



US006308768B1

(12) **United States Patent**
Rice et al.

(10) **Patent No.:** **US 6,308,768 B1**
(45) **Date of Patent:** ***Oct. 30, 2001**

(54) **APPARATUS AND METHOD FOR SEMI-SOLID MATERIAL PRODUCTION**

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Christopher S. Rice; Patricio F. Mendez**, both of Cambridge; **Stuart B. Brown**, Needham; **Shinya Myojin**, Cambridge, all of MA (US)

2320761 11/1974 (DE) .
0 476 843 A1 3/1992 (EP) .
0 657 235 A1 6/1995 (EP) .
0 719 606 A1 7/1996 (EP) .
0 761 344 A2 3/1997 (EP) .

(List continued on next page.)

(73) Assignee: **Semi-Solid Technologies, Inc.**, Cambridge, MA (US)

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/252,743**

(22) Filed: **Feb. 19, 1999**

Thesis: "The Machine Casting of High Temperature Semi-Solid Materials," By Danial G. Backman, Massachusetts Institute of Technology, Sep. 1975.

"A World Wide Assessment of Rapid Prototyping Technologies," RF Aubin United Technologies Research Center Report No. 94-13, dated Jan. 1994, 29 pages.

H.L. Marcus and D.L. Bourell, "Solid Freeform Fabrication," *Advanced Materials & Processes*, dated Sep. 1993, pp. 28-31 and 34-35.

S.B. Brown and M.C. Flemings, "Net-Shape Forming Via Semi-Solid Processing," *Advanced Materials & Processes*, dated Jan. 1993, pp. 36-40.

(List continued on next page.)

Related U.S. Application Data

(63) Continuation of application No. 08/726,099, filed on Oct. 4, 1996, now Pat. No. 5,887,640.

(60) Provisional application No. 60/027,595, filed on Oct. 4, 1996.

(51) Int. Cl.⁷ **B22D 1/00**

(52) U.S. Cl. **164/133; 164/113; 164/900; 164/71.1**

(58) Field of Search 164/900, 71.1, 164/113, 312, 335, 337, 133, 136; 75/10.65, 10.67, 10.14; 148/549

Primary Examiner—Tom Dunn

Assistant Examiner—Kevin P. Kerns

(74) Attorney, Agent, or Firm—Testa, Hurwitz & Thibault, LLP

(57) **ABSTRACT**

An apparatus and process is provided for producing a semi-solid material suitable for directly casting into a component wherein the semi-solid material is formed from a molten material and the molten material is introduced into a container. Semi-solid is produced therefrom by agitating, shearing, and thermally controlling the molten material. The semi-solid material is maintained in a substantially isothermal state within the container by appropriate thermal control and thorough three dimensional mixing. Extending from the container is a means for removing the semi-solid material from the container, including a temperature control mechanism to control the temperature of the semi-solid material within the removing means.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,745,153 5/1956 Burkett .
3,157,923 11/1964 Hodler .
3,222,776 12/1965 Kawecki .
3,528,478 9/1970 Koch et al. .
3,902,544 9/1975 Flemings et al. .

(List continued on next page.)

18 Claims, 4 Drawing Sheets

