INDUCTOTHERM GROUP

Vacuum Arc Remelting Furnaces

CONSARC


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Consarc Vacuum Arc Remelting (VAR) furnaces are available in several standard sizes. Custom designs are also offered to meet any customer requirements.

Consarc Corporation | Rancocas, New Jersey

Consarc Corporation, located in New Jersey, USA, and Consarc Engineering Ltd, located in Scotland, UK, are part of the Inductotherm Group of companies, the leading world suppliers of induction heating and melting equipment. Whether you're melting, remelting, casting, brazing, or atomizing, Consarc has a solution for you.

For over 60 years, Consarc has been designing custom vacuum furnaces and engineering solutions for the aerospace, agriculture, energy, technology, and defense sectors. From our first Vacuum Arc Remelting Furnace in 1963 to the world's largest single-electrode Electroslag Remelting Furnace produced in 2010, Consarc has been providing the most advanced solutions to vacuum metallurgy at every step of the way. Our industry-leading measurement and control systems and automated process technology demonstrate our continual comitment to innovation and improvement.

The many hundreds of Consarc furnace installations around the world attest to our proven ability to design and deliver high-performance vacuum furnaces for the world's most advanced materials. Consarc offers a wide range of furnace sizes, configurations, and options to ensure that a particular installation not only meets the purchaser's requirements, but is also suitable to use for decades to come.

We believe that if our customers are successful, than we will be successful too. This partnership approach is present throughout the furnace design, testing, and delivery process, and continues with after-sales support to develop, carry out, and troubleshoot customers' processes.

Consarc has a global Technology team dedicated to advancing our furnace technology and supporting our customers with thier knowledge. Technical staff have far-reaching backgrounds in research and production of various materials, processes, and processing equipment. Many services are offered including melting profile development and optimization, 2D/3D modeling, operator training, and on-site troubleshooting assistance.

If more than 60 years of experience across hundreds of furnace designs has taught us anything, it's that one size does not fit all. That's why we specialize in custom furnace solutions that are tailored to meet customers' unique needs. Whether you're looking for an upgrade that will improve efficiency in your manufacturing process, or a customized furnace for a specialized application, we've got you covered.

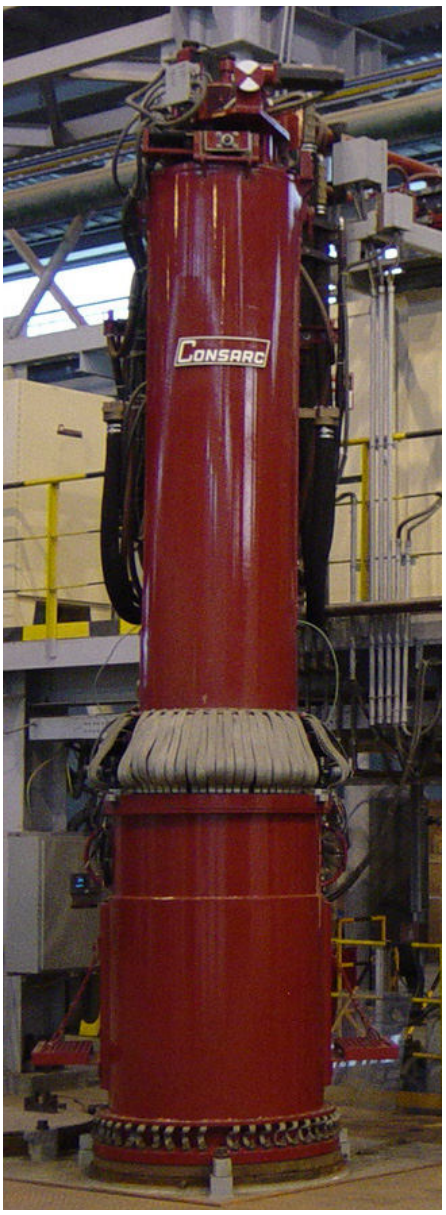
Our experienced team of engineers and designers will work closely with your engineers, metallurgists, and maintenance personnel to understand your specific requirements and develop a furnace that meets your exact specifications. With our custom solutions, you can be confident that you're getting the best possible fit for your needs, without any unnecessary compromises.

In a world where everyone seems to be looking for a quick fix or an off-the-shelf solution, we believe that there's still value in taking the time to do things right. Contact us today to learn more about our custom solutions and how they can benefit your business.

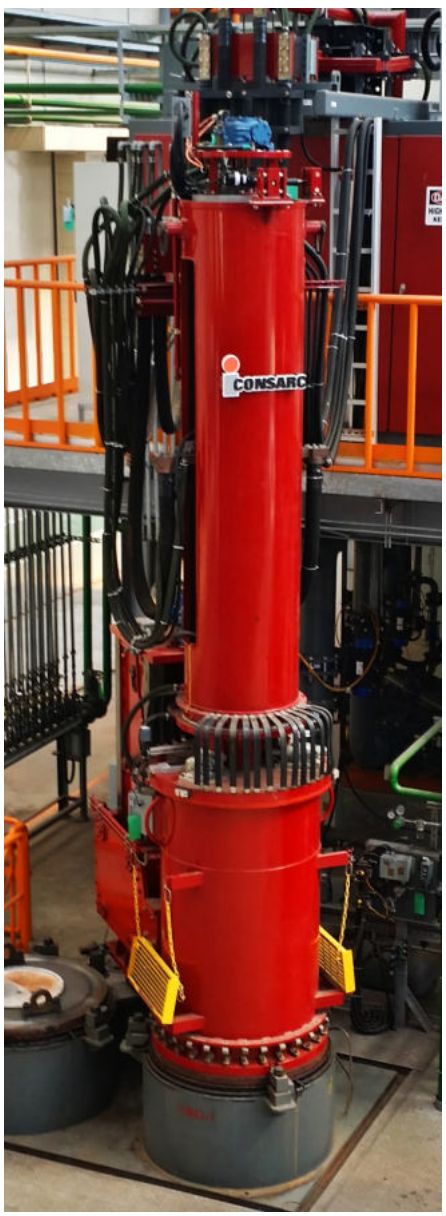
Consarc Engineering Ltd. | Holytown, Scotland

Consarc is well-known to producers of specialty steel, superalloys, and reactive metals. We pioneered commercial ingot production using automated Vacuum Arc Remelting (VAR) furnaces. We were the first to apply load cell weighing of electrodes to improve process control. We developed coaxial furnace designs to minimize uncontrolled stirring. We fully computerized the melt controls to optimize reproducibility and ease of operation. Users of Consarc VAR furnaces get proven process technology, state-of-the-art conputerized controls, robust custom-designed DC power supplies, and worldwide support from the industry's most innovative and experienced technology team.

Hydraulic VAR, 1980



900 mm VAR, 2003



700 mm VAR, 2014

A newly-formed ingot is lifted via crane out of a Consarc Vacuum Arc Remelting (VAR) furnace. The “hot top” of the ingot is still glowing.

Photo: 30-inch Consarc VAR, 1988

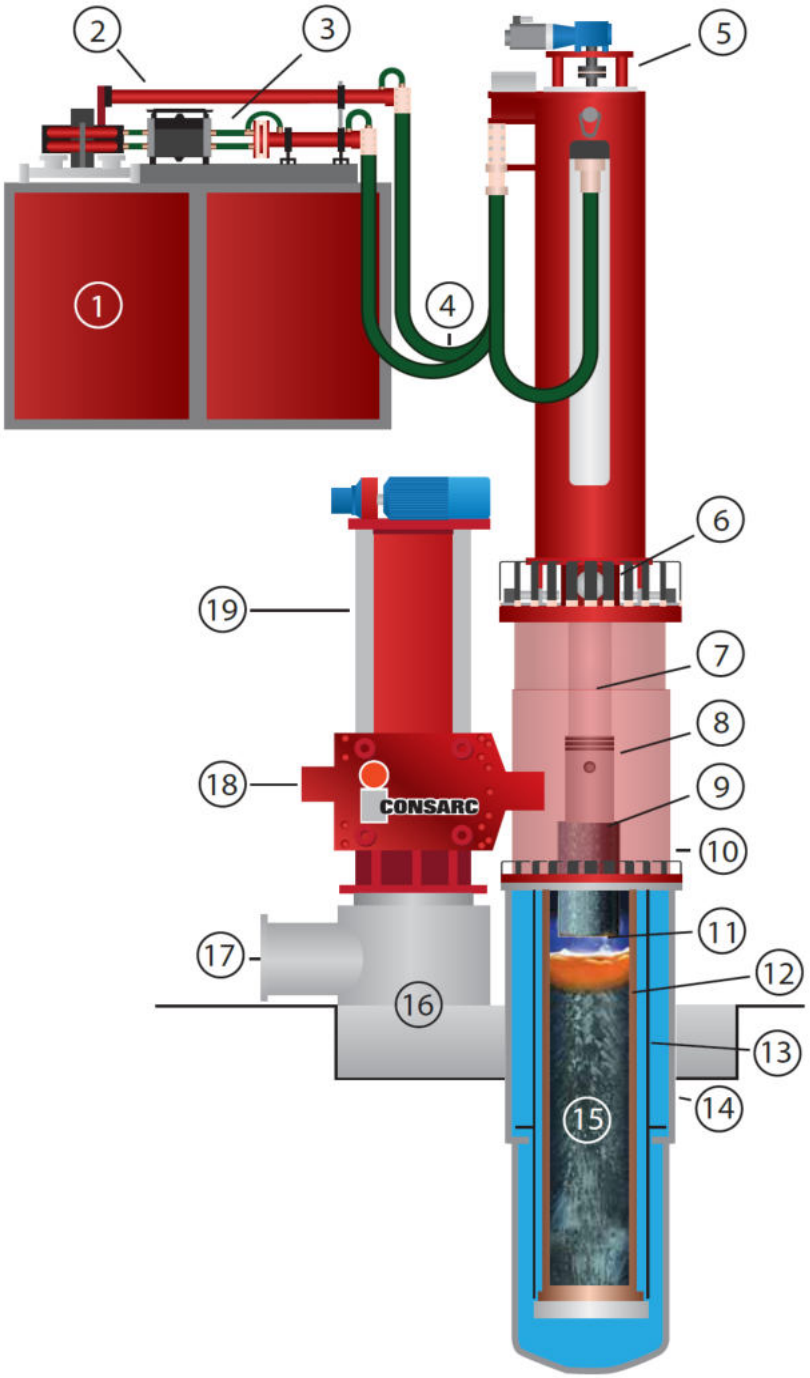
Vacuum Arc Remelting (VAR) is a secondary melting process for the production of high-value ingots.

Prior to start up, the electrode to be melted is loaded into the furnace. For specialty steels and superalloys, the electrode is previously cast in air or vacuum. For primary reactive metals like titanium, the electrode is fabricated from compacted sponge and/or scrap, or from a hearth melt process like plasma or electron beam. Two major mechanical assemblies combine to form the vacuum vessel in which melting occurs: the movable furnace head and the fixed melt station. The movable furnace head is the upper section of the vacuum vessel. An integral ram assembly connected to a highly sophisticated servo drive supports and controls the movement of the electrode. The water-cooled ram extends through a vacuum seal in the head and the electrode clamps to its lower extremity, thus becoming the cathode of the arc melting operation. The fixed melt station, which forms the lower half of the vacuum vessel, consists of a removable copper crucible, or mold, that is placed into a fixed stainless steel water jacket.

Once the electrode is clamped to the ram assembly, the ram lifts the electrode while furnace head is lowered to create a vacuum seal on top of the crucible. Once a vacuum is established, the DC power supply is activated and the control system automatically strikes a high current arc between the consumable electrode (cathode -) and the crucible base (anode +) which quickly forms a molten pool of metal. The gap between the melting electrode and metal pool (arc gap) is precisely maintained and a controlled melt rate is established. The metal droplets falling through the arc gap are exposed to the vacuum environment and the extreme temperatures of the arc zone. This causes removal of dissolved gasses, vaporization of tramp elements, and improvement in oxide cleanliness.

Because of the water-cooled copper crucible, the molten pool of metal formed by the metal droplets is solidified in a directional fashion. When the melt rate and arc gap are correctly controlled, this directional solidification prevents macro segregation and reduces the amount of micro segregation thereby enhancing the material properties of the solidified ingot.

Towards the end of the process the power is gradually reduced, providing a controlled hot top maximizing the yield of useful product by reducing porosity and shrinkage on the top end of the ingot.



Furnace Elements

1. DC Power Supply
2. Output Buss
3. Voltage Regulator
4. Power Leads
5. Single Motor Drive
6. Load Beams
7. Ram
8. Stub
9. Electrode
10. Vacuum Chamber
11. Arc Zone/Gap
12. Crucible
13. High Velocity Water Guide
14. Water Jacket
15. Ingot
16. Box Frame
17. Vacuum Piping
18. Lift Head Carriage
19. Lift Head Column

Metal droplets decending through the arc zone in a Vacuum Arc Remelting furnace

Why settle for “close enough” when you can have a custom Consarc furnace that’s precision-engineered to your exact temperature, vaccuum, and process control requirements?

Features and Advantages

The Consarc VAR process overcomes serious problems that have been historically associated with conventional VAR operations. Problems such as strong magnetic fields in the electrode melt area that cause uncontrolled metal stirring, uneven solidification, and alloy segregation, and imprecise positioning of the electrode that compromised ingot reproducibility and in the case of titanium, system safety. Consarc has developed and implemented solutions to all of these problems, solutions that have proven their worth through years of field use.

Some features of the modern Consarc VAR furance are:

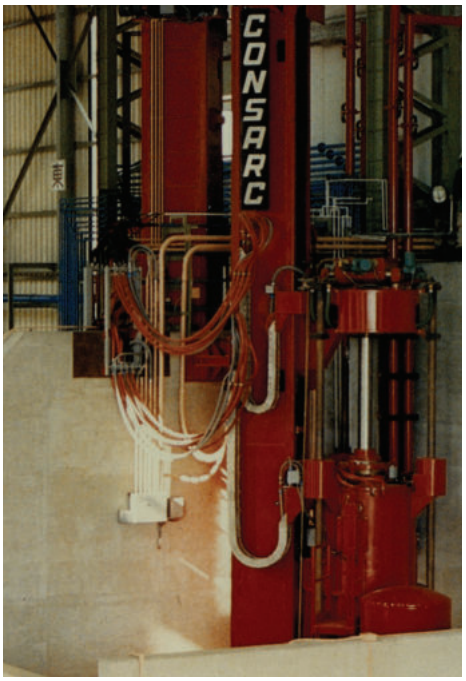
- Melt uniformity by coaxial design: Consarc furnaces provide coaxial current paths that close the electrical circuit for the cathode-anode current.
- Quality control by X-Y axis electrode positioning: Remote TV viewing and adjustable electrode positioning is used to achieve and maintain centering within the crucible.
- Precision melt control via load cells: These high accuracy sensors continuously monitor electrode weight throughout the melting process. Optimum melting conditions are maintained by the automated system control.
- Consistent yield from electrode to ingot through load cell based hot topping: Consarc incorporates the process of hot topping into the end of the melt cycle. It enhances reproducibility and is fully automated, eliminating the need for operator intervention.
- Ease of operation through full automation: Once the VAR melt is initiated by the operator, the process is fully automated to the completion of the hot top.
- Reliability assured by proprietary power supply (Reactor or Thyristor based): Consarc designs and produces power supplies to meet the exact requirements of the specific melting application. The VAR power source is a rugged, water-cooled, DC power supply.

Configurations

Consarc VAR furnaces are available in the following standard sizes, as well as custom sizes to meet any customer requirements.

DESCRIPTION	24" (600 mm) VAR	28" (700 mm) VAR	36" (900 mm) VAR	42" (1050 mm) VAR
Maximum Ingot Weight	6,000 kg	9,000 kg	16,000 kg	27,000 kg
Maximum Crucible Diameter	610 mm	711 mm	914 mm	1075 mm
Crucible Flange Diameter	36"	44"	49.5"	60"
Power Supply Rating	12,000-15,000 amps	15,000-20,000 amps	20,000-25,000 amps	25,000-30,000 amps
Maximum Ram Travel	70" (1778 mm)	70" (1778 mm)	70" (1778 mm)	70" (1778 mm)
Maximum Head Lift	50" (1270 mm)	50" (1270 mm)	50" (1270 mm)	54" (1370 mm)

A Consarc Reactive Metals Vacuum Arc Remelting (RVAR) furnace is a precision machine specifically designed for the remelting of reactive metals such as Titanium.



Primary Melt Furnace

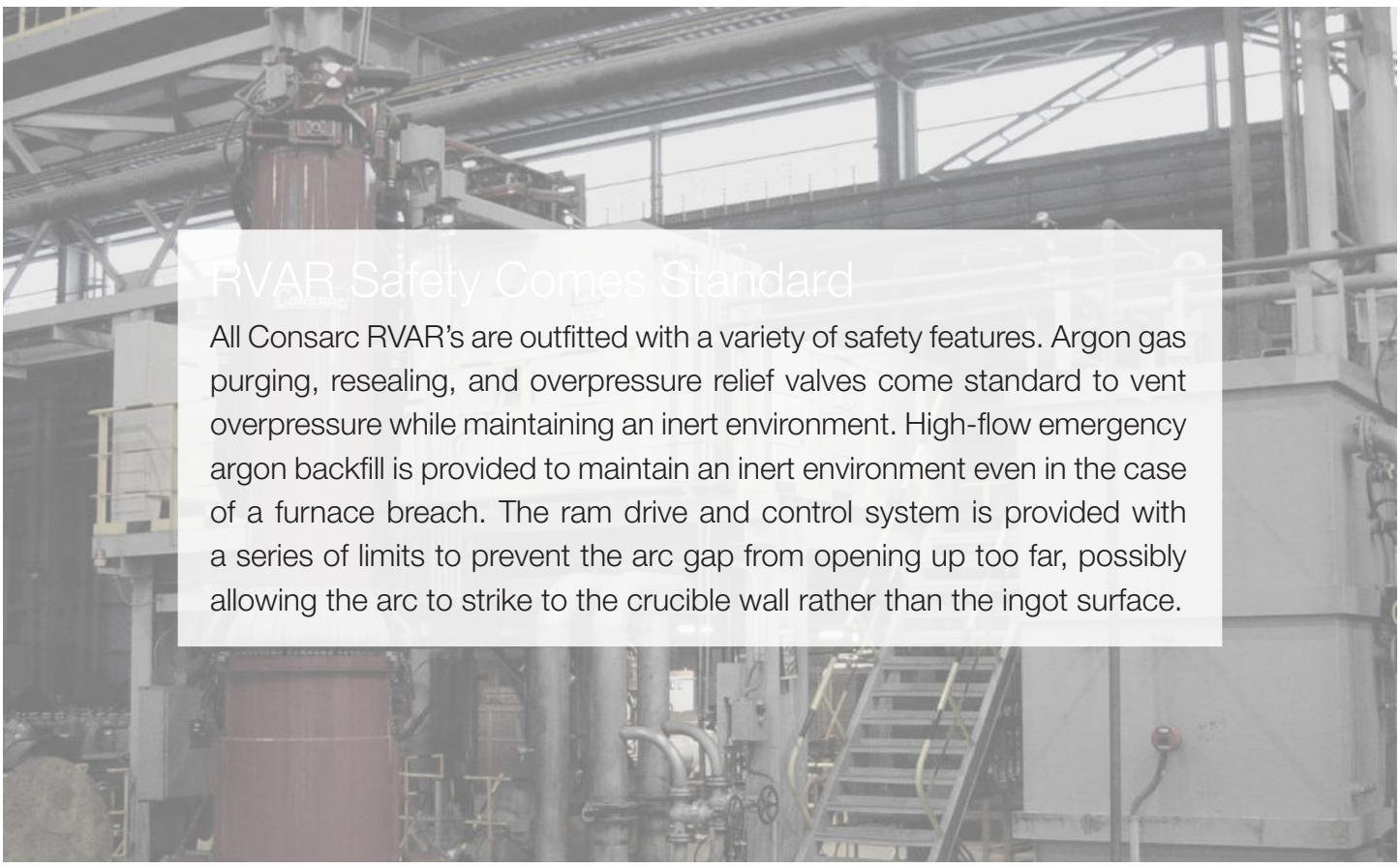
Material for Primary Melt Furnaces is initially formed by welding low density titanium sponge or scrap 'compacts' into an electrode under a protective atmosphere. Primary electrodes are especially long for a final given ingot weight due to their inherently low density. This requires that the Primary Melt RVAR furnace have extensive ram travel and head lift to accommodate such long, low density electrodes. This fact demands special design parameters to be considered if inordinately-high furnace structures are to be avoided. The Consarc Primary Melt RVAR utilizes a column design that allows the ram drive and head lift to collapse on one another, minimizing the overall furnace height while maximizing the head and ram travel available.

Secondary Melt Furnace

For Secondary / Tertiary Melt Furnaces, the electrode to be melted has previously been melted either by a hearth process, like Plasma or Electron Beam, or by a Primary Melt RVAR. The electrode is essentially fully dense so the extensive ram and head lift travels of Primary Melt RVAR furnaces are not required. However, due to titanium's potentially explosive nature, the RVAR designed for titanium requires extensive safety considerations.

Vacuum Stub Welder

RVAR furnaces also require the electrode stubs to be welded to the electrode under vacuum. The standard Consarc RVAR allows the stubs to be welded in situ, however this utilizes valuable furnace time for welding rather than remelting. To overcome this, Consarc offers an adjunct to its RVAR furnaces – a Vacuum Stub Welder. The Vacuum Stub Welder is a plunge welder consisting of a vacuum chamber, stub clamp and drive, DC power supply, vacuum system, and plunge control system. With the electrode centered to the stub inside the vacuum chamber, the stub connected to the drive, and the vacuum established, a DC arc is struck between the bottom of the stub and top of the electrode. Once a pool of metal forms, the stub is plunged into the pool creating a full penetration weld of the stub to the electrode.



RVAR Safety Comes Standard

All Consarc RVAR's are outfitted with a variety of safety features. Argon gas purging, resealing, and overpressure relief valves come standard to vent overpressure while maintaining an inert environment. High-flow emergency argon backfill is provided to maintain an inert environment even in the case of a furnace breach. The ram drive and control system is provided with a series of limits to prevent the arc gap from opening up too far, possibly allowing the arc to strike to the crucible wall rather than the ingot surface.

Consarc is the only VAR furnace supplier that designs and builds our own custom-designed DC power supplies. These units are specifically designed to meet the demanding requirements of the VAR melting application. This provides Consarc VAR customers with a single-source responsibility for the complete VAR and power transmission system.

Consarc offers both its signature Variable Reactance Transformer (VRT) power supply as well as Thyristor SCR based units. Both systems are internally water cooled by a dedicated, dual pump, closed loop, water pumping module which substantially reduces the overall power unit footprint, and offers exceptional reliability.

The VRT design represents the latest technology in VAR Power Supply development. Each VRT combines the function of a phase shift transformer, a saturable reactor, and a single-phase transformer in one package. This arrangement allows three VRT's with internal phase shift arranged for three-phase connection, to replace a combination of a phase shift transformer, six saturable reactor cores, and a three-phase step down transformer. The rectifier stage uses water-cooled diodes assemblies to output DC current.

The traditional Thyristor SCR power unit utilizes a series of 3-line reactors and two phase-shift transformers to feed the rectifier stage. DC rectification is accomplished using water-cooled SCR assemblies rather than diodes. This allows the output current to be controlled by the fast-acting SCRs instead of the VRTs.

The DC section of either type of power unit is the same. For twelve pulse operation, an interphase transformer is provided to connect between leading and lagging rectifier sections. A DC current shunt is provided in the output for accurate current monitoring and feedback control. A single ripple reactor is used to limit the ripple voltage to five (5) peak-to-peak volts over the current range from 10% to 100% of full rated load. This provides a smoother power delivery to the electrode promoting increased stability at the arc zone. Additionally, fused power factor correcting capacitors for correcting the full load power factor up to 0.9 lagging can be provided with each power supply.

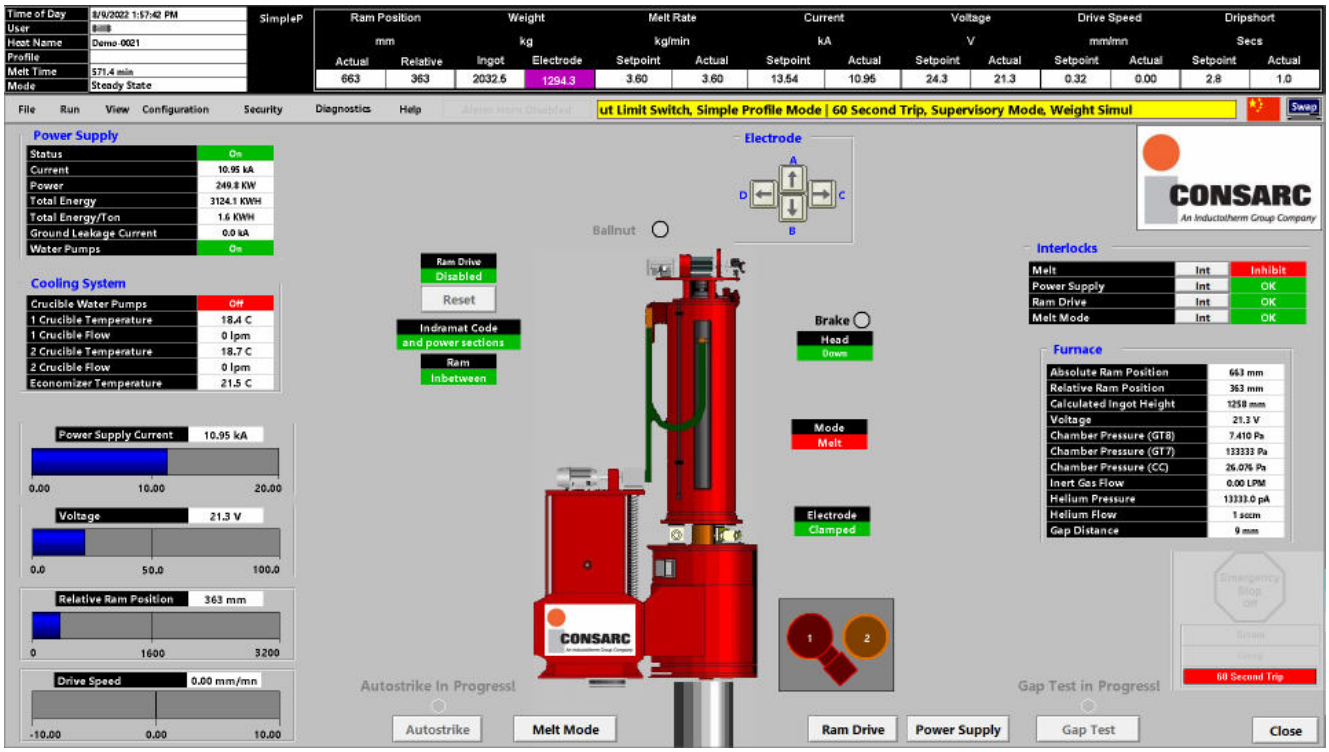
The power supply components are located inside a completely enclosed NEMA 12 fabricated steel enclosure. Windows and lights are provided for visual observation of the various components within the power supply cabinets. Access to the power supply system is through front opening doors that are interlocked to provide intrinsically-safe operation. For the benefit of maintenance personnel, lighting and a power tool outlet are provided in the interior of the enclosure.

Power units are available with VAR furnace systems or as standalone replacements for existing VAR furnaces.

Consarc pioneered Automatic Melt Controls in the early 1970's. At that time, before personal computers, melt rate was maintained using programmable calculators while operators adjusted the arc gap by manually adjusting the furnace reference voltage settings. More than 50 years later, Consarc is improving on its Generation 10 of Automatic Melt Controls.

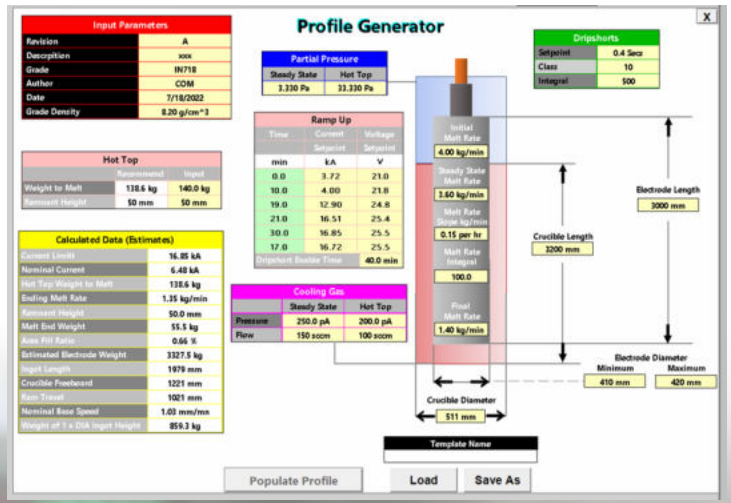
The Generation 10 Automatic Melt Controls are a full SCADA system (System Control And Data Acquisition) consisting of a PLC, a separate dripshort processor, a Personal Computer interface, and a mini PC data aquisition system. The PLC controls the furnace logic functions and sequencing along with processing all of the melt rate calculations. The dripshort processor continuously measures the instantaneous short circuits created by the melting metal dripping from the electrode tip to the ingot top. The drip shorts are classified into 15 categories, each of which can be used in the control algorithm to maintain the arc gap. The PC serves as the Human Machine Interface (HMI) to the furnace allowing components like vacuum and water pumps to be controlled, remelt profiles to be created and stored, and furnace data to be logged, stored, and analyzed.

The Generation 10 remelt profile consolidates Consarc's prior 'primary' segments - Ramp Up, Main Melt, and Hot Top - into a single profile page, allowing for easier viewing of the potential progress of the melt without losing any of the flexibility inherent in the multi-segment profile. Also new for the Generation 10 controls is a simplified profile generation system that will automatically populate the multi-segment profile with over 450 parameters.



Once the remelt profile is accepted, the operator completes the start-up sequence and initiates the Autostrike sequence. The control system automatically positions the electrode, turns on the power supply, and strikes the initial arc starting the melt sequence. The entire melt progresses automatically through the segments until the hot top alarm weight is reached and the operator is prompted to turn off the power supply.

Full data logging is provided for all measured and setpoint data including vacuum levels, power input, current, voltage, melt rate, ram travel, ram speed, water flows, water temperatures, alarms and errors. Consarc's Generation 10 controls allow for increased data logging, both in scope and frequency, over prior systems. The software allows analysis by graphing multiple logged values at user-selected time intervals. This allows a detailed look into the melt and is invaluable for process analysis and optimization.



Vacuum Induction Melting (VIM) is the first step in creating metals used in the most demanding applications. A VIM furnace incorporates an induction furnace within a vacuum chamber in order to prevent oxidation of volatile elements during the melting and refining stages. The end result of the process is a high purity metal with a homogenous chemical composition for use in secondary processing. Once molten and fully refined, the molten metal is passed through a preheated tundish for a final refinement before entering into ingots for further processing.

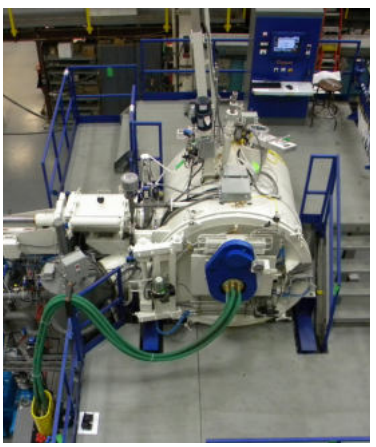
Masteralloy Vacuum Induction Melting Furnace (VIM)

Electrode Vacuum Induction Melting Furnace (VIM)

Remelting and casting are secondary melting processes used to further refine and improve the quality of materials produced from primary melting. During the remelting processes, a metal alloy ingot is melted in a controlled atmosphere environment to remove impurities and/or improve the macro and microstructure of the ingot or cast part, depending on the final application. The hallmark of secondary melting is not the melting but rather the controlled solidification which is what gives the final product its refined structure for use in high-temperature and high-stress applications.

Electroslag Remelting Furnace (ESR)

Vacuum Arc Remelting Furnace (VAR)



Vacuum Precision Investment Casting Furnace (VPIC)

Vacuum Aluminum Brazing (VAB) is a specialized process used to join aluminum components using a brazing alloy in a vacuum environment. Brazing is commonly used to join metal parts that are difficult or impossible to weld using traditional welding techniques. Other thermal processing options are also available from Consarc, deisnged to fit customers' specific process needs.

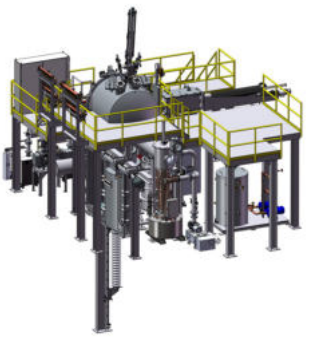
Vacuum Aluminum Brazing Furnace (VAB)

Vacuum Heat Treat Furnace (VHT)

Consarc offers a wide range of additional melting options. Inert Gas Atomization furnaces are used to produce metal powders with high purity and controlled particle size distribution. Vacuum Cap furnaces are versatile units capable of vacuum degassing and controlled-atmosphere melting operations.

Vacuum Inert Gas Atomization Furnace (VIGA)

Vacuum Cap Furnace (VCAP)



ONE SIZE DOES NOT FIT ALL

Considering a stock furnace option that doesn't meet your exact needs? Why not consider a custom-designed Consarc furnace? Our team of experts works with you to create tailored solutions that fit your unique requirements. We don't believe in a one-size-fits-all approach - every project is different, and we take the time to understand your specific needs before designing a furnace that meets them perfectly.

Our flexibility and commitment to collaboration set us apart from our competitors. You'll have input every step of the way, ensuring that the final product is exactly what you need. Plus, our flexible approach means that we can adapt to changes and make adjustments as needed.

Experience the difference a custom Consarc furnace can make. Get in touch with us today!

CONSARC
An Inductotherm Group Company

We can help you do great things with metal.

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