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SPRUE PIN AND RESERVOIR COMBINATION

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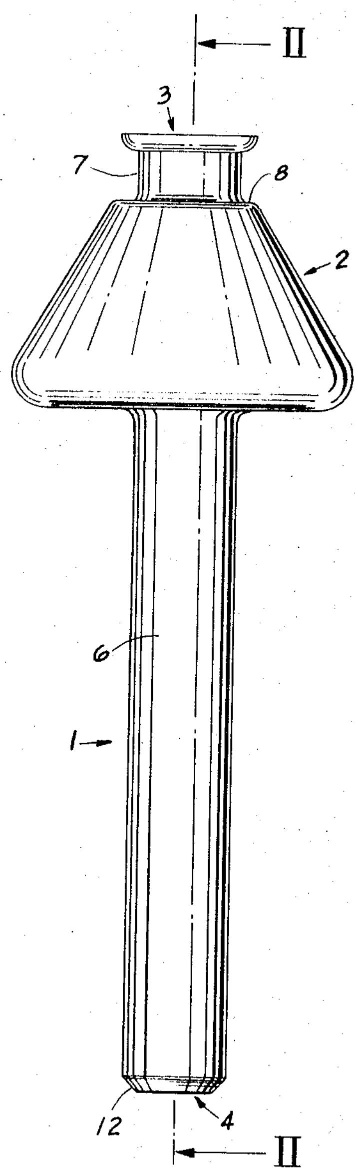

FIG.-1

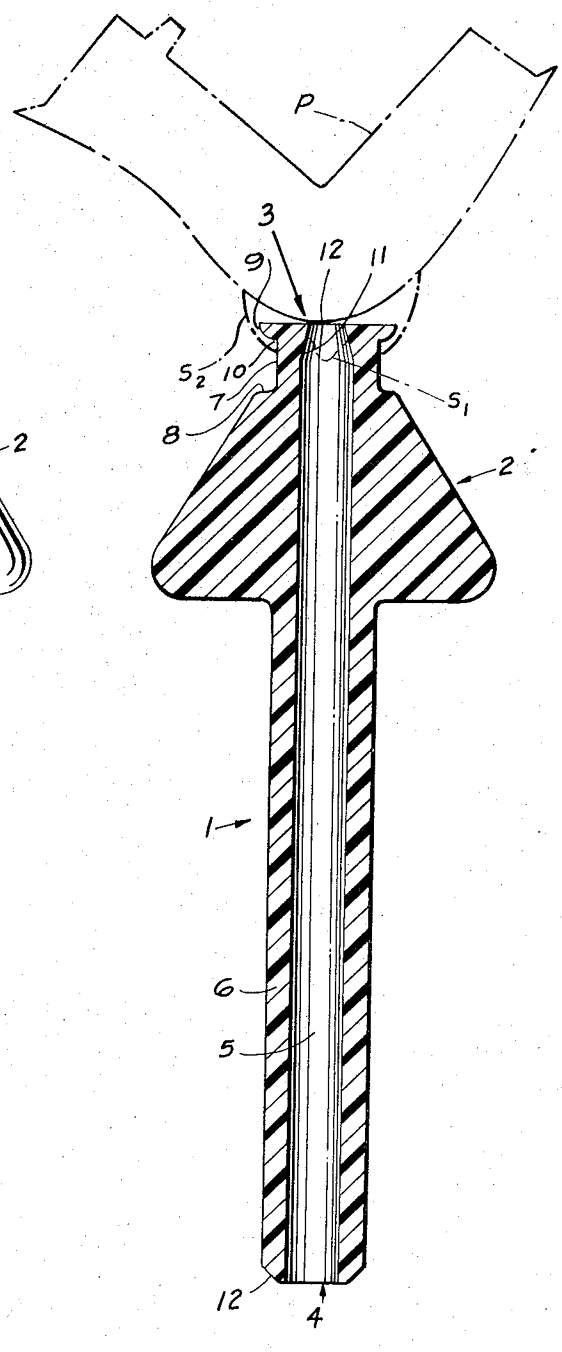

FIG.-2

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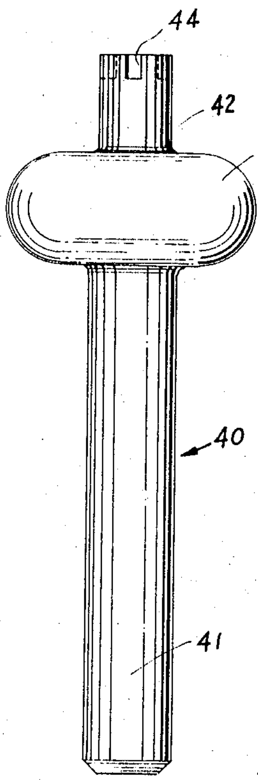

FIG.-6

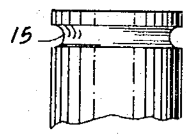

FIG.-3

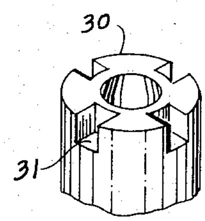

FIG.-5

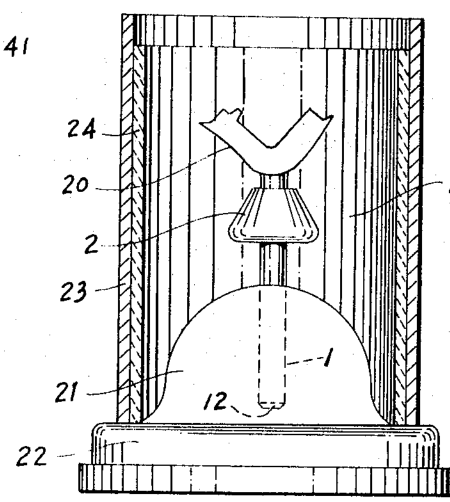

FIG.-4

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SPRUE PIN AND RESERVOIR COMBINATION

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This invention relates to a novel thermoplastic sprue pin and reservoir combination. The integral sprue pin and reservoir combination of this invention is particularly useful in dentistry in the production of dental castings by the "lost wax" process. While the description which follows relates to its use in dentistry, it should be understood that the sprue pin and reservoir combination may be used in fields other than dentistry, e.g. in the production of jewelry, as a means for producing a passageway for molten metal to gain access to the mold chamber when casings are made by the "lost wax" process.

As is well known to those versed in the art of producing dental castings, sprue pins have ben used for many years for creating a passageway in molds to gain access to the cavity of the mold which is ultimately filled with metal to produce the casting. Reservoirs have been sometimes used in conjunction with the sprue pin to produce a pool of molten metal so that as the metal in the casting cools, and consequently contracts, it may flow from the reservoir at a sufficient rate to prevent or minimize shrinkage porosity from developing in the casting. More particularly, for many years, it has been customary to attach a metal sprue pin to the wax pattern and then insert the pin (with the pattern attached) into a wax-filled hole in a sprue base or crucible former. As indicated above, the reservoir may be used in conjunction with the sprue pin. A steel ring, lined with asbestos, is placed over the crucible former and the ring is then filled with a refractory material called investment. When the investment has set, the crucible former is removed, the ring is then placed in an oven to burn out the wax and thus create a mold chamber. After the ring has been partially heated, the metal sprue pin is removed to permit the wax to escape from the mold.

The openings in the investment mold formed upon the removal therefrom of the wax pattern, sprue pin and reservoir, respectively, are referred to as the "mold cavity," "sprue" and "metal reservoir." The mold cavity is a cavity to which the sprue serves as a passageway for feeding metal thereto, while the metal reservoir is an enlarged cavity intermediate the ends of the sprue, and of a larger cross-section than the sprue, which ensures a satisfactory feed rate. The product resulting from filling up the mold cavity with metal is referred to as the "casting," while the metal stem portion attached to the casting and located in the sprue is caled the "metal sprue."

At the present time, it is common practice to use metal rods of various diameters as sprue pins. It has been considered important that such sprues be made of a metal that is not subject to corrosion as chemical residues left on the walls leading to the mold can cause contamination of the molten gold (usually used in dental castings). Various gauges of pins are used. These vary according to the size of the pattern to be cast and the type of casting equipment which is to be used. Reservoirs are sometimes fashioned by hand and added to the sprue pin in order to prevent porosity from developing in the casting itself. The reservoir acts as a feeder to the casting, but such handmade reservoirs are likely to be rather irregular in shape and to have rough surfaces. Both of these are factors which can cause unwanted turbulence in the metal as it flows into the mold. Porosity in the casting sometimes occurs if no reservoir is used or if the sprue pin is too long or thin. Some authorities advocate the use of a hollow metal sprue. These have the advantage that they permit

waxes and gases to escape from the mold, but they have to be forcibly removed from the investment material just as a solid metal sprue pin would be. Removal can cause roughening of the channel and, sometimes, chipping of the investment. If such chips find their way into the mold chamber, they cause voids in the casting. Other authorities advocate the use of wax wire or a combination of metal sprue pins and wax wire. Some technicians use solid plastic sprue pins which burn out as the casting ring is heated, but they do not melt before the wax in the mold melts because of the higher melting point of the plastic material. It is for this reason that a recently published authoritative book on dental casting techniques strongly advises against using plastic sprues. It points out that such sprues act like a cork in a bottle and that the surfaces of the mold may be damaged when the wax liquifies and/or volatilizes before the plastic material in the sprue pin melts.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of steps, methods, combinations and improvements.

The invention consists in the novel steps, methods, combinations and improvements herein shown and described.

In the drawings:

FIGURE 1 is a side view of one embodiment of a thermo-plastic sprue pin and reservoir combination produced in accordance with this invention; the upper end of the sprue pin being provided with a flared end for facilitating attachment of a wax pattern thereto and the lower end being beveled to facilitate insertion of the sprue pin in the hole of a crucible former.

FIGURE 2 is a vertical sectional view along the lines II—II of FIGURE 1 indicating the integral constructions of the sprue and reservoir combination. Attached to one end of the sprue pin is a wax pattern shown in phantom as are the outer wax seal, and inner wax seal which serve to prevent detachment of the wax pattern from the sprue pin.

FIGURE 3 is a partial side view of a sprue pin cut above the reservoir portion similar to that shown in FIGURE 1 except that, instead of a flared upper end, there is provided near the upper end of the pin, a circular groove for facilitating attachment of a wax pattern to said sprue pin.

FIGURE 4 is a partial sectional view of a conventional assembly, including the crucible former and investment material utilizing the sprue pin and reservoir combination of this invention.

FIGURE 5 is a partial isometric view of a sprue pin cut above the reservoir similar to that shown in FIGURE 1 except that, instead of a flared upper end, there are provided circumferentially spaced recesses for facilitating attachment of the wax pattern to the sprue pin.

FIGURE 6 is a side view of a different embodiment of a thermoplastic sprue pin and reservoir combination wherein the reservoir is of substantially toroidal configuration and wherein the tip of the sprue pin at the end to which the wax pattern is attached is of a smaller diameter than the stem portion of the sprue pin.

An object of this invention is to provide a novel integral sprue pin and reservoir combination that affords a combination of advantages not possessed by the pin and reservoir combination heretofore used in making castings, particularly dental castings, by the "lost wax" process.

Another object of this invention is to provide a novel thermoplastic, integral sprue pin and reservoir combination which when used in the "lost wax" process allows wax to run out as soon as it is molten; allows the escape of gases from the mold.

A still further object of this invention is to provide a novel thermoplastic integral sprue pin and reservoir combination which provides a reservoir for the flow of metal into the mold while minimizing turbulence in the flow of metal as it fills the mold.

A still further object of this invention is to provide a novel integral sprue pin and reservoir combination which may be made in varying gauges for patterns of varying size and thickness.

Another object of my invention is to provide a novel integral sprue pin and reservoir combination whereby the sprue pin thereof may be readily attached to a wax pattern so as to reduce the risk that the pattern might fall off during the subsequent steps particularly those involving the flow of investment material around the pattern.

Yet a further object of this invention is to provide a novel integral sprue pin and reservoir combination which may be burned out before the mold is heated to the necessary temperature for casting so as to avoid the necessity of pulling it through the investment material with the consequent risk of roughening the channel through which the molten metal must pass. This roughening would result in turbulence and possibly in carrying particles of investment into the mold as the casting is made thus causing voids in the casting.

A still further object of this invention is to provide a novel integral sprue pin and reservoir combination which when used in the "lost wax" process provides a reservoir of molten metal which helps to prevent shrinkage porosity from occurring in the casting.

It has been found that the objects of this invention may be realized by forming, preferably by molding, an integral thermoplastic sprue pin and reservoir comination comprising a hollow sprue pin having intermediate its ends, an integral bulbous member or reservoir. The reservoir has a larger cross-sectional area than the sprue pin so that in the later stages of the lost wax process, there is formed in the investment mold an enlarged cavity or metal reservoir intermediate the ends of the sprue of the investment mold.

As will be readily apparent from the more detailed description which follows with respect to the specific embodiment illustrated in FIGURES 1 and 2, the location of the reservoir with respect to the end of the sprue pin to which the wax pattern is to be attached is of importance. More particularly, the reservoir should be located sufficiently close to the end of the sprue pin to which the wax pattern is attached that the metal reservoir of the investment mold formed in a later stage of the lost wax process is properly located with respect to the mold cavity to ensure the feeding of metal from the sprue into the mold cavity at a sufficient rate for minimizing shrinkage porosity developing in the casting. Also, there must be a constriction between the reservoir and the pattern or else the reservoir becomes part of the pattern. The reservoir should be located at a sufficient distance away from the end of the sprue pin to which the wax pattern is attached so that the metal sprue formed in a later stage of the lost wax process may be readily cut from the casting.

Due to the hollow construction of the sprue pin, it is possible to provide the end of the sprue pin to which the wax pattern is to be attached with undercut means which helps to provide attachment means for the wax pattern. Preferably, the end of the sprue pin to be inserted in the crucible former is of a construction to facilitate insertion in the hole of the crucible former.

The thermoplastic material used in accordance with this invention is of such nature that: (1) it has a volatilizing point above that of wax; (2) it volatilizes completely below the mold temperature used in making the casting; and (3) the sprue pin and reservoir combination made therefrom is reasonably rigid. An example of a suitable thermoplastic material having the aforementioned properties is polystyrene.

Reference is now made to FIGURES 1 and 2 of the drawings illutsrating a preferred embodiment of the integral sprue pin and reservoir combination of this invention. There is provided a hollow sprue pin, designated generally by the reference numeral **1**, having a bulbous member or reservoir, designated generally by the reference numeral **2**, intermediate its ends. The top end of the sprue pin is designated generally by the reference numeral **3**, while the bottom end is designated generally by the reference numeral **4**. The opening or lumen extending the entire length of the sprue pin is designated by the reference numeral **5** in FIGURE 2.

As shown in FIGURES 1 and 2, the reservoir is of a larger cross-sectional area than the sprue pin so that the reservoir area formed in the investment mold provides an enlarged cavity intermediate the ends of the sprue. Of course, the shape of the reservoir may be quite different from the particular configuration of the embodiment of FIGURES 1 and 2 which illustrates an asymmetrical configuration which tapes outwardly from top to bottom. For example, the reservoir may be of a toroidal configuration, as shown by the embodiment of FIGURE 6; a symmetrical tapered configuration which tapers outwardly from the top to its midpoint and inwardly from its midpoint to the bottom, etc. Preferably, the reservoir is of a configuration which provides a metal reservoir in the investment mold which has a wall sloping in the direction of the mold cavity so that the metal in the sprue of the investment mold flows with increasing mechanical force as it approaches the mold cavity. It is also preferred that the reservoir **2** be of such configuration that the reservoir area formed in the investment mold have smooth, curving surfaces that do not create turbulence in the flow of the metal as it passes through the sprue to the mold cavity. The aforementioned preferred features guard against porosity developing in the casting formed in the mold cavity.

Referring again to FIGURES 1 and 2, for convenience sake, the specific portion of the sprue pin **1** below the reservoir **2** may be designated the stem **6** while the portion of the sprue pin above the reservoir may be designated the tip **7**. As indicated hereinbefore, the location of reservoir **2** with respect to the end **3** of the sprue pin is of importance. In general, in order to ensure adequate feed from the sprue and metal reservoir into the mold cavity, the distance between the top surface of the reservoir and the end of the sprue pin to which the pattern is attached should be less than one-half the total length of the sprue pin and preferably not greater than one-third the total length of the sprue pin. Also, the smaller the diameter of the sprue pin, the smaller the distance between the reservoir and end of the sprue pin permitted if optimum results are to be achieved. In order to explain this more fully, let us assume that the entire length of the sprue pin of the embodiment of FIGURES 1 and 2 having a diameter of 0.102 inch is 22 mm. and that the length (or height) of the reservoir is 5 mm. In the particular embodiment shown, the distance between the top surface **8** of the reservoir and the end **3** of the sprue pin is about 2.5 mm. With dimensions of the aforedescribed type, it has been found that in the production of dental castings by the lost wax process, metal feeds from the sprue and reservoir into mold cavity at a sufficient rate for preventing porosity from developing in the casting. Also, the metal sprue that is ultimately formed may be readily cut from the casting. With a sprue pin of 0.102 inch diameter, it has been found that the distance between the top surface **8** or point of the reservoir and the end of the sprue pin **3** should preferably not be greater than 9 mm. to ensure an adequate feed rate into the mold cavity and not less than 2 mm. to provide a sufficient space for cutting the metal sprue from the casting. With a sprue pin of smaller diameter, the preferred maximum distance would be less than 9 mm. while the minimum distance remains 2 mm.

Reference is again made to FIGURES 1 and 2 of the drawings. Means are provided on the tip of the sprue pin for facilitating and/or ensuring attachment of the sprue pin to the pattern. More particularly, the end of the sprue pin is flared at **9** to provide an undercut at **10** with respect to the top surface of the flared end. In addition, the lumen **4** begins to taper inwardly at **11** as it approaches the end **3** so that an undercut is provided at **11** with respect to the top surface of end **3**. As shown in FIGURE 2, the aforementioned undercut portions **10** and **11**, respectively, are used in association with melted wax to provide attachment means so as to reduce the risk that wax pattern P might fall off the sprue pin during subsequent steps involving the flow of investment material around the pattern. More particularly, prior to attaching the wax pattern to the sprue pin a small amount of wax is heated by means of a hot instrument to soften it. The softened wax is then flowed onto the wax pattern so as to adhere thereto. The top of the sprue pin is immediately seated in the soft wax causing a portion thereof to flow into the lumen in the form of a S_1, which engages the inner undercut **11** so as to form an inner seal. The portion of the wax near the outer undercut **10** is then heated by means of the aforementioned hot instrument causing it to flow and surround the undercut **10** and form an outer seal S_2.

The end **4** of the sprue pin is beveled at **12** to facilitate insertion of the sprue pin into a wax-filled hole of a crucible former (see FIGURE 4), the wax serving as a seal for holding the sprue pin in the crucible former.

In FIGURE 3, there is illustrated an alternative construction from that shown in FIGURES 1 and 2 for providing an undercut on the outer surface of the sprue pin for facilitating attachment of the wax pattern to the sprue pin. More particularly, instead of a flared end as provided in the embodiment of FIGURES 1 and 2, the sprue pin is provided with a circumferential groove **15** which provides the desired undercut which when filled with wax provides an outer seal which helps to prevent detachment of the wax pattern from the sprue pin.

Reference is now made to FIGURE 4 of the drawings which illustrates how the sprue pin and reservoir combination of FIGURES 1 and 2 is utilized with a conventional crucible assembly employed in the lost wax process for producing dental castings. A wax pattern **20** is secured to the flared end of the sprue pin employing with the help of melted wax used in conjuction with outer and inner undercut portions of the sprue pin to form an inner seal and outer seal in the manner described hereinbefore in detail to prevent disengagement of the wax pattern from the sprue pin. The beveled end **12** of the sprue pin opposite the end to which the wax pattern is attached is inserted into a wax-filled hole (not shown) in crucible former **21** supported on base **22**, the wax serving as a seal for maintaining the sprue pin in the crucible former. A steel ring **23**, lined with asbestos **24**, is placed over the crucible former and the space **25** is filled with refractory material (not shown) called investment. When the investment has set, the crucible former **21** is removed, the ring **23** is placed in an oven to burn out the wax and thus create a mold. The thermoplastic sprue pin and reservoir combination is burnt out before the mold is heated to the necessary temperature for casting. The thermoplastic integral sprue pin **1** and reservoir **2** combination affords many advantages when used in the above-mentioned manner. Many of these advantages will now be discussed in the order in which they are realized in the lost wax process rather than necessarily in the order of importance. Since the sprue pin is hollow it enables one to provide an inner undercut whereby a wax inner seal may be formed for helping in preventing detachment of the wax pattern from the sprue pin. It would not be possible to provide an inner undercut of the aforedescribed type if the sprue pin was of a solid rather than a hollow construction. The provision of an outer undercut at the end of the sprue pin, e.g. a flared end, also permits one to form an outer seal for the sprue pin. The consequences of disengagement of the wax pattern are very great. A miscast necessitates repeating the process beginning with the fabrication of a new wax pattern. The provision of means for ensuring adequate attachment of the wax pattern to the sprue pin guards against the risk of a miscast resulting from the pattern falling off the sprue pin during subsequent stages of the lost wax process, particularly that involving the flowing of investment material around the pattern.

Also, the fact that the sprue pin is hollow allows wax to run out as soon as it is molten by the heat from the oven. The hollow construction also permits escape of gases from the mold. Thus, there is little, if any danger of mold damage from migration of confined liquid and/or volatile materials into the investment material as would be the case if a solid sprue pin were employed in which no means would be provided for allowing escape of melted wax or gases prior to volatilization of the sprue pin itself.

As indicated hereinbefore, the reservoir **2** (FIGURE 4) forms in the investment mold a metal reservoir for ensuring proper feed rate of molten metal through the sprue into the mold cavity whereby development of shrinkage porosity in the casting is prevented.

The fact that the sprue pin and reservoir combination is made of a material which burns out before the mold is heated to the necessary temperature for casting is another advantage. It does not have to be forcibly pulled out of the investment material with the consequent risk of roughening the channel through which the molten metal must pass. It is also not necessary to remember to pull out a plastic sprue pin before casting. The sprue pin and reservoir combination is made of a material that is not subject to corrosion by the investment material and, therefore, cannot damage the surface of the channel.

In FIGURE 5, there is shown an alternative construction from those shown in FIGURES 1 and 2, and FIGURE 3, for facilitating attachment of the wax pattern to the sprue pin. More particularly, the sprue pin end **30** to which a wax pattern is to be attached is provided at the top with circumferentially spaced recesses **31** adapted to receive molten wax to which a wax pattern is attached to form an outer seal similar to the outer seal S_2 shown in FIGURE 2.

In the hereinbefore described embodiment of FIGURES 1 and 2, both the stem **6** and tip **7** are of the same diameter. If so desired, however, one may provide the sprue pin with a smaller diameter as it approaches the end to which the wax pattern is to be attached. By employing a sprue pin of the last mentioned type, the sprue in the investment mold leading to the mold cavity is smaller in size than the rest of the sprue. By providing a smaller diameter at the tip of the sprue, there is effectuated a reduction in the amount of finishing and polishing required when the sprue is cut from the casting. In such sprue pin and reservoir constructions, for example that exemplified by the embodiment of FIGURE 6, the lumen of the tip will proportionately decrease in diameter so that the wall thickness of the hollow sprue pin is adequate. Consequently, the reservoir is generally of a reduced size compared to a similar construction but wherein the tip has the same diameter as the stem portion.

Reference is now made to FIGURE 6 of the drawings. In such embodiment, the sprue pin **40** has a tip **42** which is of a smaller diameter than that of stem **41**. The reservoir **43** is of toroidal configuration. The top of tip **42** is provided with recesses **44** of the type shown in FIGURE 5 for facilitating attachment of the wax pattern to the sprue pin.

The invention in its broader aspects is not limited to the specified steps, methods, combinations and improvements described but departures may be made therefrom within the scope of the accompanying claims without departure from the principles of the invention and without sacrificing its chief advantages.

What is claimed is:

1. In an investment mold containing investment material for the production of castings by the last wax process, an integral, thermoplastic sprue pin and reservoir, one end of said sprue pin supporting a wax pattern and the other end supported by a supporting base, the wax pattern and the portion of the sprue pin and reservoir above the supporting base being embedded in the investment material; the thermoplastic composition of the sprue pin and reservoir combination being of such nature that it has a volatilizing point above that of wax; it volatilizes completely below the temperature to which the mold is heated in the making of the casting; and, the sprue pin and reservoir made therefrom is reasonably rigid; the integral thermoplastic sprue pin and reservoir comprising a hollow sprue pin having intermediate its ends, an integral bulbous reservoir member of a larger cross-sectional area than that of the sprue pin, the reservoir being located along the length of the sprue pin with respect to the end of the sprue pin to which the wax pattern is to be attached, in such a manner, that when used in the lost wax process, metal flows through the sprue into the mold cavity at a sufficient rate to prevent porosity developing in a casting formed in the mold cavity, and wherein the metal sprue may be readily cut from the casting.

2. In an investment mold according to claim 1, wherein the reservoir has a wall which slopes inwardly in the direction of the end of the sprue pin adapted to receive the wax pattern.

3. In an investment mold according to claim **1** wherein the reservoir is of an asymmetrical configuration which tapers outwardly from top to bottom.

4. In an investment mold according to claim **1** wherein means are provided near one end of said sprue pin for facilitating attachment of the wax pattern thereto.

5. In an investment mold according to claim **4** wherein

said means includes undercut means on the inner surface of the hollow pin which is provided by tapering the lumen of the sprue pin inwardly as it approaches the sprue pin end on which the wax pattern is supported.

6. In an investment mold combination according to claim **4** wherein said means includes means on the outer surface of said sprue pin near its end adapted to support a wax pattern which provides an undercut portion with respect to the top surface of said end.

7. In an investment mold according to claim **6** wherein said sprue pin end is flared to provide the undercut means.

8. In an investment mold according to claim **6** wherein there is a circumferential groove near the end of the sprue pin to provide the undercut means.

9. In an investment mold according to claim **1** wherein the end of the sprue pin opposite the wax pattern supporting end is beveled to facilitate insertion in the supporting base.

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