What is Powder Metallurgy?

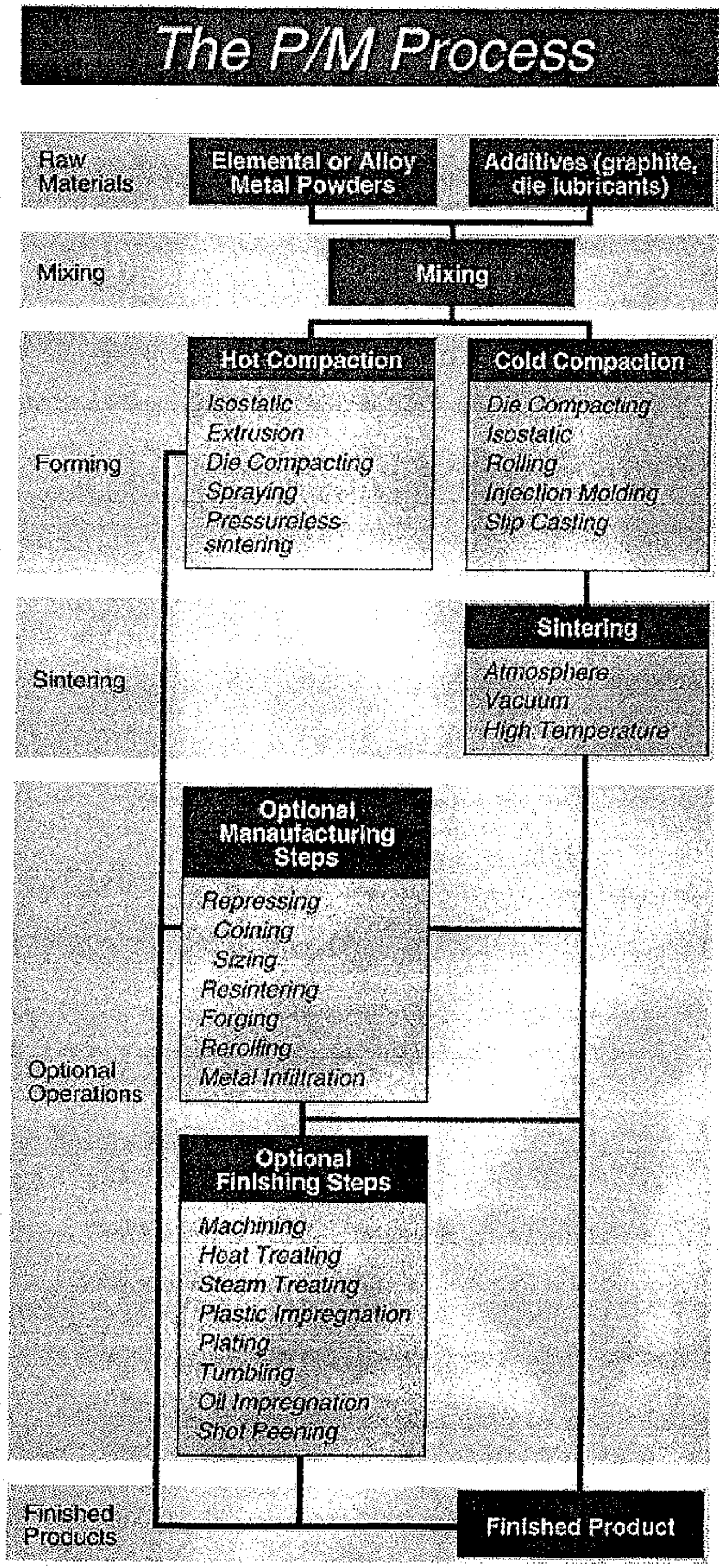
Powder Metallurgy - or P/M - is a highly developed method of manufacturing reliable ferrous and nonferrous parts. Made by mixing elemental or alloy powders and compacting the mixture in a die, the resultant shapes are then sintered or heated in a controlled-atmosphere furnace to bond the particles metallurgically. Basically a "chipless" metalworking process, P/M typically uses more than 97% of the starting raw material in the finished part. Because of this, P/M is an energy and materials conserving process.

The P/M process is cost effective in producing simple or complex parts at, or very close to, final dimensions in production rates which can range from a few hundred to several thousand parts per hour. As a result, only minor, if any, machining is required. P/M parts also may be sized for closer dimensional control and /or coined for both higher density and strength.

Most P/M parts weigh less than 5 pounds (2.27 kg), although parts weighing as much as 35 pounds (15.89 kg) can be fabricated in conventional P/M equipment. Many of the early P/M parts , such as bushings and bearings, were very simple shapes, as contrasted with the complex contours and multiple levels which are often produced economically today.

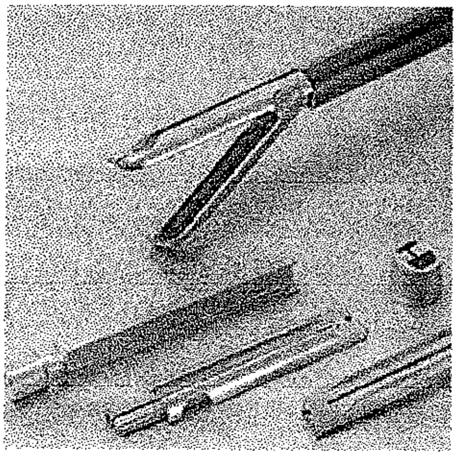
Advantages of the P/M Process

- Eliminates or minimizes machining
- Eliminates of minimizes scrap losses
- Maintains close dimensional tolerances
- Permits a wide variety of alloy systems
- Produces good surface finishes
- Provides materials which may be heat-treated for increased strength or increased wear resistance
- Provides controlled porosity for self-lubrication or filtration
- Facilitates manufacture of complex or unique shapes which would be impractical or impossible with other metalworking processes
- Suited to moderate -to high volume components production requirements
- Offers long-term performance reliability in critical applications
- Cost effective.



http://www.mpif.org

Award Winning Parts



Component—**Laparoscopic Jaws**

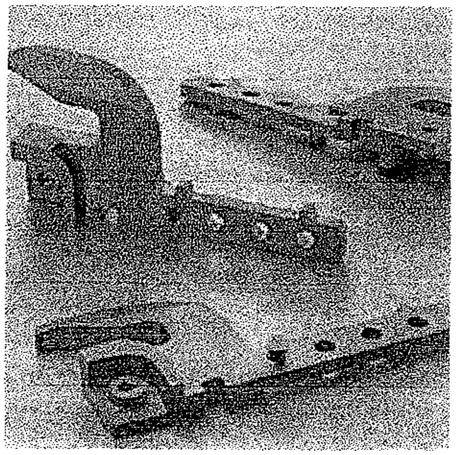
Application—**Laparoscopic Vessel-Fusion Device**

Fabricator—**Parmatech Corporation**

End User—**SurgRx, Inc.**

The award was given to a high-compression jaw used in laparaoscopic vessel fusion. The jaw design has top and bottom jaws, an anchor, and an I-beam. All four components are made from 17-4PH metal powder and have as-sintered densities greater than 7.6 g/cm³. The parts have very thin walls and highly complex geometries, making them difficult to manufacture economically by any other technology. Top and bottom jaws pivot at the lobes that provide the fulcrum for the assembly. The cutting mechanism on the laparoscopic device is in the shape of an I-beam. Very high compression is maintained as the blade is advanced from the proximal to the distal end of the jaw. The SurgRx system incorporates smart electro-technology in a high-compression jaw design to provide rapid vessel fusion without thermal effects.

Award Winning Parts



Component—**Intravenous Infusion Pump Latch**

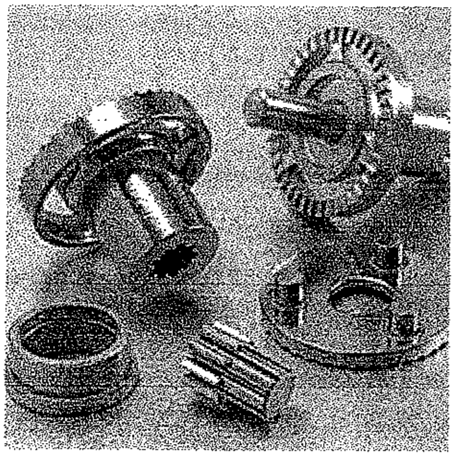
Application—**Medical Infusion Pump**

Fabricator—**Webster-Hoff Corp.**

End User—**Phillips Plastics Corp.**

The award was given to a complex pump latch made from 316 stainless steel used at the end of a door handle for a medical infusion pump that dispenses intravenous solutions. The part is produced to a density of 6.7 g/cm³ and has an ultimate tensile strength of 65,000 psi, a yield strength of 42,000 psi, and an 11.5% elongation. It must withstand high loads and repeated operation without wear or breaking. Secondary operations are limited to deburring, tempering, glass-bead finishing and tapping one hole. The P/M latch replaces a die-cast handle that was machined and fitted to a machined stainless steel latch with dowel pins and screws. P/M provided an annual cost savings of more than $100,000.

Award Winning Parts



Component—**Gear Assembly**

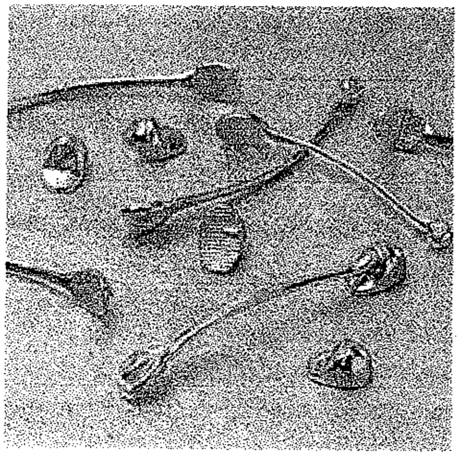
Application—**Minivan Sliding Door**

Fabricator—**ASCO Sintering Coompany**

End User—**Deltran Inc.**

The award was given to a gear assembly, consisting of four parts—armature, rotor blank, bearing, and pinion gear. The assembly operates in a motor drive for automatic sliding minivan doors and opening and closing tailgates. Made from a P/M phosphorous iron material, the parts have a density of 7.0 g/cm³, an ultimate tensile strength of 45,000 psi and a yield strength of 32,000 psi. The parts are made to a net shape, except for the rotor which requires a turning operation on the hub. Innovative tooling provides the density in the parts required to satisfy magnetic and strength properties of the rotor.

Award Winning Parts



Component—**Carriere Distalizer**

Application—**Orthodontic Apparatus**

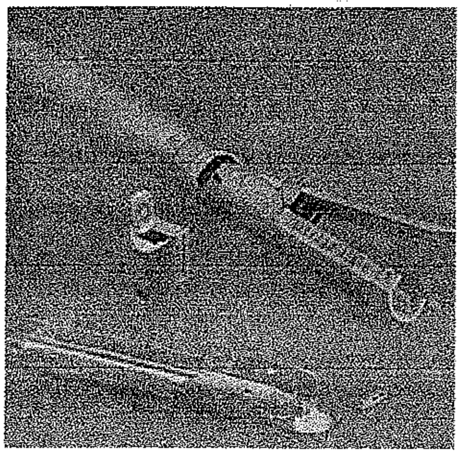
Fabricator—**World Class Technologies**

End User—**Class One Orthodontics**

The award was given to a Carriere Distalizer, a complex design consisting of two pieces, a posterior pad with a socket and an interior rod with a ball on one end and a pad with a hook on top at the other end. After sintering and polishing, the ball is pressed into the socket in the posterior pad to make the final assembly, which comes in three sizes, each with a left- and a right-hand version. Made from a nickel-free stainless steel, the parts are formed to a density of 7.6 g/cm^3 and exhibit a yield strength of 80,120 psi, an ultimate tensile strength of 95,520 psi, and a 22% elongation. Metal injection molding offered considerable cost savings over competing manufacturing techniques such as investment casting.

OTHER CASE STUDIES

Case Studies



Case Study 6

Component: Receiver, Clevis End, and Articulating Link for Endoscopic Surgical Tool

Process: MIM

Size: Receiver—68 mm (2.7 in.)
Clevis End—28 mm (1.1 in.)
Articulating Link—7.5 mm (0.3 in.)

Weight: Receiver—11 g (0.024 lb.)
Clevis End—7 g (0.015 lb.)
Articulating Link—0.097 g (0.0002 lb.)

Alloy: 17-4 PH Stainless Steel

Tensile Strength: 1,180 MPa (170,000 psi)

Yield Strength: 1,100 MPa (160,000 psi)

Elongation: 3%

Apparent Hardness: 36 HRC

Density: 7.5 g/cm³ (0.27 lb./in.³)

Secondary Operations: Sizing and Heat Treating

Annual Production: 30,000

Description:
Three intricate 17-4 PH stainless steel parts made by metal injection molding (MIM) are used in a surgical tool—an articulating endoscopic stapler.

Formed very close to their final shape, these thin-walled parts are heat treated and have an ultimate tensile strength of 1,180 MPa (170,000 psi), a yield strength of 1,100 MPa (160,000 psi), a 36 HRC hardness, an elongation of 3%, and a density of 7.5 g/cm³.

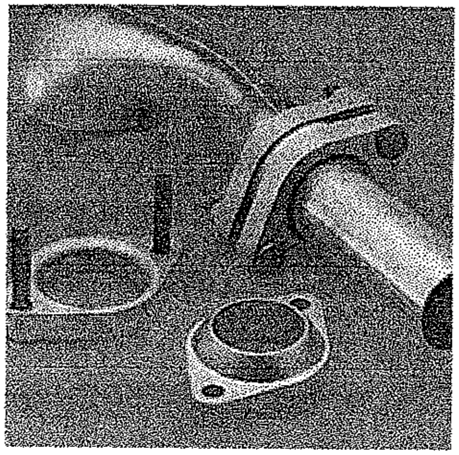
The parts adhere to precision tolerance requirements. The receiver has a 0.71 mm (0.028 in.) wall section which forms a slot held to 8.69–8.79 mm (0.342–0.346 in.) over the entire length. The clevis holds a roundness of 11.7 mm ± 0.05 mm (0.460 in. ± 0.002 in.) on a 0.864 mm (0.034 in.) wall section. The link holes are held to 1.19 mm ± 0.019 mm (0.047 ± 0.00075 in.).

The receiver is thin walled with a required varying wall section over a length of 50.8 mm (2 in.). The clevis has a thin wall of 0.711 mm (0.028 in.).

The endoscopic device combines a 45° bilateral articulation with a 360° rotation, providing excellent maneuverability and tissue access for endoscopic procedures such as appendectomies, lung resections, colectomies, splenectomies, and nephrectomies.

OTHER CASE STUDIES

Case Studies



Case Study 5

Component: Auto Exhaust-System Flanges

Process: P/M

Size: Manifold Flange—
73 x 112 x 30 mm (2.87 x 4.41 x 1.18 in.)
Outlet Flange—
73 x 112 x 16 mm (2.87 x 4.41 x 0.63 in.)

Weight: Manifold Flange—0.45 kg (1 lb.)
Outlet Flange—0.31 kg (0.7 lb.)

Alloy: 434 Stainless Steel

Tensile Strength: 450 MPa min. (65,000 psi)

Elongation: 5% min.

Apparent Hardness: 60 HRB min.

Density: Manifold Flange—6.9 g/cm³ (0.25 lb./in.³)
Outlet Flange—7.0 g/cm³ (0.25 lb./in.³)

Secondary Operations: Deburring and Press Fitting

Alternative Process: Stamping

Annual Production: 200,000

Description:

The flanges are used in automotive exhaust-system manifolds. The manifold flange connects the manifold to the exhaust pipe leading to the catalytic converter. The exhaust converter outlet flange connects the exhaust pipe leading from the catalytic converter to a flange welded to the manifold. The three-level manifold flange (6.9 g/cm³) required special tooling to form the "tulip" shape. P/M replaced a two-piece stamped-and-welded assembly which leaked exhaust fumes. P/M reduced dramatically exhaust leakage at the manifold/exhaust system junction compared to the stamped flange with a welded tulip. 434 P/M stainless steel has superior tensile properties compared to wrought 409 stainless steel at elevated temperatures, as well as improved corrosion and oxidation properties.

Formed to a minimum density of 7.0 g/cm³, the exhaust-converter outlet flange is supplied with two cold-headed wrought bolts press fitted into it and shipped as an assembly. Deburring is the only other secondary operation performed on both parts.

The exhaust systems with the P/M stainless steel parts are warranted for 160 km (100,000 miles).