



INDUCTION HEATING

Forging with Induction Heating Equipment



Forging with Induction

What really happens in an induction heater

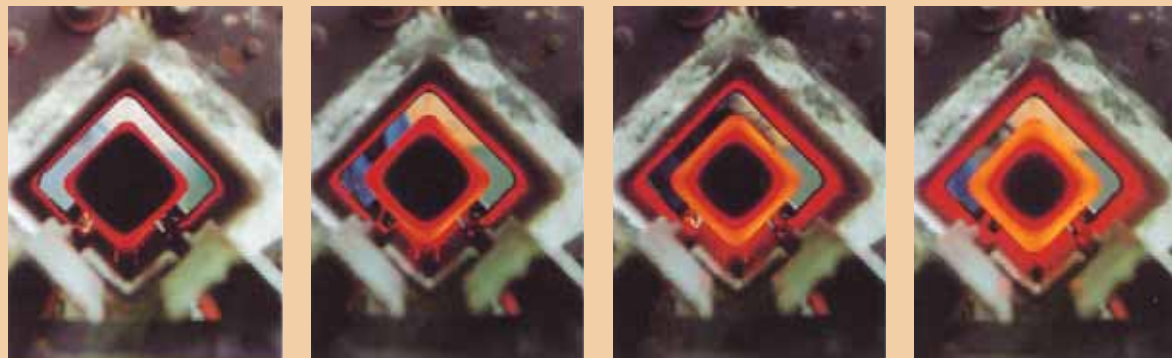
Induction heating is efficient, easily controlled, uses no energy when not heating, and puts the heat where you want it, when you want it. No idle time, no massive refractories to heat, and close coupling enables you to use energy in the best possible way.

Equally important is the manufacturer's experience and know-how in providing the right equipment to match your overall objectives. The **Ajax TOCCO Magnethermic® Corporation (ATM)** has experience that spans 90 years and covers heating all metals in all shapes and sizes utilizing a wide range of advanced solid state power supplies ranging from 50 and 60 Hz, to 450,000 Hz.

The photo sequence below and the information on page four illustrate the heating process. However, there are other determining factors which set induction heating apart from other heating methods. Factors such as energy efficiency, labor costs, quality, automation, maintenance, scale losses, cleaning and scrap losses are some of the advantages of induction heating.

Ajax TOCCO Magnethermic® Corporation

The Global Force in Induction Technology



INDUCTION HEATING

Heating Equipment

1.

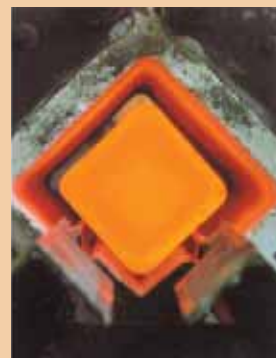
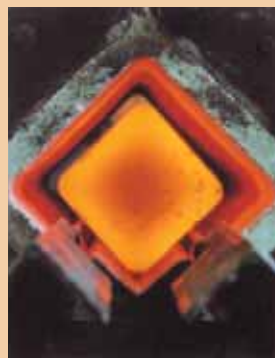
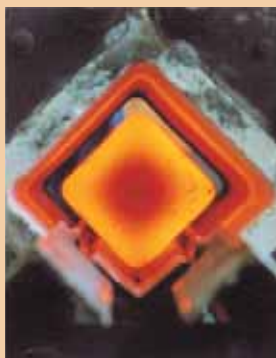
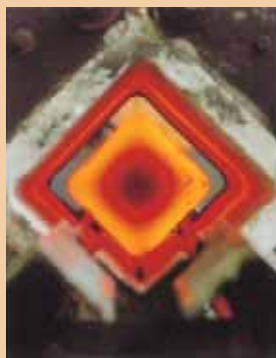


1. **This induction heater and forge press** work in perfect harmony at this automotive forge shop. Powered by a 250 KW, 10 kHz **Ajax TOCCO Pacer®**, bars are heated in a channel coil and automatically fed to the press operator.

Typical forging installations provide maximum efficiency – requiring minimal floor space, labor and material handling.

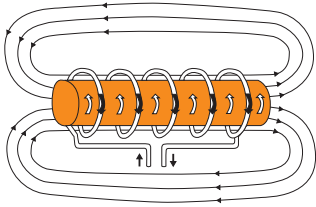
2. **No wasted energy, no wasted billets** with Walking Beam induction heaters. Heavy duty single action lifts, advances, and returns in one smooth continuous action.

2.



Forging with Induction Heating Equipment

1. Depth of Current Penetration



Approximately 87% of heat generated in the load is within the depth of current penetration. The depth of penetration is defined by the following formula:

$$d = 3160 \sqrt{\frac{\rho}{\mu f}}$$

d = depth ρ = resistivity of load

f = frequency Hz μ = permeability

Heating Steel to 2250°F	60 hertz, $d = 2.6''$
	180 hertz, $d = 1.5''$
For good efficiency, the diameter should be about 3 times the d value.	300 hertz, $d = 1.22''$
	1,000 hertz, $d = .64''$
	3,000 hertz, $d = .37''$
	10,000 hertz, $d = .20''$

2. Energy Requirements

Forge presses operate at a constant speed in pieces/hr. Induction heaters production rate is at constant pounds/hr.

It requires 384 KW seconds of energy to raise one pound of steel from 70° F to 2200° F, excluding losses.

Typical induction efficiency is considered to be 6 pounds/KW hr for carbon steel. This means it takes 1 KW hr of energy to heat 6 pounds of steel to 2250° F.

Steel billets: A 1" diameter x 10" long weighs 2.2 pounds/pc
A 1 1/2" diameter x 10" long weighs 5 pounds/pc

At 600 pc/hr a 1" diameter x 10" long is 1320 pounds/hr
At 600 pc/hr a 1 1/2" diameter x 10" long is 3000 pounds/hr

Heating the 1" diameter x 10" long billet @ 600 pc/hr @ 1320 pounds/hr requires:
Heating the 1 1/2" diameter x 10" long billet @ 600 pc/hr @ 3000 pounds/hr requires:

$$\frac{1320 \text{ pounds/hr}}{6 \text{ pounds/KW hr}} = 220 \text{ KW}$$

$$\frac{3000 \text{ pounds/hr}}{6 \text{ pounds/KW hr}} = 500 \text{ KW}$$

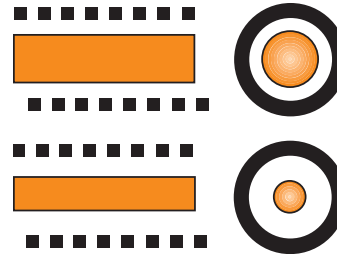
3. Production Rate (standard coil set)

To achieve a nominal surface to core temperature of 150°F for a 4.0" OD carbon steel billet, heated to an average temperature of 2250°F, approximate heat time(s) would be as follows:

Frequency	Estimated Heat Time*
500 Hz	460 Seconds
1000 Hz	535 Seconds
3000 Hz	670 Seconds
10000 Hz	795 Seconds

*This time can be decreased or increased by utilizing various power/coil combinations, to meet customer's process requirements, production demands, floor space area and billet metallurgy.

4. Range of Sizes

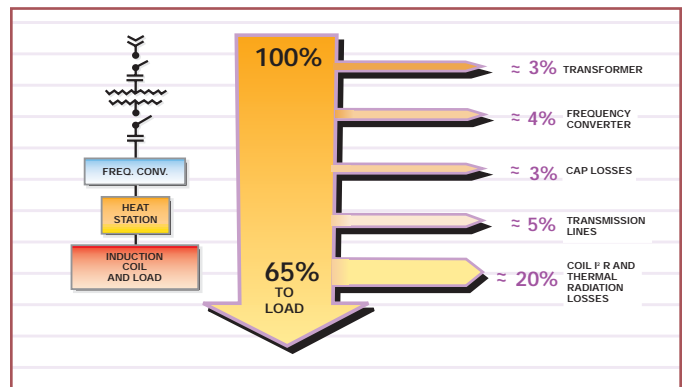
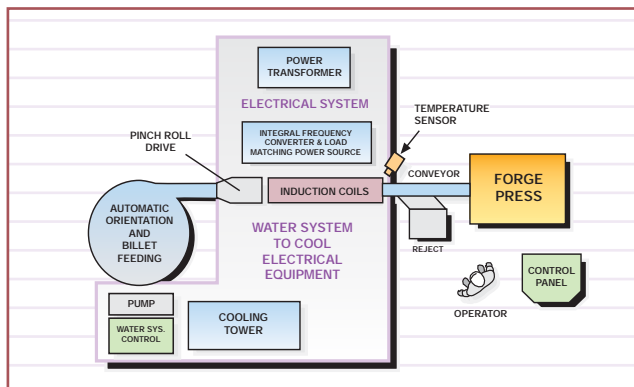


A range of part sizes can be heated in one coil. Closeness of a billet to the coil has an effect on overall electrical balance and efficiency.

Smaller part sizes can be heated in the same coil, until the cost of additional capacitors and energy to compensate for this effect reach the price of another coil size.

5. System Efficiency

Every induction heating installation experiences energy losses. These losses are typically related to getting the power from the electric company to the induction load. Ajax TOCCO takes extreme care to minimize these losses through the selection and design of system components.



Induction Benefits

Quality

Precise control provides consistent temperature uniformity and exact repeatability. Forgings have fewer inclusions and improved surface finish because of reduced scale.

Flexibility

Induction heats only the workpiece using only the needed energy to achieve the exact temperature. New solid state power supplies seek the best frequency for the load further improving operating flexibility and efficiency.

Productivity

An integral induction heating system increases productivity because it is easily integrated with in-place processes. An induction heater, not the operator, sets the pace for the production rate. Induction heaters can be started from cold to achieve full production rates within minutes. Heaters are designed for automatic hold cycles during delays and rapid recovery at re-start.

Limited Material in Process

Induction heating requires fewer parts in-process which reduces the chance of rescheduling errors and substantially reduces material inventories.

Maintenance

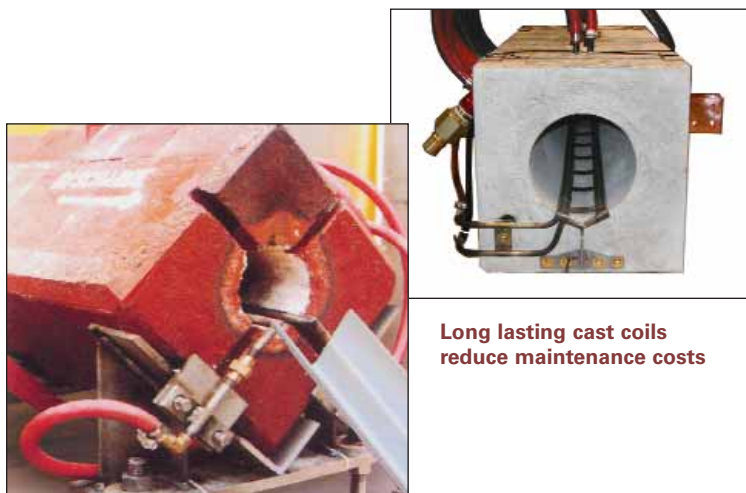
The only use of refractory in an induction system is in the coils. With the benefit of long coil life in an ATM induction system, refractory repairs and relining are greatly minimized. Die life is also extended with the drastic scale reduction.

Yield

Typical scale loss in gas fired furnaces is 3% and from induction 0.5%. Consequently, for each ton of forgings the raw steel purchased is reduced by 2.5%

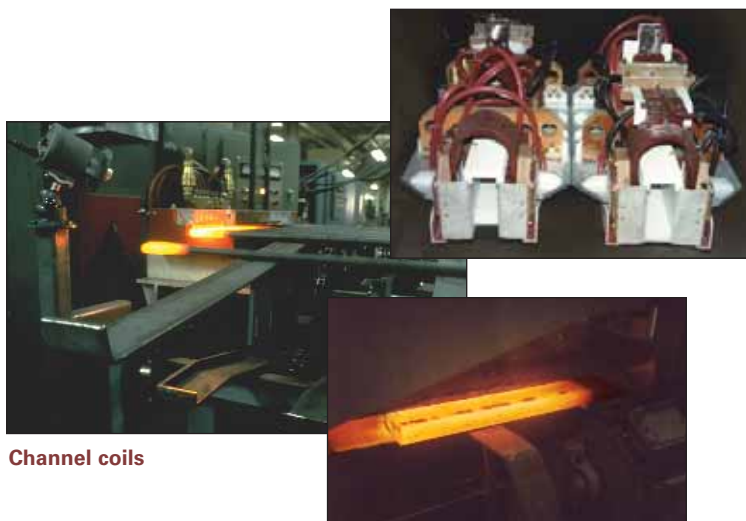
Work Environment

Since there is no heat or products of combustion, a cleaner and more comfortable environment will enhance the workplace.



**Long lasting cast coils
reduce maintenance costs**

Cast coil



Channel coils



Open style coil

ATM Induction Heating System

Application Considerations

Advanced Technology

Ajax TOCCO continues to refine induction technology offering the most efficient and flexible heating systems to the forging market. Utilizing "cast brick" or "open coil" inductor technology, we supply heating systems designed to meet customer's thermal requirements and increase process efficiencies required to meet the challenging demands of the world economy.

For typical heating applications, we provide increased operating efficiencies, reduction in installation cost plus minimizing floor space by offering our "MONO FORGE" heating systems.

For larger applications we market our standard heating concepts, which are easily modularized to meet customer's specific process applications.



Power Systems

Our power supplies are the proven choice. Their patented designs, operating into a 3 to 1 conductance range, minimize the number of inductors required, thus reducing capital expense, insuring process integrity and reducing changeover time while increasing productivity and profits. Control and monitoring of our systems is provided through our "FORGE VIEW" control packages, which monitor and control the power supply, billet feeding system and temperature of the billets.

Standard controls are PLC based, offering basic power and system monitoring. When process requirements dictate more precise control and monitoring, PC based controls can be supplied with capability to monitor and/or upgrade operating parameters via the internet allowing the user to change production requirements as needed to meet their customer's needs.

Fixturing

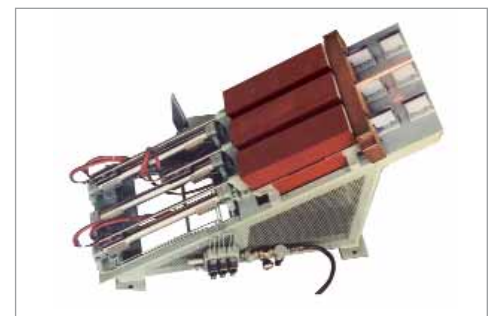
We offer billet feeding solutions via pinch wheel, pusher, and caterpillar type drive units. For special applications, a walking beam fixture may be considered.

Technical Support and Service

With our ability to integrate billet handling systems plus offering "turn-key" installation, Ajax TOCCO has the engineering, technical, service and spare parts network in position to meet the needs of the forging industry as we meet the challenges of an ever changing global market.



Two-position coil line shuttle billet heating system



Coil cast brick billet heater



Authorized OEM for AIH, IEH, Ajax Magnethermic®, and TOCCO®

MS



Automated billet heating system



Automated billet heating system



Graphite dip



Walking beam forge heating system



Dual line automated forge heating system



Five position bar end heating system

Induction Heating Components



Wobble wheel



Fast extractor



Caterpillar feed



Pick-and-Place robot arm



Automatic load table

System Power and Reliability

Experience and know-how play an important role in recommending the right equipment to handle your heating requirements dependably and economically. Properly designed induction heating equipment offers many advantages. The difference in equipment is in its reliability and the way it is applied to solve a heating problem. Each component has a function to perform. The components selected are developed by **Ajax TOCCO** specifically for induction heating applications. As a result, we offer a full range of frequencies, power sources, and inductor designs to insure that each installation is designed for your specific application.

In addition, Ajax TOCCO's power supplies have been streamlined to occupy 50% less floor space than competitive units. Ajax TOCCO has also solved the age old problem of how to heat a wide range of workpieces at the highest electrical efficiency with the minimal number of coil sets. Transmission losses have been minimized by shortening lead lengths, butting coils end to end, and making use of integral power systems.

Whether your forging system demands an incremental feed, a continuous feed, or a propulsion system that keep billets separated, Ajax TOCCO has modern, proven units in the field plus the technology to select and furnish the best equipment for the forger's needs. A full time research and development department is also available for test heats or laboratory work.



Bin and bowl material handling



Pinch roll drive

& Power Supplies

Power to Spare



Low profile Pachydyne®

Ajax TOCCO has lead the way in developing and improving induction power supplies. Our frequency line ranges from 50 Hz to 450,000 kHz to cover your frequency needs. With Pacer's flexibility, you can heat a wide range of work pieces at the highest efficiency. In fact, Pacer® is the only solid state induction power supply with a 3/1 range to allow custom adjusting of frequency for each billet size with only a capacitor change.

The Ajax TOCCO Pacer® M is a single bridge, multi-inverter power supply. Each IGBT inverter section includes a capacitor bank and output transformer, if required, allowing each coil to be individually controlled.

Each IGBT section has a self-protecting feature. If a fault is detected, the inverter will shut down.

Each inverter is capable of individually operating through the full range of rated frequency and power. This allows each inverter to function at different frequencies and/or power levels off the same bridge section.

This power system allows the flexibility of more precise bar/billet temperature control, increased efficiency and standby capability.



Pacer® II



Pacer® S-10



Pacer® T



TOCCOtron® 400



Inductron® PT



Inductron® II

Complete Comprehensive Support

Spare Parts

Ajax TOCCO offers an extensive computerized inventory of factory certified replacement parts for our induction heating and melting equipment to assure quick turn around. We also offer replacement parts for all other makes of induction equipment. Our commitment to customer support means Ajax TOCCO is available to handle emergencies any time of the day and any day of the week.

Repair Centers

Strategically located facilities are geared to meet the repair requirements of all induction users. Our skilled workforce assures the customer's peace of mind in knowing that their job will benefit from the latest technological advances in state-of-the-art materials, components, and craftsmanship.

Customer Support

- Replacement power units designed to replace all makes and models.
- Solid State contactors designed to replace the electro-mechanical devices.
- Infrared imaging for locating extraordinary sources of heat in induction equipment.
- Pre-packaged set of tools for equipment maintenance.
- MAGNE-CLEAN water system flushing service.
- MAGNE-FIELD electromagnetic field mapping of induction equipment.

Service

Technical assistance is available any time of the day or night using our **24 hour hot line**. Our experienced service team is strategically located to provide quick response to our customers wherever they are located.

24 Hour
Hotline **800.547.1527**



Authorized OEM for AIH, IEH, Ajax Magnethermic®, and TOCCO®

Installation

Installation of induction equipment performed timely and accurately is critical to the financial success of a project. Ajax TOCCO offers complete turn-key installation service on all equipment.

Training

Ajax TOCCO offers professional training by certified, experienced instructors. Regularly scheduled schools combine classroom and hands-on training on power supply troubleshooting techniques and maintenance, safety procedures, testing, reading schematics, applications and the basics of induction.

- The schools can be taught at our training facility or on-site, customer locations.
- Class curriculums are customized to the customers needs.
- Classes are held in a computer friendly training center designed specifically for this purpose.



Training and Customer Support



Well equipped workshop facilities provide skilled services for the repair, refurbishment and upgrade of most types of heating and melting equipment. Induction Power Supply Maintenance and Troubleshooting Schools, and much more!



Ajax TOCCO has heavily-invested facilities dedicated for the sole purpose of repairing and reconditioning electronic control boards and components. Using exclusive electronic simulators that duplicate actual operating conditions we are able to pin-point problems quickly and to speed repairs.



New or repaired, every step of the way, you can rely on Ajax TOCCO quality – and at reasonable costs too. That's because Ajax TOCCO has never been closer to our present and future customers. You can be sure that, regardless of the type and make of equipment, Ajax TOCCO stands behind every repair.



Ajax TOCCO commissioning and service engineers are involved with many of our customer's main equipment contracts – from commencement of manufacturing through to final on-site commissioning. Technical assistance from numerous engineers is available to solve the most complex of problems, and to offer suggestions for performance improvements and reliability.



Forging with Induction Heating

World Headquarters

Warren, OH	330-372-8511
Customer Service	800-547-1527
Boaz, AL	256-593-7770
Cleveland, OH	440-833-0386
North Canton, OH	330-818-8080
Indianapolis, IN	317-352-9880
Longview, TX	903-297-2526
Madison Heights, MI	248-399-8601
Ajax, Canada	905-683-4980
Shanghai, China	86-21-6800-9546
Birmingham, England	44-121-322-8000
Tokyo, Japan	81-3-3647-7661
Queretaro, Mexico	52-44-2221-5415
Seoul, Korea	82-2-837-0413
LeRoeulx, Belgium	32-64-67-37-77
Sinsheim, Germany	49-7261-94860
Hemer, Germany	49-2372-55980
Poznan, Poland	48-61-826-8136
Bangkok, Thailand	66-2-625-3045



Ajax TOCCO Magnethermic® Corporation

The Global Force in Induction Technology

World Headquarters

1745 Overland Ave
Warren, OH 44483
330-372-8511
330-372-8608 (FAX)

1506 Industrial Blvd
Boaz, AL 35957
256-593-7770
256-593-4735 (FAX)

333 Station St.
Ajax, Ontario, Canada
905-683-4980
905-683-6550 (FAX)

2, Dorset Road, Saltley Business Park
Birmingham, England B81BG
44-121-322-8000
44-121-322-8040 (FAX)

www.ajaxtocco.com