THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Solar Cell Company Case Study

Dunbar P. Birnie, III
dbirnie@rci.rutgers.edu

18 November 2004

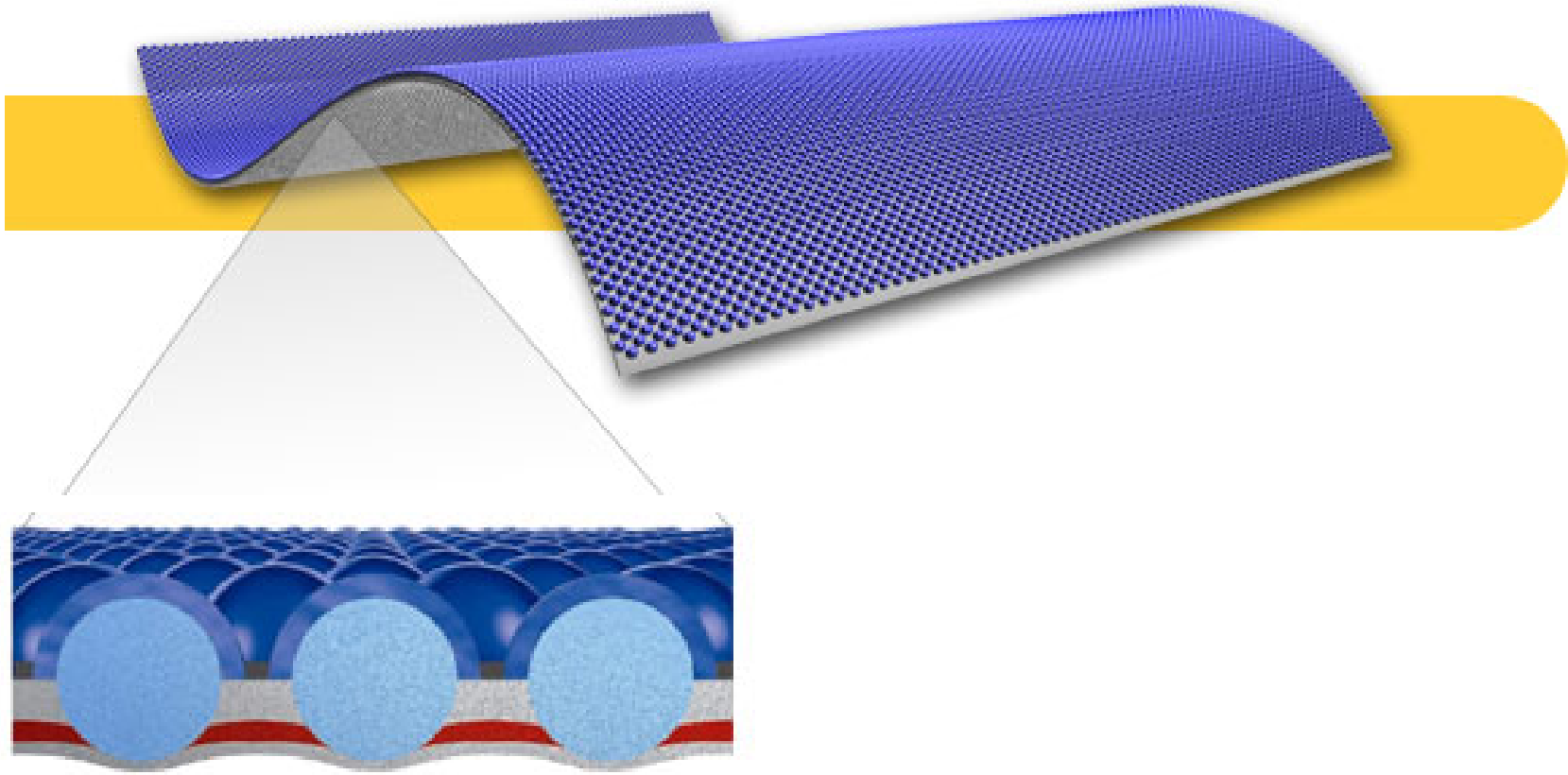
THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Outline

- Introduction to Company and Novel Product
  - "Spheral Solar Power"
- Detective Work about Technology
- Delving Through the Patent Literature

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

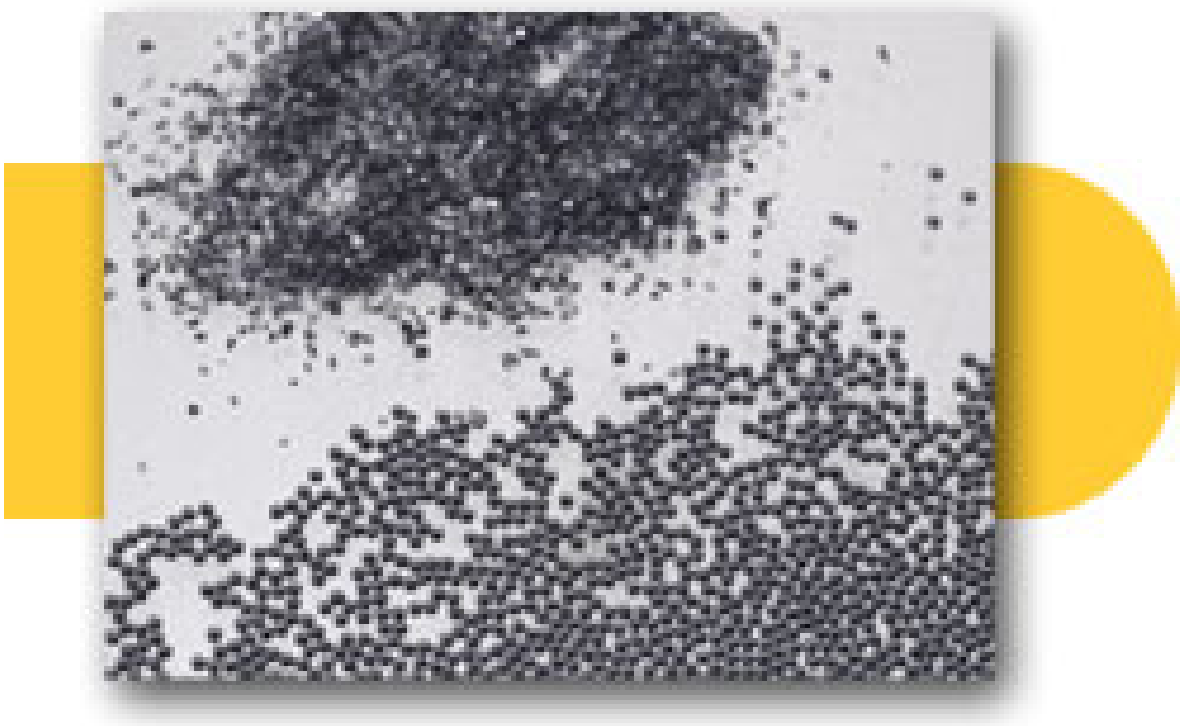
Schematic of Flex Foil



www.spheralsolarpower.com

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

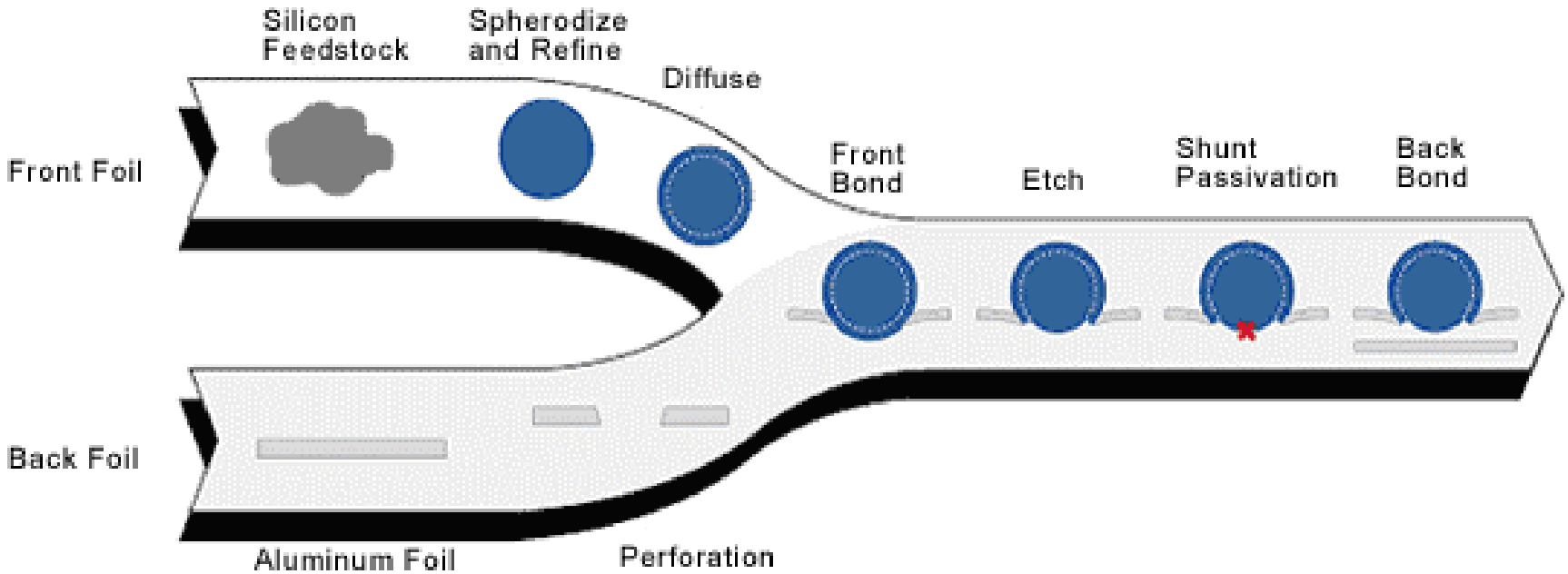
Silicon Spheroidal Grains



www.spheralsolarpower.com

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Generic Process Description



www.spheralsolarpower.com

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Large Scale Foil Lamination Line



www.spheralsolarpower.com

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Loading Si Spheres



WW

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Company Website Digestion

- News Releases
- Technology Description
- Product Offerings and Rollouts
- Who's Who?

- Milfred Hammerbacher is President of Spheral Solar Power

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Looking into the Patent Literature

www.uspto.gov

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

First Hammerbacher Lead

www.uspto.gov

US005468304A

United States Patent [19]

Hammerbacher

[11] **Patent Number: 5,468,304**

[45] **Date of Patent: Nov. 21, 1995**

[54] **OUTPUT-INCREASING, PROTECTIVE COVER FOR A SOLAR CELL**

[75] Inventor: **Milfred D. Hammerbacher**, Dallas, Tex.

[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[21] Appl. No.: **212,542**

[22] Filed: **Mar. 14, 1994**

[51] **Int. Cl.**[6] **H01L 31/052**; H01L 31/0384; H01L 31/18

[52] **U.S. Cl.** **136/246**; 136/250; 136/251; 437/2

[58] **Field of Search** 136/246, 250, 136/251; 437/2–5, 212, 216

[56] **References Cited**

U.S. PATENT DOCUMENTS

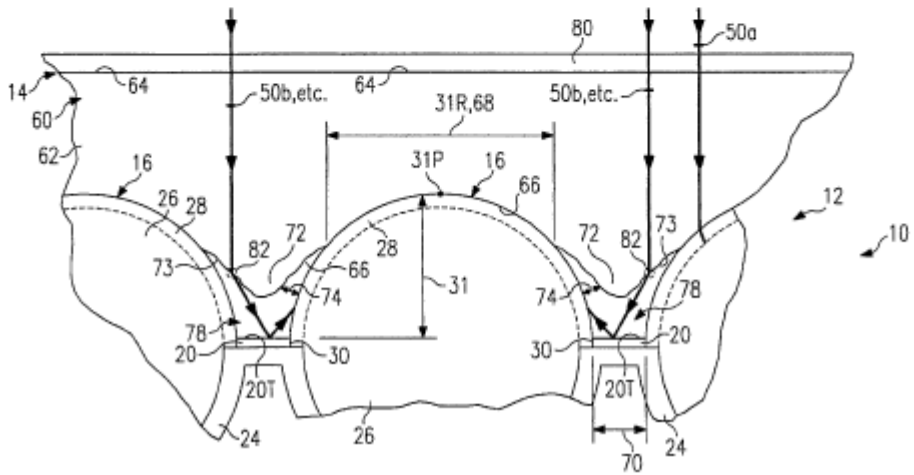
3,025,335 3/1962 Ralph 136/250

Primary Examiner—Aaron Weisstuch
Attorney, Agent, or Firm—Robert C. Klinger; James C. Kesterson; Richard L. Donaldson

[57] **ABSTRACT**

A flexible cover (**14**) for a flexible solar cell (**12**) protects the cell from the ambient and increases the cell's efficiency. The cell(**12**)includes silicon spheres (**16**) held in a flexible aluminum sheet matrix (**20**,**22**). The cover (**14**) is a flexible, protective layer (**60**) of light-transparent material having a relatively flat upper, free surface (**64**) and an irregular opposed surface (**66**). The irregular surface (**66**) includes first portions (**68**) which conform to the polar regions (**31R**) of the spheres (**16**) and second convex (**72**) or concave (**90**) portions (**72** or **90**) which define spaces (**78**) in conjunction with the reflective surface (**20T**) of one aluminum sheet (**20**). Without the cover (**14**) light (**50**) falling on the surface (**20T**) between the spheres (**16**) is wasted, that is, it does not fall on a sphere (**16**). The surfaces of the second portions are non-parallel to the direction of the otherwise wasted light (**50**), which fact, together with a selected relationship between the refractive indices of the cover and the spaces, result in sufficient diffraction of the otherwise wasted light (**50**) so that about 25% of it is reflected from the surface (**20T**) onto a sphere (**16**).

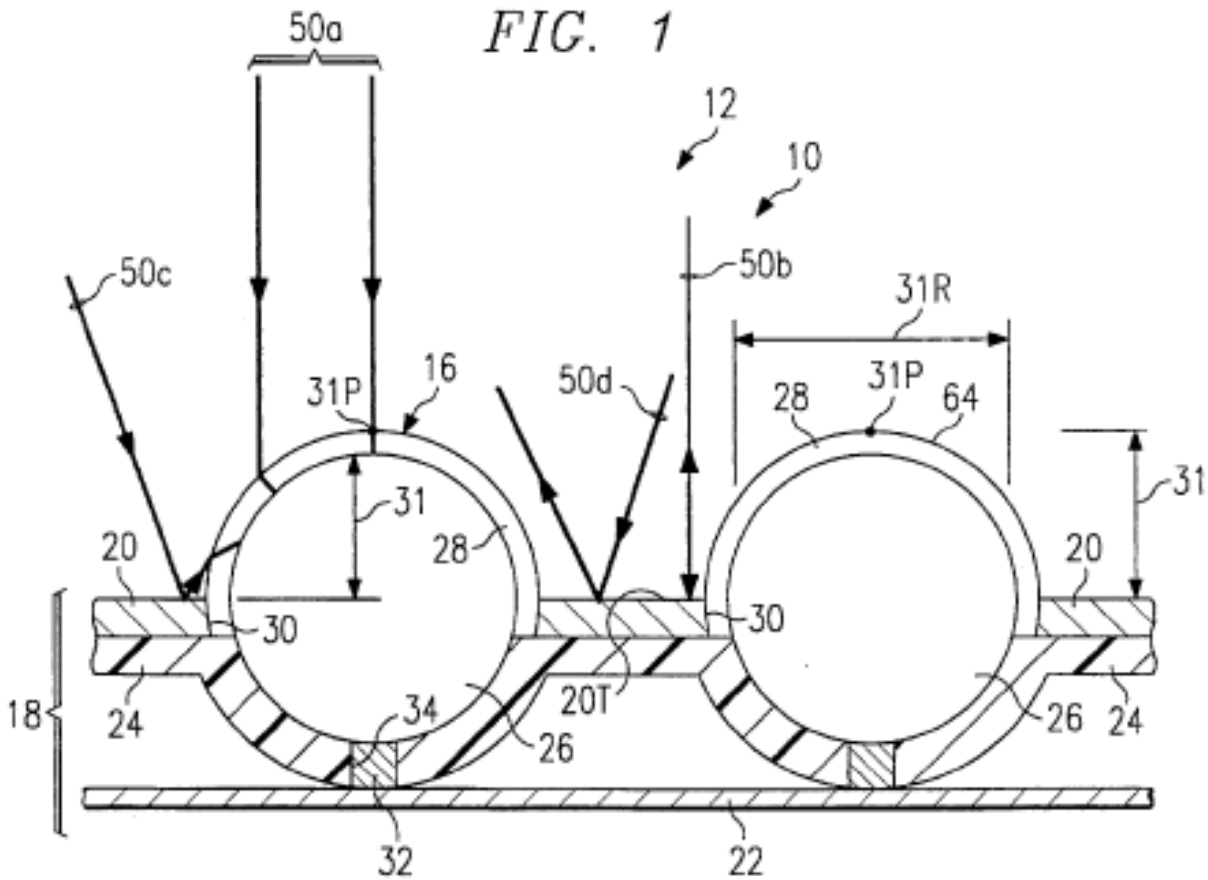
39 Claims, 3 Drawing Sheets



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Light Reflection and Contacting

FIG. 1



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Earlier Hammerbacher Patent

www.uspto.gov

US005192400A

United States Patent [19]

Parker et al.

[11] **Patent Number: 5,192,400**

[45] **Date of Patent: Mar. 9, 1993**

[54] **METHOD OF ISOLATING SHORTED SILICON SPHERES**

[75] Inventors: **Sidney G. Parker; Milfred D. Hammerbacher; Jules D. Levine**, all of Dallas; **Gregory B. Hotchkiss**, Richardson, all of Tex.

[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[21] Appl. No.: **387,244**

[22] Filed: **Jul. 31, 1989**

[51] **Int. Cl.**[5] **C25D 11/32**

[52] **U.S. Cl.** **205/124**; 136/250; 136/290; 205/148

[58] **Field of Search** 136/250, 290; 204/15, 204/34.5, 38.3, 56.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

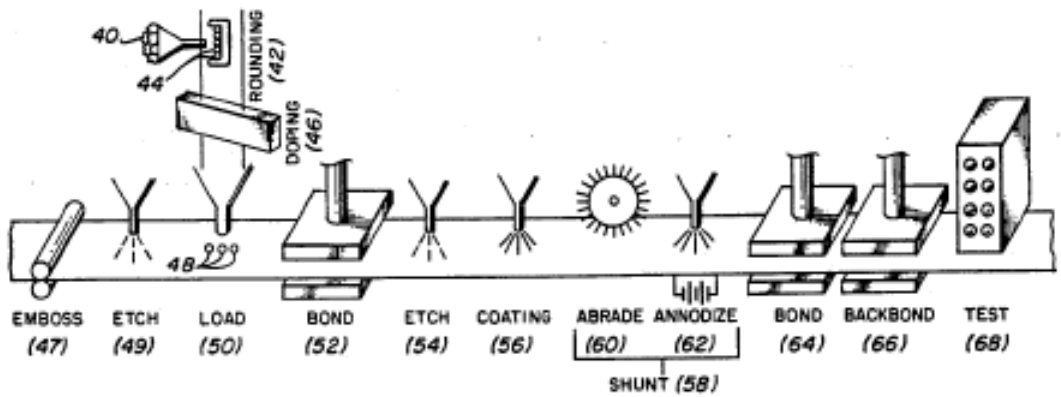
4,385,971	5/1983	Swartz	204/129.1
4,407,320	10/1983	Levine	136/250
4,425,408	1/1984	Levine et al.	428/403
4,430,150	2/1984	Levine et al.	156/616
4,451,968	6/1984	Jensen et al.	29/572
4,521,640	6/1985	Levine	136/250
4,581,103	4/1986	Levine et al.	156/659
4,582,588	4/1986	Jensen et al.	204/37.6
4,614,835	9/1986	Carson et al.	136/250
4,637,855	1/1987	Witter et al.	156/616
4,691,076	9/1987	Levine et al.	136/250
4,806,495	2/1989	Levine et al.	437/2

Primary Examiner—John F. Niebling
Assistant Examiner—William T. Leader
Attorney, Agent, or Firm—Melvin Sharp; N. Rhys Merrett; Thomas W. DeMond

[57] **ABSTRACT**

Solar cells are formed of semi-conductor spheres of P-type interior having an N-type skin are pressed between a pair of aluminum foil members forming the electrical contacts to the P-type and N-type regions. The aluminum foils, which comprise 1.0% silicon by weight, are flexible and electrically insulated from one another. The spheres are patterned in a foil matrix forming a cell. Multiple cells can be interconnected to form a module of solar cell elements for converting sun light into electricity.

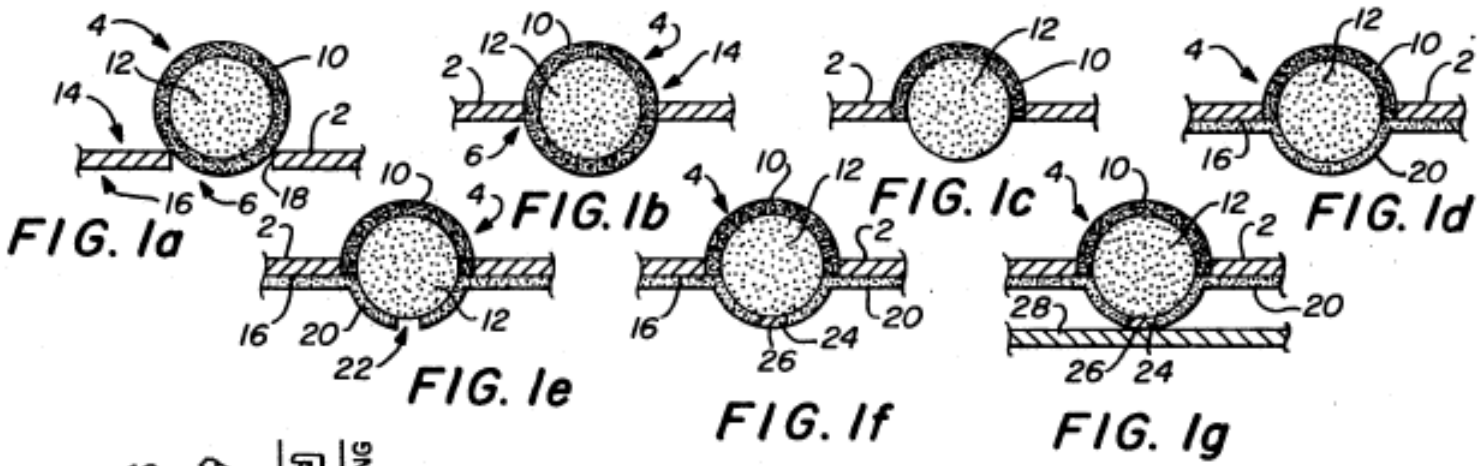
30 Claims, 4 Drawing Sheets



THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Process Line Details

U.S. Patent Mar. 9, 1993 Sheet 1 of 4 5,192,400



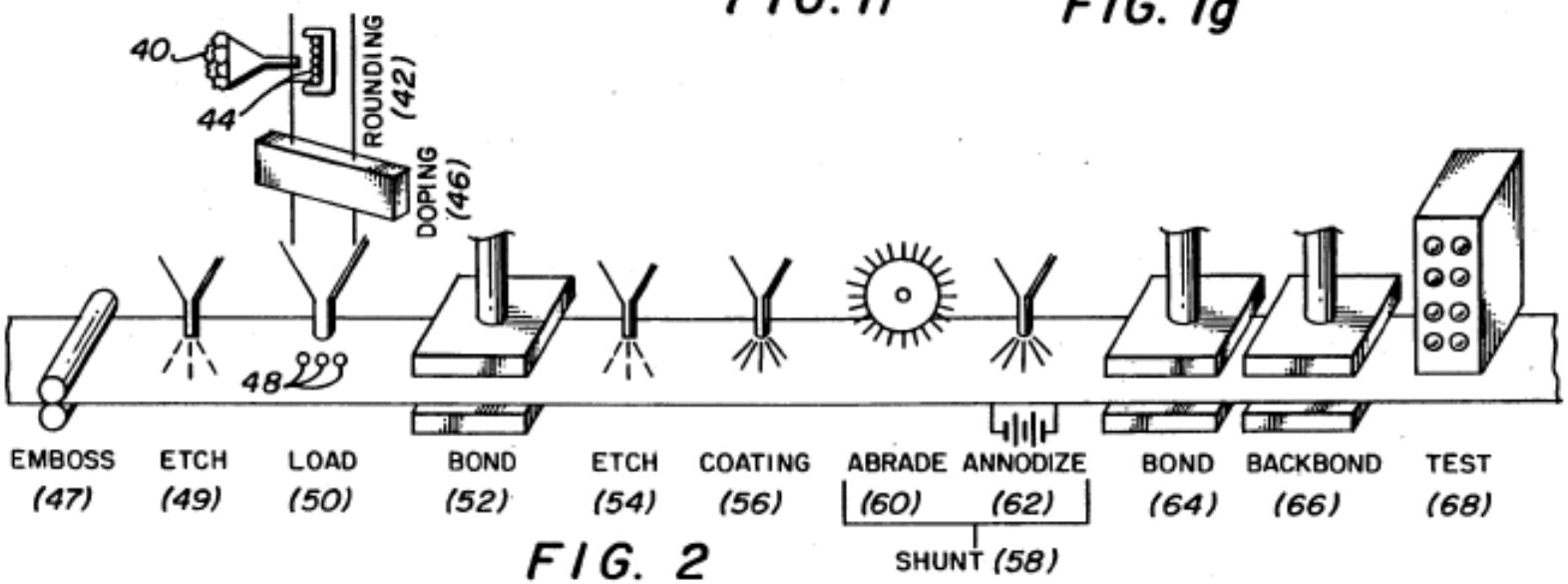


FIG. 2

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Process Line Details

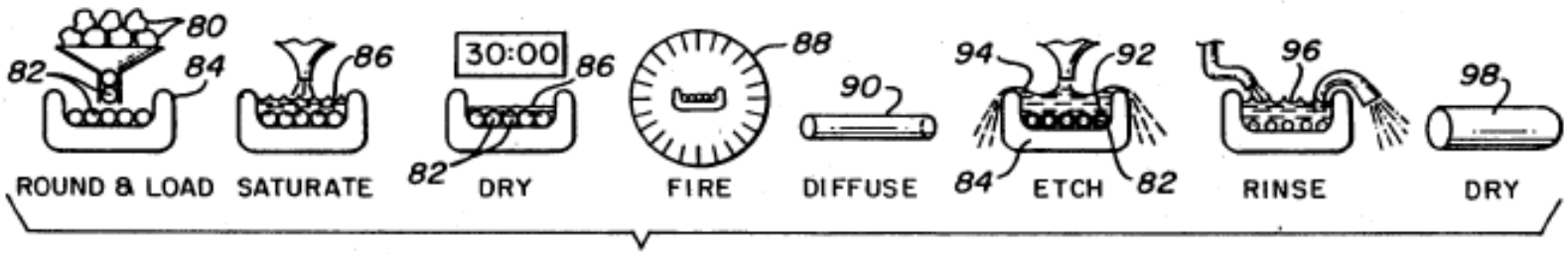


FIG. 3

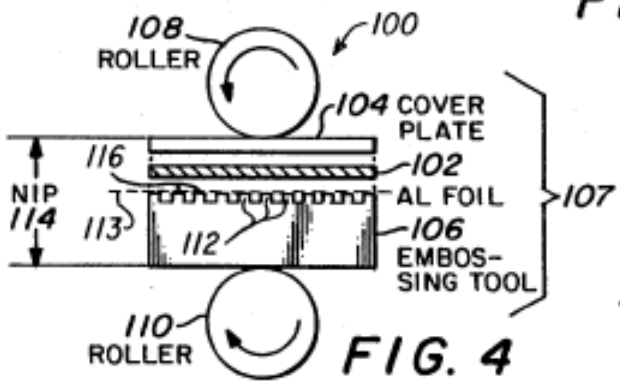


FIG. 4

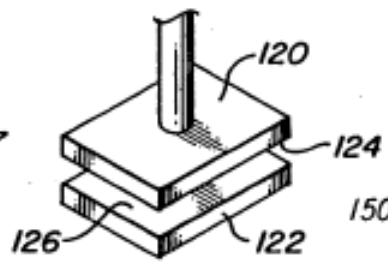


FIG. 5

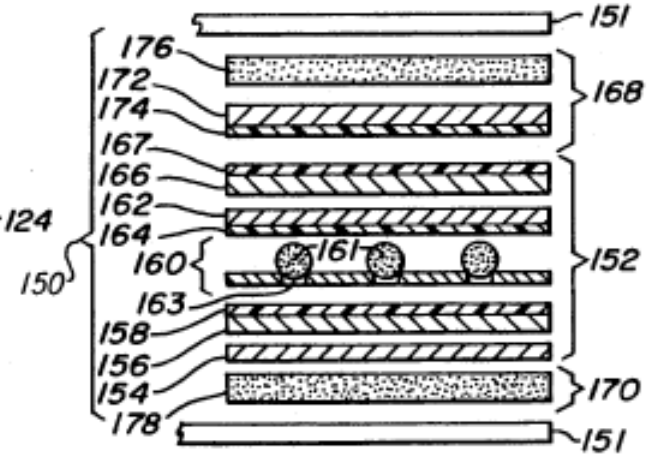


FIG. 6

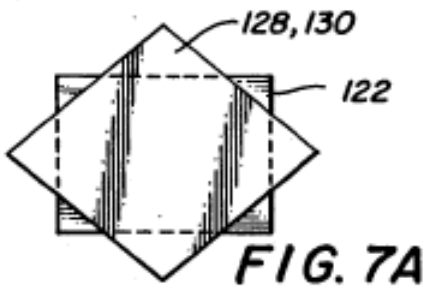


FIG. 7A

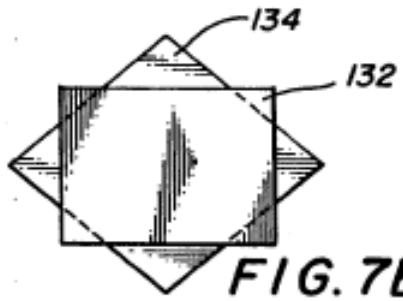


FIG. 7B



FIG. 7C

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Assignment

- Find a solar photovoltaics patent
- Print the first page for me
- Write a technical description of what advantages and utility they are covering

- Must be older than 10 years
- Look for something unusual