

Rautomead to demonstrate even greater casting capacity at Wire 2006 Düsseldorf

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Rautomead offer a range of continuous casting equipment and technology for the production of 3,000 - 30,000 tonnes per year of copper wire rod. Electric resistance heated graphite RS graphite furnace machines are supplied for single or multiple furnace installations where customers wish to gradually increase production capacity or wish to have the capability to produce different materials simultaneously. Induction heated RDG machines are supplied where customers have a requirement for large capacity and prefer a single machine installation.



The RDG machines have been developed in partnership with Induga GmbH of Germany, an experienced supplier with specialist technology for channel induction melting. This combination of experience (Rautomead: continuous casting, Induga: large scale induction melting) provides single machine technology for customers who require capacity of 10,000, 20,000 or 30,000 tonnes per year of CuOF wire rod.

RS User Group Meeting

Committed to providing the very highest levels of service and technical support for their international customers, Rautomead have just held a comprehensive User Group Meeting for users of their RS series copper rod casting machines.

An invitation-only event, held on 5th and 6th September at the company's headquarters in Dundee, Scotland, the User Group Meeting was attended by 26 representatives of Rautomead customers from ten countries around the world.

Technical papers presented

The User Group event included technical papers presented by senior members of Rautomead staff and covered best practice in the operation and maintenance of RS equipment. Papers were also presented by outside specialists on a range of relevant topics from copper refining through to superfine wire drawing. During the User Group Meeting, delegates had the opportunity for a close inspection of Rautomead's latest technology incorporated into the design of an RS 3000 copper rod casting machine, including a fully versatile rod withdrawal system, capable of handling rods in the diameter range 8mm to 30mm and with an automatic alloy dozing system for production of high copper alloys.

A separate live presentation demonstrated a new remote Plant Monitoring System, with a real-time display of a machine in production in Johannesburg. A presentation was also given regarding Rautomead's latest RDG Series induction heated casting technology, equipment designed to provide higher output from a single furnace.



Scott Tocher briefs delegates during a factory tour



Sir Michael Nairn opens the 2005 RS User Group Meeting

The two-day event concluded with a gala dinner, held at the prestigious Old Course Hotel in St Andrews, where delegates were piped to the dining room by a kilted piper.

Technological solutions

"At Rautomead, we see ourselves as much more than machine builders", commented Rautomead Chairman, Sir Michael Nairn. "Our whole business ethos is founded on gaining a clear understanding of the needs of our customers and on developing technology solutions to meet those requirements. We have a strong commitment to good customer service from the moment we meet, right through the useful life of the equipment our customers may purchase."

**Rautomead RS Users
Group Meeting,
5th & 6th September.
Mezzanine Floor.**



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"We see this User Group Meeting as an integral part of our service to customers; as an opportunity to listen, to teach and to share technical information and experiences; an opportunity to maintain and enhance the bond and sense of unity of purpose among the wider Rautomead user community and to express our appreciation to our valued international clients. I have no doubt that the informal networking links established between customers will be a significant benefit for all who attended", he added.

is a resounding success

Spread over two days, the Rautomead RS User Group Meeting involved numerous key speakers – each an expert in their particular field – and covered the following topics:

- Production and material properties of graphite
- Furnace – finite element analysis
- Crucible care – best practice and procedures
- Benchmarking machine performance
- Best Practice – heating elements, hot metal, furnace body, service intervals, tooling
- Plant monitoring
- Factory tour and RS 3000 operation
- Cu-OF – appreciation of principal characteristics and applications
- Copper cathode selection
- Wire drawing



- Rod Processing – Conform™ technology for extruded copper sections
- The Intec Hydrometallurgical copper process
- World copper markets
- New induction-heated machines for higher outputs

Horizontal Machine Sales

Engineering Alloys

Tomgshia Industrial Co. Ltd, Taiwan installed an RX 1400 model continuous casting line complete with in line automated bar cutting and handling station for the production of a range of bronze shapes and sections. The RX 1400 is fed with pre-alloyed liquid metal from the customers own melting equipment which can also feed their existing ingot casting line.

Moston Metalurji Sanayi Ltd, Turkey, acquired a used RT 650 model continuous casting machine from an independent machinery dealer and subsequently commissioned Rautomead Engineering Services team to assist with installation, start-up and commissioning of the equipment at their factory in February 2006. Rautomead also provided training services for the Moston Engineers.

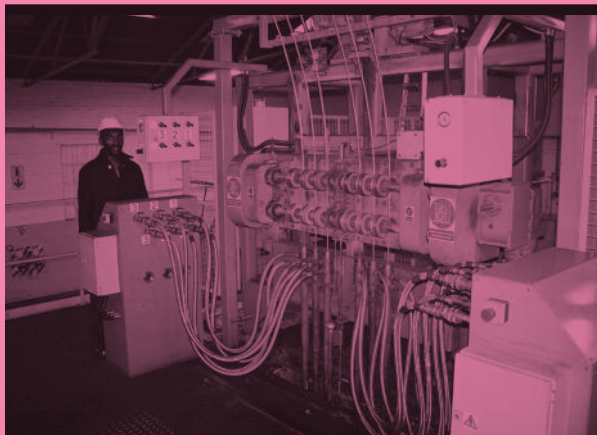


RX 1400

Precious Metals

During 2005 three USA companies; **Academy Precision Materials** (RT 850), **Morvillo & Sons** (RMT 200) and **Tessler & Weiss** (RMJ/H O25) ordered new Rautomead

horizontal continuous casting equipment for processing **gold or silver alloys** to increase their production capacity adding to existing Rautomead equipment.



Renowned for its inherently safe, low voltage continuous casting equipment - technology that embraces the use of a naturally oxygen-reducing graphite crucible and high intensity electric resistance heating – Rautomead began in 1978 by producing machines for processing bronzes and brasses for the manufacture of various semi-finished rods, bars, strips and hollow sections.

A range of smaller precious metals machines then followed, with all models capable of being used as integrated melting/casting or casting-only units. Here, Rautomead Chairman, Sir Michael Nairn, discusses the various advances in the development of the CuOF production process.

The production of oxygen-free copper

In 1994, Rautomead launched the RS series of upwards-vertical casting machines for the production of oxygen-free copper rod. The company's graphite furnace technology was adapted to accept whole cathode sheets as feedstock and take advantage of the naturally reducing characteristics of the graphite system to de-oxygenate the copper. The crucible was partitioned to separate the melting and casting stages and ensure a still bath of molten oxygen-free copper at the casting dies. Today, rod cast by the RS process is normally of 8mm dia., but larger rods up to 32mm dia. can also be produced. The process is designed for long periods of operation without interruption.

Graphite Furnace Technology

An excellent material from which to manufacture crucibles, the thermal conductivity and electrical resistance of graphite corresponds to the characteristics of a metal. Its mechanical properties are similar to a ceramic, but offer substantially higher thermal shock resistance. Additionally, as elemental carbon, graphite forms a naturally oxygen reducing environment.



High Speed Casting

When first launched, the Rautomead oxygen-free copper rod process offered casting speeds of 3.0 metres/minute, or 80 kg/strand/hour for 8mm rod. An eight-strand machine therefore produced 640 kg/hour. Today, casting speeds of 5.0 metres/minute or 133 kg/strand/hour, mean a six-strand machine will produce 750 - 800 kgs/hour.

Optimising of Thermal Balance

Rautomead graphite crucibles have two separate chambers for melting and casting. The company uses a thyristor-controlled low voltage radiant heating system to transfer energy to melt the copper through the walls of the graphite crucible. The mass of the crucible

– and some rec

itself plays an important role in the stored energy of the system, enabling very close control of casting chamber temperature ($\pm 3\text{ }^{\circ}\text{C}$) to be maintained, while cathodes are plunged into and melted in the adjacent melting chamber.

Mains power is fed to a transformer and stepped down to approx 40 volts. Three-phase secondary power is fed to the furnace through flexible leads and water-cooled graphite busbars to an element chain surrounding the crucible. Heating is biased towards the melt chamber. Typical furnace temperature when melting copper is $1330\text{ }^{\circ}\text{C}$, while casting temperature is approx. $1170\text{ }^{\circ}\text{C}$.

Withdrawal Design

Standard Rautomead RS machines are built to accommodate requirements for rod diameters of 8mm to 12.7mm. They can however be designed for the production of rods up to 32mm diameter, with enhanced rod coiler design to accommodate these larger sizes.

Remote Plant Monitoring

Rautomead machines are PLC controlled, with an advanced level of automatic monitoring of approximately 250 production parameters with appropriate alarm signalling and control procedures. Through built-in Plant Monitoring, production and maintenance data is analysed, recorded and reported through the user's own computer network for product traceability. Reports can also be downloaded to Rautomead for diagnostic purposes.

Failsafe Procedures

Any continuous production process requires procedures to deal with unexpected failure of the services required to run it. In the case of the RS upwards vertical casting process, these essential services are: electrical power, cooling water, inert gas and compressed air.

Electrical Power

In the Rautomead process, electrical power is used principally to melt the copper, via high intensity graphite heating elements surrounding the crucible, with power input thyristor-controlled. Electrical power also drives the rod withdrawal mechanisms, the rod coilers, the primary cooling water circulating pumps and the control circuits of the machine.



Rautomead provides a battery-operated emergency device automatically to lift the withdrawal frame with the supercoolers out of the melt, thus making the system immediately safe in the event of mains power failure. A small UPS unit in the control console maintains the control circuits and provides emergency lighting.

Following power failure, the copper in the crucible will begin to cool. Within approximately 45 minutes, power must be restored or the furnace emptied. In areas where mains power is unreliable, therefore, a standby diesel generator, capable of maintaining the copper charge in its molten state, can be provided.

• Brasses and Bronzes

The Rautomead upwards-vertical process has been found to be suitable for the production of a range of binary brass and bronze alloys. In these applications, the casting machine is fed from a separate melting furnace where the brass or bronze alloy is prepared and composition checked before pouring to the casting machine.

Cathode Feedstock

The Rautomead RS process for the production of oxygen-free copper is designed to use electrolytically-refined Grade A copper cathode. There are presently over 70 brands of LME-approved grade A cathode. Some brands of cathode which are not presently LME-approved have also been found to perform satisfactorily in the Rautomead process.

Electro-refining (ER) vs Electro-winning (SXEW)

LME grade A certification may be given to brands of both ER and SXEW cathode conforming to LME criteria. To date, Rautomead approves only ER cathode. Rautomead does not presently recommend the use of SXEW cathode in the RS copper rod casting process.

Electro-refined Cathode (ER)

In electrolytic refining, the copper is plated onto a copper starter sheet (full deposit type) or onto a stainless steel starter sheet (ISA process).

oxygen-free copper rod Recent Rautomead developments

Cooling Water

Each Rautomead RS upwards vertical casting machine is supplied with its own dedicated closed circuit secondary cooling water system, with duplicated circulating pumps heat-exchangers. On mains power failure, the circulating pump stops. The supercoolers are immediately lifted out of the melt by the battery-operated lifting device. As it is necessary to maintain a supply of cooling water to the power terminals, dump valve and furnace body, users are offered a choice of options to achieve this.

Inert Gas

Inert gas, usually oxygen-free nitrogen, is used to purge air from the interior of the furnace body and avoid erosion of graphite components at high temperature. It is essential that this inert atmosphere is maintained at all times when the machine is at 400 °C or above. Bulk supplies of oxygen-free nitrogen are available in most industrialised areas. Where such supplies are not available, Rautomead can supply a dedicated nitrogen generator.

Compressed Air

Compressed air is used to create the "nip" between the drive and the pressure idler rolls of the rod withdrawal mechanism. The process will not function without it.

Production of Copper Alloys

As a direct result of the development of RS technology, the following production processes have been realised:

• High Copper Alloys

Copper-silver, copper-tin and copper-phosphorous comprise three groups of high copper alloys for which the process has been developed to work satisfactorily.

Either process can produce good quality cathode, though Rautomead recommends ISA process cathode, on account of its smooth, clean surface and general absence of nodules.

Faults in ER cathode production and handling can cause processing and rod quality problems and include:

• Cathode chemistry

Iron and nickel contamination through failure to filter and purify the electrolyte. Hydrogen and oxygen gas contamination through the formation of bubbles in the electrolyte.

• Cathode Surface Quality

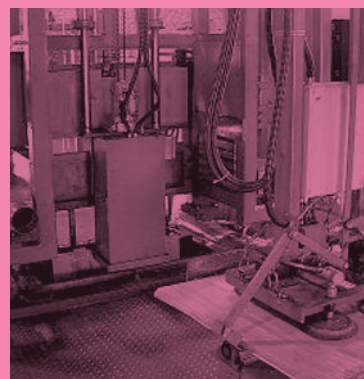
Presence of nodules on the cathode surface caused by floating slime in the tankhouse, particularly where these nodules contain trapped electrolyte, including hydrogen, sulphur and oxygen.

• Cathode Handling

Severe surface oxidation or the presence of moisture through trapped electrolyte in the suspension lugs, surface condensation or careless handling/storage in wet conditions.

Cathode Selection

With a policy of making the copper rod production process as versatile as possible, via the use of a wide spectrum of cathode brands, Rautomead also provides advice to customers, not only on feedstock quality issues, but also on brands which have proved to be reliable and of consistent quality.



Rautomead in Vietnam



NGO HAN

Under the guidance of Mr Nguyen van Sung (Chairman), NGO Han Ltd have established themselves as one of the leading suppliers of high quality copper wire and strip products in Vietnam. This has been achieved by a combination of investing in the best available European technology (eg: Rautomead continuous casting, Niehoff wire drawing, Sicme and Neutec enamelling equipment) and using high quality copper cathode feedstock from Australia and Chile.

NGO Han installed their first Rautomead machine in 2003 with capability to produce wire rods 8.0mm, 12.7mm and 16mm diameter according to the intended finished end product. NGO Han produce a range of diameters of bare and enamelled copper wires and also a range of bare or paper wound transformer strip sections. These products are supplied to local customers and a proportion is exported to customers outside of Vietnam.

The second Rautomead machine will be installed and commissioned during 2006 and will double the available production capacity at the factory.



Mr Thai, Mr Phong & Mr Sung with Guy Henderson of Rautomead

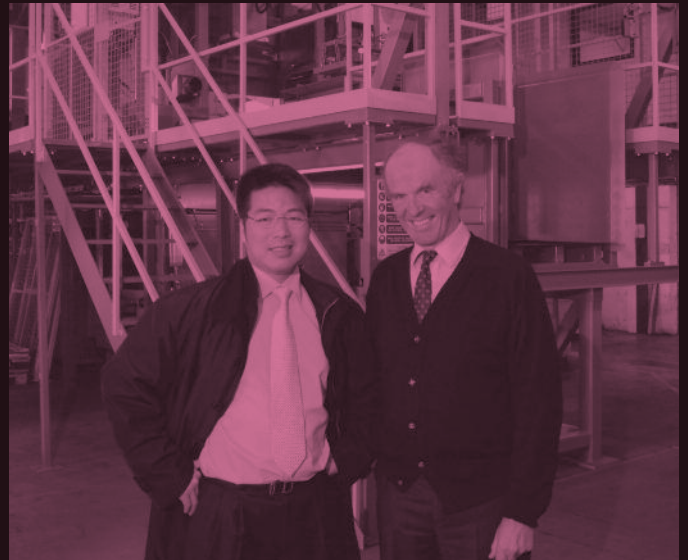
HANAKA

Electric Equipment Factory

Rautomead are to supply an RS 3000 casting machine with graphite furnace technology to Hong Ngoc Co. Ltd. (Hanaka Electrical Equipment Factory), in Hanoi, North Vietnam.

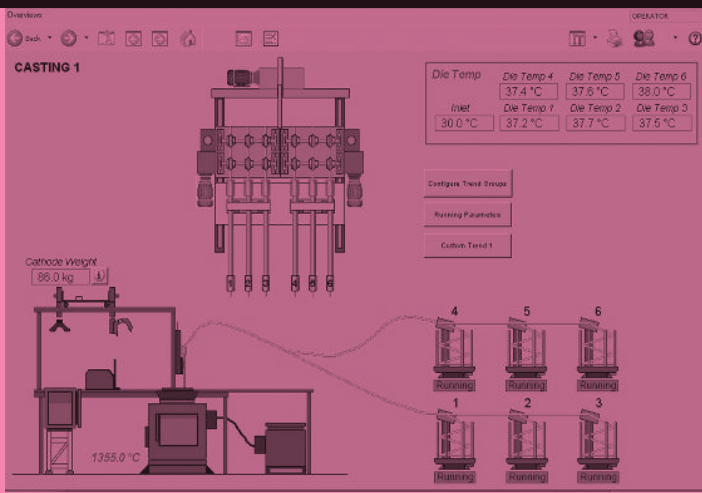
A well established electrical wire manufacturing company, Hanaka Electric Equipment Factory ("Hanaka") decided to invest in Rautomead technology to improve product quality and increase opportunities for selling product in the domestic and export markets.

Scheduled for delivery, installation and start-up during the first half of 2006, the Hong Ngoc machine will be the second Rautomead machine to be installed in Vietnam but the first to be installed in the Hanoi region.



Mr Anh Ngoc Man and Sir Michael Nairn

A delegation from Hanaka, led by Mr Anh Ngoc Man, Chairman, Hong Ngoc Co., visited Dundee in January 2006 to see their machine after it had been assembled at the Rautomead factory. The machine is supplied with tooling for the production of 8.0mm and 12.0mm diameter copper wire rod. The casting machine has the capability to cast either all 8.0mm rods or all 12.0mm rods or to produce a combination of both sizes simultaneously.



The new Plant Monitoring facility with remote (off site) viewing capability has been designed to record and present production data from the continuous casting process in a user friendly format to assist with quality control and product traceability and also to provide comprehensive historical data to enhance technical service support and troubleshooting.

New plant monitoring technology enhances data presentation and provides remote diagnostic support

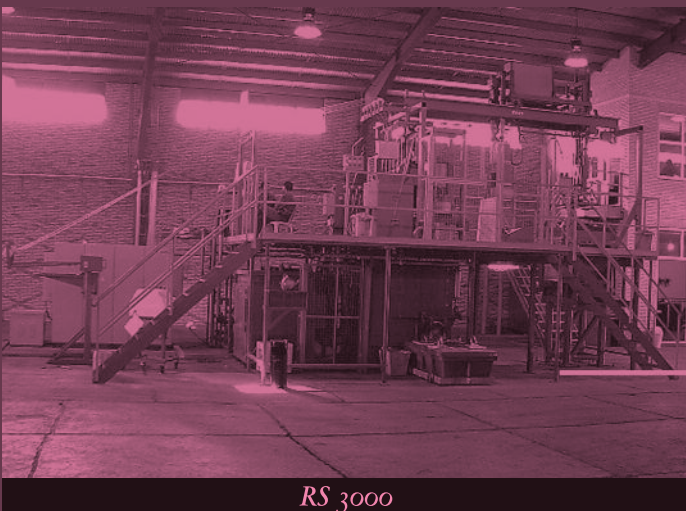
The Windows based Citect Scada software package connects the Rautomead casting machine PLC (Omron) by hardware to a PC located in an office in the vicinity of the casting machine. This enables the Production Manager to observe (but not control) the operating performance and production parameters on the remote PC. With the purchase of additional software licences and the provision of broadband internet access the same “live” and historic production data can be viewed either at a separate office facility or at an overseas office facility. With the provision of appropriate internet access, the customer may permit viewing of the production data by Rautomead Customer Service Support department in Dundee.

NEW BUSBAR PLANT FOR SARCHESHMEH OF IRAN

Cheshmeh Copper Investment Co. in Iran, an affiliate of the National Iranian Copper Industries, has purchased a complete copper busbar plant from Rautomead Ltd for installation at its Cheshmeh Copper Rod factory. The plant comprises a continuous casting machine and a continuous extrusion machine to make the finished copper sections.



Conform™ 550



RS 3000

The Rautomead continuous casting machine will produce oxygen-free copper rod of 16mm to 20mm diameter from a grade A cathode feedstock. The cast rod will then form the feedstock for the Conform™ continuous extrusion machine for production of fine grain, fully soft busbar sections of 200 sq. mm to 1800 sq. mm.

Initial output capacity of the plant will be 5,000 tonnes per year with significant scope for future expansion. The combination of Rautomead's continuous casting technology and the Conform™ continuous extrusion machine makes an elegant combination of two modern processes to produce a finished busbar product, significantly truncating the traditional capital-intensive process route of billet basting and extrusion or rolling and annealing.

RAUTOMEAD COMPLETES 'SIGNIFICANT' BULGARIAN TURNKEY PROJECT – AND ASSISTS 'FIRST TIME' USERS

Rautomead have completed a considerable turnkey contract for the design, installation and commissioning of copper rod casting technology capable of providing Cablecommerce Ltd., of Sevlievo, Bulgaria, with 6,000 tonnes per year of the highest quality 8.0mm CuOF wire rod.

An established trading company, with over 40 years' experience of supplying a wide variety of wires and associated electrical components to the local marketplace, Cablecommerce had reached a point where their distribution network accounted for some 40% of the Bulgarian market. As such, they made the decision to invest in their own copper rod manufacturing facility – a move that would allow them to produce cable products for distribution and offer copper rod to suppliers. Copper cathodes would be sourced locally from the Umicore Pirdop facility.

Complete Rautomead solution

After reviewing the various options available – and clearly focused on a solution that would be simple to operate, highly reliable and exceptionally easy to maintain - Cablecommerce ordered a complete Rautomead continuous casting copper wire rod production facility. The package supplied and installed included Rautomead's renowned RS continuous casting technology, utilising a naturally oxygen-reducing graphite crucible and inherently safe, low voltage resistance heating for the production of oxygen-free copper wire and rod of the very highest quality.

The Rautomead solution also included primary and secondary water cooling equipment, laboratory instruments, a nitrogen generator, back-up power supply and dust extraction facility. As with every new Rautomead installation, comprehensive user training and support was also provided.

Better understanding the needs of first-time users

Commented Mrs Balbanova of Cablecommerce Ltd., "The progression to copper wire and rod manufacturer was a major extension to our business. As such, we considered it necessary to deal with an

organisation that not only provided the finest technology, but was also 100% committed to working with us in order to fully understand and meet our needs. Becoming first-time copper manufacturers was a big step for Cablecommerce, and Rautomead not only clearly established plant and production costs from the outset, but also made the whole process as straightforward as possible."

Service and support

Following the installation and start-up of Cablecommerce's copper wire rod production facilities in April 2005, Rautomead continues to work closely with the company in order to provide the highest levels of technical support. Complete service and maintenance of the casting technology will also be provided as part of a supplementary service contract.

Marketing expertise

Using their considerable experience of the copper rod producing marketplace, Rautomead's turnkey package also included valuable assistance in the promotion and marketing of Cablecommerce's continuous cast oxygen free wire rod to manufacturers in Bulgaria.

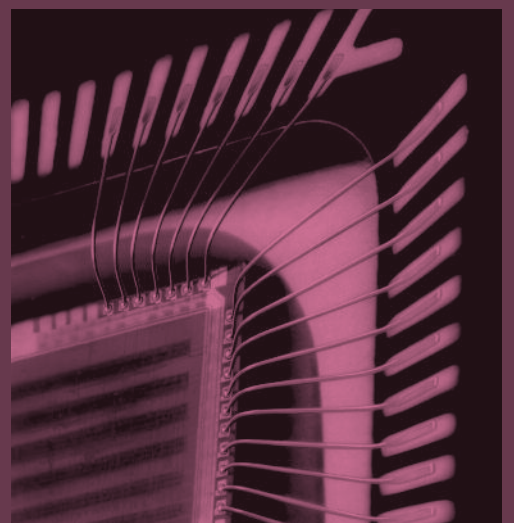
Creating the opportunity for diversification

Speaking of the contract, Rautomead Chairman, Sir Michael Nairn, said "We are convinced that the concept of supplying a turnkey equipment package together with a service contract will be of particular interest to many other companies that are considering diversification into the copper wire and copper wire rod business and who wish to see plant maintenance costs clearly established at the outset of the project."

Gold bonding wire

Rautomead supplied two RMK model continuous casting machines to two Chinese companies ***Tianjin Zenith Electronic Materials Co. Ltd*** and ***Yantai Zhaojin Kanfort Precious Metals Co.*** during 2004 & 2005 respectively. Both machines were specially configured for the processing of high purity (99.999) gold to cast 7mm diameter wire rod for subsequent drawing down to superfine gold bonding wire. Rautomead have previously delivered several similar RMJ horizontal model continuous casting machines for the same application to one of the leading producers in this market, ***WC Heraeus GmbH***. The Heraeus machines are installed at factories around the Asean region including Korea, China and the Philippines.

Using high purity graphite crucible and heating technology the melting and casting is performed in a sealed furnace with an argon gas atmosphere.



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Rautomead Limited

P O Box 100, Dundee DD1 9QY, Scotland, United Kingdom

Tel: +44 (0)1382 622341 Fax: +44 (0)1382 622941

Email: sales@rautomead.com or visit our website at

www.rautomead.com