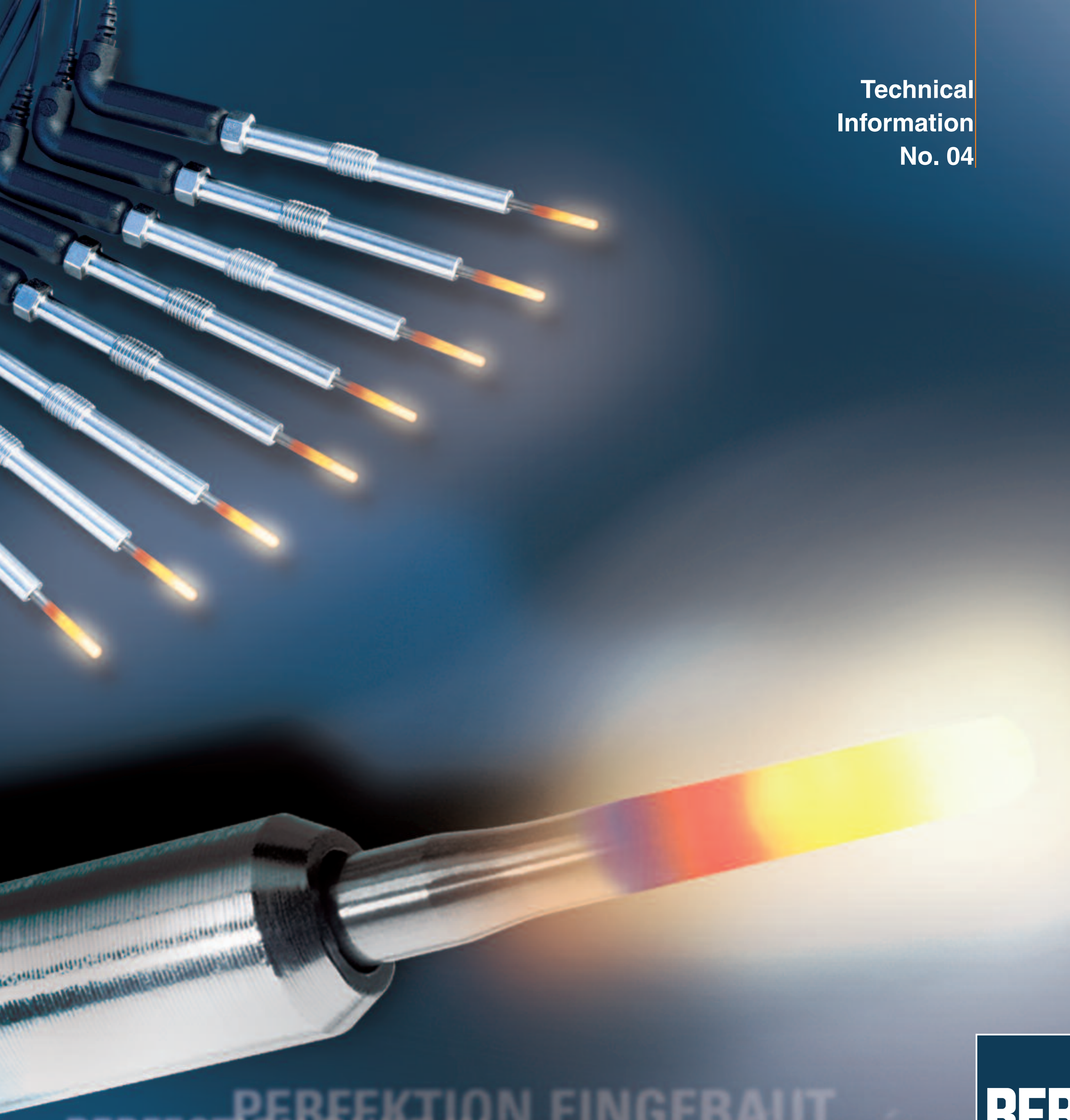
All about glow plugs

Technical
Information
No. 04



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Perfection built in

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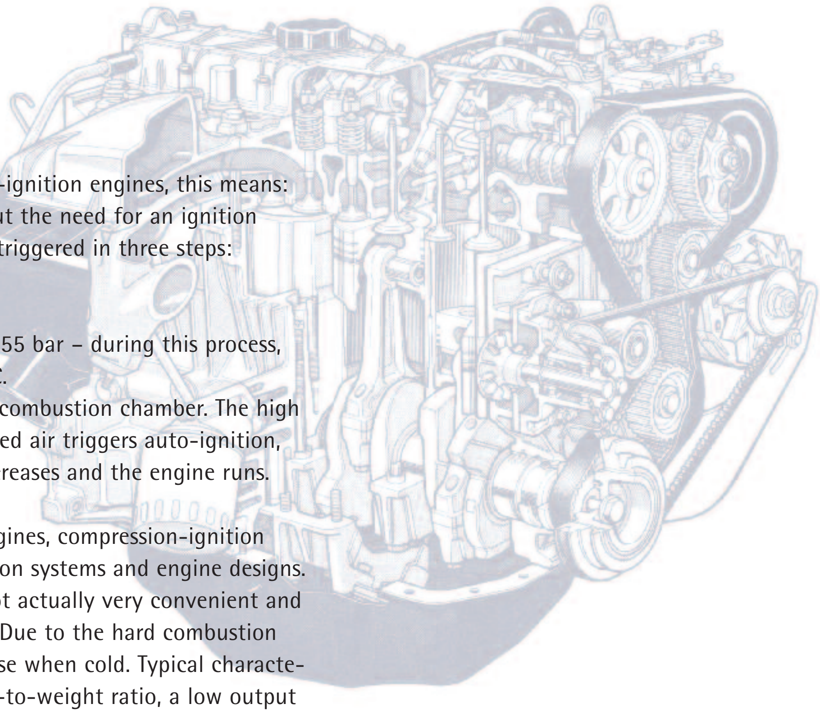
The diesel engine



Function

Diesel engines are compression-ignition engines, this means: The injected fuel ignites without the need for an ignition spark. The combustion cycle is triggered in three steps:

1. First, clean air is taken in.
2. This air is compressed to 30–55 bar – during this process, it will heat up to 700–900 °C.
3. Diesel fuel is injected in the combustion chamber. The high temperature of the compressed air triggers auto-ignition, internal pressure strongly increases and the engine runs.

Compared to spark-ignition engines, compression-ignition engines require complex injection systems and engine designs. The first diesel engines were not actually very convenient and high-revving drive aggregates. Due to the hard combustion process, they made a lot of noise when cold. Typical characteristics included a higher power-to-weight ratio, a low output per liter displacement as well as a poor acceleration performance. Through continuous development of the injection technology and the glow plugs, it was possible to eliminate all these disadvantages. Today, the diesel engine is considered an equivalent or even better drive source.

Cold start

A cold start describes all start processes during that the engine and the media have not reached operating temperature. The lower the temperature, the less favorable are the conditions for a quick ignition and complete, environmentally friendly combustion. Certain aids are used to assist during cold start and so that starting will not be unacceptably long or even impossible. These compensate for the poorer start conditions while initiating a well-timed and even ignition to ensure stable combustion.

The glow plug is one component that assists during cold start. It creates ideal ignition conditions for the injected fuel by electrically generated thermal energy that is taken in the combustion chamber. It is indispensable as cold start aid for engines with a divided combustion chamber to ensure that these can start even in the frequently occurring temperature range of 10–30 °C. As the start quality deteriorates considerably below freezing point, the glow plug is also used as cold start aid for direct-injection diesel engines.

The diesel engine

Injection systems

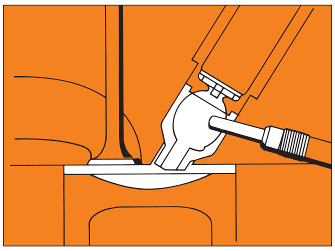
Depending on the design and arrangement of the combustion chamber, a distinction is made between the following three injection systems in diesel engines:

1. Antechamber system
2. Turbulence chamber process
3. Direct injection

Glow plugs are required for all systems – to ensure that the injected fuel can evaporate and the fuel-air mixture can ignite on the hot surface of the plug.

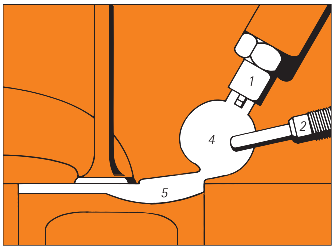
ANTECHAMBER SYSTEM

In this system, the combustion chamber is divided into two: an antechamber and the main chamber. These are connected by several bores (injection channels). During the compression cycle, a part of the compressed air is pressed in the antechamber. Shortly before reaching the top dead centre, the fuel is injected through a nozzle directly into the antechamber of the respective piston. The injected fuel is partially combusted there. The generated high temperatures ensure that the pressure increases quickly. The entire content of the antechamber is thus blown through the injection channels into the main combustion chamber, where the actual combustion takes place.



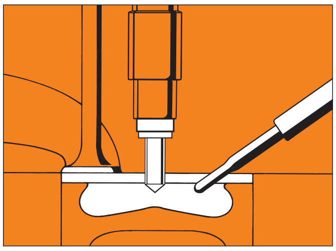
TURBULENCE CHAMBER PROCESS

The spherical turbulence chamber is arranged separate from the main combustion chamber in the cylinder head. Main combustion chamber and turbulence chamber are connected by a large-diameter injection channel. During the compression cycle, the injection channel in the turbulence chamber causes intensive rotation of the intake air. The Diesel fuel is injected into this air turbulence. Combustion starts in the turbulence chamber and then expands into the main combustion chamber. In driving operation, the temperature of the compressed air is sufficiently high for auto-ignition. However, it is not sufficient for starting the engine, in particular when outside temperatures are low.



DIRECT INJECTION

In diesel direct injection (fuel-air distribution), the fuel is injected at high pressure through the multiple-hole nozzle into the highly compressed intake air for atomization; during this process, the special piston crown design helps with carburetion. During start, the cold intake air is very quickly heated up due to the high compression pressure. The heating rod protrudes into the main combustion chamber. In principle, the glow plug of direct injection engines has the same function as in the chamber engines: It helps with ignition during start. The heating rod of a modern glow plug reaches a temperature of more than 1,000 °C within only a few seconds.



1 | Injection nozzle
2 | Glow plug
3 | Antechamber
4 | Turbulence chamber
5 | Combustion chamber

The following is always applicable during cold start: Cold intake air will cause low temperatures at the end of compression. However, the effect of lower torques during start is more serious. Due to the long exposure period of the charge, the pressure and temperature loss is much higher than, for instance, in idle speed.

Self-regulating glow plugs

Requirements of a modern glow plug

SHORT HEAT-UP TIME

Glow plugs must provide a high temperature within an as short as possible time to assist with ignition – and it must maintain this temperature regardless of the basic conditions, or even adjust the temperature in dependence of the latter.

SMALL SPACE REQUIREMENT

In the past, the diesel engines of passenger cars mainly operated as direct injection engines with 2 valves and thus offered sufficient space for injection nozzles and glow plugs. In modern diesel engines with common rail or pump-nozzle injection system and 4-valve technology, however, the available space is very restricted. This means that the space required for the glow plug must be reduced to a minimum, resulting in a very thin and long shape. Today, BERU glow plugs with glow tube diameters that have been reduced to 3 mm are already in use.

PRECISE ADAPTATION TO THE COMBUSTION CHAMBER

Ideally, the glow rod should be situated precisely at the edge of the mixture turbulence - however, it must still immerse sufficiently deep into the combustion chamber or the antechamber. Only then is it able to introduce the heat accurately. It may not protrude too far into the combustion chamber, as it would otherwise interfere with the preparation of the injected fuel and thus the carburetion of an ignitable fuel-air mixture. This would result in increased exhaust gas emissions.

SUFFICIENT GLOWING VOLUME

Apart from the glow plug, the injection system is of particular significance for the engine cold start. Only a system that has been optimized in terms of its injection point, quantity and carburetion in conjunction with the correct position and thermal rating of the glow plug will ensure good cold start performance. Even after the engine has been started, the glow plug may not be "blown cold" by the increased air movement in the combustion chamber. Very high air speeds are in particular present in ante- or turbulence chamber engines at the glow plug tip. In this environment, the plug will only work if it has sufficient reserves; i.e. if sufficient glowing volume is available so that heat can immediately be introduced in the cold-blown zone.

The glow plugs developed by BERU fulfill all these requirements in an optimal manner. BERU engineers work closely with the automotive industry during engine development. The result: an environmentally-sound diesel quick start in 2-5 seconds (in conjunction with the Instant Start System ISS even shorter), a reliable start up to –30 °C, a steady engine start-up that is gentle on the engine, up to 40 % less carbon-particulate emission in the warm-up phase for post-heating glow plugs (for more information read pages 7 and following).

Self-regulating glow plugs

Design and function

The BERU glow plug basically comprises the plug body, heating rod with heating and regulating coil, as well as the connecting bolt. The corrosion resistant glow rod is pressed in the housing in a manner that it is gas-tight. The plug is additionally sealed by a sealing ring or a plastic component at the connector. A battery supplies the electrical energy for the glow plug. It is controlled by an electronic glow time control unit.

HEATING AND REGULATING COIL

The basic principle of a modern glow plug is the combination of a heating and a regulating coil to one common resistor element. The heating coil is made of high-temperature resistant material the electrical resistance of which is largely temperature-independent. Together with the front part of the glow rod, it forms the heating zone. The regulating coil is attached to the live connecting bolt; its resistance has a large temperature coefficient.

The entire coil is firmly packed in a compressed, electrically insulating but highly heat-conductive ceramic powder. During mechanical compressing, the powder is compressed so much that the coil is fitted as if it was cast in cement. This makes it so stable that the thin wires of the heating and regulating coil can permanently resist all vibrations. Even though the individual windings are arranged only a few decimillimeters apart, no winding short circuits can be produced – and certainly no short circuit with the glow tube that would destroy the plug.

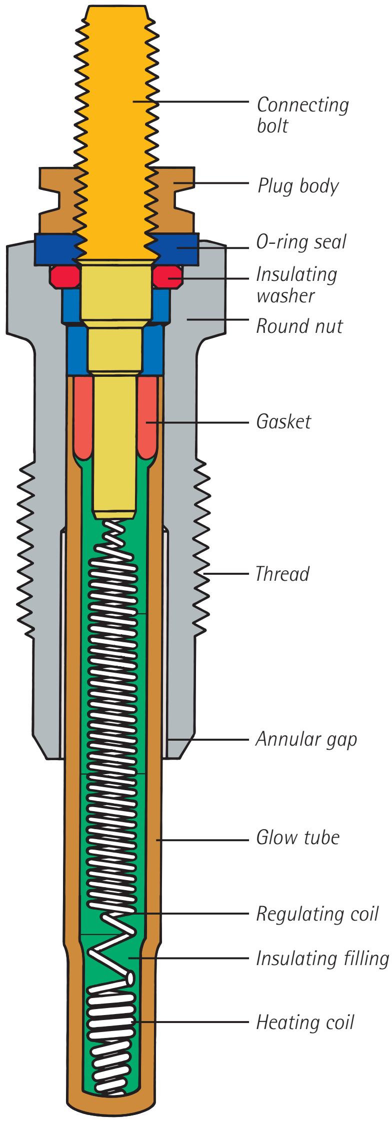
With the different materials, lengths, diameters and wire strengths of the heating and regulating coil, it is possible to change the heat-up times and glow temperatures of the plug in accordance with the respective requirements of the engine.

FUNCTION

During pre-heating, high current initially flows via the connecting bolt and the regulating coil to the heating coil. The latter heats up quickly, causing the heating zone to glow. Glowing quickly expands – after 2-5 seconds, the heating rod glows up to near the plug body. This additionally increases the temperature of the regulating coil that has already been heated up by the current. Then, the electrical resistance increases and the current are reduced to a point where it cannot cause any damage to the glow rod. Overheating of the glow plug is thus not possible.

If the engine is not started, the glow plug will be switched off by the glow time control unit after a certain stand-by time.

The resistance of the alloy used on BERU glow plugs increases with the temperature. It is thus possible to design the regulating coil in such manner that it will initially let through a higher current to the heating coil than upon reaching the target temperature. The target temperature is thus reached quicker and is maintained within the permissible range by increased limitation.



Design of a self-regulating quick-heating glow plug.

Self-regulating glow plugs

Post-heating glow plugs (GN)

Old model vehicles are normally equipped with glow plugs that only glow before and during the start phase. They can be recognized from the abbreviation GV. Modern Diesel passenger cars normally leave the assembly line with fitted GN glow plugs. They are equipped with the innovative 3-phase glow system. This means that they glow

- before the start,
- during the start phase,
- after the start, and
- during engine operation (in trailing throttle).

FUNCTION

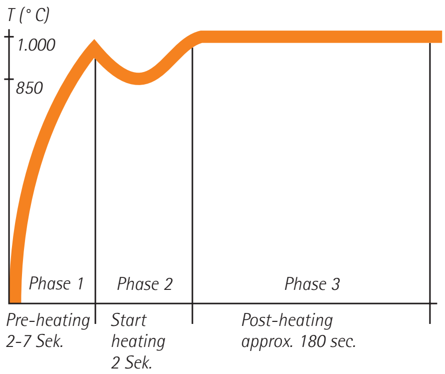
The electronically controlled pre-heating starts when the ignition lock starter switch is operated and lasts for approx. 2-5 seconds at normal outside temperatures until the engine is ready for start. The post-heating time is up to 3 minutes after starting the engine to reduce pollutant and noise emissions to a minimum.
The engine operating state is recorded e.g. by measurement of the coolant temperature. The post-heating process is continued until the coolant has reached a temperature of 70 °C, or it will be switched off after a certain time set in the performance map. No post-heating will normally take place if the coolant temperature is higher than 70 °C already before the start.

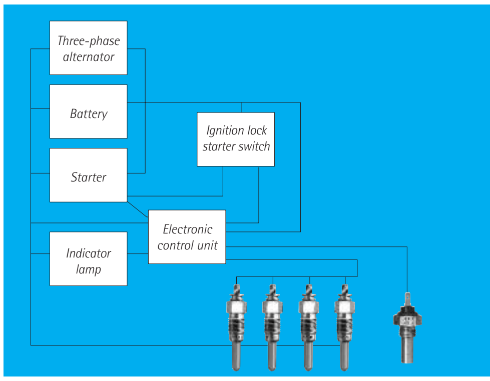
PROTECTION AGAINST OVERHEATING

Self-regulating glow plugs restrict the current flowing from the battery to the plug with increasing temperature to prevent overheating. However, when the engine is running, the voltage will increase to a point where glow plugs that do not comply with the state of the art will blow. Besides, the plugs that are impinged with current are exposed to high combustion temperatures after the start, and are thus heated up from the inside and the outside. The post-heating BERU glow plugs are functional at full generator voltage. Their temperature increases very quickly, but will then be limited by the new regulating coil to a saturation temperature that is lower than that of non post-heating plugs.

Important: Only GN glow plugs may be installed in a glow system designed for GN glow plugs – GV glow plugs could be damaged very quickly.

The 3-phase glow technology.





Switching principle of a post-heating glow system with four quick-heating glow plugs connected in parallel and temperature sensor.

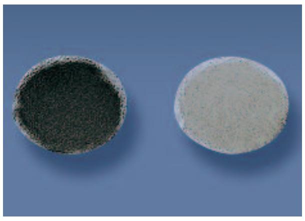
Self-regulating glow plugs

QUICK START IN 2 SECONDS

With the post-heating BERU GN glow plug, it was possible to reduce the glow time to 2-5 seconds. To achieve this, the designers reduced the diameter at the front end of the heating rod. The heating rod thus starts glowing quicker in this zone. At a temperature of 0 °C, this takes just 2 seconds until start. When temperatures are lower, the system is accordingly adapted to the requirements by the glow-time control, and glow time will respectively increase: at –5 °C approx. 5 and at –10 °C approx. 7 seconds.

REDUCTION OF WHITE/BLUE SMOKE

So-called white or blue smoke is emitted from the exhaust until the ideal ignition temperature has been reached. These produced smokes are the result of incomplete combustion of the fuel as a result of a too low ignition temperature. Post-heating causes the diesel fuel to burn more completely and with less noise during the warm-up phase. Smoke opacity is thus reduced to up to 40 %.



Carbon deposits in the filter paper three minutes after the cold start. With post-heating (on the right), carbon deposits are approx. 40% less than without post-heating.

ELIMINATION OF COLD-START KNOCKING

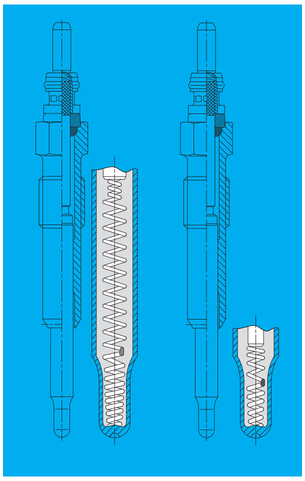
Knocking during cold-start of a diesel engine is caused by an increased ignition delay when the engine is cold. The fuel ignites all of a sudden, the engine knocks. Pre-heating and post-heating of GN glow plugs ensure that the engine reaches the operating temperature quicker. This preserves the engine, results in a quieter engine running and prevents knocking. The fuel will then be burnt more evenly and more completely. More energy is thus released and the combustion chamber temperature will increase quicker.

Technical features of the GN glow plug

- Quick-start glow plug in slim design
- Short pre-heating time: only approx. 2 - 7 seconds
- Reliable start (even at -30 °C)
- Environmentally friendly: 40 % less pollutant emission during the warm-up phase
- No knocking
- Quieter engine running
- Start is gentle on the engine
- For vehicles with operating voltages up to 14.5 V

The BERU Instant Start System (ISS)

Making a "SI engine like" key start possible also for diesel-fuelled vehicles was a great challenge. The solution of BERU engineers: the Instant Start System ISS.



Interior design of the self-regulating standard glow plug SR (left) and the power-optimized glow plug of the ISS (right).

System concept

The BERU ISS comprises an electronic glow plug control unit and performance-optimized glow plugs with a reduced heat-up time of maximum 2 seconds – compared to 5 seconds for a standard glow plug (SR). Both in the heating-up and in the saturation phase, they require significantly less energy.
Power semi-conductors are used in the control unit as switches to control the glow plugs, replacing the electro-mechanic relay used in the past. Compared to the conventional self-regulating glow plugs, the winding combination of the power-optimized glow plug of the ISS is considerably shorter and the glowing area is reduced to approximately one third. In direct-injection engines, this corresponds to the part of the heating rod that protrudes into the combustion chamber.

Electronic control

When the engine is running, the glow plug is cooled by charge cycles and air movement in the compression phase. The temperature of the glow plug will go down with increased speed for a constant glow plug voltage and injection quantity, and will increase for an increasing injection quantity and constant glow plug voltage and speed. The electronic control unit can compensate for these effects: The glow plugs are always supplied with the optimal effective voltage for the respective operation point. The glow plug temperature can thus be controlled depending on the operating state. Besides, the combination of the low-voltage glow plug and the electronic control unit is used for heating up the glow plug extremely quickly. This is done by impressing the full on-board voltage at the glow plug for a pre-defined period, and only then driving with the necessary effective voltage in synchronized operation. The normal pre-heating period is thus reduced to a maximum of 2 seconds even at low temperatures. The efficiency of the system is so high that not much more than the voltage required by the glow plug is taken from the on-board power supply. As each glow plug can be controlled by a separate power semiconductor in the ISS, the current can be monitored separately in each glow current circuit. Individual diagnostics at each plug is thus possible.

Electronically controlled glow system ISS: Control unit and glow plugs.

The BERU Instant Start System makes an "SI engine like key start" of the compression-ignition engine possible.

Technical features of the ISS

- Reliable start even at temperatures of -30 °C
- Extremely quick heat-up time: 1,000 °C are reached in 2 seconds
- Low power requirement (in particular important for engines with 8 or more cylinders)
- Higher functional reliability
- Controllable temperature for pre-, intermediate and post-heating
- Numerous diagnostics functions
- Immediate stable idling and clean load assumption
- Reduced pollutant emission (fulfils EURO-IV standard)
- Especially designed for diesel engines with direct injection
- On-board diagnostics-capable

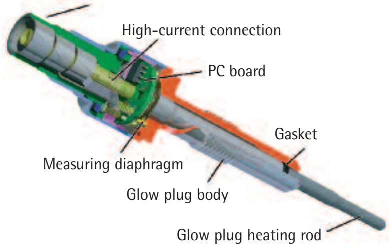
Development for the vehicles of tomorrow

Recognizing trends at an early state, developing powerful products jointly with our customers and producing cost-efficiently – these are our strengths.

INTELLIGENT PRESSURE-SENSOR GLOW PLUG

New emission laws in Europe (Euro V) and in the US (Tire 2/LEV II) will further reduce the permissible exhaust gas emissions of diesel engines. The thresholds for NOx and particulate emissions, which are relevant for the diesel engine, will in future be up to 90 % lower than the current value. It will not be possible to comply with these emission standards with conventional solutions alone.

When modern particulate filter systems are used, the necessary particulate reduction seems to be achievable. After-treatment measures known today alone will not suffice to fulfill the NOx targets. Here, the raw emission of the engine will also have to be improved considerably. Intensive research is therefore carried out in alternative combustion processes, such as HCCI (Homogeneous Charge Compression Ignition), HCLI (Homogeneous Charge Late Injection), HPLI (Highly Premixed Late Injection) and DCCS (Dilution Controlled Combustion System), which produce very low NOx emissions.



The intelligent PSG (pressure sensor glow plug).

Against this background, all our customers are intensely working on the development of alternative combustion processes. Due to the necessary very high accuracy of injection quantity, injection point and exhaust gas recirculation rates in alternative combustion processes, constant monitoring of the combustion process is required. Positioned in the combustion chamber, the glow plug is the ideal sensor in this regard.

In this connection, BERU developers have integrated a piezoresistive pressure sensor in the plug. In view of the extremely high temperatures, vibrations and pressure conditions in the cylinder head, the mechanical design of the glow plug is an important success factor. The heating rod is not pressed in the glow plug body, as was the standard in the past, but is supported elastically as mobile component, and it transmit the pressure to a diaphragm located in the rear area of the glow plug. The actual pressure sensor is thus positioned far away from the combustion chamber in an area with significantly more favorable ambient conditions. Thermal load on the sealing remains controllable as a heating rod of the BERU Diesel quick-start system ISS is used, which only glows at its tip.

Intelligent innovation: In the run-up to Automechanika 2006, the BERU PSG pressure sensor glow plug has been honored with the Automechanika Innovation Award by a vendor-independent panel of experts.

The intelligent PSG (pressure sensor glow plug) is already being tested at several European car manufacturers and is to be used in the latest diesel engines soon.

BERU glow plugs: Fivefold safety for maximum quality

1. DESIGNED IN CLOSE COOPERATION WITH CAR MANUFACTURERS

As diesel cold-start specialist and development partner of the automotive industry, BERU has not only been involved in the glow plug design from the beginning, but is present on location already during the development of new engines. The installation position of the glow plug in the engine can thus be precisely coordinated - and BERU engineers know exactly what parameters are particularly important or respectively what performance reserves the glow plug to be developed must have.

2. MANUFACTURED ACCORDING TO ISO STANDARDS

BERU glow plugs are designed in compliance with ISO Standard 7578 and 6550. These specify the dimensions and tolerances of the geometry, of the sealing angle, of the wrench size, of the heating rod diameter, etc.

3. DEVELOPED ACCORDING TO THE SPECIFICATIONS OF THE AUTOMOTIVE INDUSTRY

BERU glow plugs comply with the specifications of automotive industry, which vary from one vehicle manufacturer to the next. Thus, for instance, between 10,000 and 25,000 cycles are required as continuous running.
Besides, BERU glow plugs undergo test runs in the cold chamber. In addition, the resistance to environmental influences, contact media, additives and engine cleaners is tested.

4. SUBJECTED TO SPECIAL BERU TESTS

BERU glow plugs undergo special test runs that have been adapted to the practical requirements in everyday operation and in the workshop, for instance through simulation of connector pull-off forces or overload quick tests. The testers are unrelenting in these overload quick tests: Every test specimen must still be fully functional even after 3,000 cycles.

5. MANUFACTURED ACCORDING TO THE LATEST PRODUCTION METHODS

The manufacture of the modern extremely long and slim glow plugs for diesel engines with direct injection involves particular challenges. The diameter of the glow tube must be exactly aligned at the combustion chamber. A precisely dimensioned length of the glow tube must protrude into the combustion chamber – only then can it be ensured that the turbulence will not generate any additional harmful emissions. The temperature properties of the glow plug must also be accurately adapted to the combustion chamber design – and the current draw of the glow plugs must be accurately adapted to the existing on-board power supply. Only the latest production systems, as those operated at BERU, provide the conditions to manufacture these slim glow plugs in the desired quality.

Cheap designs – something you should do without

2-COIL OPTICS, BUT ONLY 1-COIL TECHNOLOGY

Only a 2-coil glow plug achieves the short heat-up time and temperature resistance demanded by car manufacturers. However, as the second coil is not immediately visible from the outside, some manufacturers spare themselves the so-called regulating coil. The lack of limitation of the glow current puts excessive stress on the battery during start – and since heating is not reached within the prescribed time, the vehicle will not or only difficultly start. (See Figure 3 in this regard)

HEATING ROD FILLING USING LOW-QUALITY INSULATING POWDER

Instead of the magnesite powder that is used by BERU and that is compressed and dried before filling, cheap glow plugs normally use loose, in some cases contaminated insulating powder that is filled in without drying. Disastrous result: During first glowing, the powder expands significantly, the glow tube inflates. The glow plugs can then only be removed by disassembling the cylinder head! (See Figure 9 in this regard)

HEATING COIL NOT CENTERED AND CRIMPED AT THE CONNECTION PIN

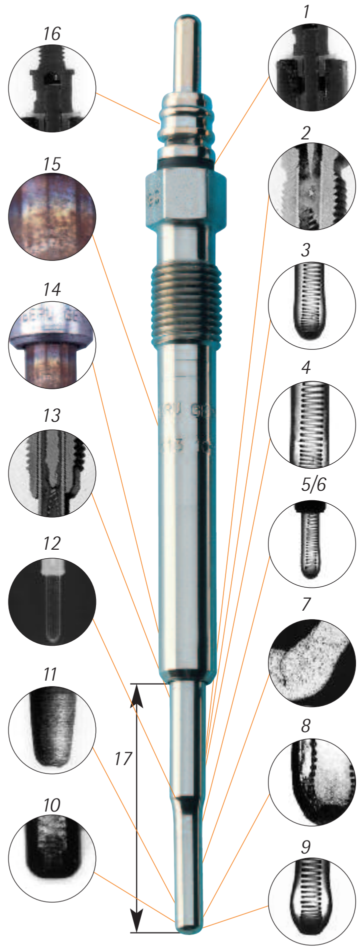
Here as well, production quality shows: Only the latest production machines can accurately center and crimp the connection pin. Dubious manufacturers manage by simply attaching the heating coil on the connection pin. However, the required short-circuit protection cannot be guaranteed in this manner. (See Figures 5 and 13 in this regard)

FAULTY CONTACT

In low quality glow plugs, the position of the lugs for the electrical connection does not comply with the OE specifications. Even though the connection looks similar to that of the original glow plugs, the contact will not correctly engage. The electrical connection to the glow plug is thus not ensured. Some of these manufacturers also save on the material of the connecting components – at the cost of the contact. (See Figure 16 in this regard)

GLOW TUBE NOT ACCURATELY WELDED

Many cheap manufacturers do not have the production technology to accurately weld a glow tube. The result: Hairline cracks in the glow tubes – and thus leaks, which again could result in short-circuits.



How to recognize low-quality glow plugs

Symptom	Risk
1 Single sealing	not water-tight
2 Filling with low-grade insulation, Magnesium powder of the glow tube	Inflation
3 2-coil technology required, but only one coil installed	characteristic profile does not comply with the manufacturer's specification
4 Wall strength not continuous	Glow plug blows
5 Coil in an inclined position in the glow tube	Short circuit
6 Glow tube not centered, thus no concentricity: The glow plug is in an inclined position in the ante- or turbulence chamber	The glow plug is destroyed by the injection spray and burns
7 Heating rod with hairline cracks	Blowing
8/9 Heating rod tip is filled with not compressed and/ormoist magnesium powder	Short circuit, inflation of the glow rod, reduced service life

Symptom	Risk
10 Round end drilled on, not correctly welded through	Blowing
11 Glow tube tip twisted off, heating rod too thin	scales, reduced service life
12 Glow spiral not correctly designed	Battery overload due to excessive current draw, consequently risk of burning of the glow time control unit contacts: This reduces the service life or impairs the function
13 Glow coil mounted in inclined position	Short circuit
14 Cone does not fit the cylinder head	Sealing problems, destroyed cylinder head
15 Surface without surface protection	Seizing in the bore
16 Sleeve merely attached	Loosening and interruption of current supply, loose contact
17 Pencil length not according to manufacturer's specifications	If pencil length is too long: Glow plug is destroyed by the injection spray. If it is too short: start problems

Causes of failure of glow plugs

In warm and dry weather, the diesel engine will start even if one glow plug is defective and only the other plugs preheat. In such event, there will usually be increased pollutant emission and possibly also knocking during start, however, the driver will not consciously take note of these signs, or will not know how to interpret them. There will be a rude surprise once the weather becomes cold and clammy and the first night frost sets in: the "heat supply" of the diesel engine fails to function, and it will start difficultly and smoke at best – most probably, however, nothing will work at all. Below is a list of typical damage and the respective causes. In most cases, it will be possible to correct the fault with this diagnostics aid.

BERU warranty: If none of the causes of failure is applicable, please send the plug to BERU AG, Ludwigsburg, for testing. In the event of a material fault or faulty manufacture, we will naturally exchange the plug for you.

HEATING ROD WITH FOLDS AND DENTS

Causes:

Coil interruption due to
- a) operation at too high voltage, e.g. jump start
- b) too long power supply due to a stuck relay
- c) impermissible post-heating when engine is running
- d) use of a non post-heating glow plug

Corrective action:
- a) Jump start only with 12 volt on-board power supply.
- b)/c) Check preheating system, replace glow time relay.
- d) Install post-heating glow plugs.

HEATING ROD PARTIALLY OR FULLY MOLTEN OR BROKEN OFF

Causes:

Overheating of the heating rod due to
- a) beginning of atomization too early
- b) coked or worn nozzles
- c) engine failure, e.g. because of piston jamming, valve breakage, etc.
- d) dripping nozzles
- e) seized piston ring

Corrective action:
- a) Set injection point accurately.
- b) Clean injection nozzles.
- c) Check jet.

HEATING ROD TIP DAMAGED

Causes:

Overheating of the heating rod due to
- a) Atomization begins too early, and heating rod and heating coil are overheated during this; the heating coil becomes brittle and breaks.
- b) closed annular gap between plug housing and heating rod; as a consequence, too much heat is deflected from the heating rod, the regulating
- c oil remains cold and lets too much current flow to the heating coil, causing the latter to overheat.

Corrective action:
- a) Check injection system, set injection point accurately.
- b) When screwing in a glow plug, always comply with the tightening torque specified by the vehicle manufacturer.

CONNECTING BOLT TORN OFF, HEXAGON DAMAGED

Causes:
- a) Torn off connecting bolt: The current connecting nut was tightened with excessive torque.
- b) Damaged hexagon: Use of incorrect tool; the plug is deformed and causes a short circuit from the housing to the round nut.

Corrective action:
- a) Tighten current connecting nut with torque wrench. Always observe specified tightening torque. Do not lubricate or grease the thread.
- b) Tighten plug with suitable torque socket wrench. Strictly comply with the specified torque (refer to specifications of the car manufacturers).

Workshop tips

Glow plug test device: Testing without removing the plugs

Using the glow plug quick tester, it is possible to test 12-volt rod glow plugs **(no ISS glow plugs, as these are designed for less than 11 volt)** in an easy, reliable and quick manner – individually, in installed position and without starting the engine. Current draw and regulation are measured.

There should be a BERU glow plug test device in every workshop.

TEST CONDITIONS

- Cooling during the glow process: The installed plug is sufficiently cooled by the cylinder head. If a disassembled glow plug is to be tested, it must be screwed in a cooling block or a dismounted cylinder head. If absolutely necessary, the plug can also be lightly clamped at the hexagon in a vise.
- Voltage source: 12-volt battery or constant direct current voltage source

TEST PROCEDURE

1. Remove glow plug connections (busbar).
2. Clamp the test device with red pliers to the plus and with the black pliers to the minus pole of the battery (or analogously to the poles of the constant direct voltage source). Then attach the alligator clip to the connecting bolt of the plug to be tested.
3. Press button to start plug test. If the indicator remains in the red field, the glow plug is defective; if it moves into the green field, it is fully functional. The defective plug must be exchanged. Test period approx. 14 seconds.
4. Check power supply. If plug is functional, the power supply must still be tested for any interruption, loose contact or short circuit after the plug test. Its function is only ensured if the full voltage is impressed at the plug.

For a functional rod glow plug, the current draw will be between 15 and 8 amperes after 20 seconds.

Our tip:
Test the glow plugs every 75,000-100,000 km with the glow plug quick tester. Ideally, you should replace the entire glow plug set in the event of any defects or impaired function

How to start the diesel engine quickly and safely

The problem	The cause	BERU's solution
Fume during start Smoke development	Glow plug with only one coil too low temperature	Use BERU 2-coil technology glow plug (heating and regulating coil ensure that a higher temperature is reached during a shorter heat-up time)
Knocking start phase	Glow plug without limiting effect and without heat reserve	Install BERU post-heating glow plugs for a better and quicker heat supply
Battery-depleting long start	Glow plug only heats up slowly, heat-up time too long	Install BERU GN glow plug that has accurately been adapted to the engine and the 3-phase glow system (pre-heating – start heating – post-heating)
Difficult and irregular running of engine	End temperature of glow plug too low	
Engine only starts running after several starting attempts	Glow plug defective	
Strong odors are produced when engine starts running	The electrical values of the glow plugs have not appropriately been set	
The glow rod is slightly molten or scaled	The wall strength of the heating rod is too small (this is often the case with cheap glow plugs)	
The glow rod is fully molten	The injection nozzle is defective	Replace nozzle holder with BERU replacement nozzle holder assembly

Workshop tips

Torques

Important when replacing glow plugs: Observe torques!

Glow plug thread	Shear torque
8 mm	20 Nm
9 mm	22 Nm
10 mm	35 Nm
12 mm	45 Nm

SHEAR TORQUE

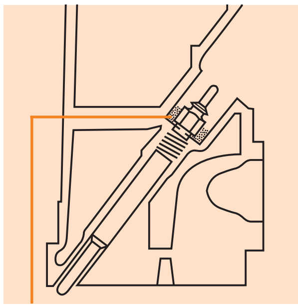
Observe shear torque when disassembling glow plugs.

WHAT MUST I DO WHEN THE SHEAR TORQUE HAS BEEN REACHED?

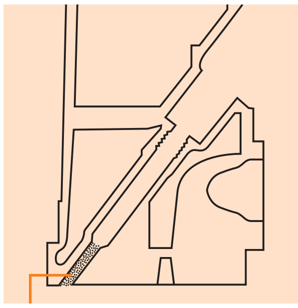
Under no circumstances continue turning – the glow plug might otherwise break off. Instead, proceed according to the 3-point program warming up – slightly loosen – unscrew:

1. Warming up: Run engine until it is warm or use a separate cable to supply current to the functional glow plugs for 4-5 minutes – the glow plug will heat up and burn loose.
2. Slightly loosen: Apply a generous amount of rust solvent to the glow plug thread and leave to act for approx. 5 minutes.
3. Unscrew: Then try to unscrew it once again and carefully loosen the glow plug out of the cylinder head with a suitable tool. (Do not exceed the maximum loosening torque – see table above. Always stop before reaching the shear torque, if necessary try once again by heating up.)

After the old glow plugs have been removed, always clean the thread, the conical seat and the glow plug channel in the cylinder head with suitable tools. (see below).



Inject synthetic oil here.



These residues from combustion can be removed with the BERU reamer.

TIGHTENING TORQUE

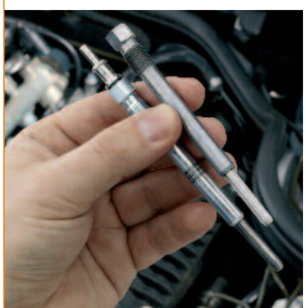
Note: The tightening torque of the connecting nut must also be observed for glow plugs with screwed connection. In particular after baking (coking) between the glow rod and the cylinder head, the cylinder head bore is often soiled by residues from burning or dirt particles. Such coking can easily and safely be removed from cylinder heads with 10-mm threads – with the BERU reamer (Order No. 0 890 100 003).

Glow plug thread	Tightening torquet
M 8	10 Nm
M 9	12 Nm
M 10	12–18 Nm
M 12	22–25 Nm

Connecting nut thread	Tightening torque
M 4	2 Nm
M 5	3 Nm

Always use a torque wrench when disassembling and assembling glow plugs.

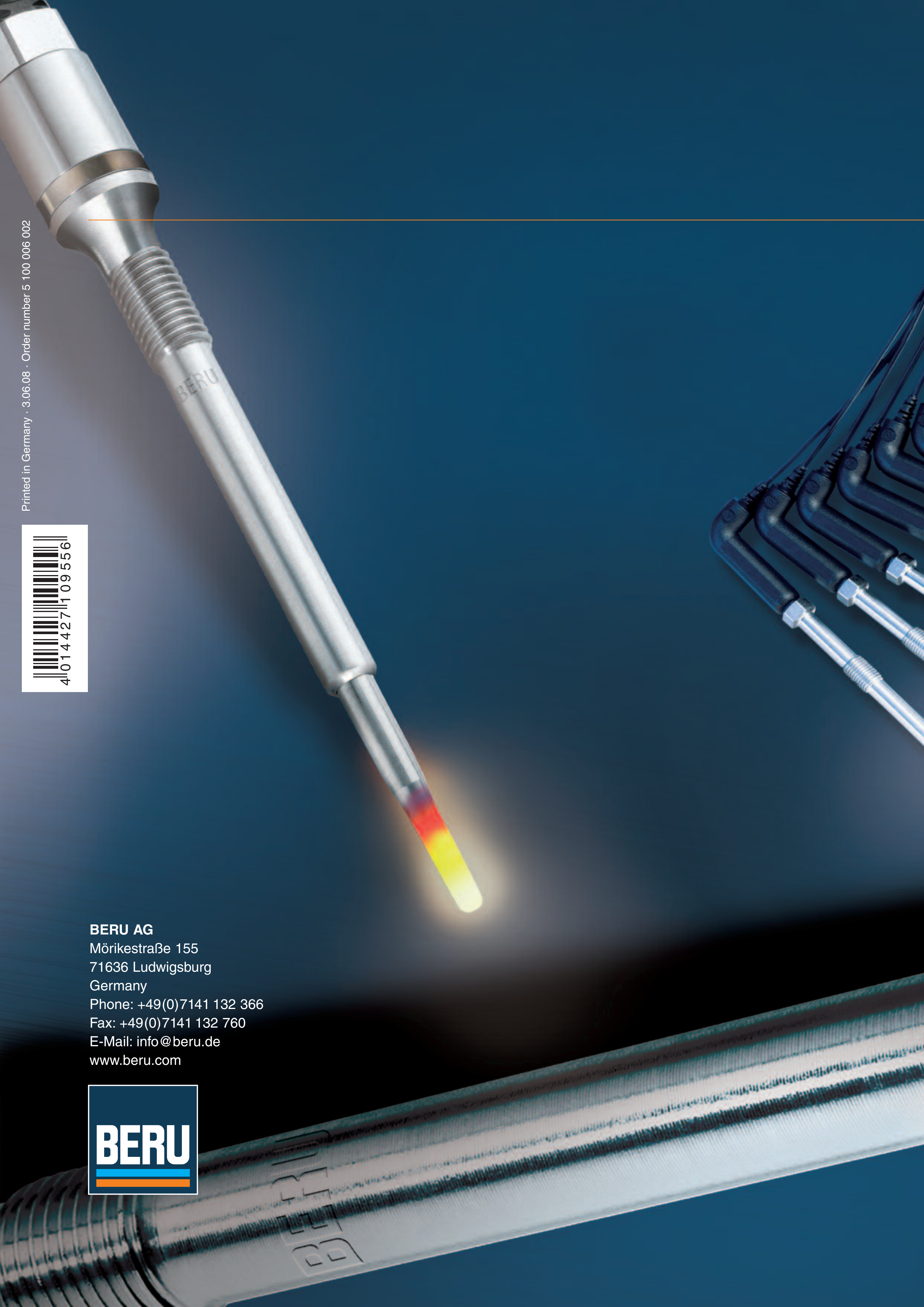
BERU reamer: for a quick and reliable cylinder head bore



The BERU reamer – loosens coking that might occur after "baking" between glow plug and cylinder head.

AND THIS IS HOW IT WORKS:

- Provisionally clean the glow plug bore with a cloth.
- Apply grease to cutting area of BERU reamer and screw it in the cylinder head: The combustion residues will stick to the grease and will be removed when unscrewing the tool.
- The new glow plug can then be mounted without any problem (please observe tightening torque again!).
- Before installing the glow plugs, grease the shaft and thread of these with GK grease.



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