A.L. Johnson Secures Castings in Plaster

By means of the rubber plaster molding process, A.L. Johnson Co. provides its customers with near-net-shape parts at accelerated speeds.

Kevin O'Shaughnessy, Associate Editor

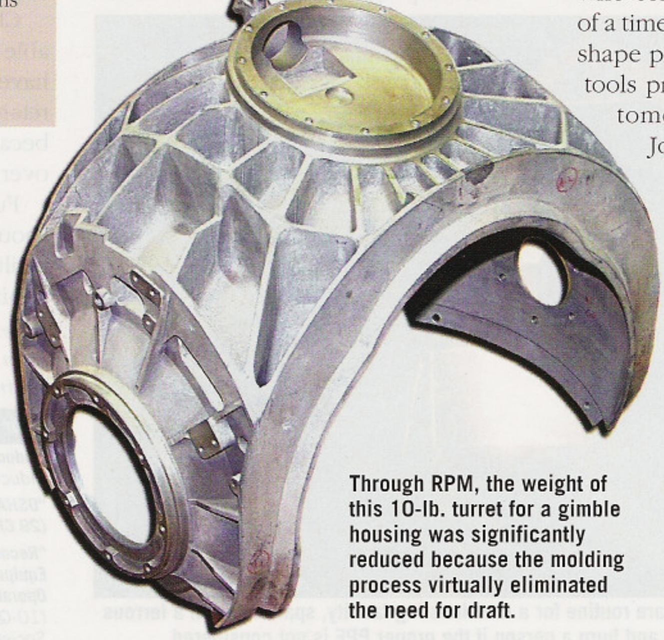
A.L. Johnson Co.
(A Division of GC International Inc.)
Camarillo, California

Year Founded:	1954.
Metals Cast:	Aluminum—A356; Zinc—ZA8.
Molding Process:	Rubber Plaster Molding.
Melt Capabilities:	Gas Reverbatory and Electric.
Size:	45,000 sq. ft.
Key Markets:	Medical, Military, Electronics, Telecommunications and Aerospace.
Employees:	43.

During the last year, an Oregon-based electronics manufacturer was looking to have an alternator enclosure produced as a diecasting. Its customer demanded to see a prototype of this enclosure, but a diecast prototype would take months to create because of hard tooling production. However, this electrical firm saw a cost- and time-effective way to overcome this burden—have the prototype parts cast by A.L. Johnson Co., Camarillo, Calif.

Via its rubber plaster molding (RPM) process, A.L. Johnson took on the task and used stereolithography (SLA) models as tooling for the molds. Within a month, the casting company produced 40 prototype parts measuring 7.5 x 4.5 in. (19.05 x 11.4 cm). Such acceleration inherent in the RPM process allowed the electrical firm to provide prototypes to its customers and subsequently have die tooling made.

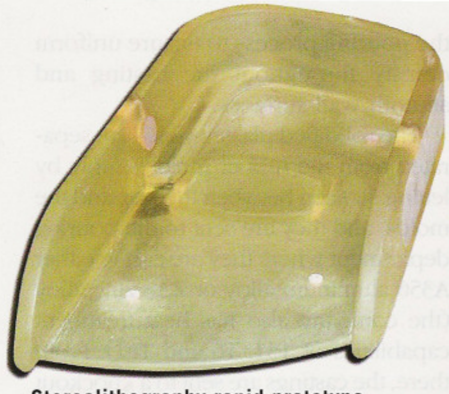
This manufacturer is one of many who come to A.L. Johnson in search of a timely method to obtain near-net-shape prototype components as step tools prior to diecasting. These customers also commission A.L. Johnson to produce long-run production components, and this has paid off for more than 50 years.

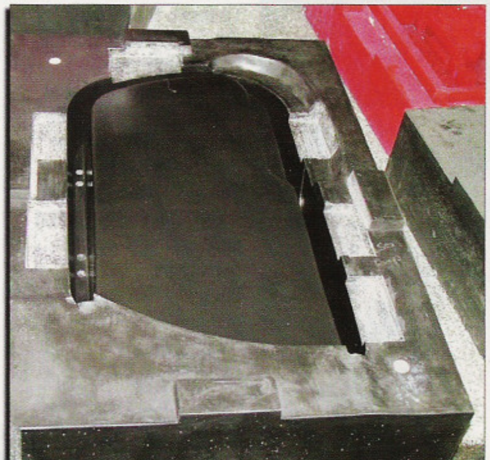


Through RPM, the weight of this 10-lb. turret for a gimble housing was significantly reduced because the molding process virtually eliminated the need for draft.

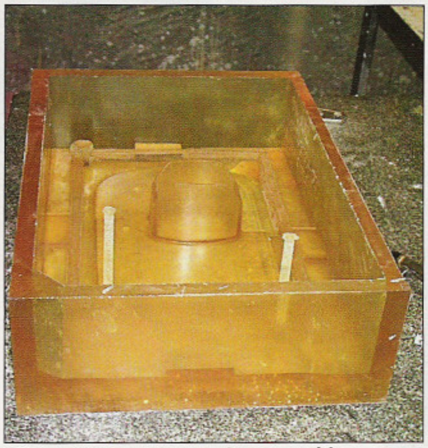
The Creation of RPM

A.L. Johnson, a pottery industry worker, developed the RPM process in 1954 while making molds for slip casting, a method used to produce pottery. After leasing a building to Winslow Manufacturing, a machine shop that produced nut plate drills (for aerospace applications), Johnson was con-





Stereolithography rapid prototype models (above) can be used as patterns to have tooling epoxy cast against them. An epoxy mold (r) has a limitless lifespan in which it can be used years after rubber is first cast against it.



The rubber molds are always positive patterns that are created after rubber is cast against a pattern made of tooling epoxy.

A.L. Johnson cast this military gimble housing to a near-net-shape with thick and thin sections, no draft and an excellent surface finish. The component originally was considered as a hog-out and then a green sand casting, but both processes could not meet the design intricacies or surface finishes achievable through RPM.

tacted by one of the Winslow employees on how to cast the drills instead of machine them. Johnson then consolidated several plaster casting processes from other firms and partnered with a gypsum company to develop an aerating plaster that could be used as a mold material. The use of this material in metalcasting applications would not require vacuum assistance and would offer customers near-net-shape castings that can be produced in less than two weeks. Johnson's RPM process was born.

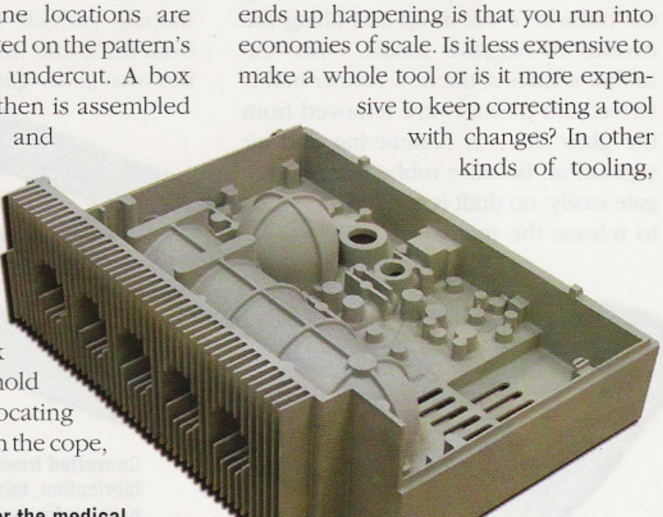
In 1958, Johnson moved the company from Arcadia, Calif., to Monrovia, Calif., where he sold the company in 1968. The new manager, as part of GC (Griffith & Carlson) International, Camarillo, Calif., co-purchased the casting firm in 1975. In 1991, A.L. Johnson moved to its present 45,000-sq.-ft. facility, where it brought together an RPM tooling line, casting line and CNC machining capabilities. Since then, the company has tapped into further markets and increased its use of rapid prototype patterns to accelerate leadtimes and improve production.

Defining the RPM Process

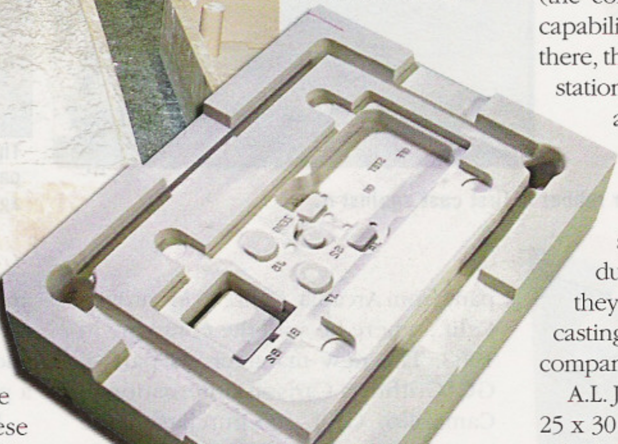
The RPM process begins with the creation of a master mold made from tooling epoxy. A machined aluminum component (which is CNC machined in-house) or an SLA rapid prototype part first is placed on a table, and after parting line locations are marked, clay is mounted on the pattern's sections that will be undercut. A box made of sheet glass then is assembled around the pattern, and soon after, epoxy is poured in the box and around the pattern, creating a negative cavity. Once the epoxy solidifies to form a cope, the box is removed, and the mold segment is flipped. Locating pins then are placed in the cope, and a glass box is built around the reversed pattern. The clay is removed, and the box is filled with epoxy to form a positive cavity in the drag.

Multiple cores—also made from epoxy—can be assembled on the patterns. This can be done by making an outside positive shrink pattern, and casting negative epoxy against it. The pattern then is extracted and machined further to create the core. This can eliminate the need for subsequent machining on the castings. If an epoxy pattern needs minor alterations, additional holes can be CNC machined, and unwanted holes and grooves can be filled with epoxy. Also, if an internal wall needs to be fixed, the company can remove a whole section of the epoxy and put a new CNC machined piece in its place.

"We have a lot of versatility," said Terry Carlson, vice president of sales. "When you have design changes, what ends up happening is that you run into economies of scale. Is it less expensive to make a whole tool or is it more expensive to keep correcting a tool with changes? In other kinds of tooling,



This 10 x 5-in. device for the medical industry was able to achieve thin walls and cast-in fins while retaining smooth surfaces.



To make the molds, liquid plaster is poured into rubber mold cavities to form a final cope and drag (l). The plaster molds (below) contain porosity that helps maintain the heat within the molten metal pour and allows cast parts to have both thick and thin walls.

you have a steel tool, and have to start over if you want to change it."

For a new order, an epoxy can be made in as little as two days. These tooling epoxies have an unlimited life, thus allowing the company to easily produce components that it has not cast in 10 years. "The epoxy is permanent," said Mark Griffith, vice president of engineering. "You can always pour on the rubber, and it's not that expensive to do."

When compared to diecasting tooling, RPM epoxies are one-tenth of the cost. Also, the time to produce epoxy molds is greatly reduced versus hard tooling and machining, which can take several months to complete.

After the epoxy molds are created, a similar process is used to create the rubber molds. Glass boxes are assembled around the epoxies, and rubber is poured into the box, completely surrounding the outside of the mold and filling the cavities of negative molds. Once the rubber solidifies, the new rubber molds (which are positive) are removed from the glass box via hammering and air separation. Because rubber can elongate easily, no draft is needed to release the molds from the box. Simple rubber molds also can be made in two days, and they generally have a lifespan of five years depending on the number of runs and overall wear on the material.

When the rubber molds are set, liquid plaster is poured into the rubber mold cavities to form a final cope and drag. The company mixes the plaster before pouring to create air bubbles for the plaster mold. The porosity allows the molds to conduct little heat from the molten metal, thus maintaining the heat within the metal pour and helping provide cast parts that have both thick and thin walls. The porosities also allow gases to escape during the pouring process to ensure uniform density throughout the casting and smooth wall surfaces.

The solidified plaster molds are separated from the rubber molds simply by letting air seep between the box and the molds, and they are sent to the pouring department where they are cast in either A356 aluminum alloy or ZA8 zinc alloy (the company also has heat treatment capabilities of T51, T6 and T61). From there, the castings are sent to a knockout station, where the plaster is broken away from the components, and the cast parts are sent through cleaning, finishing and inspection (the shaken-out plaster is sent to the local agriculture industry for sorrel amendment). If they need additional machining, the castings will be sent to one of the company's CNC stations.

A.L. Johnson can cast parts measuring 25 x 30 in. (63.5 x 76 cm), up to 20 lbs. (9 kg). RPM allows for dimensional tolerances ranging from 0.010-0.050 in./in. and wall thicknesses of 0.060 in. (0.1524 cm). Typical production runs range from 10-1,000 pieces per year, making RPM castings a good alternative to diecast components when the tooling cost outweighs the profits. "We have a customer for who we make 500 parts a year," said Griffith, "And we've made thousands of these parts during a 10-year period. It's better for them to come to us because it makes no sense to go to diecasting if they only need 500 parts. The tooling is too expensive."

A.L. Johnson casts parts for a variety of industries, such as medical, military and aerospace, and this flexibility between industries has been boosted further as the company suggests rapid prototyping to its customers. Currently, 80% of the company's patterns are SLA parts, and 40% of its customers incorporate rapid prototype patterns into production. "We've been addressing rapid prototyping as one of the things that works hand-in-hand with rubber plaster mold, and that's been a real nice move for us," Carlson noted.

Staying Rapid

Due to the quick tooling speed of the RPM process, the company can produce parts from CAD to casting in 10-14 days. Often, customers use this process as a stepping stone to check for accuracy before ordering a high-production tooling contract for diecasting. The acceler-

Converted from a sheet metal fabrication, this 4-lb. aluminum laser housing for the electronics industry was cast via RPM, which helped enhance the component's appearance.

ated casting process has been further augmented by the use of SLA parts as base patterns.

When a customer submits a CAD model it wants as an SLA part, A.L. Johnson will outsource the model to one of several rapid prototyping companies. The casting firm prefers to control the manufacturing sequence as a one-stop shop by sourcing the prototype parts. Carlson said the same idea applies to machining, which is why the company has its own CNC machining operations. "We prefer to do machining in-house," he said. "You run into problems if you have a machine house in one place, a casting house in another and the customer in another. So, that's why it's really nice when our customers go to one stop. That's why we have all the services available."

The plaster molds are gravity-poured in either A356 aluminum alloy or ZA8 zinc alloy. The molds' porosities help produce parts with uniform densities.

The practicality of using SLA patterns in comparison to machined patterns for RPM depends on the complexity of the components. SLA patterns are faster and significantly less-expensive for simple castings, but are more challenging for intricate designs. Carlson said one problem faced with some customers' prototype models is the rough surfaces produced by certain prototyping machines. "If that happens, we have to spend days of hand cleanup time, which is very expensive, to remove all the build lines," he said. "And we have to be very careful around those build lines and the areas of the pattern to make sure we're not taking away tolerances of the pattern."

Griffith noted that because the RPM process can cast down to the most minute details on an SLA part, build lines of 0.004 in. (0.010 cm) will show perfectly on a casting. "RPM is great at mimicking features," he said. "In many ways, we were in rapid prototyping before the term even came out, because we used to have people hand-carve wood patterns for us. You could then have a pattern and make a mold because (for the RPM process) it doesn't really matter what the material is."

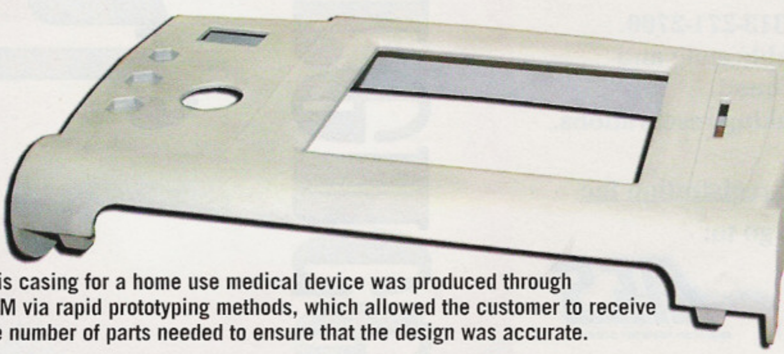
Delivering the RPM Process

Carlson mentioned that a lot of preproduction jobs with SLA can become production contracts as customers are pleased with the results of RPM. However, one of the largest challenges, he said, is educating people about the process. "We want people to examine the options and say, 'A sand casting or V-process might not be accurate enough, so we should look at RPM,'" he commented. "Diecasters, especially domestic, want to get their parts to market quicker, and they can use RPM as a primary tool while they wait to get their tools made. We want them to know they actually can get (production-grade parts from us) until they're ready to go to high-volume tooling."

One of the best means the company uses to educate its customers is through the preliminary design process. Because RPM is not common to the metalcasting industry, A.L. Johnson needs to address the details of the process before customers deliver a CAD model. "Most people are taught to include draft, uniform wall thicknesses and no undercuts," Carlson said. "That's not true for RPM. There are features that can be very critical, and if engineers design a part for the process right from the start, it's much better to help them design and help them hold certain tolerances so we can cast it. Some parts have certain areas that can be left as-cast and other areas that have really tight tolerances."

Although customers often will comply to the RPM process, the company has faced recent competition from CNC production facilities. A.L. Johnson has kept a steady inflow of production during the recent economic slide, but Griffith noted that the RPM process competes with CNC shops and investment casting facilities often because they are more commonly known. However, the company still continues strong with its current production, short runs for diecastings and short leadtimes obtained with RPM.

"We work with hundreds, if not thousands, of customers per year," Carlson said. "We're always looking to keep our bucket full." ***MC***



This casing for a home use medical device was produced through RPM via rapid prototyping methods, which allowed the customer to receive the number of parts needed to ensure that the design was accurate.

For More Information

"Cutting Diecasting Leadtimes via Rapid Prototyping," *K. O'Shaughnessy, MODERN CASTING, April 2005, p. 26-28.*