CLAIMS

What is claimed is:

1. A method for casting an alloy part in a mold (280) having a part-forming cavity (292, 294, 296), the method comprising:

pouring a first alloy (336) into the mold, the pouring causing:

a surface (338) of the first alloy in the part-forming cavity to raise relative to the part-forming cavity;

a branch flow of the poured first alloy to pass upwardly through a first portion (304) of a passageway (303); and

the branch flow to pass downwardly through a second portion (310), of the passageway;

solidifying some of the first alloy in the passageway to block the passageway while at least some of the first alloy in the part-forming cavity remains molten;

pouring a second alloy (340) into the mold atop the first alloy; and

solidifying the second alloy.

2. The method of claim 1 wherein:

the pouring of the first alloy terminates before the blocking of the passageway.

3. The method of claim 1 wherein:

the passageway has an enlarged reservoir portion (302) distally of or formed by the second portion (310).

4. The method of claim 1 wherein:

the mold is progressively cooled to provide an upwardly moving solidification front (552) which passes through the first alloy to the second alloy to completely solidify the article.

5. The method of claim 1 wherein:

a boundary (540) between respective regions formed by the first alloy and the second alloy is determined by the position of a junction (308, 314) of the passageway first portion and passageway second portion.

6. The method of claim 1 wherein:

the first alloy and second alloy are introduced through a downsprue (400) which telescopes (402, 404) between first and second conditions.

7. The method of claim 1 wherein:
the first alloy and second alloy are introduced through the same port.

8. The method of claim 1 wherein:
the first alloy is bottom-fed via a downsprue; and
the second alloy is top-fed.

9. The method of claim 1 wherein:
a crystalline structure propagates across a transition from the first alloy to the second alloy.

10. The method of claim 1 wherein:
the crystalline structure is initiated by a grain starter (298).

11. The method of claim 1 wherein the part is a blade and the part-forming cavity comprises:
a root portion (292) for casting an attachment root of the blade; and
an airfoil portion (296) for casting an airfoil of the blade, the airfoil having a first end and a second end and a span between the first end and the second end.

12. The method of claim 1 wherein:
there are no additional pours.

13. A casting mold (280; 398)comprising:
a part-forming cavity (292, 294, 296) having a lower end and an upper end; and
at least one overflow passageway (302, 304, 310; 302-2; 304-2; 310-2) having an apex (314; 314-2) at a level between the upper end and the lower end.

14. The casting mold of claim 13 wherein the part is a blade and the part-forming cavity comprises:
a root portion for casting an attachment root of the blade; and

an airfoil section for casting an airfoil of the blade, the airfoil having a first end and a second end and a span between the first end and the second end.

15. The casting mold of claim 14 wherein:
the apex (550; 550-2) is at a level along the span.

16. The casting mold of claim 13 further comprising a grain starter (298) below the part-forming cavity.

17. The casting mold of claim 13 wherein the overflow passageway comprises an up-pass (304; 304-2) from the part-forming cavity to the apex and a downpass (310; 310-2) from the apex and including an enlarged chamber (302; 302-2).

18. The casting mold of claim 13 further comprising:
a pour cone (406); and
a downsprue extending from the pour cone toward the part-forming cavity and comprising:
a lower portion (402) having a plurality of ports (422, 428) in communication with the part-forming cavity; and
an upper portion (404) telescoping relative to the lower portion and coupling the lower portion to the pour cone.

19. The casting mold of claim 13 further comprising:
a first pour cone (602);
a downsprue (606, 360) extending from the first pour cone toward the part-forming cavity; and
a second pour cone (604) in communication with the part-forming cavity.

20. The casting mold of claim 13 in combination with a casting apparatus, the casting apparatus having:
a first ingot feeder (804);
a first induction melter (808) positioned to receive an ingot from the first ingot feeder;
a first actuator (809) for rotating the first induction melter from a charging orientation to a pouring orientation for pouring into the part-forming cavity;

a second ingot feeder (804);

a second induction melter (808) positioned to receive an ingot from the second ingot feeder; and

a second actuator (809) for rotating the second induction melter from a charging orientation to a pouring orientation for pouring into the part-forming cavity.

21. A casting apparatus having:

a first molten metal source (802-1; 902-1);

a second molten metal source (802-2; 902-2) and

a furnace section (820) for holding a mold to receive the first molten metal and the second molten metal.

22. The casting apparatus of claim 21 wherein:

the first molten metal source (802-1) comprises:

a first ingot feeder (804);

a first induction melter (808) positioned to receive an ingot from the first ingot feeder; and

a first actuator for rotating the first induction melter from a charging orientation to a pouring orientation; and

the second molten metal source (802-2) comprises:

a second ingot feeder (804);

a second induction melter (808) positioned to receive an ingot from the second ingot feeder; and

a second actuator for rotating the second induction melter from a charging orientation to a pouring orientation.

23. The casting apparatus of claim 21 wherein:

the first molten metal source (902-1) comprises:

a first ingot feeder (904);

a first electron beam source (922) positioned to heat an ingot from the first ingot feeder;

a first hearth (930); and

a first actuator (932) for rotating the first hearth from a charging orientation to a pouring orientation; and

the second molten metal source (902-2) comprises:

a second ingot feeder;

a second beam source positioned to heat an ingot from the second ingot feeder;

a second hearth (930); and

a second actuator (932) for rotating the second hearth from a charging orientation to a pouring orientation.

24. A casting mold comprising:

a part-forming cavity (296) having a lower end and an upper end (406);

a pour cone; and

a downsprue extending from the pour cone toward the part-forming cavity and comprising:

a lower portion (402) having a plurality of ports in communication with the part-forming cavity; and

an upper portion telescoping (404) relative to the lower portion and coupling the lower portion to the pour cone.

25. The casting mold of claim 24 wherein:

the mold along the part-forming cavity and the lower portion are formed as a single piece.

26. The casting mold of claim 24 wherein:

the part-forming cavity is one of a plurality of part-forming cavities;

each of the plurality of part-forming cavities coupled to a single said downsprue.

27. A method for using the casting mold of claim 24, the method comprising:

introducing a molten alloy to the part-forming cavity through the pour cone and a lower port of the plurality of ports;

extending the upper portion relative to the lower portion; and

introducing a molten alloy to the part-forming cavity through the pour cone and an upper port of the plurality of ports.

28. The method of claim 27 wherein one or more of:

the molten alloy introduced through the upper port is different from the molten alloy introduced through the lower port;

the molten alloy introduced through the upper port is introduced after a partial solidification of the molten alloy introduced through the lower port; and

the molten alloy introduced through the upper port is introduced from a second ingot and the molten alloy introduced through the lower port is introduced from a first ingot.

29. A method for casting with a mold (600) having a plurality of part cavities, the method comprising:

a first pour through a first pour cone (602), the first pour filling a lower portion of each of the part cavities; and

a second pour through a second pour cone (604), the second pour filling an upper portion of each of the part cavities.

30. The method of claim 29 wherein:

the first pour cone is concentric with the second pour cone.

31. The method of claim 29 wherein:

the first pour is a bottom feed and the second pour is a top feed.

CLAIMS

1. A method for casting an alloy part in a mold (280) having a part-forming cavity (292, 294, 296), the method comprising:

pouring a first alloy (336) into the mold, the pouring causing:

a surface (338) of the first alloy in the part-forming cavity to raise relative to the part-forming cavity;

a branch flow of the poured first alloy to pass upwardly through a first portion (304) of a passageway (303); and

the branch flow to pass downwardly through a second portion (310), of the passageway;

solidifying some of the first alloy in the passageway to block the passageway while at least some of the first alloy in the part-forming cavity remains molten;

pouring a second alloy (340) into the mold atop the first alloy; and

solidifying the second alloy.

2. The method of claim 1 wherein the pouring of the first alloy terminates before the blocking of the passageway.

3. The method of claim 1 wherein the passageway has an enlarged reservoir portion (302) distally of or formed by the second portion (310).

4. The method of claim 1 wherein the mold is progressively cooled to provide an upwardly moving solidification front (552) which passes through the first alloy to the second alloy to completely solidify the article.

5. The method of claim 1 wherein a boundary (540) between respective regions formed by the first alloy and the second alloy is determined by the position of a junction (308, 314) of the passageway first portion and passageway second portion.

6. The method of claim 1 wherein the part forming cavity further comprises an upper port and a lower port in fluid communication with a telescopically extendable downsprue the first and second alloys being introduced into the part forming cavity through the respective ports when the downsprue (400) telescopes (402, 404) between the upper port and the lower port.

7. The method of claim 6 wherein one or more of:

the molten alloy introduced through the upper port is different from the molten alloy introduced through the lower port;

the molten alloy introduced through the upper port is introduced after a partial solidification of the molten alloy introduced through the lower port; and

the molten alloy introduced through the upper port is introduced from a second ingot and the molten alloy introduced through the lower port is introduced from a first ingot.

8. The method of claim 1 wherein the first alloy and second alloy are introduced through the same port.

9. The method of claim 1 wherein the first alloy is bottom-fed via a downsprue and the second alloy is top-fed.

10. The method of claim 1 wherein a crystalline structure propagates across a transition from the first alloy to the second alloy.

11. The method of claim 10 wherein the crystalline structure is initiated by a grain starter (298).

12. The method of claim 1 wherein the part is a blade and the part-forming cavity comprises:

a root portion (292) for casting an attachment root of the blade; and

an airfoil portion (296) for casting an airfoil of the blade, the airfoil having a first end and a second end and a span between the first end and the second end.

13. The method of claim 1 wherein there are no additional pours.

14. A casting mold (280; 398) comprising:

a part-forming cavity (292, 294, 296) to form a part, the part-forming cavity having a lower end and an upper end; and

at least one overflow passageway (302, 304, 310; 302-2; 304-2; 310-2) having an apex (314; 314-2) at a level between the upper end and the lower end.

15. The casting mold of claim 14 wherein the part is a blade and the part-forming cavity comprises:

a root portion for casting an attachment root of the blade; and

an airfoil section for casting an airfoil of the blade, the airfoil having a first end and a second end and a span between the first end and the second end.

16. The casting mold of claim 15 wherein the apex (550; 550-2) is at a level along the span.

17. The casting mold of claim 14 further comprising a grain starter (298) below the part-forming cavity.

18. The casting mold of claim 14 wherein the overflow passageway comprises an up-pass (304; 304-2) from the part-forming cavity to the apex and a downpass (310; 310-2) from the apex and including an enlarged chamber (302; 302-2).

19. The casting mold of claim 14 further comprising:

a pour cone (406); and

a downsprue extending from the pour cone toward the part-forming cavity and comprising:

a lower portion (402) having a plurality of ports (422, 428) in communication with the part-forming cavity; and

an upper portion (404) telescoping relative to the lower portion and coupling the lower portion to the pour cone.

20. The casting mold of claim 14 further comprising:

a first pour cone (602);

a downsprue (606, 360) extending from the first pour cone toward the part-forming cavity; and

a second pour cone (604) in communication with the part-forming cavity.

21. The casting mold of claim 14 having a casting apparatus, the casting apparatus having:

a first molten metal source (802-1; 902-1) in the form of:

a first ingot feeder (804);

a first induction melter (808) or first hearth positioned to receive an ingot from

the first ingot feeder;

and

a first actuator (809) for rotating the first induction melter or first hearth from a charging orientation to a pouring orientation for pouring into the part-forming cavity; and

a second molten metal source (802-2; 902-2) in the form of:

a second ingot feeder (804);

a second induction melter (808) or second hearth positioned to receive an ingot from the second ingot feeder; and

a second actuator (809) for rotating the second induction melter or second hearth from a charging orientation to a pouring orientation for pouring into the part-forming cavity.

22. The casting apparatus of claim 21 further comprising:

a furnace section (820) for holding a the casting mold adapted to receive the first molten metal and the second molten metal.

23. The casting apparatus of claim 22 wherein when the first and second molten metal sources (902-1, 902-2) comprise first and second respective hearths, and the first and second molten metal sources (902-1, 902-2) further comprise:

independent respective electron beam sources (922) positioned to heat an ingot from the respective ingot feeders.

24. The casting mold of claim 19 wherein the mold along the part-forming cavity and the lower portion are formed as a single piece.

25. The casting mold of claim 19 wherein the part-forming cavity is one of a plurality of part-forming cavities, each of the plurality of part-forming cavities coupled to a single downsprue.

26. The method of claim 1 wherein the part forming cavity comprises a pair of part forming cavities (602, 604) comprising first and second pour cones, enabling the method to comprise the step of:

a first pour through a first pour cone (602), the first pour filling a lower portion of

each of the part cavities; and

a second pour through a second pour cone (604), the second pour filling an upper portion of each of the part cavities.

27. The method of claim 26 wherein the first pour cone is concentric with the second pour cone.

28. The method of claim 26 wherein the first pour is a bottom feed and the second pour is a top feed.