MASCHINENFABRIK
ALFING KESSLER GMBH

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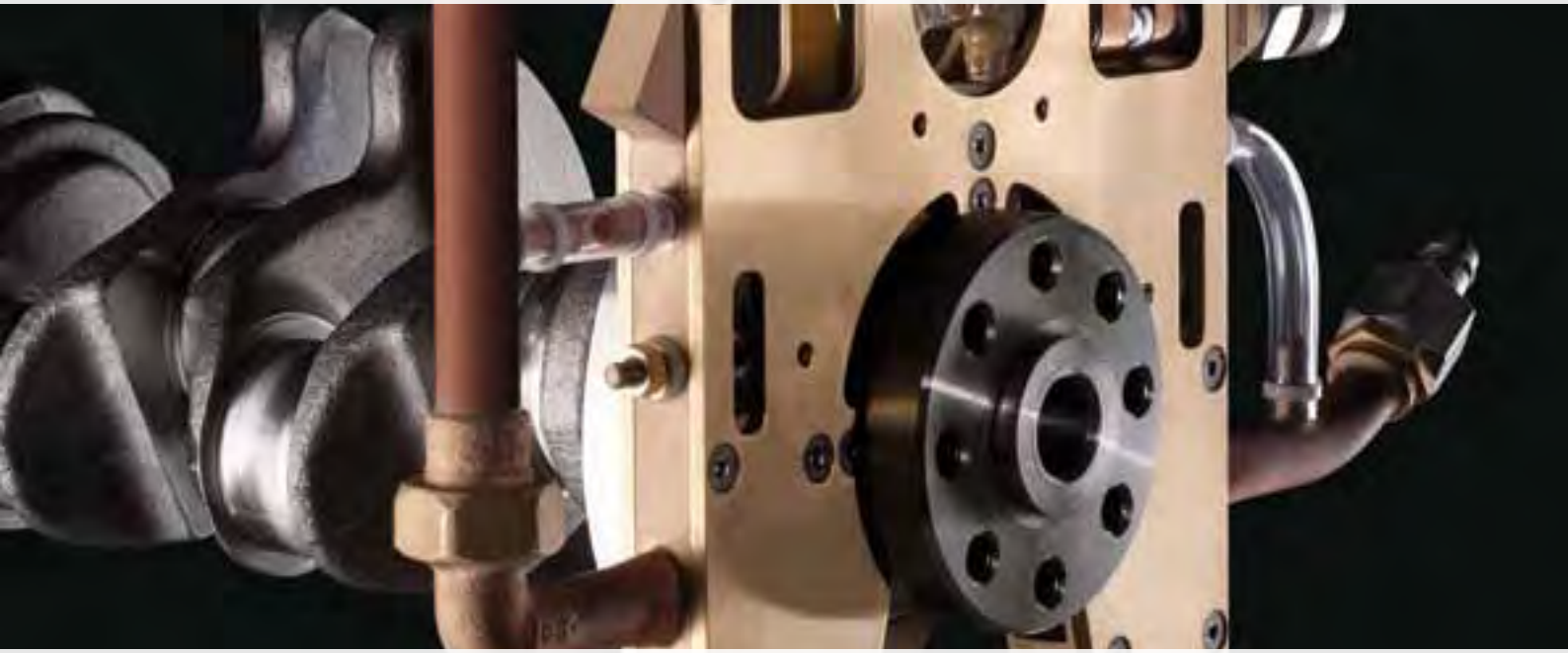
ALFING

MASCHINENFABRIK
ALFING KESSLER GMBH

WE KEEP IT **RUNNING**



HARDENING EQUIPMENT

Imagefilm

PERFECTION IN PRECISION

MASCHINENFABRIK ALFING KESSLER

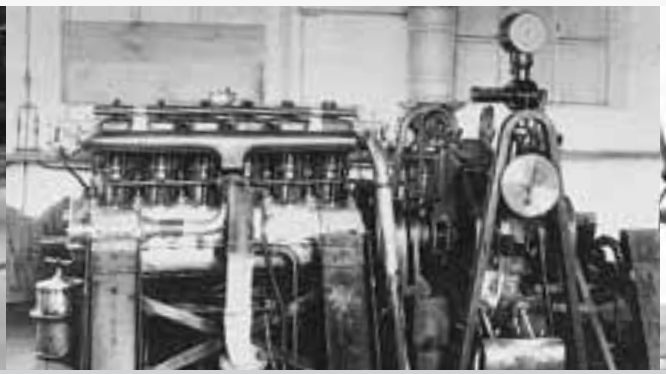
CONTENTS

MASCHINENFABRIK ALFING KESSLER
MILESTONES

"My career as an engineer took me to many countries in Europe and North America and it struck me that such a high grade product as the crankshaft of an internal combustion engine would be a suitable object to manufacture in my home country of Germany. It was with this in mind that I returned home from North America."

Company founder Karl Kessler in the anniversary book "25 Years Alfing"

A site with tradition in Aalen-Wasseralfingen in Württemberg: With technical pioneering spirit, many ideas and the conviction to be successful, Karl Kessler founded Maschinenfabrik Alfing GmbH in 1911. Production started in a disused steam brickworks. In 1917 the up-and-coming company moved into this new, prestigious factory building with modern equipment and ideal lighting and ventilation.


1911 Maschinenfabrik Alfing GmbH founded by Karl Kessler
1913 Production of the first case-hardened crankshafts
1936 Establishment of the special-purpose forge for making crankshaft forgings
1951 Manufacture of the one millionth crankshaft
1952 First induction hardening machine for crankshafts
1966 Change of name to Maschinenfabrik ALFING Kessler GmbH
1969 New facilities for large crankshaft production
1990 Expansion of automotive crankshaft production, new shop
1995 Establishment of a separate production department for prototypes and motor sports crankshafts
2003 Reorganisation and restructuring: LARGE, AUTOMOTIVE, HARDENING
2004 Expansion of the automotive crankshaft production, new production halls
2006 Production of the seven millionth crankshaft
2008 New building for the large crankshaft production and a press forge
2011 Maschinenfabrik ALFING Kessler celebrates its centenary
2011 Further expansion of the facilities for series crankshafts
2012 Sixty years of hardening machines

ALFING

Maschinenfabrik Alfing G.m.b.H.
Wasseralfingen, Württemberg.

MASCHINENFABRIK ALFING KESSLER
COMPANY PROFILE

Maschinenfabrik ALFING Kessler GmbH stands for highest crankshaft competence. In over 100 years more than 8 million crankshafts have been manufactured. On a production area of more than 90,000 m² we manufacture crankshafts of up to 8 m in length using state-of-the-art production facilities and excellent technical know-how. As a medium-sized company with around 1,250 employees the globally oriented Maschinenfabrik ALFING Kessler has developed an outstanding reputation on the world markets.

Maschinenfabrik ALFING Kessler is the largest independent manufacturer of 1.5 to 8 m long large crankshafts in the world. Our automotive crankshaft division produces ready-to-install crankshafts for automotive engines for speeds up to 20,000 rpm. The hardening division develops and produces hardening machines which are sold worldwide but also used in our own crankshaft production. This is the basis of our success in crankshaft production and also the 60 years of experience in the construction of hardening machines.

Last but not least our strong market position is also based on the expertise of our experienced and qualified employees, their commitment to the company and systematic education and training.

Optimised material flow and state-of-the-art technology: in 2008 new production shops were erected for the manufacture of large crankshafts.

Aerial view of Maschinenfabrik ALFING Kessler GmbH. The companies Alfing Kessler Sondermaschinen GmbH and Alfing Montagetechnik GmbH can be seen in the background.

HV

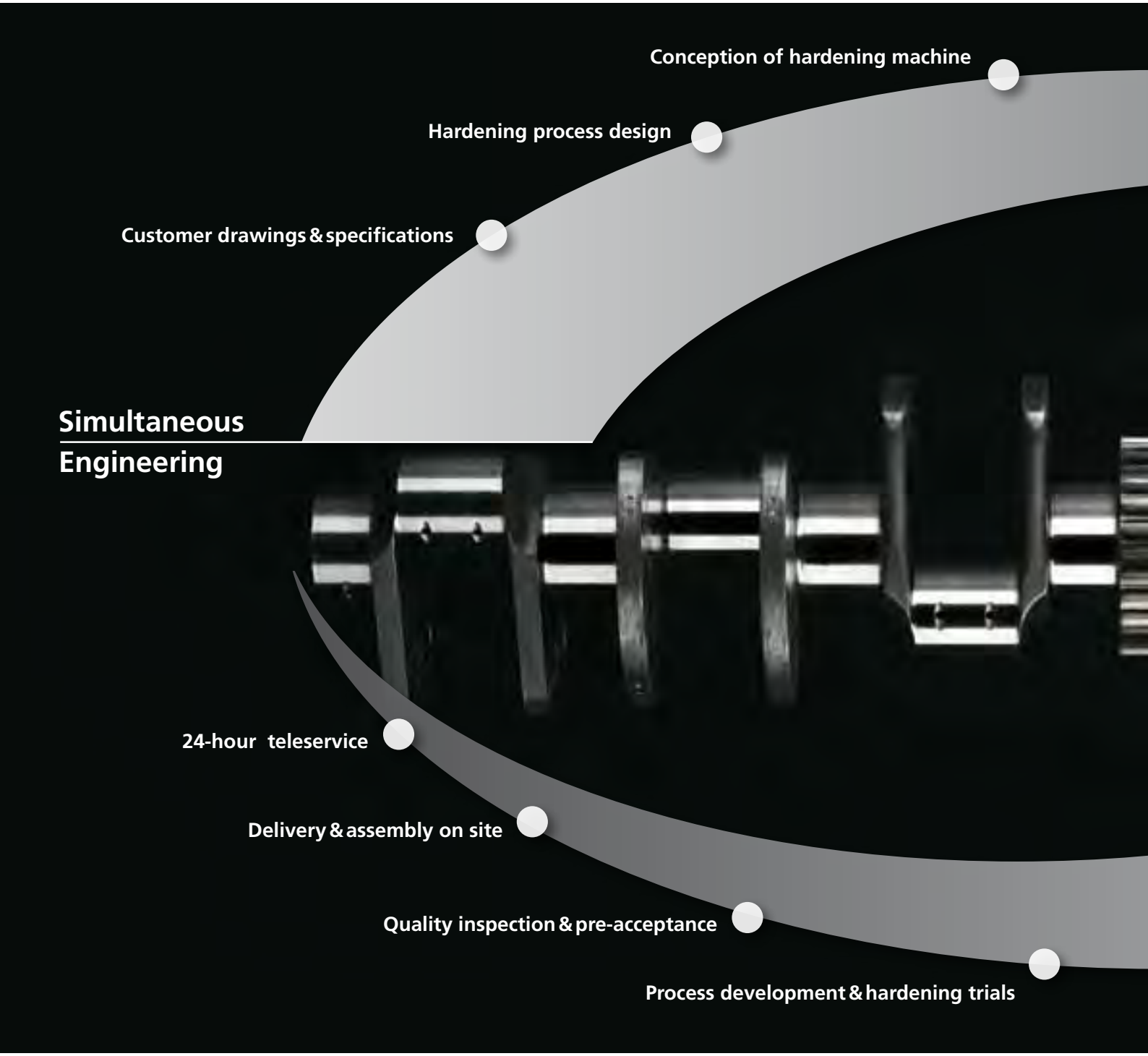
MASCHINENFABRIK ALFING KESSLER
HARDENING DIVISION

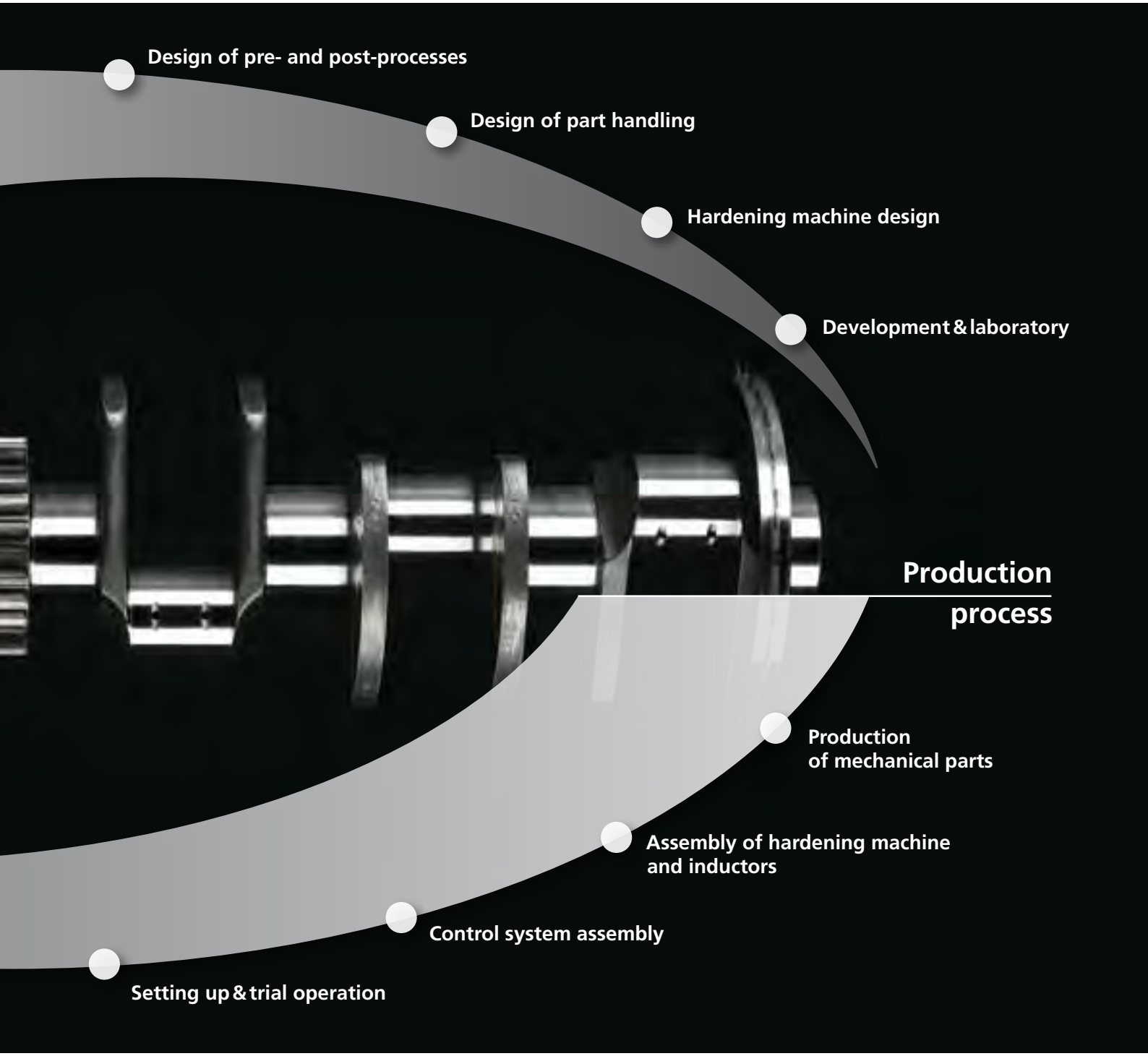
The hardening division develops and produces induction hardening machines for manufacturing crankshafts since 1952. Until today more than 500 machines have been delivered and installed in production lines for automotive and large crankshafts. Customers worldwide appreciate our long term experience and competence in hardening machine production, inductor production, development of specific and complex hardening processes and energy efficient processes such as tempering from residual heat. The cross-section above shows the hardening distribution in the peripheral zones. The crankshaft pin journals have been hardened in order to increase the stiffness and fatigue strength of the crankshaft. To support the development of crankshafts tests can be made on our application center machine and thus adaptations in the design made already early on.

$$\approx 0{,}1891 \frac{F}{d^2}$$

Simplified formula for determining the surface hardness according to Vickers

HARDENING
CORPORATE COMPETENCE





Our customers can depend on high safety and competence in all processes concerning hardening and reliability for years to come. They benefit from the practical expertise regarding crankshaft production and all technologies and methods related to the whole hardening process: from specification analysis to upstream and downstream operations with worldwide support.

ALL IN ONE SITE
RANGE OF SERVICES

Through Simultaneous Engineering the performance, cost and design of hardening machines are optimised prior to the start of production.

SIMULTANEOUS ENGINEERING

Customer drawings & specifications
The customer specifications are the database for the design of the hardening machine and hardening process.

Hardening process design
The hardening process is designed based on the crankshaft geometry, material, cycle time, hardening zone and other relevant constraints.

Conception of hardening machine
The modular machine design based on standard machine types allows our hardening machines to comply with all individual customer parameters such as cycle times, floor space, changeover times and automation requirements.

Design of pre- and post-processes
Based on the operations before and after hardening specified by the customer, we offer a wide range of pre- and post-processing modules which are integrated into the hardening machine or offered as stand-alone solution.

Design of part handling
Depending on the production environment and degree of automation required by the customer we can provide proven loading and unloading systems, such as portal loaders, robots or manual handling with the appropriate orientation systems.

Hardening machine design
The machine layout is designed in the 3D CAD/CAM system according to the above mentioned concepts and the customer's individual requirements, from which the production drawings, the electrical and pneumatic plans, parts lists and work schedules are derived.

Development & laboratory
We are able to test innovative developments and new processes on our laboratory machine and also carry out long-term studies on the hardening results in the test laboratory.

All sub-processes from production to assembly and customer approval take place on site at Maschinenfabrik ALFING Kessler.

PRODUCTION PROCESS

Production of mechanical parts
The hardening division has its own state-of-the-art CNC machines for mechanical machining. Due to the high vertical integration nearly all operations can be carried out on site.

Assembly of hardening machine and inductors
The subassemblies of the hardening machine designed in-house are built up in the final assembly area and tested for correct functioning. Thanks to the modular design we are able to achieve very short throughput times and high process reliability.

Control system assembly
Hardware and software for the NC-PLC-control of the hardening machine, pre- and post-processing and part handling are designed, assembled and tested in-house by the company using proven and tested purchased parts.

Setting up & trial operation
Setting up and trial operation take place in our final assembly area. Those responsible for the component play a key role in this process.

Process development & hardening trials
Technicians test all the required processes on the customer's machine and conduct hardening trials on customer's workpieces.

Quality inspection & pre-acceptance
Examination of the hardening zones in our laboratory enable us to determine whether the customer requirements regarding the hardening zone, surface hardness, microhardeness and microstructure meet the customer´s expectations.

Delivery & assembly on site
Installation, commissioning and final acceptance trials are carried out at the customer's premises by experienced mechanical and control system service technicians. Their intimate knowledge of the hardening machine ensures short commissioning times.

24-hours teleservice
Our hardening machines often operate around the clock, seven days a week. Thus our customer can receive service and support on demand 24 hours a day, seven days a week.

HARDENING PROCESSES

The area to be hardened is heated up by the inductor and quenched in just a few seconds.

Induction hardening
Induction hardening is a particular type of heat treatment in which the metal parts are hardened through partial heating and followed by quenching. Induction hardening is based on the physical law of electromagnetic induction. We have been building hardening machines based on this principle since 1952, using them in our own crankshaft production as well as supplying more than 500 machines to customers worldwide.

Pre-processing
The modular design of our machines permits seamless integration of further processes e.g. washing and deburring, unambiguous identification and correct positioning in order to achieve faultless results.

Post-processing
After the crankshaft has been hardened other operations can be carried out at the customer´s request, such as marking with the product data and measured radial runout. Measuring the hardness achieved, which is performed immediately after the induction hardening, is also an integral part of the post-processing procedure. Perfect harmonisation of all operations is a hallmark of our expertise, ensuring the high efficiency of the overall process. All pre- and post-processes required can either be integrated in the hardening machine itself or supplied as a standalone solution.

Part handling
Different types of conveyor systems for handling the crankshaft before and after the hardening process can be integrated as required including portal loaders and robot-based systems. Thanks to the experience gained in the design and operation of our own crankshaft production lines, we are able to design and realise the ideal configuration for every production situation. In short: induction hardening machines complete with conveyor systems and handling equipment out of one hand.

We make sure that the process operations are optimally aligned with each other. Pre-cleaning and cooling of the media using modular systems are just two potential options.

Using the same tool for heating and quenching guarantees precise process control and high quality of hardening

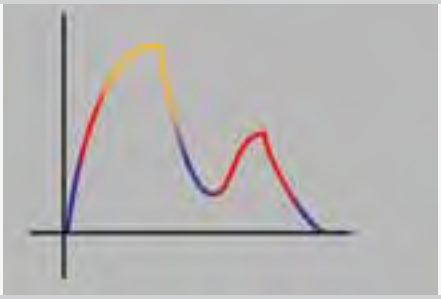
HARDENING
INDUCTION HARDENING

Optimal interaction between inductors and frequency converters ensures the shortest possible heating times.

Heating up and subsequent quenching process take just a few seconds and are very effective. A reliable hardening process is decisive for the fatigue and wear resistance of the crankshaft – one of the most highly stressed parts in the engine.

This led to the pioneer and company founder Karl Kessler to harden the pin journals of his crankshafts as early as 1913. Whereas the bearing journals were heated with naked flames in the 1930s,

Maschinenfabrik ALFING Kessler introduced induction hardening to its own crankshaft production in the early 1950s. This led to the production of the first hardening machines for customers in 1952. Modular machine design, the latest converter technology, in-house inductor production and intelligent processes such as tempering from residual heat have helped our hardening machines to achieve world renown.



Tempering from residual heat to relieve stress in the workpiece is part of our special expertise. It reduces energy and investment costs as no separate tempering furnace is required.

The exact amount and temperature of the cooling media is decisive for ensuring the quality of the quenching process. Thus the cooling system is constantly monitored.

HARDENING
PRE-PROCESSING

High pressure washing machines ensure crankshafts are free of production residues before hardening.

Other operations are required prior to the actual hardening process. Based on modular concepts we are able to integrate these processes in the hardening machine or provide them upstream. Thorough cleaning of each crankshaft is decisive for the success of the hardening process. The hardening machine control system also controls the washing machine.

Automatic workpiece orientation ensures radial alignment of the crankshafts in the hardening machine. Additional process reliability is assured through identification of each crankshaft by reading the customer code, e.g. a data-matrix or a bar code. In close cooperation with the customer we aim to design the ideal overall solution offering the greatest efficiency.

Automatic reading of the data-matrix code ensures a reliable identification of the workpiece.

Different washing techniques using hot or cold water and ring or swiveling nozzle systems ensure an effective washing process.

The engraving system for marking the crankshaft can be integrated into the hardening process.

HARDENING
POST-PROCESSING

Production data can be marked on each crankshaft, e.g. via data-matrix code. This makes it possible, besides the production data, to analyse the hardening results for retraceability.

Integrated monitoring of process parameters such as hardening results and concentricity ensure the highest quality. Particularly the radial runout occurring in each hardening process needs to be as small as possible in order to minimise subsequent grinding operation.

Marking and coding units ensure that the hardening process parameters are reliably allocated to each hardened crankshaft. Naturally these parameters can also be saved in a database and transferred to host systems.

The concentricity of the main journal is measured after hardening. The aim is to control the hardening process so that the amount of grinding required is kept to a minimum.

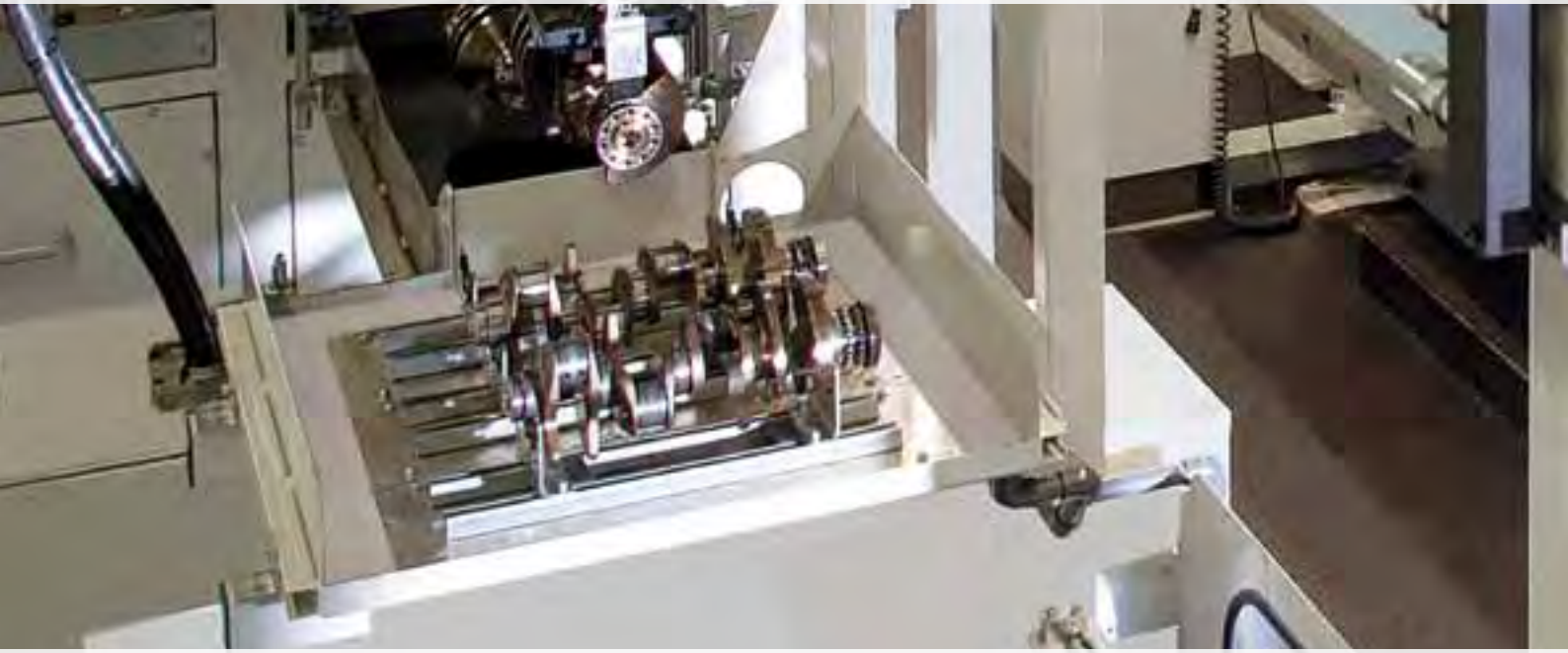
HARDENING
PART HANDLING

Modern shuttle handling systems for internal parts transport are very flexible and minimise setup times.

Production processes are only efficient if the hardening system is an integral part of the customer's production line. Therefore we offer a variety of conveyor systems which can be individually configured. We ensure harmonisation of all interfaces around the core process of induction hardening. We can supply automatic conveyor systems as well as systems for safe manual handling of the workpiece loading and unloading process. Parts are mainly transported by internal shuttle systems which combine high work speed and flexible design – CNC controlled. Safety enclosures with automatic loading doors ensure the work area is protected and no splash water can leak out. Thus an overall process is created in which all components interact with each other to increase productivity and save time.

Loading and unloading conveyors ensure a reliable material flow.

Integration of the hardening plant in a fully automated production line using portal loaders.



Initial operation of the "COMPACT-S" hardening machine in our final assembly area.

MODULAR HARDENING MACHINE
COMPACT-S

- Minimum space requirement (footprint)
- Loading via portal systems or manually
- Integrated, highly flexible shuttle system
- Short setup times and maximum user friendliness
- Easy access to the workstation
- Maximum three crankshafts per machine
- Individually expandable, e.g. with pre-washing, post-washing and tempering from the residual heat
- Crankshafts up to 0.6 m in length and 30 kg in weight
- Cycle time approx. 60 s

Our modular machine design based on a few standard types meets almost all customer requirements.

Any other special tasks are tailored to the customer's requirements thus leading to a hardening machine that can be easily integrated into the customer's crankshaft production process.

MODULAR HARDENING MACHINES
FAST-FT, FAST

FAST-FT
- **Two-station machine in traditional throughput design**
- **Loading and unloading via portal systems**
- **Integrated, highly flexible shuttle system**
- **Short setup times and optimal user friendliness**
- **Easy access to the workstation**
- **Maximum seven crankshafts in the machine**
- **Individually expandable, e.g. with pre-washing, post-washing and tempering from the residual heat**
- **Crankshafts up to 0.6 m in length and 30 kg in weight**
- **Cycle time approx. 35 s**

FAST
- **Two-station machine in parallel design**
- **Loading and unloading via portal systems**
- **Integrated, highly flexible shuttle system**
- **Short setup times and optimal user friendliness**
- **Easy access to the workstation**
- **Maximum six crankshafts in the machine**
- **Individually expandable, e.g. with pre-washing, post-washing and tempering from the residual heat**
- **Crankshafts up to 0.6 m in length and 30 kg in weight**
- **Cycle time approx. 45 s**

Two-station machines for pin and main journals can also be realised using our standardised machine design. Depending on the layout of the production line, either the traditional throughput layout or a parallel arrangement of the hardening stations can be chosen.

Hardening machine "FAST" for 4-cylinder crankshafts ready for the preliminary acceptance at the customer's premises.

Final assembly of a "FLEX" hardening machine.

MODULAR HARDENING MACHINE
FLEX

- **Ideal ratio of machine size and crankshaft size**
- **Loading via portal systems or manual loading**
- **Integrated and highly flexible heavy-duty shuttle system**
- **Short setup times and maximum user friendliness**
- **Easy access to the workstation**
- **Maximum three crankshafts in the machine**
- **Individually expandable, e.g. with pre-washing, post-washing, tempering from the residual heat, concentricity measurement, marking unit**
- **Crankshafts up to 1.5 m in length and 250 kg in weight**
- **Cycle time approx. 60 s**

Our machine design offers maximum flexibility for different crankshaft types and variants as required in commercial vehicle engine production.

Cycle time and the amount of investment required can be weighed up against each other. The ability to adapt at a later stage to changing demands regarding cycle time adds to the flexibility.

MODULAR HARDENING MACHINE
BAZ

- **Machining centre type design (BAZ) based on two modules:**
  Hardening of pin journals (Module 1) and hardening of main journals (Module 2)
- **Advanced hardening machine design with small footprint**
- **Short setup times and maximum user friendliness**
- **Loading and unloading via portal systems**
- **Direct access by the operator to the hardening stations**
- **Simplified service and maintenance all at one level**
- **Fully enclosed work area**
- **Main power requirement reduced by 50% compared to traditional hardening machines**
- **Improved process reliability through reduced elongation and runout especially with radii hardening**
- **Easily expandable, e.g. with pre-washing, post-washing and tempering from the residual heat**
- **Crankshafts up to 0.6 m in length and 30 kg in weight**
- **Cycle time approx. 60 s**

A new type of machine design with a fully enclosed work area similar to a machining centre. The design offers the operator maximum user friendliness with direct access to the hardening stations. All the functional components are accessible for service and maintenance at ground level.

Hardening center "BAZ KW 600" integrated in customer's production.

Cooling system for inductors, quenching media and transformer equipment.

EFFICIENCY
ENERGY, MEDIA

Standardised recirculation cooling units are used for cooling the quenching media, inductors and other electrical components.

Induction hardening is a energy-consuming process. The electrical components, inductors, quenching water and workpieces all have to be cooled continuously. Thus our constant focus is on the efficiency and optimal design of all components. As a source of power for the inductors we use the latest technologies such as TIV2-D frequency converters which reduce power consumption and permit precise process control.

The use of sophisticated coax cables for power transmission, short cable lengths and frequency-controlled pumps reduce the overall energy consumption of the equipment. Our tempering from the residual heat saves energy and money, because no separated furnaces are required. Steam extraction with condensation recovery combined with closed quenching water circuits are a matter of course. Thus our hardening systems are among the most energy efficient in the world.

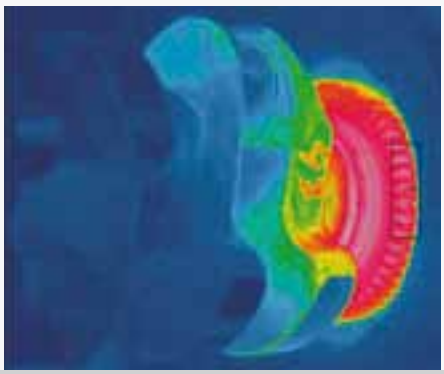
Energy efficient steam extraction with condensation recovery.

A chiller for the independent cooling water supply can be integrated into the hardening system.

The latest converter technology ensures optimal benefit of the electrical power used for hardening.

INDUCTORS
DEVELOPMENT AND APPLICATION CENTER

Simulation of temperature distribution during quenching to optimise the quenching process. The infrared camera and graphic representation indicate potential improvements to our experts.



Inductors are the heart of our hardening system. Their design and development are one of our core competences. The inductors are dimensioned based on the machine design, crankshaft geometry, material used and the customer requirements with highest effectiveness. They can be designed as half-shell or ring type inductors for a variety of special shapes and free forms to suit all radii and diameters. The performance of the inductors can be tested in our laboratory, the technical parameters adjusted and optimised even before the hardening machine has been built. Crankshaft prototypes can be test-hardened and fatigue tested, for example, in pre-series engines. The alternating bending and torsional fatigue strength of hardened crankshafts can be determined precisely using our self-developed testing rigs, making it possible to optimise the crankshafts prior to their use in practice.

Test rig for determining the alternating bending and torsional fatigue strength of a crankpin.

Optimising the hardening process for prototypes on our laboratory machine for highest effectiveness.

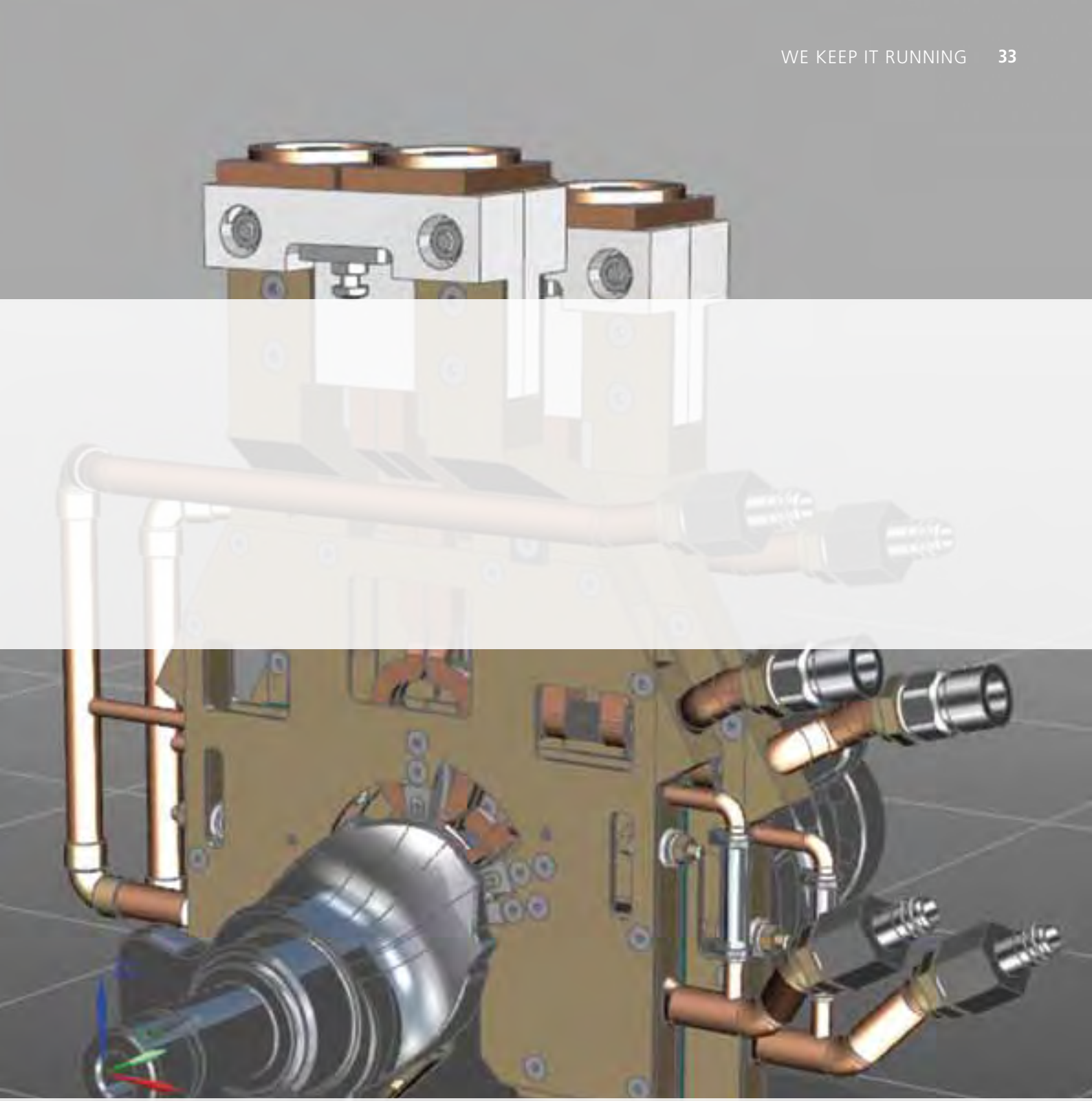


Photo-realistic representation of a split-pin inductor produced using our CAD system.

Where inductors are made individually, craftsmanship is of great importance right from the start. This also includes precise welding of the heating element.

INDUCTORS MANUFACTURE

All inductors are manufactured exclusively in-house.

A hardening machine is only as good as the inductors which are its central tool. Thus all our inductors are manufactured exclusively in-house. The inductors are built in our workshops using top-quality materials and the great skill of our experienced employees – from the components like the induction heating loops themselves and the housing to the final assembly of the completed parts.

A very important step is the final adjustment down to the last one hundredth of a millimetre. Prior to the spacing pads of an inductor ever touching the crankpin journal, a wealth of engineering experience, skill and precision craftsmanship and painstaking final assembly work are necessary. This is what makes the outstanding quality of our inductors.

Assembly of the delicate heating coil of an inductor.

Final assembly and adjustment of an inductor.

Set of inductors for hardening automotive crankshafts.

AFTER-SALES SERVICE
WORLDWIDE TECHNOLOGY SUPPORT

We offer customers comprehensive service support. When required our After-Sales Service is available round the clock every day of the week.

Our hardening machines often operate around the clock, seven days a week. Thus our customer can receive service and support when required 24 hours a day, seven days a week. Our worldwide network of sales and service partners ensures that qualified support is on site as soon as possible.

All our machines are equipped with an online diagnostics system so that our developers and customer service technicians can check individual components and functions remotely. Thus we can offer analyses and tips to the team on site or carry out service work online once the remote access has been activated.

Our network of sales and service partners ensures that excellent technical support is available at every installation site.

Service technicians from all over the world are trained at our training centre.

Our technicians can inspect the complex interior of our equipment all over the world via teleservice.

Spare parts can be delivered throughout the world at very short notice. Our global service organisation with well qualified technicians ensures the best possible machine availability.

QUALITY MANAGEMENT
CERTIFICATES AND TESTS

Dependable supply chain
AEO certificate

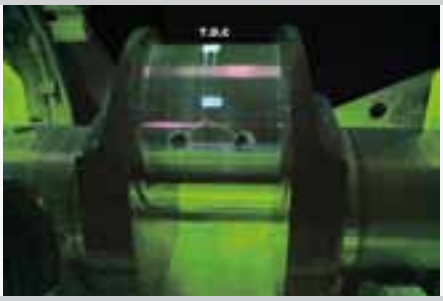
Energy
ISO 50001:2011

Occupational Health & Safety
BS OHSAS 18001:2007

Testing

Our development engineers with many years of experience are much appreciated by engine developers in the industry. For example in our own laboratories and R&D departments we perform fatigue testing, crack detection and hardening tests on our own test rigs. Strong synergies are created by the close cooperation with our divisions LARGE (crankshafts up to 8 m in length) and AUTOMOTIVE crankshafts. The practical experience gained from using our hardening machines in our own crankshaft production shops lies at the heart of our on-going development work. Thus induction hardening machines from Maschinenfabrik ALFING Kessler is proven quality for our customers.

Comprehensive testing series using different inductors and quenching media can be performed on a specially installed hardening machine in our application center.



A torsional fatigue strength test resulted in a crack in the pin journal: the root cause analysis is about to start.

A torsion test bench developed by the company determines the torsional fatigue strength of an automotive crankshaft using programmable automated test procedures.

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Certificate No.: 89127-2010-AE-GER-TGA

This is to certify that

Maschinenfabrik Alfing Kessler GmbH
Auguste-Kessler-Str. 20
73433 Aalen

has been found to conform to the Management System Standard

ISO 14001:2004

This certificate is valid for the following product or service ranges:

Fabrication and sales of forgings and crankshafts in forged and/or finished state as well as development, design, assembly, sales and after-sales-service of machines and special purpose plants for heating and hardening of parts by induction

Initial Certification date: 17.05.2005
This certificate is valid until: 30.04.2014
The audit has been performed under the supervision of
Britta Nockenberg Arandia
Lead Auditor

TGA-ZM-04-92-60

Place and date: Essen, 01.05.2011
for the Accredited Unit: DNV ZERTIFIZIERUNG UND UMWELTGUTACHTER GmbH
Nikolaus Kim
Management Representative

Environmental Protection
ISO 14001:2004

VDA QMC

CERTIFICATE SUPPLEMENT

The TÜV SÜD Management Service GmbH
approved by
VERBAND DER AUTOMOBILINDUSTRIE e.V. (VDA) / Z. Nr. 08-QMC-6.4-020
hereby certifies that the company

Maschinenfabrik Alfing Kessler GmbH
Produktbereich Härtemaschinen
Location:
Auguste-Kessler-Str. 20
D-73433 Aalen

for the scope of application:
Assembly of Special Purpose Plants and Equipments for Heating and Hardening of Parts by Induction with development, design, sales and After-Sales-Service

maintains a

Quality Management System according to VDA 6.4:2005
(with product development).

This certificate supplement is only valid in connection with the ISO 9001-Certificate Registration No.: 12 100 20812 TMS. It confirms that the quality management system is additionally qualified in fulfilling the requirements specified in VDA 6.4:2005, which supplements those in ISO 9001:2008.
Evidence has been provided during the quality audit, report no. 70019210.

This certificate supplement is valid until **2014-11-10**
TMS-Registration No.: **12 110 20812 TMS**
VDA-Number (Database): **0001887**
Date of issue: 2011-11-28

Munich, 2011-11-28

Quality Management
VDA 6.4:2005

CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH
certifies that

Maschinenfabrik Alfing Kessler GmbH
Produktbereich Härtemaschinen
Auguste-Kessler-Str. 20
D-73433 Aalen

has established and applies
a Quality Management System for

Development, design, assembly, sales and After-Sales-Service of Special Purpose Plants and Equipments for Heating and Hardening of Parts by Induction.

An audit was performed, Report No. **70019210**
Proof has been furnished that the requirements according to

ISO 9001:2008

are fulfilled. The certificate is valid until **2014-11-10**
Certificate Registration No. **12 100 20812 TMS**

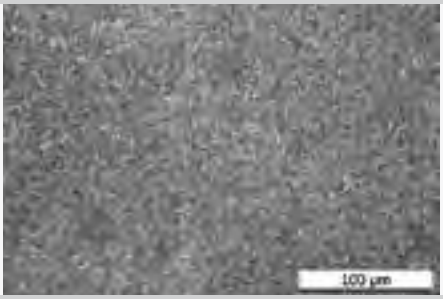
Munich, 2011-11-28

QMS-TGA-ZM-07-92

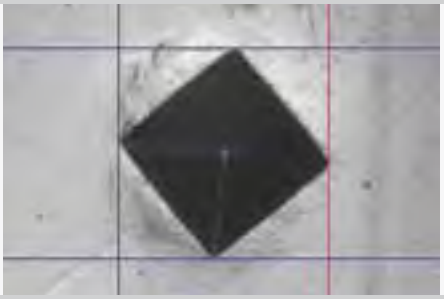
Quality Management
ISO 9001:2008

Checking hardening specimens
The results of the hardening tests are analysed and documented in our laboratories through non-destructive and destructive material tests. Hardness depth and micro-hardness must meet the required specification before we invite the customer for the pre-acceptance.

Certificates
Our quality assurance systems have been approved by internationally recognised classification societies, thus proving that we meet all current standards and regulations regarding quality, the environment, occupational health & safety, energy, customs and export control.



The metallurgical structure is analysed under the microscope in our laboratory.



The Vicker's hardness HV is determined by measuring the penetration depth of a diamond pyramid.

The darkened border areas show the extent of the hardened zone. Our overall knowledge of engineering, production and material expertise enable us to achieve the required hardening results.

COORDINATION
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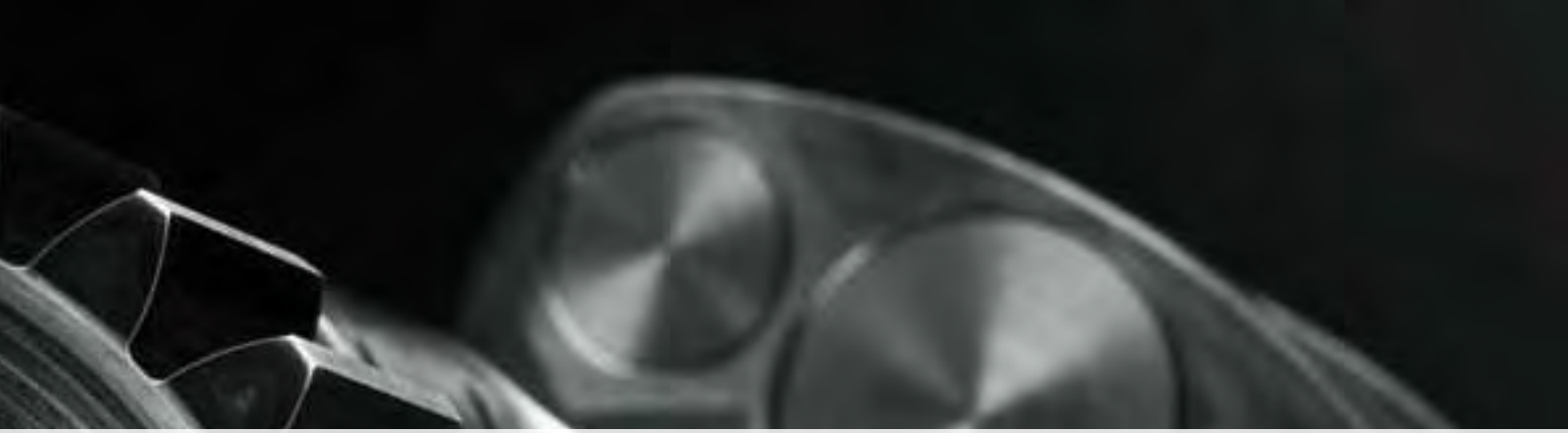

PRECISION BY PERFECTION

MASCHINENFABRIK ALFING KESSLER

Wherever a translational motion needs to be converted to a rotationally symmetrical motion a crankshaft is required.