FABRICATING METAL FOOTPLATES

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I. The Lost Wax Process

Introduction

The "lost wax" process for making metal castings has been used for the production of art works for centuries. Benvenuto Cellini sculptured his masterpieces in wax and then cast them in bronze by this process. Decades ago, the dental profession adopted the method as a means of making inlays. Soft wax was pressed into the tooth cavity and assumed the true contours which the inlay was to have. The wax pattern thus obtained was then invested and evacuated, and a true inlay was cast. In the early 1930's there was developed the practice of making duplicate dispensable patterns in wax, so that many parts which were exactly alike could be cast. In this process an accurate steel mold was used to form the wax pattern. This was the beginning of "lost wax" as a real industrial process.

The adaptation of this process for making corrective footplates came about because the Fellowship could not properly fit a test case of congenital flaccid feet by the well-known method of hammering a footplate to shape on a lead block. It was also found that the normal physical properties of the metal had been greatly reduced by the excessive cold working necessary to produce the deep draws required to fit the foot.

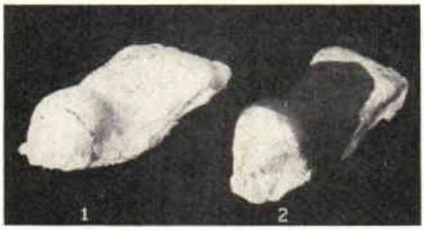


Fig. 1. (1) Replica Cast with outlines for footplate drawn on it. (2) Wax pattern.

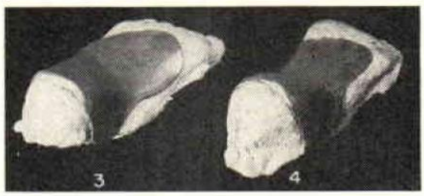


Fig. 2. Completed footplates before coating or final finishing.

It seems at first that stainless steel, vitallium or titanium footplates might be more acceptable than aluminum footplates. Equipment for melting these metals is available at Mellon Institute. It was felt, however, that a process could be developed and equipment designed which would be more readily available to the orthotists.

Aluminum appeared to be most readily adaptable for work in the average brace shop. The 355 aluminum casting alloy was deemed to be more suitable than other casting alloy, as it has: (1) high strength, (2) it can be heat-treated to give additional strength, (3) it has some

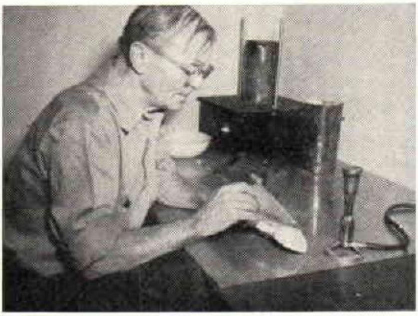


Fig. 3. Attaching web to wax pattern for footplate.

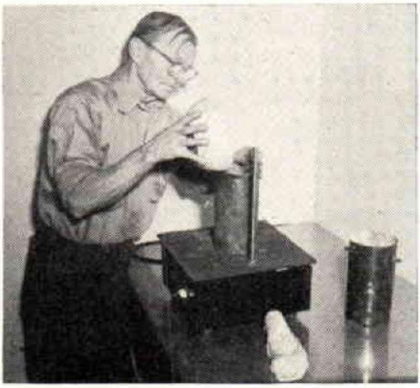


Fig. 4. Investing wax pattern in plaster paris-sand mixture.

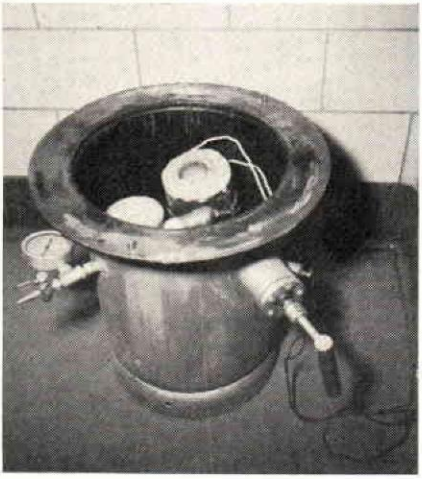


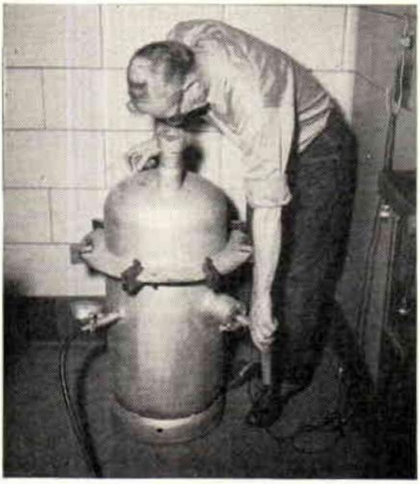
Fig. 5. Furnace, mold, and container for pouring aluminum in vacuum.

ductility when hot and can be bent a small amount to correct small defects, and (4) it melts at a relatively low temperature. Finally a number of methods of heat-treating this alloy produce typical yield strengths of over 30,000 pounds per square inch.

Because only the orthopedic specialist knows the nature of the correction that is needed to give the patient comfort in these very serious cases, corrective footplates require a prescription which preferably is in the form of a negative cast of the patient's foot *in the corrected position.* The orthotist should be present in making the cast, and the doctor should actually hold the foot in the corrected position while the cast is being applied. *The preparation of this type of footplate should not be attempted unless the assistance of the physician can be obtained.*

The steps in preparing the aluminum footplate by the lost wax process are as follows: The negative cast of the foot, with the edges of the footplate outlined on it, is waxed and filled with plaster-of-paris. A sheet of wax of the required thickness is softened in warm water and wrapped around the foot. The edges are cut with a knife to the desired shape. A wax sprue is attached, and the wax replica of the desired footplate is then removed from the cast and placed in cold water so that it will maintain its shape.

A mixture of sand, plaster-of-paris, and water is then prepared, and the wax cast is embedded in this mixture in a metal can. When the plaster has set, the can and contents are inverted and placed in a hot oven so that the water and wax will be re-



Above: Fig. 7. Metal footplates covered with plastisol. Footplate on left is covered with flesh-colored plastisol; footplate on right is covered with brown plastisol.

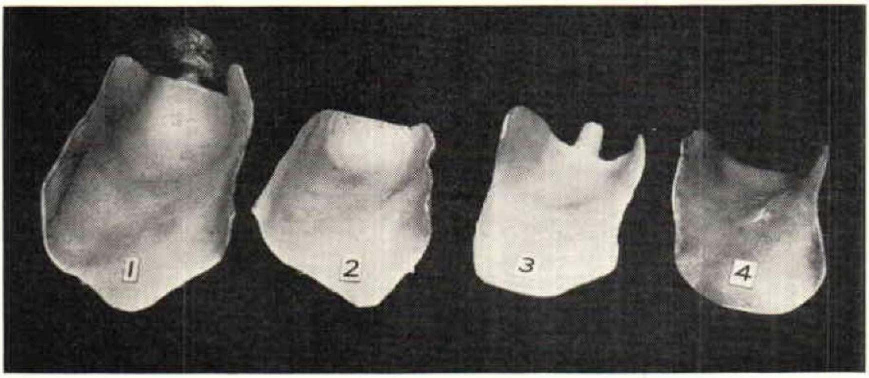
At left: Fig. 6. Pouring footplate.

moved, leaving a cavity in the sand-plaster mixture into which the molten aluminum can be poured. The can and contents are next placed in a furnace where they are held overnight at a dull red heat. The can is then removed from the furnace, allowed to cool, and molten aluminum is poured into the cavity. The plaster-of-paris is then soaked in water to soften it and the cast footplate extracted.

The most reliable method of filling the cavity with aluminum is to place the can and aluminum in a container which is air-tight. And then to evacuate the air from the container before pouring the molten aluminum into the cavity. One man can prepare and pour about ten footplates a day by this method.

The process is illustrated in the accompanying photographs: Figure 1 shows the replica cast with the outlines for the footplate drawn on it, on the left side; the wax pattern is shown on the right. Figure 2 illustrates the completed footplates before coating or final finishing. Figure 3 shows the addition of web and sprue to the wax pattern (the web is used for footplates made for heavy persons). In Fig. 4 the plaster-of-paris, sand, and water investment is being poured into the can around the wax pattern. The vibrating platform is of assistance in removing air bubbles, but is not absolutely necessary to obtain satisfactory results. Figure 5 shows a small electric melting pot in the center of the vacuum container. The melted aluminum is poured into the mold in the left hand corner by turning the handle on the outside of the furnace. This container for maintaining vacuum was constructed from a hot-water boiler. This was cut in two and flanges added in the welding shop. Figure 6 shows a window in the top of the container which permits the pouring operation to be observed. Figure 7 presents two finished footplates prepared by this method.

Note: This shop equipment has been used for making many types of castings suitable for orthopedic devices; it seems probable that the process may have considerable utility for orthopedic work.



II. The Incasement Method

Fig. 5

With the adaptation of the lost wax method for producing footplates the Fellowship has been able to make any shape footplate desired by the physician without an appreciable increase in the difficulty of construction. Any arch desired can be readily obtained. The entire heel can be enclosed and the footplate can extend as high on the sides as desired. It does not require any more skill to make these complicated footplates than would be required to cast a flat plate. Because flaccid feet have a tendency to extend over the side of the footplate and irritate the skin, it has been found that there is less chance of troublesome footplates resulting if the plate is constructed as shown in Figure 1.

In this method the wax sheet is extended around the heel and considerably higher around the sides of the foot than is required. When the casting is completed the patient steps into the incasement for the foot and the parts of the footplate which are not needed are then cut off.

Figures 2, 3, and 4 show footplates that were failures because the patient's foot over-rode the footplate at some point. Figure 5 gives the method of fitting the incasement footplate to the foot after casting. (The foot shown in the photograph is not that of the patient in this case.)

The incasement footplate has been known for many years. It is seldom seen in use, however, because it is so difficult to construct by hammering a plate on a lead block, that only the most skilled workers can make it. It has been found here that this type of plate is very comfortable and well liked by the patients. As it is so easily constructed by the lost wax process its wider use should perhaps be encouraged.