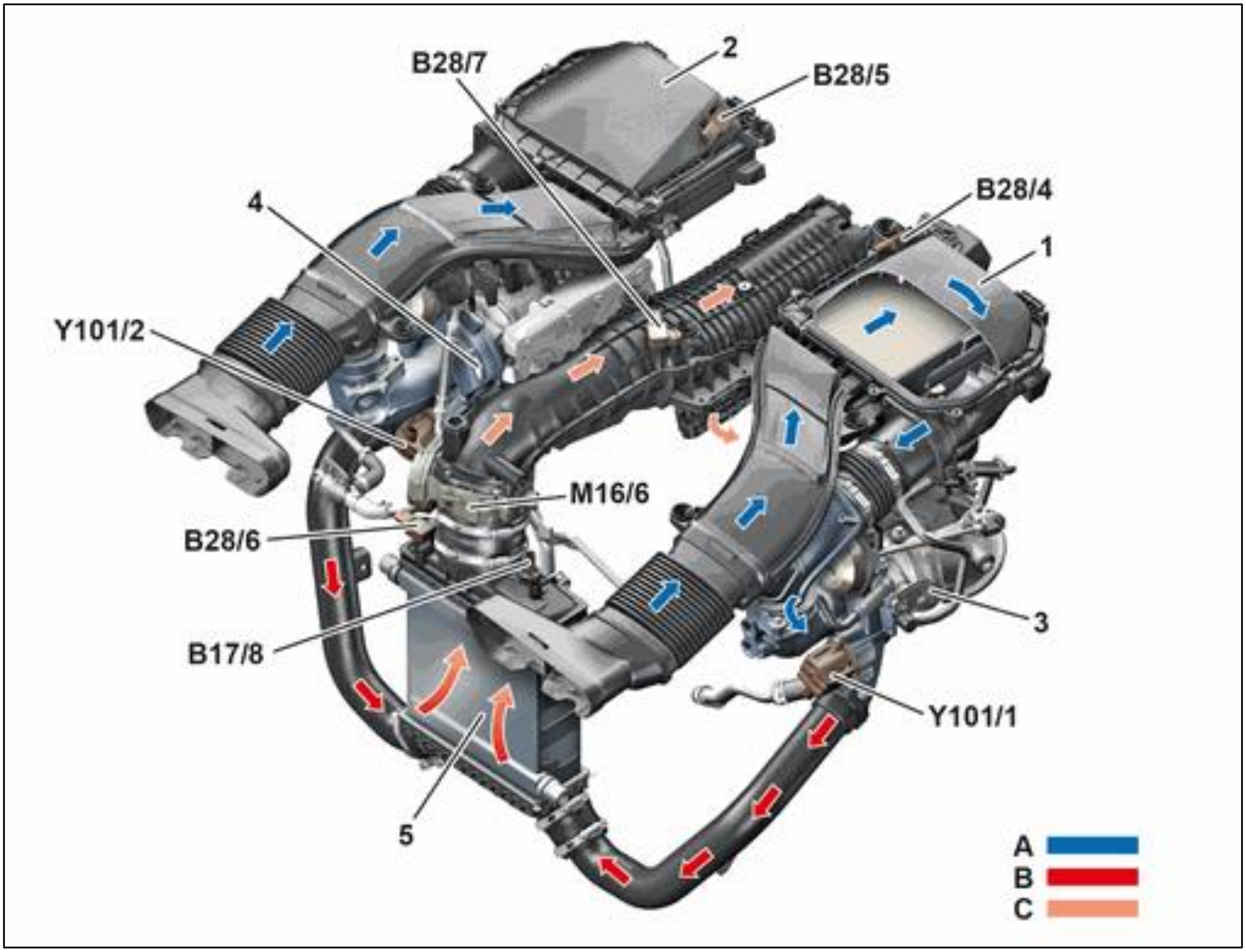
After the fresh air has been aspirated through the air filter, it is then routed to the turbocharger and each cylinder bank for compression. The integrated boost pressure and blow-off control ensure an optimized torque curve, coupled with efficient use of the turbocharger.

As a consequence of the air compression it can heat up to approx. 150 °C, which in turn results in a disadvantageous expansion of the charge air and a lower fill level. This is counteracted through cooling the charge air with a compact charge air cooler, which is connected to the low temperature cooling circuit. The charge air in the charge air manifold is then routed, at a pressure of up to approx. 0.8 bar, to the individual cylinders.

Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Shown: flow pattern of the intake air/charge air

1	*Left air filter housing*
2	*Right air filter housing*
3	*Left turbocharger*
4	*Right turbocharger*
5	*Charge air cooler*
A	*Intake air*
B	*Charge air (uncooled)*
C	*Charge air (cooled)*
B17/8	*Charge air temperature sensor*
B28/4	*Pressure sensor downstream air filter, left cylinder bank*
B28/5	*Pressure sensor downstream of air filter*
B28/6	*Pressure sensor upstream of throttle valve*
B28/7	*Pressure sensor downstream of throttle valve*
M16/6	*Throttle valve actuator*
Y101/1	*Left bypass air switchover valve*
Y101/2	*Right bypass air switchover valve*



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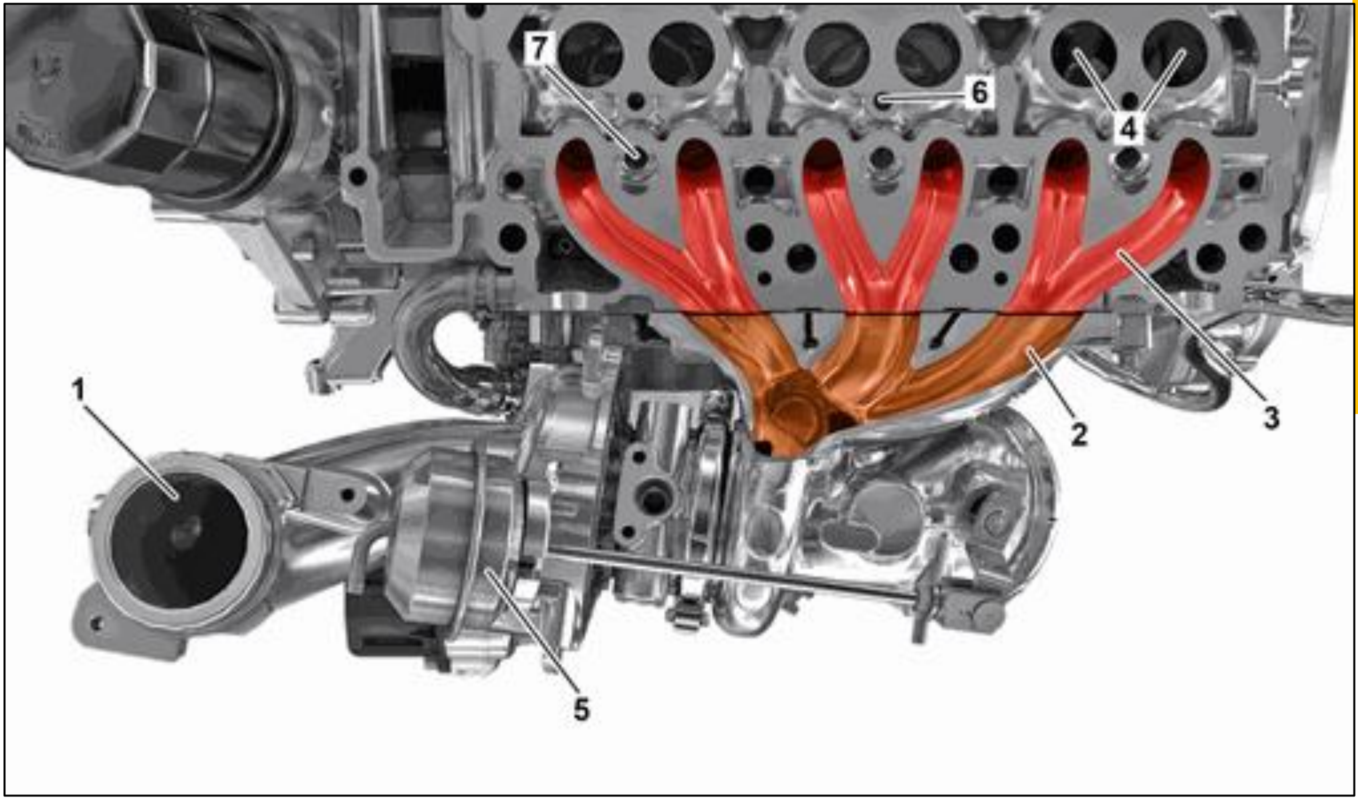
Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Sectional view of left turbocharging cylinder bank

1	*Compressor inlet*	*5*	*Boost pressure control flap vacuum unit*
2	*Duct routing in turbine housing*	*6*	*Bore for fuel injector*
3	*Outlet duct routing in cylinder head*	*7*	*Bore for spark plug*
4	*Inlet duct*		



Cylinder head with optimized exhaust ducting for direct pulse charging

Alignment of the outlet duct in the cylinder head itself, towards the turbine housing, this enables direct-pulse charging coupled with excellent responsiveness during load changes.

Note: Direct pulse charging
The exhaust gas pressure wave from the opening exhaust valves is almost fully retained until entry into the turbocharger, which in turn enables extremely fast turbine wheel acceleration.

Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Charge pressure control

As a matter of principle, the turbocharger shaft turns increasingly faster through the driving exhaust flow as engine speed increases. The faster the turbine turns, the greater the volume of air delivered by the compressor, the resulting increase in exhaust flow then drives on the turbine even more. This means that the compressor may reach its delivery limit or the mechanical and thermal limits of the engine may be exceeded.

To prevent this and to keep the output rate within practical limits, in other words, to limit the engine's forced induction, the boost pressure and the delivery rate of the compressor are limited by the boost pressure control.

The boost pressure is regulated electro-pneumatically through the boost pressure control pressure transducer (Y31/5). This is actuated map-dependent by the ME-SFI [ME] control unit.

To reduce the boost pressure the four exhaust flows are each routed over a bypass straight into the exhaust manifold, thereby restricting the turbine speed. The bypasses are closed by the boost pressure control flaps, which are pneumatically operated through vacuum units. When inactive, the boost pressure control flaps are opened by spring force.

In this way the boost pressure can be adapted to the current load demand on the engine.

Blow-off control

The exhaust gas turbocharger continues turning for a period of time after the start of deceleration mode due to the inertia of the shaft, compressor and turbine wheel.

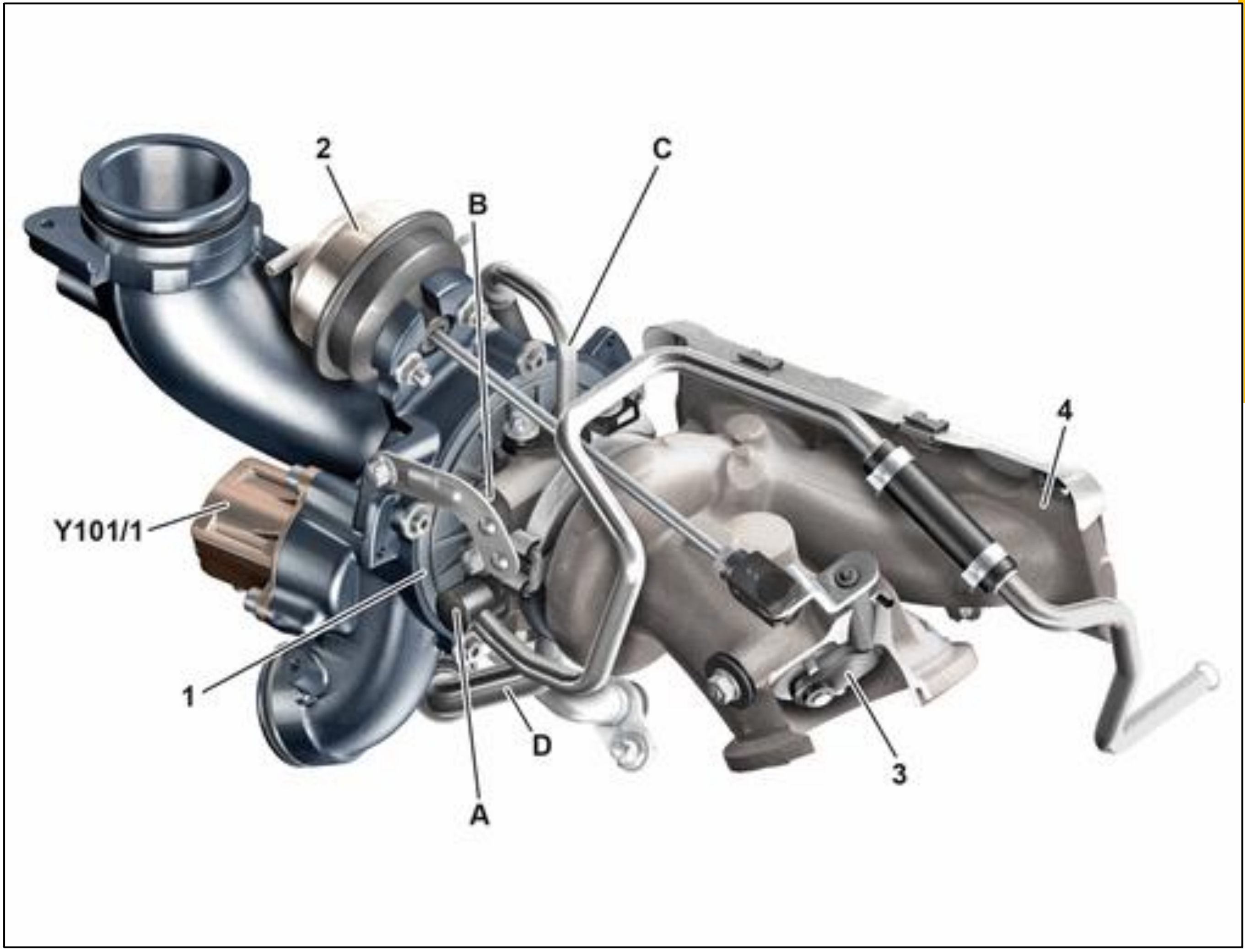
In the case of rapid closing of the throttle valve, a charge pressure wave therefore runs back to the turbocharger. This charge pressure wave would create a condition with a low delivery volume and high pressure conditions at the compressor wheel, which causes charger pumping (brief howling and mechanical stress).

By opening the switchover valves for blow air at the left and right (Y101/1, Y101/2) these pressure peaks are routed through a bypass duct into the intake section of the turbocharger.

In engine load operation the corresponding bypass duct is held reliably closed.

View of left turbocharger

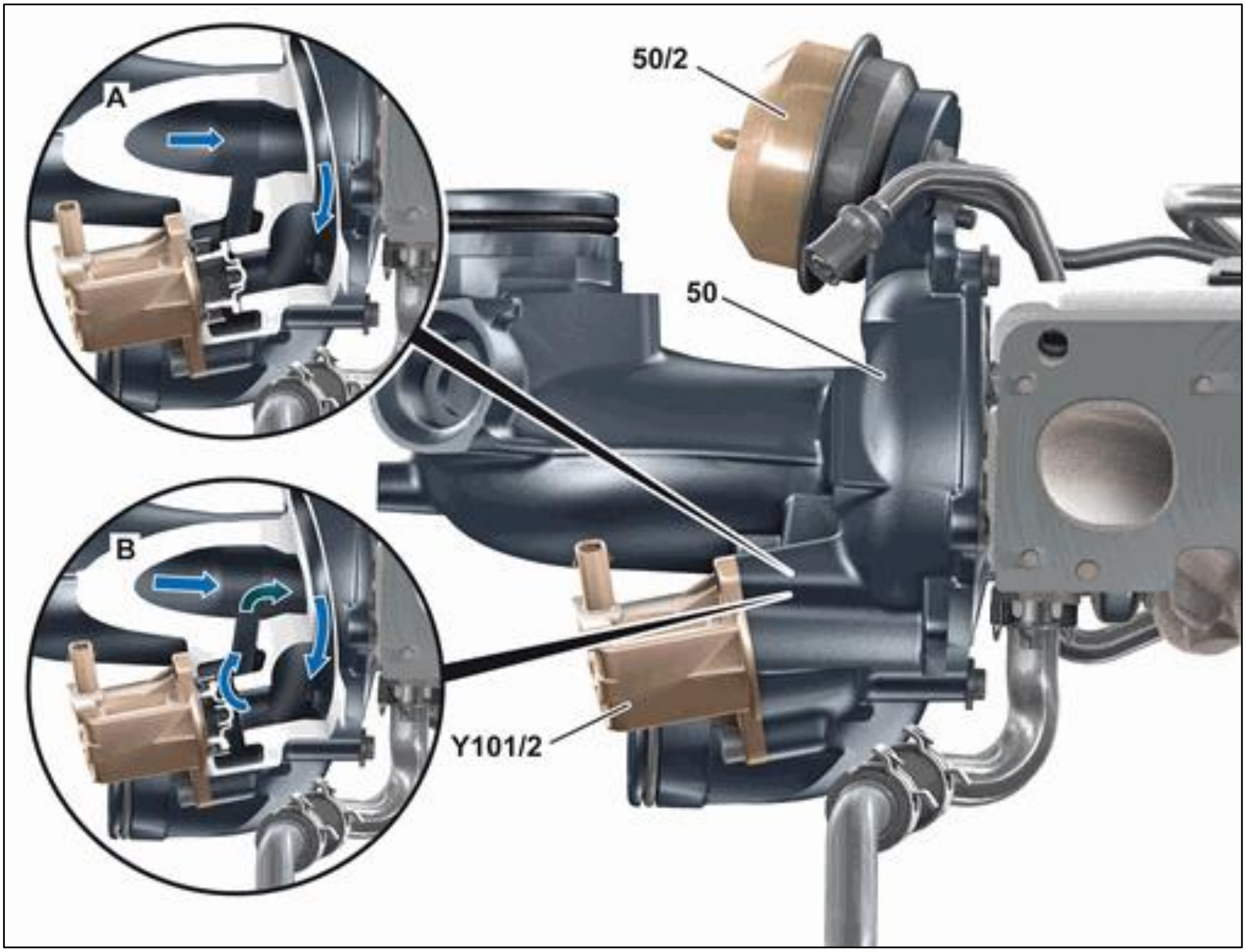
1	*Turbocharger*	*A*	*Coolant feed line*
2	*Boost pressure control flap vacuum unit*	*B*	*Coolant return line*
3	*Boost pressure control flap*	*C*	*Engine oil feed line*
4	*Exhaust manifold*	*D*	*Engine oil return line*
		Y101/1	*Left bypass air switchover valve*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

View of right turbocharger with sectional view of right divert air switchover valve

50	*Turbocharger*
50/2	*Boost pressure control flap vacuum unit*
A Status:	*Closed*
B Status:	*Opened*
Y101/2	*Right bypass air switchover valve*



Charge air cooling

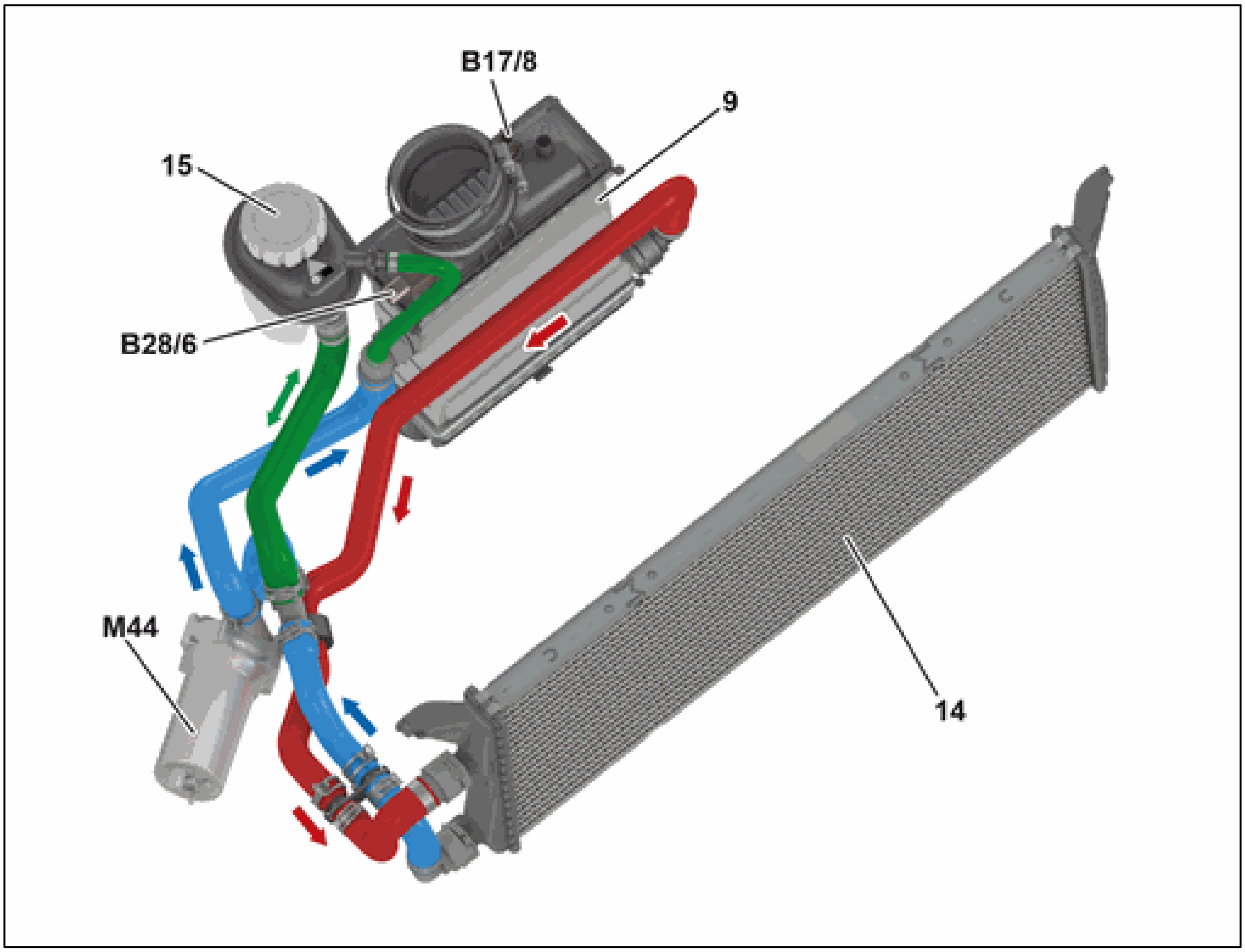
A compact charge air cooler and short flow paths enable low flow-specific resistances, while also contributing to greater engine efficiency.

The cooled air downstream of the charge air cooler has higher density. This increases the cylinder volumetric efficiency, and therefore engine performance. The tendency to knock is also reduced and also the tendency to generate nitrogen oxide (NOx) is reduced by low exhaust temperatures.

To cool down the hot turbocharger after switching off the engine, the low temperature cooling circuit is separately supplied with coolant through the charge air cooler circulation pump for several minutes.

View of low temperature cooling circuit

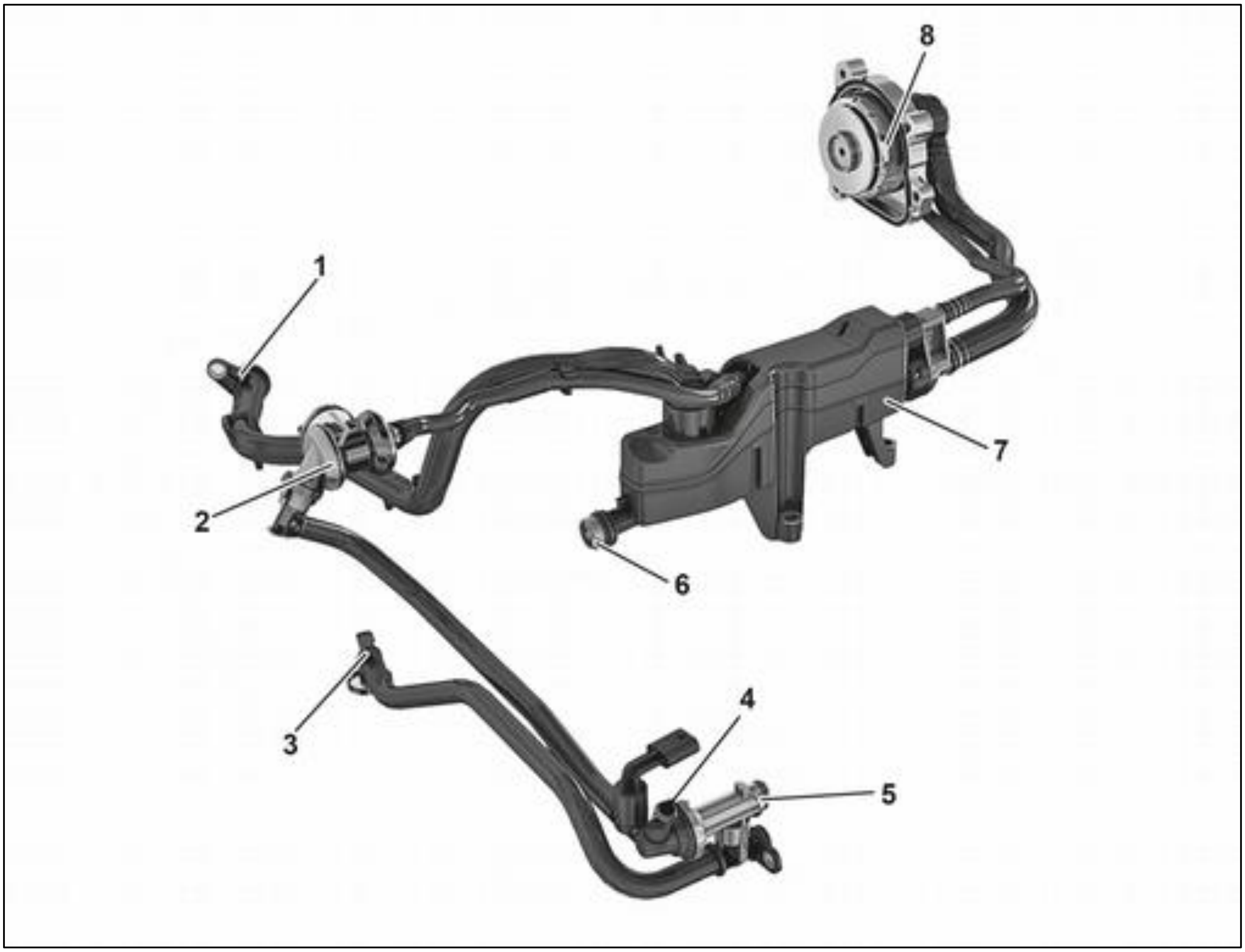
9	*Charge air cooler*
14	*Low-pressure cooler*
15	*Expansion reservoir*
B17/8	*Charge air temperature sensor*
B28/6	*Pressure sensor upstream of throttle valve*
M44	*Charge air cooler circulation pump*



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Two-stage crankcase ventilation

1	*Connection for wide open throttle vent line in clean air line downstream of damper filter*
2	*Check valve for partial load ventilation*
3	*Connection for trailing throttle air for wide open throttle purging*
4	*Connection for activated charcoal filter purging*
5	*Combined connection for engine/fuel tank ventilation*
6	*Oil drain fine separation and ventilation connection in crankcase*
7	*Fine separation for partial load and wide open throttle ventilation*
8	*Centrifugal prefilter (driven by camshaft)*



Crankcase ventilation

The crankcase ventilation system ensures under all operating conditions of the engine that overpressure and excess gases are discharged from the crankcase and fed back to the engine through the intake tract for combustion. To prevent poor engine emissions behavior and an increased oil consumption, the suctioned off gases must be cleansed beforehand by oil vapors.

Installed in the M276 E30 DEH LA is a two-stage ventilation system, consisting of a centrifuge for general and precision separation, and a superfine separation located in the engine's internal ventilation.

Because the crankcase ventilation is impinged on by both partial load and wide open throttle, the centrifuge rotating at camshaft speed achieves an extremely high oil separation rate. The last residue oil is captured by the precision separation.

The new, two-stage crankcase ventilation improves the emissions behavior, lowers oil consumption and exerts a positive influence on oil aging.

Ventilation of fuel tank / purging of activated charcoal canister

The legislator prescribes that fuel vapor must not escape into the air when venting fuel tanks. To this end, the fuel vapors are stored in an activated charcoal canister, separated when the activated charcoal filter reaches a specific load level, and then routed to the engine for combustion.

<u>Function sequence for partial load purging</u>

In partial load operation the fuel vapors stored in the activated charcoal canister (77) are suctioned off by the existing vacuum through the purging switchover valve, the partial load check valve (71) and the partial load purge line (1) downstream of the throttle valve, and sent to the engine for combustion.

The use of turbocharging in the engine 276 DEH LA means that in wide open throttle operation a vacuum prevails downstream of the throttle valve, which in turn prevents the fuel vapors from being suctioned off through the partial load purge line. The partial load check valve prevents any pressure buildup towards the activated charcoal canister. This means that the activated charcoal filter cannot be properly purged when the engine is in permanent load operation. Wide open throttle purging serves to fulfil this requirement.

<u>Function sequence for wide open throttle purging</u>

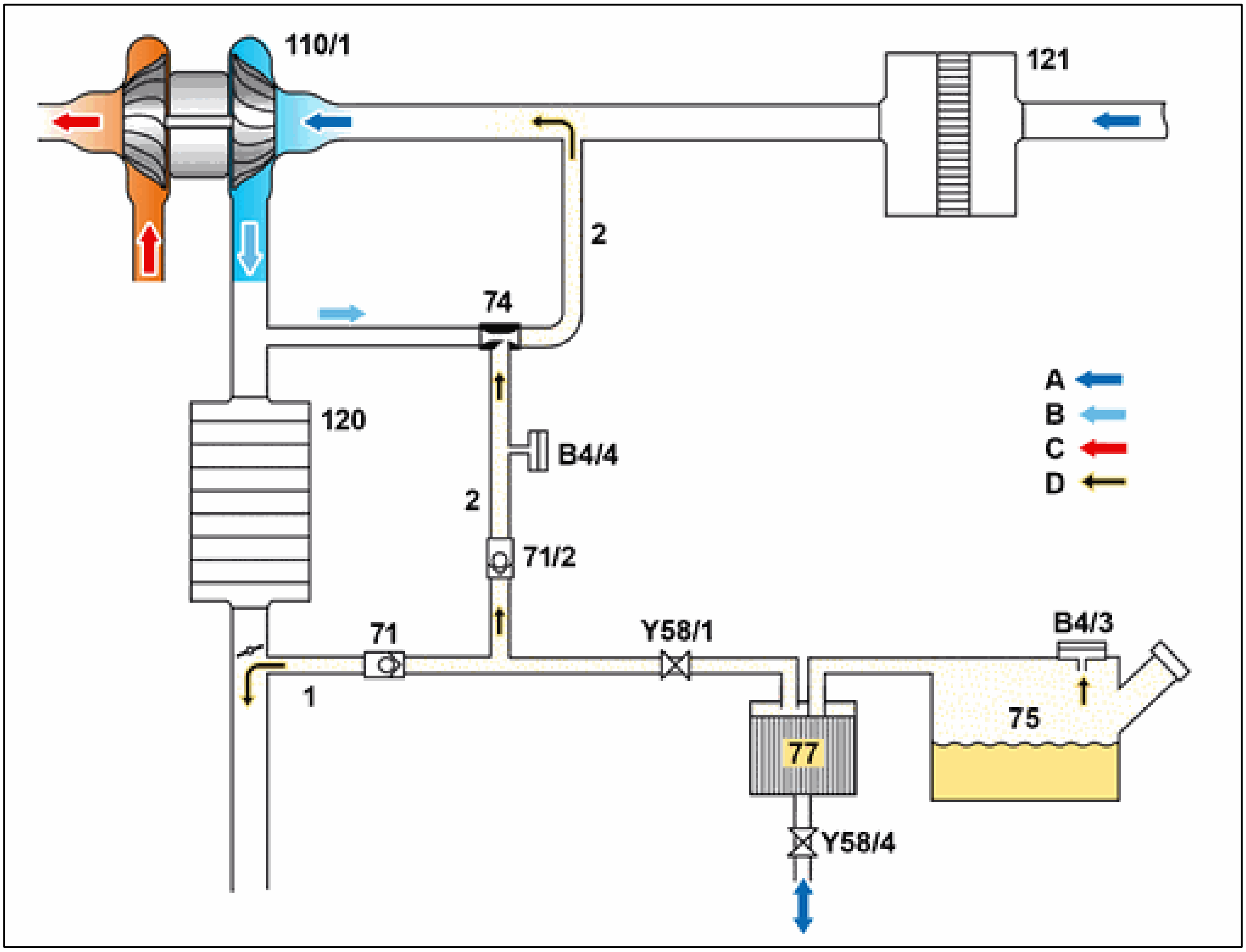
In wide open throttle operation the fuel vapors are suctioned off through the wide open throttle operation check valve (71/2) and the wide open throttle purge line (2). The vacuum required for this is generated by a Venturi nozzle (74). The fuel vapors are then routed over the wide open throttle purge line, turbocharger (110/1) and the charge air cooler (120) to the charge air manifold.

To check whether the wide open throttle purging can be enabled, the purging switchover valve is opened suddenly three times in succession. Pressure peaks of > 120 mbar must be registered here. The purging pressure sensor records the given pressure conditions in the wide open throttle purge line, and forwards a signal to the ME-SFI [ME] control unit.

Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Schematical representation of purging

1	*Partial load purge line*	*A*	*Fresh air*
2	*Wide open throttle purge line*	*B*	*Boost pressure*
71	*Partial load check valve*	*C*	*Exhaust*
71/2	*Wide open throttle operation check valve*	*D*	*Fuel vapors*
74	*Venturi nozzle*	*B4/3*	*Fuel tank pressure sensor (with code (494) USA version)*
75	*Fuel tank*		
77	*Activated charcoal canister*	*B4/4*	*Purging pressure sensor*
110/1	*Left turbocharger*	*Y58/1*	*Purge control valve*
120	*Charge air cooler*	*Y58/4*	*Activated charcoal canister shutoff valve (with Code (494) USA version)*
121	*Left air filter*		



Overview of new features/modifications with introduction of new V-engine M276 with turbocharging

Model designation overview					
Sales designation	**Type**	**Motor**	**Transmission**	**Engine management**	**Notes**
E 400	212.065	276.820	722.904	MED 17.7.3	Sedan
E 400 4MATIC	212.067	276.820	722.961	MED 17.7.3	Sedan
E 400	212.265	276.820	722.904	MED 17.7.3	Wagon
E 400 4MATIC	212.267	276.820	722.961	MED 17.7.3	Wagon

Technical data comparison		**M 276.9 (E35 DES) as of 09/2011**	**M 276.8 (E30 DEH LA) as of 04/2013**
Displacement	cm^3	3498	2996
Rated output	kW at rpm	225 6500	245 5500
Rated torque	Nm at rpm	370 3500 - 5250	480 1400 - 4000
Compression ratio	ε	12,2 : 1	10,7 : 1
Cylinder arrangement/number		V6	V6
Valves/cylinders		4	4
Bore/stroke	mm	92,9/86	88/82,1
Air supply		Selectable resonance intake manifold with selector drum and a resonance flap each between the right and left cylinder bank, which connects or separates the two resonance chambers	Turbocharging with spontaneously responsive turbocharger with wastegate control for each cylinder bank, and a compact water-air charge air cooler design
Boost pressure	bar	---	0.8
Emissions standard	Standard	EU 5	EU 6

Fuel supply function

ENGINE 276.8 in MODEL 207, 212 as of model year 2014

ENGINE 276.8 in MODEL 218 as of model year 2015

Function requirements for fuel supply, general points

- Circuit 15 (ignition ON)
- Circuit 87M (engine timing ON)

Fuel supply, general points

The fuel supply supplies filtered fuel out of the fuel tank in adequate amounts under all operating conditions at an adequate pressure to the fuel injectors (Y76).

Function sequence for fuel supply

The function sequence for fuel supply is described in the following steps:

- **Function sequence for fuel low-pressure circuit**
- **Function sequence for fuel high-pressure circuit**
- **Function sequence for safety fuel shutoff**
- **Function sequence for fuel quality monitoring (for code 494 (USA version) and for code 929 (Engine for ethanol fuel))**

Function sequence for fuel low-pressure circuit

Switching on of the fuel pump (M3) takes place when the signal "fuel pump ON" is received by the fuel system control unit (N118). This signal is sent redundantly from the ME-SFI [ME] control unit (N3/10) as a CAN signal via the drive train CAN (CAN C) and as a ground signal.

The fuel system control unit also receives the CAN signal "specified pressure of the fuel" from the ME-SFI [ME] control unit.

The fuel system control unit detects the current fuel pressure based on a voltage signal from the fuel pressure sensor (B4/7) (model 204, model 207, model 212), fuel pressure sensor (B4/7) (model 218) and transmits this information via the drive train CAN to the ME-SFI [ME] control unit.

ENGINE 276.9 in MODEL 204, 207, 212 (except 212.095), 218

The fuel system control unit evaluates the current fuel pressure, compares it with the specified fuel pressure and actuates the fuel pump with a pulse width modulated signal (PWM signal) as required such that the nominal pressure is equivalent to the specified pressure. The fuel pump pressure is controlled dependent on the fuel temperature and the engine rpm between about 4.5 and a maximum of 6.7 bar.

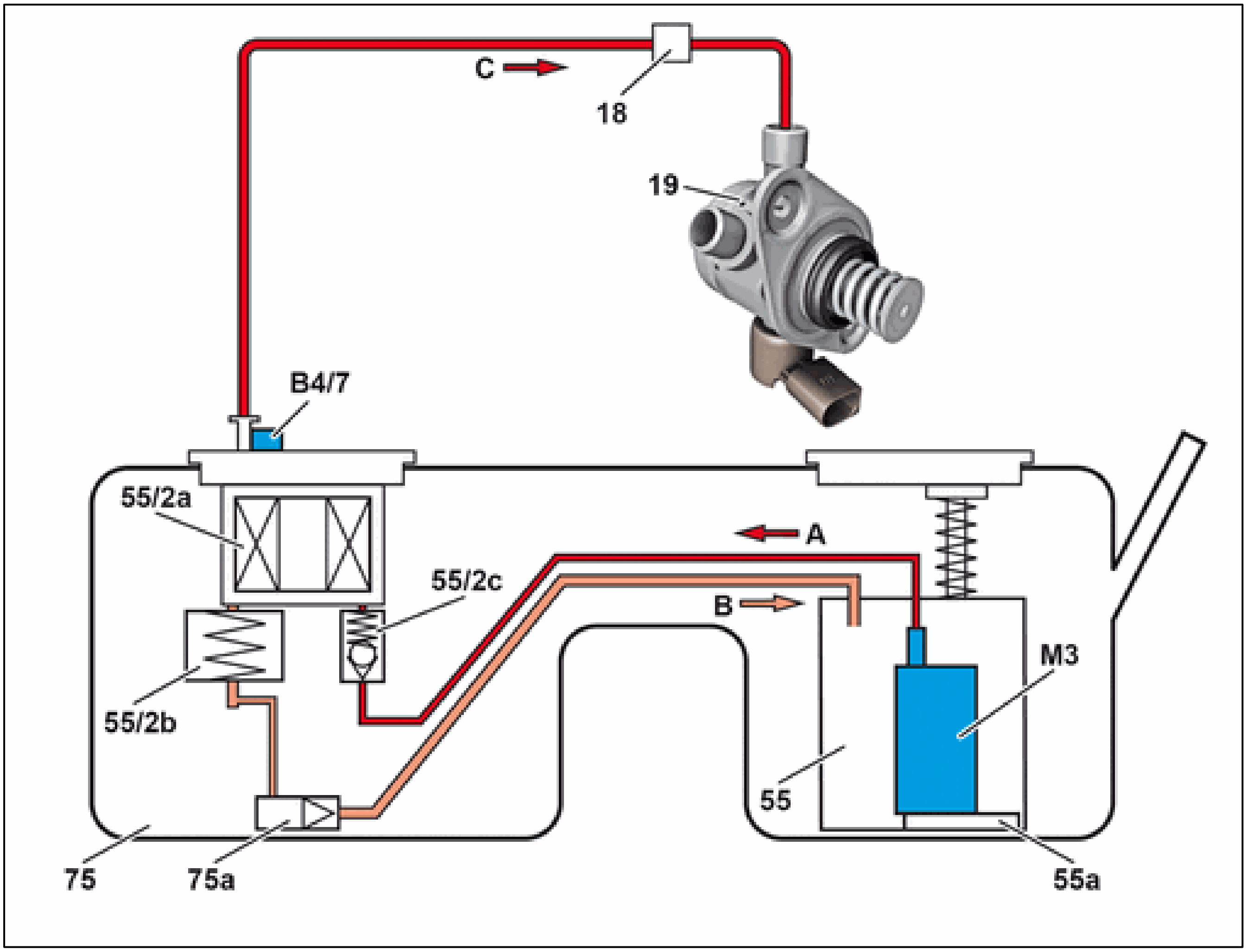
For actuation the fuel pump suctions the fuel from the fuel feed module and pumps it through the fuel filter to the fuel system high pressure pump (single line system without return line).

The overflow valve in the fuel filter opens at a fuel pressure from about 7 to 9 bar. Fuel is removed upstream of the filter over a T-piece which drives the suction jet pump with 20 to 40 l/h. This suction jet pump delivers the fuel out of the left fuel tank chamber into the fuel feed module (in the right fuel tank chamber) and thus prevents single-sided emptying of the fuel tank.

There is a check valve in the feed line to the fuel filter which prevents dropping of the fuel pressure (down to below 4.5 bar) for a switched off fuel pump.

Fuel low-pressure circuit

18	*Low-pressure fuel distributor*
19	*Fuel system high pressure pump*
55	*Fuel feed module*
55a	*Right suction jet pump*
55/2a	*Fuel filter*
55/2b	*Overflow valve*
55/2c	*Check valve*
75	*Fuel tank*
75a	*Left suction jet pump*
B4/7	*Fuel pressure sensor or fuel pressure sensor*
M3	*Fuel pump (FP)*
A	*Fuel feed to fuel filter*
B	*Fuel return from overflow valve*
C	*Fuel to the fuel system high pressure pump*



Fuel supply function

Function sequence for fuel high-pressure circuit

In the fuel high-pressure circuit, the fuel high pressure of about 200 bar required for spray guided direct injection is generated, regulated and stored in the rails.

The ME-SFI [ME] control unit reads in the following sensor for regulation of the fuel high pressure:

- Fuel pressure and temperature sensor (B4/25)

The fuel from the fuel tank flows from the low-pressure fuel distributor to the fuel system high pressure pump. This delivers the fuel (according to the operating condition) at a pressure of up to 200 bar and directs it to the fuel injectors via the high-pressure lines and the rails. The three fuel injectors per cylinder head are supplied directly from the associated rail with fuel.

Located on the fuel system high pressure pump is a quantity control valve (Y94) that regulates the fuel quantity fed to the pump element to match the specified fuel pressure.

The fuel pressure and temperature sensor detects the current fuel high pressure as well as the temperature of the fuel in left the rail. The operating pressure is up to about 200 bar. It is only at vehicle standstill and for a selector lever position "N" or "P" that the pressure drops to 150 bar in order to reduce the noise emissions from the fuel system high pressure pump.

In the case of shutting off a vehicle with a hot engine, the fuel pressure can increase up to 250 bar (+17 bar) in the fuel high-pressure circuit. Upon reaching this threshold a pressure limiting valve opens in the fuel system high pressure pump and the pressure is reduced. Upon starting the engine the pressure falls rapidly to the normal operating pressure of 200 bar.

In order to achieve rail pressure regulation, the quantity control valve is actuated by means of a PWM signal by the ME-SFI [ME] control unit until the fuel specified pressure is set up in the rail.

There are leakage lines on both rails which, in the case of a leak on the sealing rings for the fuel injectors to the rail, lead the fuel into the cylinder head. This prevents fuel escaping and thus any possible ignition on hot engine parts.

During regulation of the fuel high-pressure circuit one differentiates between the following operating conditions:

- <u>Start</u>
- <u>Normal mode</u>
- <u>Low-pressure limp-home mode (fuel high pressure is not reached)</u>
- <u>Stop</u>

<u>Start</u>

- The quantity control valve is energized and closed, so there is full delivery from the fuel system high pressure pump and rapid pressure buildup.
- Fuel pump pressure is approx. 4.5 up to 6.7 bar.

<u>Normal mode</u>

- The quantity control valve regulates over the duty cycle of the fuel high pressure.
- Fuel pump pressure is dependent on the fuel temperature between about 3.0 to 5.5 bar.
- The fuel predelivery pressure is dependent on the engine speed and fuel temperature and varies between 4.5 and 6.7 bar (absolute).

<u>Low-pressure limp-home mode (fuel high pressure is not reached)</u>

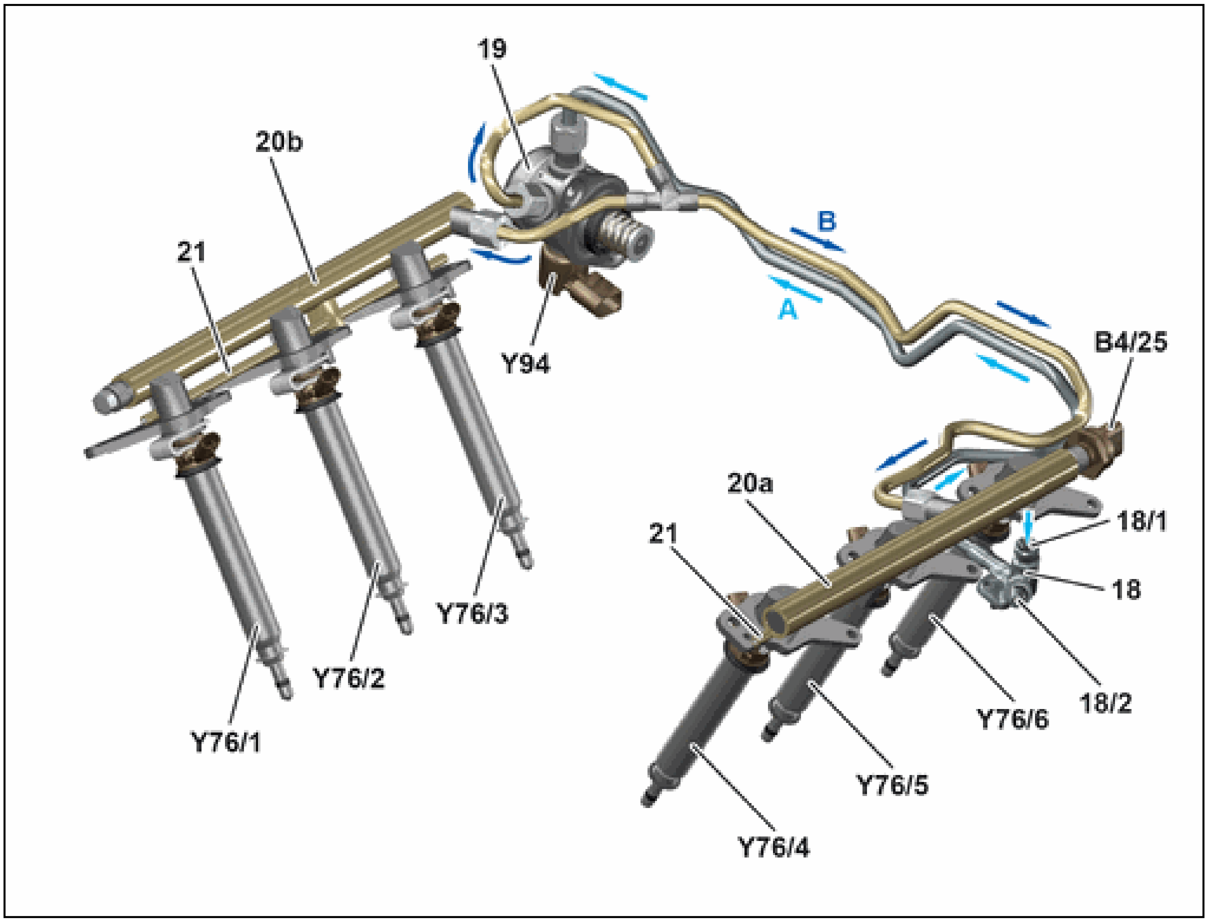
- The quantity control valve is deenergized and therefore opened.
- Fuel pump pressure about 4.5 to 6.7 bar, fuel flows over the open quantity control valve into the rails.
- Actuation of fuel injectors extended.
- Blocked stratified operation (for code (920) Gasoline direct injection with stratified charge).
- Performance reduction, max. speed about 70 km/h.

<u>Stop</u>

- Quantity control valve is deenergized and opened.
- Fuel pump not actuated

Note: Assembly operations

The high pressure fuel lines made out of stainless steel can be reused after checking. An appropriate test specification can be found in the repair instructions.



Fuel high-pressure circuit

18	*Low-pressure fuel distributor*
18/1	*Fuel feed (low pressure)*
18/2	*Pressure gauge connection with service valve*
19	*Fuel system high pressure pump*
20a	*Left rail*
20b	*Right rail*
21	*Leakage line*
B4/25	*Fuel pressure and temperature sensor*
Y76/1	*Cylinder 1 fuel injector*
Y76/2	*Cylinder 2 fuel injector*
Y76/3	*Cylinder 3 fuel injector*
Y76/4	*Cylinder 4 fuel injector*
Y76/5	*Cylinder 5 fuel injector*
Y76/6	*Cylinder 6 fuel injector*
Y94	*Quantity control valve*
A	*Low fuel pressure*
B	*Fuel high pressure*

Fuel supply function

Function sequence for safety fuel shutoff

The safety fuel shutoff system is designed to ensure traffic and passenger safety.

The ME-SFI [ME] control unit controls the safety fuel shutoff on the basis of the following sensors and signals:

- Crankshaft Hall sensor (B70), engine rpm
- Throttle valve positioner (M16/6), throttle valve position
- Supplemental restraint system control unit (N2/10) (model 204), supplemental restraint system control unit (N2/10) (model 207, 212, 218)
- Supplemental restraint system control unit or supplemental restraint system control unit, indirect crash signal via the chassis CAN (CAN E) (up to model year 2014)
- Supplemental restraint system control unit or supplemental restraint system control unit, indirect crash signal via the chassis CAN 1 (CAN E1) (as of model year 2014)

The safety fuel shutoff is activated by the ME-SFI [ME] control unit for the following conditions:

- Mechanical fault in the throttle valve actuator
- Absence of the engine speed signal
- Crash signal

Mechanical fault in the throttle valve actuator
When evaluating the throttle valve position, if the ME-SFI [ME] control unit detects a mechanical fault in the throttle valve actuator, engine speed is limited to about 1400 rpm at idle and about 1800 rpm in driving mode by shutting off the fuel injectors.

Absence of the engine speed signal
If the engine speed signal generated by the crankshaft Hall sensor is missing, the fuel pump is shut off via the fuel system control unit.

Crash signal
If the ME-SFI [ME] control unit receives a crash signal indirectly via the chassis CAN or directly from the supplemental restraint system control unit or supplemental restraint system control unit, it switches off the fuel pump via the fuel system control unit (directly and via the drive train CAN) and the quantity control valves, in order to depressurize the fuel system.

Function sequence for fuel quality monitoring (for code 494 (USA version) and for code 929 (Engine for ethanol fuel)

With the ever higher increase in the admixture of ethanol into the fuel it has become necessary to monitor the ethanol content or the fuel ethanol mixture. Variations in the stoichiometric fuel air/fuel ratio can occur due to the variable ethanol contents. This can lead to a loss of engine power.

Monitoring takes place by means of the fuel quality sensor (B4/31) which detects the relative conductivity of the gasoline ethanol mixture.

The value of the relative conductivity is dependent on the gasoline ethanol mixture and the fuel temperature. This value is measured by the fuel quality sensor and is transmitted with an appropriate voltage signal to the FSCU. There it is converted and sent as information to the ME-SFI [ME] control unit in order to undertake the appropriate adaptation of the engine timing.

The power supply of the fuel quality sensor takes place from the FSCU.

ENGINE 276.8 in MODEL 207, 212 as of model year 2014

ENGINE 276.8 in MODEL 218 as of model year 2015

Function requirements for camshaft adjustment, general points

- Circuit 87M (engine timing ON)
- Engine runs

Camshaft adjustment, general points

With camshaft adjustment all four camshafts can be adjusted continuous for up to 40° CKA (CrankAngle). This means the valve overlap in the event of a gas exchange can be varied within wide limits.

This optimizes engine torque characteristics and improves the exhaust characteristics.

Note: Valve overlap

The intake valves open before the exhaust valves close.

The ME-SFI [ME] control unit (N3/10) reads in the following sensors for camshaft adjustment:

- Left and right intake camshaft hall sensors (B6/4, B6/5), intake camshaft positions
- Left and right exhaust camshaft hall sensors (B6/6, B6/7), exhaust camshaft positions
- Coolant temperature sensor (B11/4) (model 204, 207, 212), coolant temperature sensor (B11/4) (model 218)
- Pressure sensor downstream of throttle valve (B28/7), engine load
- Crankshaft Hall sensor (B70), engine rpm

Function sequence for camshaft adjustment

The function sequence is described in the following steps:

- **Function sequence for release of the camshaft adjustment**
- **Function sequence for oil pressure**
- **Function sequence for adjustment**
- **Function sequence for adjustment range**
- **Function sequence for start position**
- **Function sequence for valve overlap**

ENGINE 276.9 in MODEL 204, 207, 212 (except 212.095), 218

- **Function sequence for camshaft positions monitoring**
- **Function sequence: diagnosis**

Function sequence for release of the camshaft adjustment

Camshaft adjustment is enabled by the ME-SFI [ME] control unit dependent on engine speed and engine oil temperature.

The engine oil temperature is determined by the ME-SFI [ME] control unit using various operating data (e.g. coolant temperature, time, engine load) and a stored temperature model determined.

Note: The engine oil temperature is important, even when the oil is hot, to ensure that there is sufficient oil pressure (>1.5 bar) for adjusting the camshafts.

Release of adjustment of the exhaust camshafts takes place by means of a comparison to the intake camshafts, at first at a high rotational speed. In this way for exhaust, also at a low oil pressure level, reaching the locking position against the "retard" operating reaction torques of the camshaft are secured. There is a return spring located for support in each camshaft positioner.

If all four camshafts are adjusted, adjustment of the exhaust camshafts takes place after a delay (later). Oil supply problems are prevented and secure functioning of the locking mechanism achieved.

Release of the camshaft adjustment occurs load-dependent:

- For an 80°C engine oil temperature from about 600 rpm
- For a 120°C engine oil temperature (inlet side) from about 800 rpm
- For a 120°C engine oil temperature (exhaust side) from about 1050 rpm

Camshaft adjustment, function

Function sequence for oil pressure
The engine oil pressure is regulated via the engine oil pump valve (Y130) in order to ensure an adequate oil supply and to lower the oil pressure if necessary (a saving on fuel).

Function sequence for adjustment
The left and right intake camshaft solenoids (Y49/4, Y49/5) and the left and right exhaust camshaft solenoids (Y49/6, Y49/7) are actuated by the ME-SFI [ME] control unit by means of a pulse width modulated signal (PWM signal). The control plungers are adjusted via the characteristics map-dependent duty cycle. The oil filling quantities (hydraulic fluid) for the camshaft positioners are controlled according to their position. The vane plungers which are firmly connected to the camshafts are thus turned by the hydraulic fluid in the camshaft positioners.

Function sequence for adjustment range

Intake camshaft: a 4°CKA before TDC (**T**op **D**ead Center) up to a 36°CKA after TDC (intake open)

Exhaust camshaft: 25° CKA before TDC up to 15° CKA after TDC (exhaust closes)

Function sequence for start position

Intake camshaft: 36° CKA after TDC (intake opens)

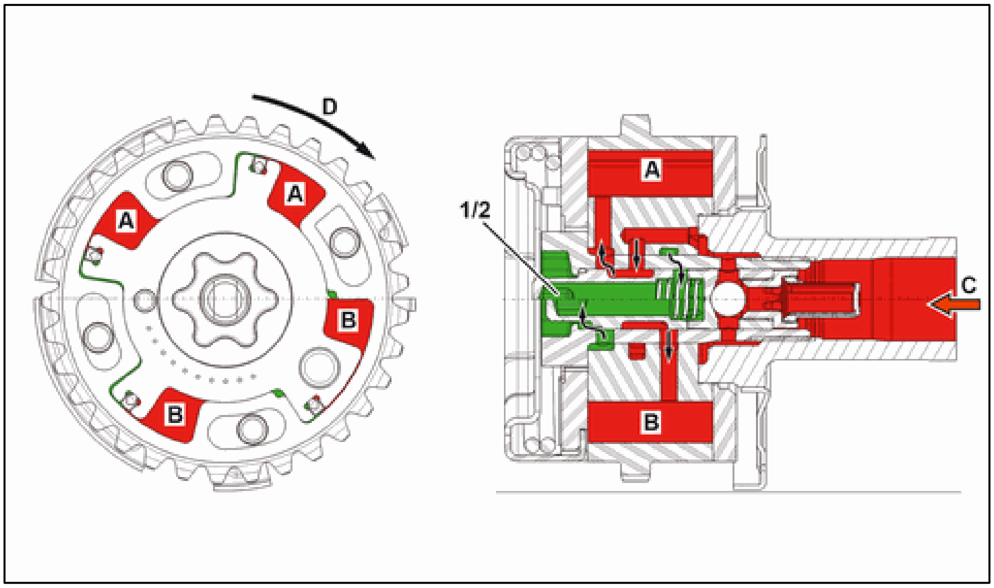
Exhaust camshaft: 25° CKA before TDC (exhaust closes)

The camshafts are locked in a fixed position for starting by catch bolts (locked). This start position is unlocked hydraulically at the first actuation of the intake camshaft and exhaust camshaft solenoids.

The upper half of the illustration shows:
Filling of oil reservoir galleries (A), oil reservoir galleries (B) open.

The lower half the illustration shows:
Filling of oil reservoir galleries (B), oil reservoir galleries (A) open.

Shown is oil flows in the intake camshaft camshaft positioner



½ Control plunger
A Oil reservoir for retarding the ignition timing
B Oil reservoir for timing advance
C Hydraulic fluid from intake camshaft
D Rotation direction

Function sequence for valve overlap

At low engine speed and load, the ME-SFI [ME] control unit sets a large valve overlap in order to produce internal exhaust gas recirculation. Less fresh air is admitted, as exhaust gases with low oxygen content are still present in the cylinders. This lowers the combustion temperature and reduces the formation of nitrogen oxides (NOX).

The intake air mass is reduced by the amount of exhaust gases present. The ME-SFI [ME] control unit shortens the injection period accordingly.

The smallest valve overlap for gas exchange occurs if the exhaust camshaft are adjusted to the maximum BTDC (advanced) and the intake camshaft to the maximum after TDC (retarded). The resulting increased fresh air content produces more engine torque and engine power.

Function sequence for camshaft positions monitoring

The camshafts positions are detected by the intake camshaft Hall sensors and the exhaust camshaft Hall sensors, and communicated to the ME-SFI [ME] control unit. Acquisition of the positions takes place through detection of the positions of pulse wheels which are located at the front on the camshafts.

Function sequence: diagnosis

During diagnosis of the camshaft adjustment, the ME-SFI [ME] control unit checks whether the camshafts are in start position at engine start and whether the requested adjustment has been reached after the engine has been running for a short time. Output stage errors in the camshaft solenoids (integrated with the ME-SFI [ME] control unit) and defective camshaft Hall sensors are also detected.

1	*Control valve*
1/1	*Valve body*
1/2	*Control plunger*
1/3	*Return spring*
2	*Camshaft positioner*
3	*Intake camshaft*
Y49/4	*Left intake camshaft solenoid*
Y49/5	*Right intake camshaft solenoid*