



US005724400A

United States Patent [19]

[11] Patent Number: **5,724,400**

Swerdloff et al.

[45] Date of Patent: ***Mar. 3, 1998**

- [54] **RADIATION THERAPY SYSTEM WITH CONSTRAINED ROTATIONAL FREEDOM** 519887 3/1977 U.S.S.R. 378/65
553766 11/1977 U.S.S.R. 378/65

[75] Inventors: **Stuart Swerdloff; Thomas Rockwell Mackie; Timothy Holmes**, all of Madison, Wis.

[73] Assignee: **Wisconsin Alumni Research Foundation**, Madison, Wis.

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,317,616.

[21] Appl. No.: **591,335**

[22] Filed: **Jan. 25, 1996**

Related U.S. Application Data

[60] Division of Ser. No. 71,742, Jun. 9, 1993, which is a continuation-in-part of Ser. No. 854,521, Mar. 19, 1992.

[51] Int. Cl.⁶ **A61N 5/10**

[52] U.S. Cl. **378/65; 378/150**

[58] Field of Search **378/65, 150**

[56] References Cited

U.S. PATENT DOCUMENTS

- 4,233,519 11/1980 Coad 250/514
- 4,660,799 4/1987 Butland 248/676
- 4,754,147 6/1988 Maughan et al. 250/505.1
- 4,794,629 12/1988 Pastyr et al. 378/152
- 4,817,125 3/1989 Sklebitz 378/152
- 4,868,843 9/1989 Nunan 378/65
- 4,868,844 9/1989 Nunan 378/152
- 4,905,268 2/1990 Mattson et al. 378/152
- 4,987,309 1/1991 Klasen et al. 250/492.1
- 4,998,268 3/1991 Winter 378/63
- 5,012,506 4/1991 Span et al. 378/152

FOREIGN PATENT DOCUMENTS

- 0 037 008 3/1981 European Pat. Off. .
- 0 113 879 12/1983 European Pat. Off. .
- 0 464 645 A1 1/1991 European Pat. Off. .
- 2023648 8/1970 France .
- 2 346 754 10/1977 France .

OTHER PUBLICATIONS

Optimization by simulated Annealing Of Three-Dimensional Conformal Treatment Planning For Radiation Fields Defined by A Multileaf Collimator. S. Webb. *Phys. Med. Biol.*, 1991 vol. No. 9, 1201-1226.

On The Use Of Cimmino's Simultaneous Projections Method For Computing A Solution Of The Inverse Problem In Radiation Therapy.

A Constrained Least-Squares Optimization Method For External Beam Radiation Therapy Treatment Planning. G. Starkschall *Med. Phys.* 11 (5), Sep./Oct. 1984.

Optimization of Conformal Radiotherapy Dose Distributions by Simulated Annealing. S. Webb. *Phys. Med. Biol.* 1989, vol. 43, No. 10, 1349-1370.

Calculation and Application of Point Spread Functions For Treatment Planning With High Energy Photon Beams. Ahnesio et al. *Acta Oncol.* 26:49-56; 1987.

Methods of Image Reconstruction From Projections Applied to Conformation Radiotherapy. Bortfeld. et al., *Phys. Med. Biol.* 35(10), 1423-1434; 1990.

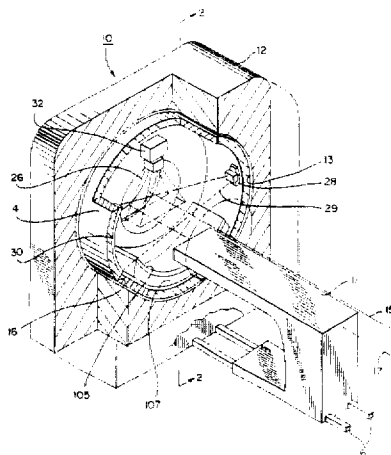
(List continued on next page.)

Primary Examiner—Craig E. Church
Attorney, Agent, or Firm—Quarles & Brady

[57] ABSTRACT

A radiation therapy machine has a constrained angular freedom to produce a beam only within a gantry plane. A radiation shield may be stationary and not attached to the gantry or rotating to always block the primary beam. The constrained motion reduces the risk of patient/gantry collision and provides for extremely accurate radiation therapy planning. The therapy machine, so constrained, may include a tomographic imaging system on a single gantry. The two systems cooperate and employ many of the same hardware components to both plan and carry out therapy sessions in which irregularly shaped treatment volumes are accurately irradiated while tissue surrounding those volumes is minimally irradiated.

4 Claims, 11 Drawing Sheets



OTHER PUBLICATIONS

Feasibility solutions in Radiation Therapy Treatment Planning, Altschuler et al., *IEEE Comp. Soc.* 1984: 220-224.

Optimization of Stationary and Moving Beam Radiation Therapy Techniques, Brahme, *Radiotherapy and Oncol.* 12:129-140; 1988.

A Unified Approach to the Optimization of Brachytherapy and External Beam Dosimetry, Holmes et al., *Int. J. Rad. Oncol. Biol. Phys.*, vol. 20, 859-873, 1991.

A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy, *Medical Physics Pub. Corp.*, (1981) C.J. Karzmark, et al.

Tomotherapy: A New Concept for the Delivery of Conformal Radiotherapy Using Dynamic Compensation, Jul. 1992, Swerdloff, et al.

Progress in Medical Radiation Physics vol. 2, 1985, added by Colin Orton, Plenum Press, W.A. Jennings pp. 1-111.

The Accuray Neutron 1000. A Medical Systems for Frameless Stereotoxic Radiosurgery, Accuray, Inc., J.R. Adler, et al., May 1992.

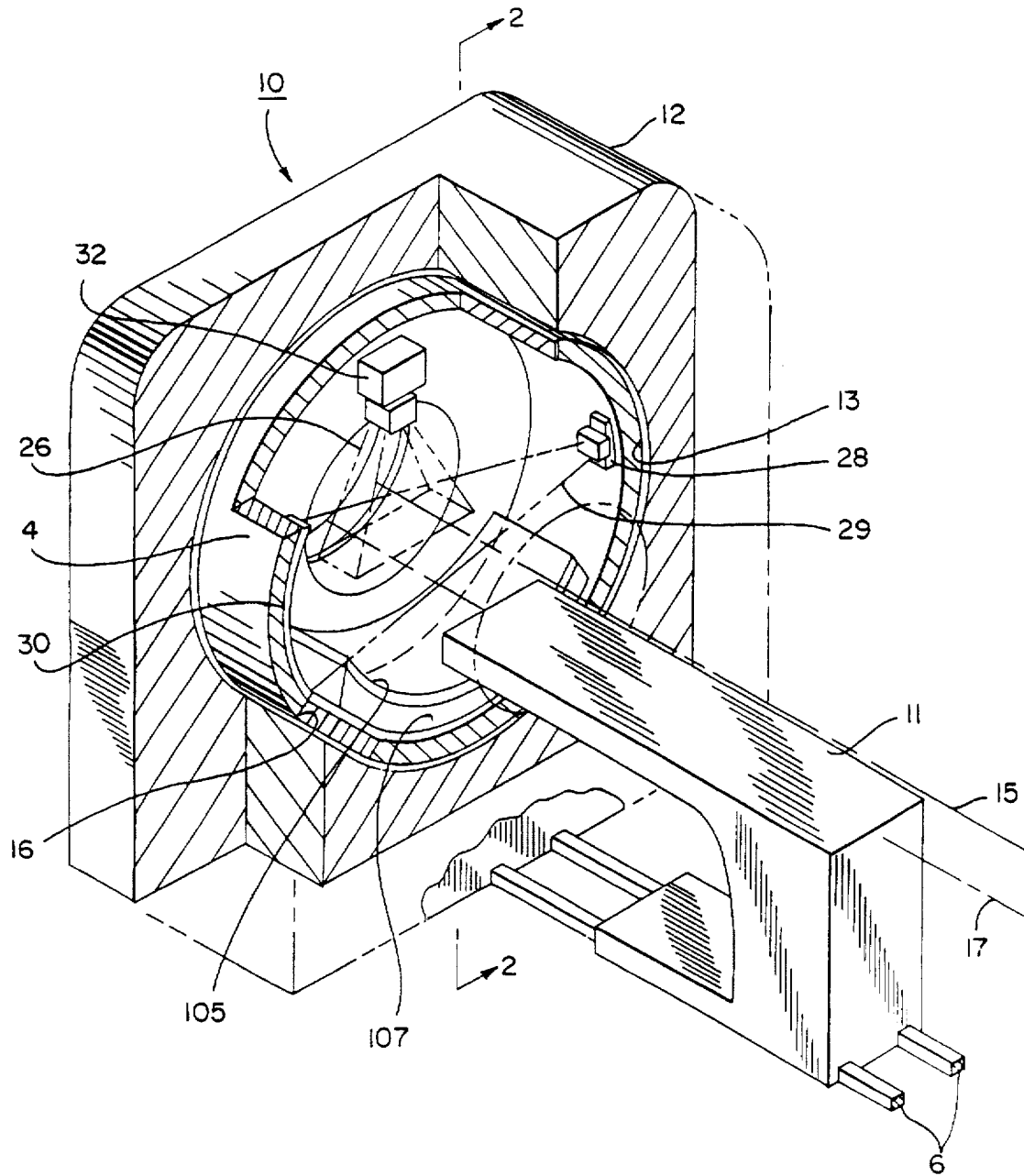


FIG. 1

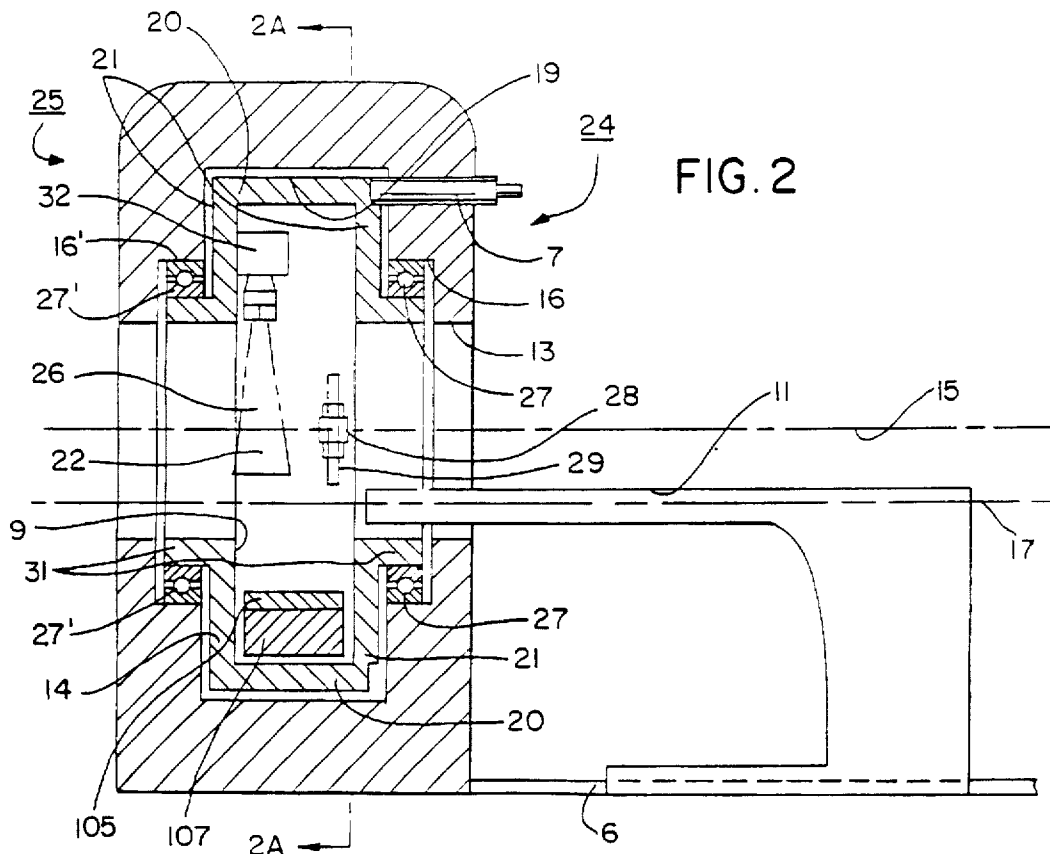


FIG. 2

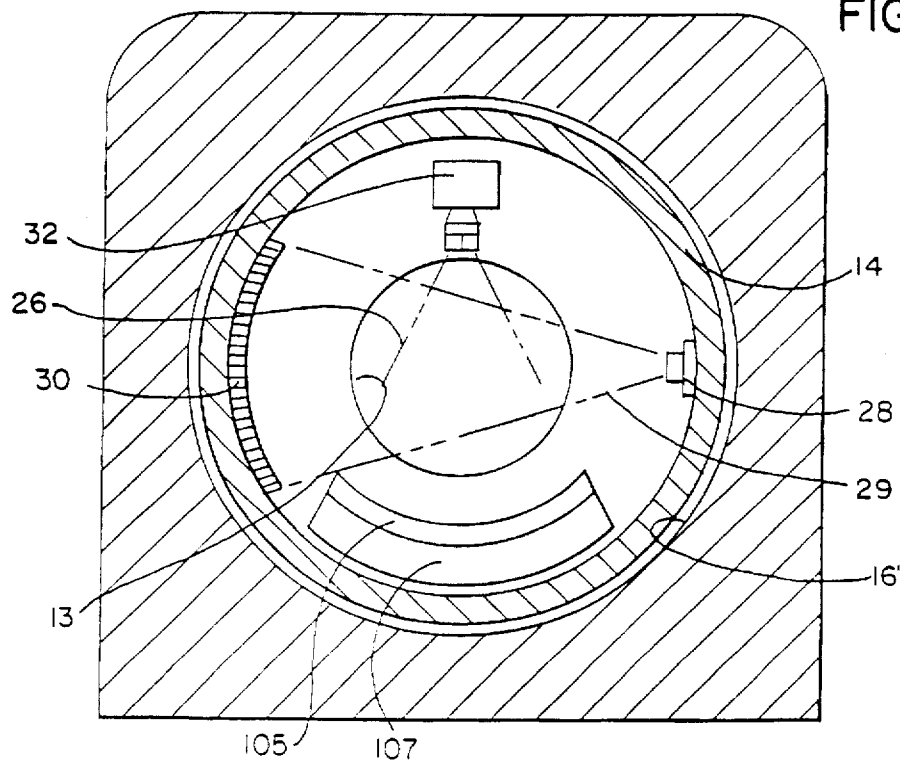


FIG. 2A

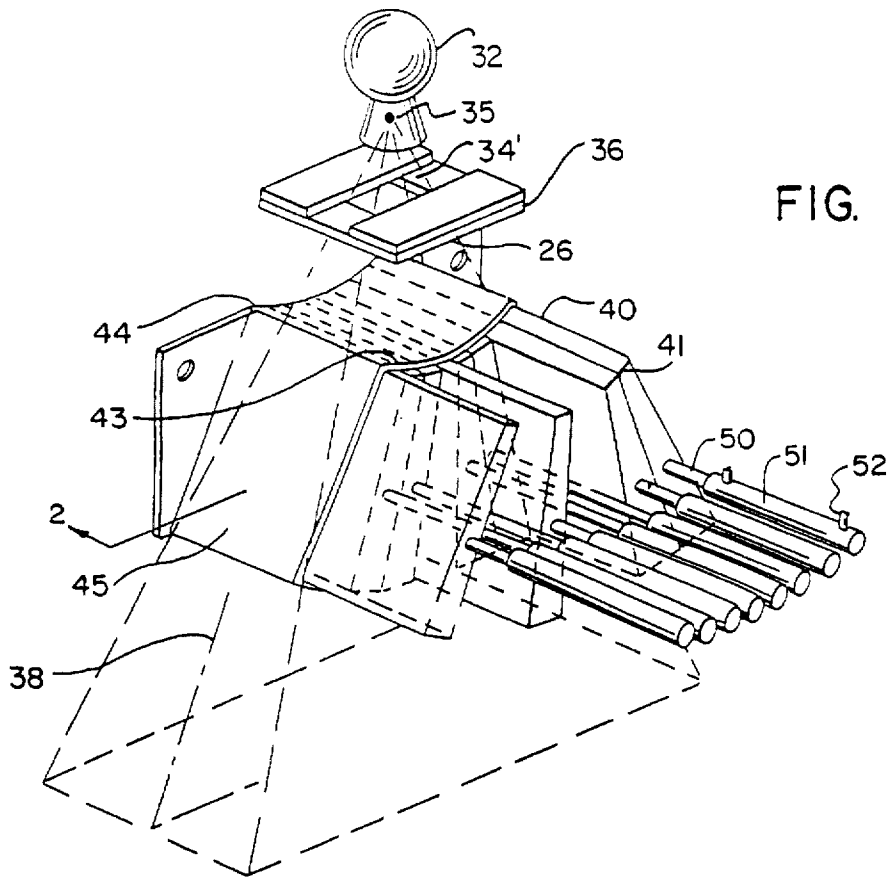


FIG. 3

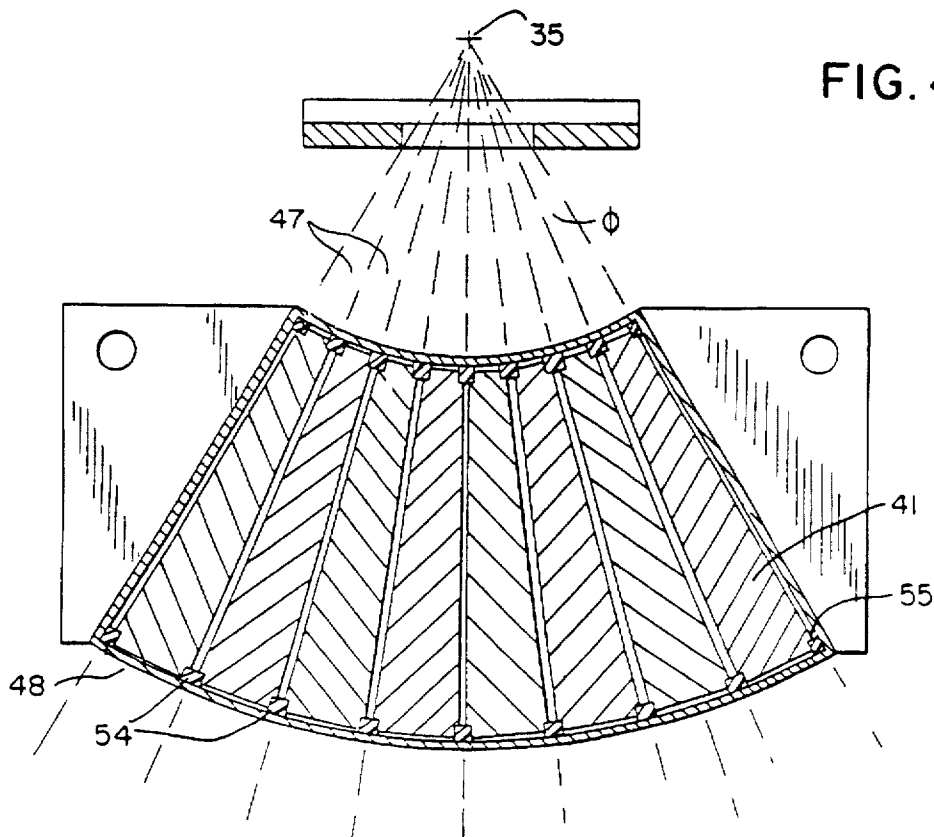


FIG. 4

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.