CLAIMS

1. An ingot puller apparatus for growing a monocrystalline silicon ingot from a melt of silicon, the apparatus comprising:

a puller housing defining a growth chamber;

a crucible disposed within the growth chamber for containing the melt of silicon;

a pulling mechanism for pulling the ingot from the melt along a pull axis; and

a heat shield disposed within the growth chamber, the heat shield defining a central passage for receiving the ingot as the ingot is pulled by the pulling mechanism, the heat shield comprising:

a leg segment that extends downward relative to the pull axis, the leg segment comprising a leg segment housing that defines a leg chamber;

insulation disposed within the leg chamber; and

a ledge disposed in the leg chamber, the insulation being supported by the ledge, the insulation being separated from the leg segment housing by a gap, the gap being disposed above the ledge; and

a foot at a distal end of the leg segment that extends radially inward; and

wherein the leg segment has a void formed therein, at least a portion of the void being disposed below the ledge.

2. The ingot puller apparatus as set forth in claim 1 wherein the void extends into the foot.

3. The ingot puller apparatus as set forth in claim 1 or claim 2 wherein the insulation is made of carbon, felt, or layered molybdenum.

4. The ingot puller apparatus as set forth in any one of claims 1 to 3 wherein the leg segment housing is made of graphite.

5. The ingot puller apparatus as set forth in any one of claims 1 to 4 wherein the void is at least partially disposed within the foot.

6. The ingot puller apparatus as set forth in claim 5 wherein the foot comprises a foot housing that defines a foot chamber, there being no insulation disposed within the foot chamber.

7. The ingot puller apparatus as set forth in claim 5 or claim 6 wherein the foot comprises a foot housing, the foot housing having a radially inward sidewall that is parallel to the pull axis.

8. The ingot puller apparatus as set forth in claim 5 or claim 6 wherein the foot comprises a radially inward lower sidewall and a radially inward upper sidewall, the radially inward lower sidewall and radially inward upper sidewall angling toward each other and forming an apex, the apex being the most radially inward portion of the heat shield.

9. The ingot puller apparatus as set forth in claim 8 wherein the foot does not include a void formed therein.

10. The ingot puller apparatus as set forth in any one of claims 1 to 9 comprising a cooling jacket that at least partially overlaps the heat shield along the pull axis, the cooling jacket being radially inward to the heat shield, the cooling jacket defining a central passage for receiving the ingot as the ingot is pulled by the pulling mechanism.

11. An ingot puller apparatus for growing a monocrystalline silicon ingot from a melt of silicon, the apparatus comprising:

a housing defining a growth chamber;

a crucible disposed within the growth chamber for containing the melt of silicon;

a pulling mechanism configured to pull the ingot from the melt along a pull axis;

a heat shield disposed within the growth chamber, the heat shield defining a central passage for receiving the ingot as the ingot is pulled by the pulling mechanism, the heat shield having a leg segment that extends along the pull axis, the leg segment comprising:

a leg segment housing that defines a leg chamber;

insulation disposed within the leg chamber; and

a ledge disposed in the leg chamber, the insulation being supported by the ledge, the insulation being separated from the leg segment housing by a gap, the gap being disposed above the ledge; and

a foot at a distal end of the leg segment that extends radially inward, the foot comprising:

a radially inward lower sidewall; and

a radially inward upper sidewall, the radially inward lower sidewall and radially inward upper sidewall angling toward each other and forming an apex, the apex being the most radially inward portion of the heat shield,

wherein the leg segment has a void formed therein.

12. The ingot puller apparatus as set forth in claim 11 wherein the foot does not include a void formed within the foot.

13. The ingot puller apparatus as set forth in claim 11 or claim 12 wherein the foot comprises graphite.

14. The ingot puller apparatus as set forth in any one of claims 11 to 13 wherein the apex is an inner wall that is parallel to the pull axis.

15. The ingot puller apparatus as set forth in any one of claims 11 to 14 comprising a cooling jacket that at least partially overlaps the heat shield along the pull axis, the cooling jacket being radially inward to the heat shield, the cooling jacket defining a central passage for receiving the ingot as the ingot is pulled by the pulling mechanism.