

SHOT TUBE PLUNGER TIP PORTION

BACKGROUND

5 This disclosure relates generally to die casting, and more particularly to a shot tube plunger tip portion that can be used in a die casting system.

Casting is a known technique used to yield near net-shaped components. For example, investment casting is often used in the gas turbine engine industry to manufacture blades, vanes and other components having relatively complex geometries. A component is investment cast by pouring molten metal into a ceramic
10 shell having a cavity in the shape of the component to be cast. Generally, the shape of the component to be cast is derived from wax or SLA patterns that define the shape of the component. The investment casting process can be relatively time, capital and labor intensive.

Die casting is another known casting technique. Die casting involves injecting
15 molten metal directly into a reusable die to yield a near net-shaped component. The components of the die casting system, including the shot tube and the shot tube plunger, are subjected to relatively high thermal loads and stresses during the die casting process. The differences in melting temperatures between the die casting components and the molten metal that is injected during the die casting process can
20 result in die casting components having a relatively limited operational life span.

SUMMARY

A die casting system according to an exemplary embodiment of this disclosure can include a shot tube plunger and a tip portion connected to the shot tube plunger.
25 The tip portion can include an inner flange and a lip portion circumferentially disposed about the inner flange. A recess can be circumferentially disposed between the lip portion and the inner flange.

In a further embodiment of the foregoing die casting system embodiment, the lip portion can include a radially inner wall and the inner flange can include a radially
30 outer wall. The recess can extend between the radially inner wall and the radially outer wall.

In a further embodiment of either of the foregoing die casting system embodiments, the radially inner wall and the radially outer wall can be angled relative to a floor of the recess.

5 In a further embodiment of any of the foregoing die casting system embodiments, the inner flange and the lip portion can be concentric about a longitudinal axis of the tip portion.

In a further embodiment of any of the foregoing die casting system embodiments, the inner flange can include an outermost surface that extends in a first plane that is axially offset from a second plane of an outermost surface of the lip
10 portion.

In a further embodiment of any of the foregoing die casting system embodiments, the first plane can be axially offset from the second plane in a direction that extends from a rear face toward a front face of the tip portion.

15 In a further embodiment of any of the foregoing die casting system embodiments, the recess can be positioned radially inwardly from an outer peripheral surface of the tip portion.

In a further embodiment of any of the foregoing die casting system embodiments, the tip portion can be cylindrical shaped.

20 In a further embodiment of any of the foregoing die casting system embodiments, the tip portion can be at least partially hollow and establish an internal cooling chamber.

In a further embodiment of any of the foregoing die casting system embodiments, the lip portion can extend between an outer peripheral surface of the tip portion and a radially inner wall.

25 In a further embodiment of any of the foregoing die casting system embodiments, the lip portion can be circumferentially disposed about a front face of the tip portion.

A die casting system according to another exemplary embodiment of this disclosure can include a die including at least one die element that defines a die
30 cavity, a shot tube in fluid communication with the die cavity, a shot tube plunger moveable within the shot tube to communicate a charge of material into the die cavity, and a tip portion connected to the shot tube plunger and having a front face, a rear face and an outer peripheral surface that extends between the front face and the

rear face. A lip portion can circumferentially extend about the front face of the tip portion and establish a recess at a radially inward position from the outer peripheral surface of the tip portion.

5 In a further embodiment of the foregoing die casting system embodiments, the recess can be circumscribed by said lip portion.

In a further embodiment of either of the foregoing die casting system embodiments, the lip portion can include a radially inner wall and an inner flange that includes a radially outer wall, and the recess can extend between the radially inner wall and the radially outer wall.

10 In a further embodiment of any of the foregoing die casting system embodiments, the lip portion can extend between the outer peripheral surface and a radially inner wall of the lip portion.

In a further embodiment of any of the foregoing die casting system embodiments, the recess can circumferentially extend about the front face and in a
15 direction that extends from the front face toward the rear face.

In a further embodiment of any of the foregoing die casting system embodiments, the die casting system can be a vacuum die casting system.

A method of providing a tip portion of a shot tube plunger according to yet another embodiment of this disclosure includes circumferentially positioning a lip
20 portion about an inner flange of the tip portion, and positioning a recess between the lip portion and the inner flange.

In a further embodiment of the foregoing method embodiment, the step of positioning the recess can include positioning the recess between a radially inner wall of the lip portion and a radially outer wall of the inner flange.

25 In a further embodiment of either of the foregoing method embodiments, the step of positioning the recess can include positioning the recess radially inwardly from an outer peripheral surface of the tip portion.

The various features and advantages of this disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that
30 accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates an example die casting system.

Figure 2 illustrates a shot tube plunger that can be incorporated into a die casting system.

5 Figure 3 illustrates a tip portion of a shot tube plunger.

DETAILED DESCRIPTION

Figure 1 schematically illustrates a die casting system 10 including a reusable die 12 having a plurality of die elements 14, 16 that function to cast a component 15. 10 The component 15 could include aeronautical components, such as gas turbine engine blades or vanes, or non-aeronautical components. Although two die elements 14, 16 are depicted by Figure 1, it should be understood that the die 12 could include more or fewer die elements, as well as other parts and other configurations.

The die 12 is assembled by positioning the die elements 14, 16 together and 15 holding the die elements 14, 16 at a desired position via a mechanism 18. The mechanism 18 could include a clamping mechanism powered by a hydraulic system, pneumatic system, electromechanical system and/or other systems. The mechanism 18 can also separate the die elements 14, 16 subsequent to casting.

The die elements 14, 16 include internal surfaces that cooperate to define a die 20 cavity 20. A shot tube 24 is in fluid communication with the die cavity 20 via one or more ports 26 that extend into the die element 14, the die element 16, or both. A shot tube plunger 28 is received within the shot tube 24 and is moveable between a retracted and injected position (in the direction of arrow A) within the shot tube 24 by a mechanism 30. A shot rod 31 extends between the mechanism 30 and the shot tube 25 plunger 28. The mechanism 30 could include a hydraulic assembly or other suitable system, including, but not limited to, pneumatic, electromechanical, hydraulic, or any combination of systems.

The shot tube 24 is positioned to receive a charge of material from a melting unit 32, such as a crucible, for example. The melting unit 32 may utilize any known 30 technique for melting an ingot of metallic material to prepare molten metal for delivery to the shot tube 24. In this example, the charge of material is melted into molten metal by the melting unit 32 at a location that is separate from the shot tube 24 and the die 12. However, other melting configurations are contemplated as within the

scope of this disclosure. The example melting unit 32 can be positioned in relatively close proximity to the die casting system 10 to reduce the transfer distance of the charge of material between the melting unit 32 and the die casting system 10.

Materials that can be used to die cast a component 15 with the die casting system 10 include, but are not limited to, nickel-based super alloys, cobalt-based super alloys, titanium alloys, high temperature aluminum alloys, copper-based alloys, iron alloys, molybdenum, tungsten, niobium or other refractory metals. This disclosure is not limited to these materials, and other high melting temperature materials may be utilized to die cast a component 15. As used in this disclosure, the term “high melting temperature material” is intended to include materials having a melting temperature of approximately 1500°F/815°C and higher.

The charge of material is transferred from the melting unit 32 to the die casting system 10. For example, the charge of material may be poured into a pour hole 33 of the shot tube 24. A sufficient amount of molten metal is communicated to the shot tube 24 to fill the die cavity 20. The shot tube plunger 28 is actuated to inject the charge of material under pressure from the shot tube 24 into the die cavity 20 to cast a component 15. Although the casting of a single component 15 is depicted, the die casting system 10 could be configured to cast multiple components in a single shot.

Although not necessary, at least a portion of the die casting system 10 can be positioned within a vacuum chamber 34 that includes a vacuum source 35. A vacuum is applied in the vacuum chamber 34 via the vacuum source 35 to render a vacuum die casting process. The vacuum chamber 34 provides a non-reactive environment for the die casting system 10. The vacuum chamber 34 therefore reduces reaction, contamination or other conditions that could detrimentally affect the quality of the die cast component, such as excess porosity of the die cast component from exposure to air. In one example, the vacuum chamber 34 is maintained at a pressure between 5×10^{-3} Torr (0.666 Pascal) and 1×10^{-6} Torr (0.000133 Pascal), although other pressures are contemplated. The actual pressure of the vacuum chamber 34 will vary based on the type of component 15 or alloy being cast, among other conditions and factors. In the illustrated example, each of the melting unit 32, the shot tube 24 and the die 12 are positioned within the vacuum chamber 34 during the die casting process such that the melting, injecting and solidifying of the high melting temperature material are all

performed under vacuum. In another example, the vacuum chamber 34 can be backfilled with an inert gas, such as argon, for example.

Figure 1 is highly schematic and is included for illustrative purposes only. The die casting system 10 could include more or fewer sections, parts and/or components.

5 This disclosure extends to all forms of die casting, including but not limited to, horizontal, inclined or vertical die casting systems, and other die casting configurations.

Figure 2 illustrates an example shot tube plunger 128 for use with a die casting system, such as the die casting system 10. In this disclosure, like reference numerals signify like features, and reference numerals identified in multiples of '100' signify slightly modified features. Moreover, select features of one example embodiment of this disclosure may be combined with select features of other example embodiments within the scope of this disclosure. It should further be understood that the shot tube plunger 128 is not necessarily shown to the scale it would be in practice. Rather, the
10 shot tube plunger 128 is enlarged to better illustrate its features.
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The shot tube plunger 128 includes a tip portion 46 connected to an end face 47 of the shot tube plunger 128. The tip portion 46 includes a front face 40, a rear face 42 and an outer peripheral surface 44 that extends between the front face 40 and the rear face 42. The front face 40 faces toward a charge of material M within the
20 shot tube 24, while the rear face 42 faces toward the end face 47 and can receive a portion of the shot tube plunger 128. For example, the tip portion 46 can be threadably received onto a protruding member 49 of the shot tube plunger 128, although other connections are also contemplated.

In this example, the outer peripheral surface 44 of the tip portion 46 embodies
25 a cylindrical shape disposed about a longitudinal axis A of the shot tube plunger 128. However, the tip portion 46 could embody other shapes within the scope of this disclosure. The example tip portion 46 could be made steel, steel alloys, copper, copper alloys or any other suitable material.

The tip portion 46 may be at least partially hollow to establish an internal
30 cooling chamber 48. A cooling tube 50 extends at least partially through said internal cooling chamber 48 and defines a flow path that extends at least partially into the tip portion 46. The cooling tube 50 can receive a fluid, such as water, that is circulated

through the internal cooling chamber 48 to either add or remove heat from the tip portion 46.

5 The tip portion 46 can further include a lip portion 60 that is circumferentially disposed about the front face 40 of the tip portion 46. In this exemplary embodiment, the lip portion 60 circumscribes an inner flange 62 of the tip portion 46.

10 A radially outer wall of the lip portion 60 is established by the outer peripheral surface 44 of the tip portion 46. The lip portion 60 extends between the outer peripheral surface 44 and a radially inner wall 64. A recess 66 circumferentially extends between the radially inner wall 64 of the lip portion 60 and a radially outer wall 68 of the inner flange 62. The recess 66 can extend in a direction toward the rear face 42 of the tip portion 46. In one non-limiting embodiment, each of the radially inner wall 64 and the radially outer wall 68 are angled relative to a floor 70 of the recess 66. In other words, the radially inner wall 64 and the radially outer wall 68 are transverse to the longitudinal axis A.

15 An outermost surface 72 of the inner flange 62 can extend in a first plane P1 that is axially offset from a second plane P2 of an outermost surface 74 of the lip portion 60. In this example, the first plane P1 is axially offset from the second plane P2 in a direction that extends from the rear face 42 toward the front face 40. However, the first plane P1 can also be axially offset from the second plane P2 in a direction that extends from the front face 40 toward the rear face 42 (See Figure 4).
20 The outermost surfaces 72, 74 can also include curved edges 76.

Referring to Figure 3, the recess 66 circumferentially extends about the front face 40 of the tip portion 46 at a radially inward position from the outer peripheral surface 44 of the tip portion 46 and a radially outer position from the radially outer wall 68 of the inner flange 62. The lip portion 60 and the inner flange 62 are concentrically disposed about the longitudinal axis A in this exemplary embodiment.

25 Providing the shot tube plunger 128 with a lip portion 60 redistributes the contact load of the shot tube plunger 128 over a greater area of the tip portion 46. This can result in less tendency of the shot tube plunger 128 becoming jammed within the shot tube 24 after a relatively limited number of shots, which may also reduce scratching of the shot tube 24.

Although the different examples have specific components shown in the illustrations, embodiments of this disclosure are not limited to those particular

combinations. It is possible to use some of the components or features from one of the examples in combination with features or components from another one of the examples.

5 Furthermore, the description shall be interpreted as illustrative and not in any limiting sense. A worker of ordinary skill in the art would understand that certain modifications could come within the scope of this disclosure. For these reasons, the following claims should be studied to determine the true scope and content of this disclosure.

CLAIMS

1. A die casting system, comprising:
 - a die including at least one die element that defines a die cavity;
 - a shot tube in fluid communication with said die cavity;
 - a shot tube plunger moveable within said shot tube to communicate a charge of material into said die cavity,
 - a tip portion connected to said shot tube plunger and having a front face, a rear face and an outer peripheral surface that extends between said front face and said rear face, wherein a lip portion circumferentially extends about said front face of said tip portion and establishes a recess at a radially inward position from said outer peripheral surface of said tip portion; and
 - wherein said tip portion is threadably received onto a protruding member of said shot tube plunger.
2. The system as recited in claim 1, wherein said recess is circumscribed by said lip portion.
3. The system as recited in claim 2, wherein said lip portion extends between said outer peripheral surface and a radially inner wall of said lip portion.
4. The system as recited in claim 2, wherein said recess circumferentially extends about said front face and in a direction that extends from said front face toward said rear face.
5. The system as recited in claim 2, wherein said die casting system is a vacuum die casting system.
6. A die casting system, comprising:
 - a die including at least one die element that defines a die cavity;
 - a shot tube in fluid communication with said die cavity;
 - a shot tube plunger moveable within said shot tube to communicate a charge of material into said die cavity,
 - a tip portion connected to said shot tube plunger and having a front face, a rear face and an outer peripheral surface that extends between said front face and said rear face, wherein a lip portion circumferentially extends about said front face of said tip portion and establishes a recess at a radially inward position from said outer peripheral surface of said tip portion; and
 - wherein said lip portion is circumferentially disposed about an inner flange of said tip portion, and said inner flange includes an outermost surface that extends in a first plane that is axially offset from a second plane of an outermost surface of said lip portion, the first plane being offset from the second plane in a direction that extends from said rear face toward said front face.
7. A die casting system, comprising:
 - a die including at least one die element that defines a die cavity;
 - a shot tube in fluid communication with said die cavity;
 - a shot tube plunger moveable within said shot tube to communicate a charge of material into said die cavity,
 - a tip portion connected to said shot tube plunger and having a front face, a rear face and an outer peripheral surface that extends between said front face and said rear face, wherein a lip portion circumferentially extends about said front face of said tip portion and establishes a recess at a radially inward position from said outer peripheral surface of said tip portion; and
 - wherein said tip portion is at least partially hollow and establishes an internal cooling chamber.

8. The system as recited in claim 2, wherein said tip portion is made of steel, steel alloys, copper, or copper alloys.