

AO 120 (Rev. 08/10)

TO: <b>Mail Stop 8</b> <b>Director of the U.S. Patent and Trademark Office</b> <b>P.O. Box 1450</b> <b>Alexandria, VA 22313-1450</b>	<b>REPORT ON THE</b> <b>FILING OR DETERMINATION OF AN</b> <b>ACTION REGARDING A PATENT OR</b> <b>TRADEMARK</b>
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court \_\_\_\_\_ for the District of Delaware \_\_\_\_\_ on the following  
 Trademarks or  Patents. (  the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED 9/25/2015	U.S. DISTRICT COURT for the District of Delaware
PLAINTIFF VARIAN MEDICAL SYSTEMS, INC.		DEFENDANT ELEKTA AB, et al.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 6,888,919 B2	5/3/2005	Varian Medical Systems, Inc.
2		
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY <input type="checkbox"/> Amendment <input type="checkbox"/> Answer <input type="checkbox"/> Cross Bill <input type="checkbox"/> Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT
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CLERK	(BY) DEPUTY CLERK	DATE
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Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director  
 Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/033,327	11/02/2001	Ulrich Martin Graf	01-029-US

**CONFIRMATION NO. 9666**

**POWER OF ATTORNEY NOTICE**

45288  
VARIAN/BSTZ  
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP  
1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94085-4040



Date Mailed: 12/16/2008

**NOTICE REGARDING CHANGE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 12/03/2008.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/hgray/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003

**CONFIRMATION NO. 9666**

**POA ACCEPTANCE LETTER**

65383  
VARIAN MEDICAL SYSTEMS, INC.  
Attn: Legal Department  
3100 Hansen Way  
M/S E339  
Palo Alto, CA 94304



Date Mailed: 12/16/2008

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 12/03/2008.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/hgray/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

RECEIVED  
CENTRAL FAX CENTER P. 1/2  
DEC 03 2008

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ulrich Graf  
Title: Radiotherapy Apparatus Equipped  
With An Articuable Gantry For  
Positioning An Imaging Unit  
Patent No.: 6888919  
Issue Date: 03-May-2005  
Examiner: Allen C Ho  
Art Unit: 2882  
Confirmation No. 9666

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office, Alexandria, Virginia at 1-571-273-8300 on the date below.

Marti Lombana  
(Printed Name)

*Marti Lombana*  
(Signature)

12/3/08  
(Date of Transmission)

TRANSMITTAL

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450  
Via Facsimile: 571-273-8300

Sir:

Transmitted herewith is:

(1) Revocation of Prior Powers of Attorney By Assignee, Appointment of New Power of Attorney by Assignee, and Change of Correspondence Address and STATEMENT UNDER 37 CFR 3.73(b) from Varian Medical Systems, Inc. (2 pages).

Please change the attorney docket to 01-029-US.

Respectfully submitted,

Date 12/2/08

Varian Medical Systems, Inc.  
3100 Hansen Way, M/S E-339  
Palo Alto, CA 94304-1038  
Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

By Keith G. Askoff

Keith G. Askoff  
Attorney for Applicant  
Reg. No. 33,828

01-029-US

REVOCAION OF PRIOR POWERS OF ATTORNEY BY ASSIGNEE  
APPOINTMENT OF NEW POWER OF ATTORNEY BY ASSIGNEE  
CHANGE OF CORRESPONDENCE ADDRESS  
STATEMENT UNDER 37 CFR 3.73(b)

RECEIVED  
CENTRAL FAX CENTER  
DEC 03 2008

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450  
Via Facsimile: 1-571-273-8300

Sir:  
Varian Medical Systems, Inc. is the assignee of the right title and interest in the U.S. patent application identified below, by virtue of an assignment recorded in the United States Patent and Trademark Office at the indicated Reel/Frame:

Atty Dkt	Application No.	Application Date	Patent No.	Grant Date	Inventors	Reel/Frame	Assignee
005513.P00 3	10/033327	02-Nov-2001	6888919	03-May-2005	Graf	021669/0494	Varian Medical Systems, Inc

Varian Medical Systems, Inc., through its duly-delegated representative, hereby revokes all prior Powers of Attorney submitted in the above application, and hereby appoints the registered patent attorneys and patent agents associated with Customer Number:

**65383**

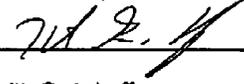
as its principal attorneys to have full power to prosecute the above applications and any continuations, divisions, reissues, and reexaminations thereof, to receive the patents, to transact all business in the United States Patent and Trademark Office connected therewith, and to have full power of substitution, association, and revocation, including the power to revoke the power of attorney of any associate attorney.

Please direct all future correspondence concerning this application to:

VARIAN MEDICAL SYSTEMS, INC.  
Customer Number: 65383  
Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

Executed this 2<sup>nd</sup> day of December, 2008.

Varian Medical Systems, Inc.

By: 

Keith G. Askoff  
Assistant Secretary

01-029-US



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/033,327	6888919	2882	9200



**Correspondence Address/Fee Address Change**

The following fields have been set to Customer Number 45288 on 10/17/2008

- Correspondence Address
- Maintenance Fee Address
- Power of Attorney Address

The address of record for Customer Number 45288 is:

45288  
VARIAN/BSTZ  
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP  
1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94085-4040



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/033,327	11/02/2001	Ulrich Martin Graf	01-029-US

**CONFIRMATION NO. 9666**

**IMPROPER CPOA LETTER**

45288  
VARIAN/BSTZ  
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP  
1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94085-4040



Date Mailed: 09/02/2008

**NOTICE REGARDING POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 08/18/2008. The Power of Attorney in this application is not accepted for the reason(s) listed below:

- The Power of Attorney is from an assignee and the Certificate required by 37 CFR 3.73(b) has not been received.

/mnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

RECEIVED  
CENTRAL FAX CENTER  
AUG 18 2008

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ulrich Graf  
Title: Radiotherapy Apparatus Equipped  
With An Articulate Gantry For  
Positioning An Imaging Unit  
Patent No.: 6888919  
Issue Date: 03-May-2005  
Examiner: Allen C Ho  
Art Unit: 2882  
Confirmation No. 9666

CERTIFICATE OF FACSIMILE TRANSMISSION	
I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office, Alexandria, Virginia at 1-571-273-8300 on the date below.	
_____	Marti Lombana (Printed Name)
_____	<i>Marti Lombana</i> (Signature)
_____	8/18/08 (Date of Transmission)

TRANSMITTAL

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450  
Via Facsimile: 571-273-8300

Sir:

Transmitted herewith is:

(1) Revocation of Prior Powers of Attorney By Assignee, Appointment of New Power of Attorney by Assignee, and Change of Correspondence Address from Varian Medical Systems Technologies, Inc. (2 pages).

Please change the attorney docket to 01-029-US.

Respectfully submitted,

Date August 18, 2008

Varian Medical Systems Technologies, Inc.  
3100 Hansen Way, M/S E-339  
Palo Alto, CA 94304-1038  
Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

By Keith G. Askoff

Keith G. Askoff  
Attorney for Applicant  
Reg. No. 33,828

01-029-US

RECEIVED  
CENTRAL FAX CENTER  
AUG 18 2008

REVOCATION OF PRIOR POWERS OF ATTORNEY BY ASSIGNEE  
APPOINTMENT OF NEW POWER OF ATTORNEY BY ASSIGNEE  
CHANGE OF CORRESPONDENCE ADDRESS

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450  
Via Facsimile: 1-571-273-8300

Sir:  
Varian Medical Systems Technologies, Inc. is the assignee of the right title and interest in the U.S. patent identified below, by virtue of an assignment recorded in the United States Patent and Trademark Office at the indicated Reel/Frame:

Atty Dkt	Application No.	Application Date	Patent No.	Grant Date	Inventors	Reel/Frame	Assignee
005513.P00 3	10/033327	02-Nov-2001	6888919	03-May-2005	Graf	014558/0459	Varian Medical Systems Technologies, Inc

Varian Medical Systems Technologies, Inc., through its duly-delegated representative, hereby revokes all prior Powers of Attorney submitted in the above application, and hereby appoints the registered patent attorneys and patent agents associated with Customer Number:

**65383**

as its principal attorneys to have full power to prosecute the above applications and any continuations, divisions, reissues, and reexaminations thereof, to receive the patents, to transact all business in the United States Patent and Trademark Office connected therewith, and to have full power of substitution, association, and revocation, including the power to revoke the power of attorney of any associate attorney.

Please direct all future correspondence concerning this application to:

VARIAN MEDICAL SYSTEMS TECHNOLOGIES, INC.  
Customer Number: **65383**  
Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

Executed this 18 day of August, 2008.

Varian Medical Systems Technologies, Inc.

By: *Keith G. Askoff*

Keith G. Askoff  
Assistant Secretary

01-029-US



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/033,327	11/02/2001	Ulrich Martin Graf	01-029-US

**CONFIRMATION NO. 9666**

**IMPROPER CPOA LETTER**

45288  
VARIAN/BSTZ  
BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP  
1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94085-4040



Date Mailed: 08/12/2008

**NOTICE REGARDING POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 07/30/2008. The Power of Attorney in this application is not accepted for the reason(s) listed below:

- The Power of Attorney is from an assignee and the Certificate required by 37 CFR 3.73(b) has not been received.

/s/ibrahim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

RECEIVED  
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE JUL 30 2008

Applicant: Ulrich Graf  
Title: Radiotherapy Apparatus  
Equipped with an Articulate  
Gantry for Positioning an  
Imaging Unit  
Patent No.: 6888919  
Issue Date: 03-May-2005  
Examiner: Allen C Ho  
Art Unit: 2882  
Confirmation No. 9666

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office, Alexandria, Virginia at 1-571-273-8300 on the date below.

Marli Lombana  
(Printed Name)

*Marli Lombana*  
(Signature)

7/30/08  
(Date of Transmission)

TRANSMITTAL

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450  
Via Facsimile: 571-273-8300

Sir:

Transmitted herewith is:

(1) Revocation of Prior Powers of Attorney By Assignee, Appointment of New Power of Attorney by Assignee, and Change of Correspondence Address from Varian Medical Systems Technologies, Inc. (4 pages).

Respectfully submitted,

Date 7/29/08  
Varian Medical Systems Technologies, Inc.  
3100 Hansen Way, M/S E-339  
Palo Alto, CA 94304-1038  
Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

By *Keith G. Askoff*  
Keith G. Askoff  
Attorney for Applicant  
Reg. No. 33,828

01-029-US

**RECEIVED**  
**CENTRAL FAX CENTER**  
**JUL 30 2008**  
 REVOCATION OF PRIOR POWERS OF ATTORNEY BY ASSIGNEE  
 APPOINTMENT OF NEW POWER OF ATTORNEY BY ASSIGNEE  
 CHANGE OF CORRESPONDENCE ADDRESS

Commissioner for Patents  
 P.O. Box 1450  
 Alexandria, VA 22313-1450  
 Via Facsimile: 1-571-273-8300

Sir:

Varian Medical Systems Technologies, Inc. is the assignee of the right title and interest  
 in the U.S. patents and patent applications identified below, by virtue of an assignment recorded  
 in the United States Patent and Trademark Office at the indicated Reel/Frame:

Atty Dkt	Application No.	Application Date	Patent No.	Grant Date	Inventors	Reel/Frame	Assignee
05-006-US	11/192849	28-Jul-2005	7355385	08-Apr-2008	Zental	016836/0470	Varian Medical Systems Technologies, Inc.
01-002-US	10/358940	05-Feb-2003	7343002	11-Mar-2008	Lee et al.	014559/0835	Varian Medical Systems Technologies, Inc.
03-048-US	10/745947	24-Dec-2003	7339320	04-Mar-2008	Meddaugh et al.	015339/0568	Varian Medical Systems Technologies, Inc.
06-007-US	11/495838	28-Jul-2006	7336760	26-Feb-2008	Virshup et al.	018335/0041	Varian Medical Systems Technologies, Inc.
02-019-US	10/828637	20-Apr-2004	7327829	05-Feb-2008	Chidester	015252/0200	Varian Medical Systems Technologies, Inc.
04-024-US	11/380701	28-Apr-2006	7302042	27-Nov-2007	Hansen et al.	017550/0775	Varian Medical Systems Technologies, Inc.
05-031-US	11/249819	13-Oct-2005	7295649	13-Nov-2007	Johnsen	016787/0165	Varian Medical Systems Technologies, Inc.
05-015-US	11/153017	14-Jun-2005	7291842	06-Nov-2007	Zental et al.	017359/0214	Varian Medical Systems Technologies, Inc.
01-034-US	10/933806	03-Sep-2004	7289603	30-Oct-2007	Andrews et al.	015788/0643	Varian Medical Systems Technologies, Inc.
04-005-US	10/833696	28-Apr-2004	7286644	23-Oct-2007	Andrews et al.	015280/0651	Varian Medical Systems Technologies, Inc.
07-017-US	11/305750	16-Dec-2005	7286630	23-Oct-2007	Holt	019613/0449	Varian Medical Systems Technologies, Inc.
07-015-US	11/127431	12-May-2005	7263156	28-Aug-2007	Roberts	019530/0931	Varian Medical Systems Technologies, Inc.
03-028-US	10/778540	09-Feb-2004	7257194	14-Aug-2007	Smith	014980/0134	Varian Medical Systems Technologies, Inc.
05-007-US	11/070143	28-Feb-2005	7257188	14-Aug-2007	Bjorkholm	016538/0687	Varian Medical Systems Technologies, Inc.
01-008-US-D1	10/989569	15-Nov-2004	7248673	24-Jul-2007	Miller	016000/0797	Varian Medical Systems Technologies, Inc.
04-006-US	10/953232	29-Sep-2004	7236570	26-Jun-2007	Canfield	015994/0841	Varian Medical Systems Technologies, Inc.
04-010-US	11/057442	14-Feb-2005	7231014	12-Jun-2007	Levy	016207/0625	Varian Medical Systems Technologies, Inc.
02-014-US	10/284111	21-Apr-2006	7274768	05-Jun-2007	Mansfield et al.	014559/0184	Varian Medical Systems Technologies, Inc.
02-001-US	10/037477	02-Jan-2002	7221733	22-May-2007	Takal et al.	014561/0807	Varian Medical Systems Technologies, Inc.
01-037-US	10/122567	15-Apr-2002	7209546	24-Apr-2007	Arnold et al.	014555/0174	Varian Medical Systems Technologies, Inc.

-1-

03-032-US	10/882603	01-Jul-2004	7208810	24-Apr-2007	Wright	015184/0339	Varian Medical Systems Technologies, Inc
01-028-US	10/688484	16-Oct-2003	7208717	24-Apr-2007	Partain et al.	014958/0971	Varian Medical Systems Technologies, Inc.
01-035-US	10/798637	11-Mar-2004	7203281	10-Apr-2007	Smith et al.	015867/0589	Varian Medical Systems Technologies, Inc.
04-009-US	10/954042	29-Sep-2004	7201514	10-Apr-2007	Andrews	015856/0082	Varian Medical Systems Technologies, Inc.
03-019-US-C1	11/283422	18-Nov-2005	7180366	20-Feb-2007	Roos et al.	014617/0668	Varian Medical Systems Technologies, Inc.
03-004-US	10/801947	15-Mar-2004	7177386	13-Feb-2007	Mostafavi et al.	015543/0188	Varian Medical Systems Technologies, Inc.
04-007-US	10/937132	09-Sep-2004	7174001	06-Feb-2007	Andrews et al.	015783/0447	Varian Medical Systems Technologies, Inc.
02-008-US	10/199781	19-Jul-2002	7162005	09-Jan-2007	Bjorkholm	014769/0649	Varian Medical Systems Technologies, Inc.
03-010-US	10/658063	05-Sep-2003	7158610	02-Jan-2007	Mostafavi	014667/0280	Varian Medical Systems Technologies, Inc.
04-003-US	10/823923	14-Apr-2004	7154994	26-Dec-2006	Gray	019520/0297	Varian Medical Systems Technologies, Inc.
03-017-US	10/701724	04-Nov-2003	7151006	19-Dec-2006	Zentai et al.	014679/0761	Varian Medical Systems Technologies, Inc.
03-038-US	10/937150	09-Sep-2004	7150562	19-Dec-2006	Hansen et al.	016198/0519	Varian Medical Systems Technologies, Inc.
03-001-US	10/827153	19-Apr-2004	7142639	28-Nov-2006	Smith et al.	015237/0018	Varian Medical Systems Technologies, Inc.
02-038-US	10/327603	20-Dec-2002	7123758	17-Oct-2006	Jeung et al.	014561/0834	Varian Medical Systems Technologies, Inc.
95-057-US	10/410819	10-Apr-2003	7123687	17-Oct-2006	Colbeth et al.	014561/0791	Varian Medical Systems Technologies, Inc.
01-030-US	10/202273	24-Jul-2002	7103137	05-Sep-2006	Seppi et al.	014769/0671	Varian Medical Systems Technologies, Inc.
03-016-US	10/687552	15-Oct-2003	7095028	22-Aug-2006	Mollov et al.	015120/0308	Varian Medical Systems Technologies, Inc.
02-007-US	10/438684	14-May-2003	7078699	18-Jul-2006	Seppi	014561/0815	Varian Medical Systems Technologies, Inc.
02-034-US	10/439350	15-May-2003	7054410	30-May-2006	Zentai et al.	014561/0824	Varian Medical Systems Technologies, Inc.
03-019-US	10/685787	15-Oct-2003	7002408	21-Feb-2006	Roos et al.	014617/0668	Varian Medical Systems Technologies, Inc.
01-018-US	10/305416	15-Nov-2002	6980679	27-Dec-2005	Jeung et al.	014561/0829	Varian Medical Systems Technologies, Inc.
01-017-US	10/234658	03-Sep-2002	6973202	06-Dec-2005	Mostafavi	014561/0750	Varian Medical Systems Technologies, Inc.
02-028-US	10/639931	12-Aug-2003	6869896	29-Nov-2005	Partain et al.	014559/0197	Varian Medical Systems Technologies, Inc.
02-033-US	10/423770	25-Apr-2003	6954515	11-Oct-2005	Bjorkholm et al.	014173/0325	Varian Medical Systems Technologies, Inc.
98-086-US	09/893122	26-Jun-2001	6937696	30-Aug-2005	Mostafavi	014561/0086	Varian Medical Systems Technologies, Inc.
07-019-US	10/651272	28-Aug-2003	6901135	31-May-2005	Fox et al.	020594/0296	Varian Medical Systems Technologies, Inc.
01-029-US	10/033327	02-Nov-2001	6888919	03-May-2005	Graf	014558/0459	Varian Medical Systems Technologies, Inc.
01-006-US	10/013199	02-Nov-2001	6800658	05-Oct-2004	Seppi	014562/0745	Varian Medical Systems Technologies, Inc.
07-018-US	10/346143	16-Jan-2003	6785357	31-Aug-2004	Bernardi	020490/0534	Varian Medical Systems Technologies, Inc.
01-011-US	09/792418	22-Feb-2001	6718069	06-Apr-2004	Mollov et al.	014561/0075	Varian Medical Systems Technologies, Inc.
98-034-US-C1	09/712724	14-Nov-2000	6690965	10-Feb-2004	Riazal et al.	014561/0089	Varian Medical Systems Technologies, Inc.
07-014-US	09/965165	28-Sep-2001	6683935	27-Jan-2004	Moore	019597/0523	Varian Medical Systems Technologies, Inc.
01-004-US	09/797076	28-Feb-2001	6653992	25-Nov-2003	Colbeth et al.	014571/0131	Varian Medical Systems Technologies, Inc.
98-043-US	09/178383	23-Oct-1998	6621889	16-Oct-2003	Mostafavi	014059/0648	Varian Medical Systems Technologies, Inc.

00-017-US	09/875031	07-Jun-2001	6549802	15-Apr-2003	Thomton	014059/0646	Varian Medical Systems Technologies, Inc
99-030-US-C1	10/005908	03-Dec-2001	6539247	25-Mar-2003	Spetz	014059/0646	Varian Medical Systems Technologies, Inc
07-043-US	09/642755	21-Aug-2000	6463122	08-Oct-2002	Moore	020594/0245	Varian Medical Systems Technologies, Inc
95-056-US-D1	09/309725	11-May-1999	6424750	23-Jul-2002	Colbeth et al.	014059/0646	Varian Medical Systems Technologies, Inc
99-002-US	09/479466	06-Jan-2000	6366021	02-Apr-2002	Meddaugh et al.	014059/0646	Varian Medical Systems Technologies, Inc
99-029-US	09/258280	28-Feb-1999	6360116	19-Mar-2002	Jackson et al.	014059/0646	Varian Medical Systems Technologies, Inc
99-030-US	09/258122	28-Feb-1999	6327490	04-Dec-2001	Spetz	014059/0646	Varian Medical Systems Technologies, Inc
98-033-US	09/178385	23-Oct-1998	6279579	28-Aug-2001	Riazat et al.	014059/0646	Varian Medical Systems Technologies, Inc
95-054-US	08/758538	29-Nov-1996	6084461	04-Jul-2000	Colbeth et al.	014059/0646	Varian Medical Systems Technologies, Inc
95-056-US	08/978177	25-Nov-1997	5970115	19-Oct-1999	Colbeth et al.	014059/0646	Varian Medical Systems Technologies, Inc
95-058-US	08/758528	29-Nov-1996	5801571	01-Sep-1998	Allen et al.	014027/2003	Varian Medical Systems Technologies, Inc
92-010-US	07/848498	25-Feb-1992	5381072	10-Jan-1995	Tanabe	014027/0459	Varian Medical Systems Technologies, Inc

Varian Medical Systems Technologies, Inc., through its duly-delegated representative, hereby revokes all prior Powers of Attorney submitted in the above applications, and hereby appoints the registered patent attorneys and patent agents associated with Customer Number:

**65383**

as its principal attorneys to have full power to prosecute the above applications and any continuations, divisions, reissues, and reexaminations thereof, to receive the patents, to transact all business in the United States Patent and Trademark Office connected therewith, and to have full power of substitution, association, and revocation, including the power to revoke the power of attorney of any associate attorney.

Please direct all future correspondence concerning this application to:

VARIAN MEDICAL SYSTEMS TECHNOLOGIES, INC.  
Customer Number: **65383**

Telephone: (650) 424-6220  
Facsimile: (650) 424 5998

Executed this 11 day of July, 2008.

Varian Medical Systems Technologies, Inc.

By: Keith G. Askoff  
Keith G. Askoff  
Assistant Secretary

**PART B - FEE(S) TRANSMITTAL**

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**  
**Commissioner for Patents**  
**P.O. Box 1450**  
**Alexandria, Virginia 22313-1450**  
**or Fax (703) 746-4000**

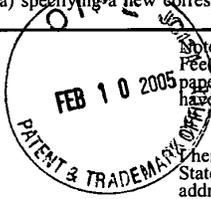
INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

008791 7590 11/08/2004

**BLAKELY SOKOLOFF TAYLOR & ZAFMAN**  
**12400 WILSHIRE BOULEVARD**  
**SEVENTH FLOOR**  
**LOS ANGELES, CA 90025-1030**

02/11/2005 MBERHE1 00000092 10033327  
 01 FC:1501 1400.00 OP  
 02 FC:1504 300.00 OP  
 03 FC:8001 30.00 OP



Note: A certificate of mailing can only be used for domestic mailings of Fee(s) Transmittal. This certificate cannot be used for any other accompany papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

**Certificate of Mailing or Transmission**  
 I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (703) 746-4000, on the date indicated below.

Angela M. Quinn	(Depositor's name)
<i>[Signature]</i>	(Signature)
February 8, 2005	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666

TITLE OF INVENTION: **RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT**

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1370	\$300	\$1670	02/08/2005

EXAMINER	ART UNIT	CLASS-SUBCLASS
HO, ALLEN C	2882	378-065000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).  
 Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.  
 "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list  
 (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,  
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. **BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP**  
 2. \_\_\_\_\_  
 3. \_\_\_\_\_

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)  
 PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: **VARIAN MEDICAL SYSTEMS, INC.**  
 (B) RESIDENCE: (CITY and STATE OR COUNTRY) **PALO ALTO, CALIFORNIA**

Please check the appropriate assignee category or categories (will not be printed on the patent):  Individual  Corporation or other private group entity  Government

4a. The following fee(s) are enclosed:  
 Issue Fee  
 Publication Fee (No small entity discount permitted)  
 Advance Order - # of Copies ten (10)

4b. Payment of Fee(s):  
 A check in the amount of the fee(s) is enclosed.  
 Payment by credit card. Form PTO-2038 is attached.  
 The Director is hereby authorized by charge the required fee(s), or credit any overpayment Deposit Account Number 02-2666 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)  
 a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.  b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above. NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other part interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature *[Signature]* Date 2/8/05  
 Typed or printed name Michael J. Mallie Registration No. 36,591

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 14 Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.



005513.P003

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: )  
Ulrich Martin Graf )  
Serial No.: 10/033,327 )  
Filed: November 2, 1001 )  
For: RADIOTHERAPY APPARATUS )  
EQUIPPED WITH AN ARTICULABLE )  
GANTRY FOR POSITIONING AN )  
IMAGING UNIT )

Art Unit: 2882

Examiner: Allen C. Ho

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Commissioner for Patents, PO Box 1450, Alexandria, Virginia 22313-1450

on February 8, 2005  
Date of Deposit  
Angel M. Quinn  
Name of Person Mailing Correspondence  
Signature Date 2-8-05

PAYMENT OF ISSUE FEE

MS ISSUE FEE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

In response to the Notice of Allowance mailed November 8, 2004, enclosed herewith is a check in the amount of \$1,430.00 for payment of the issue fee (soft copies requested) and publication fee and a check in the amount of \$300.00 for the publication fee.

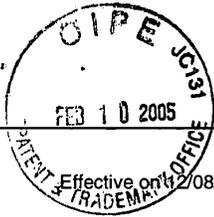
Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: 2/4/05

Michael J. Mallie  
Reg. No. 36,591

12400 Wilshire Boulevard  
Seventh Floor  
Los Angeles, CA 90025-1026  
(408) 720-8598



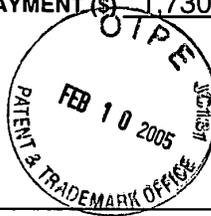
**FEE TRANSMITTAL FOR FY 2005**

Effective on 2/08/2004. Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

TOTAL AMOUNT OF PAYMENT (\$) 1,730.00

**Complete if Known:**

Application No. 10/033,327  
 Filing Date November 2, 2001  
 First Named Inventor Ulrich Martin Graf  
 Examiner Name Allen C. Ho  
 Art Unit 2882  
 Attorney Docket No. 005513.P003



Applicant claims small entity status. See 37 CFR 1.27.

**METHOD OF PAYMENT** (check all that apply)

Check  Credit Card  Money Order  None  Other (please identify)

Deposit Account

Deposit Account Number : 02-2666

Deposit Account Name: \_\_\_\_\_

The Director is Authorized to do the following with respect to the above-identified Deposit Account:

Charge fee(s) indicated below.

Charge any additional fee(s) or underpayment of fee(s) during the pendency of this application.

Charge fee(s) indicated below except for the filing fee

Credit any overpayments.

Any concurrent or future reply that requires a petition for extension of time should be treated as incorporating an appropriate petition for extension of time and all required fees should be charged.

Warning: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

**FEE CALCULATION**

**1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Large Entity		Small Entity		Fee Description		Fees Paid (\$)
Code	Fee (\$)	Code	Fee (\$)			
1011	300	2011	150	Utility application filing fee	} 1,000/500	_____
1111	500	2111	250	Utility search fee		_____
1311	200	2311	100	Utility examination fee		_____
1012	200	2012	100	Design application filing fee	} 430/215	_____
1112	100	2112	50	Design search fee		_____
1312	130	2312	65	Design examination fee		_____
1013	200	2013	100	Plant filing fee	} 660/330	_____
1113	300	2113	150	Plant search fee		_____
1313	160	2313	80	Plant examination fee		_____
1004	300	2004	150	Reissue filing fee	} 1,400/700	_____
1114	500	2114	250	Reissue search fee		_____
1314	600	2314	300	Reissue examination fee		_____
1005	200	2005	100	Provisional application filing fee		_____
SUBTOTAL (1) \$						_____

**2. EXCESS CLAIM FEES**

	<u>Extra Claims</u>	<u>Fee from below</u>	<u>Fees Paid (\$)</u>
<b>Total Claims</b> _____ - 20 or HP = _____		X _____ = _____	
HP = highest number of total claims paid for, if greater than 20			
<b>Independent Claims</b> _____ - 3 or HP = _____		X _____ = _____	
HP = highest number of independent claims paid for, if greater than 3			
<b>Multiple Dependent Claims</b> _____		_____ = _____	

<u>Large Entity</u>		<u>Small Entity</u>		<u>Fee Description</u>
<u>Code</u>	<u>Fee (\$)</u>	<u>Code</u>	<u>Fee (\$)</u>	
1202	50	2202	25	Each claim over 20
1201	200	2201	100	Each independent claim over 3
1203	360	2203	180	Multiple dependent claims, if not paid
1204	200	2204	100	Reissue: each claim over 20 and more than in the original patent
1205	50	2205	25	Reissue: each independent claim more than in the original patent

**SUBTOTAL (2) \$ \_\_\_\_\_**

**3. APPLICATION SIZE FEE**

If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

<u>Total Sheets</u>		<u>Extra Sheets</u>		<u>Number of each add'l 50 or fraction thereof</u>		<u>Fee from below</u>	<u>Fees paid (\$)</u>
_____	- 100 =	_____	/ 50 =	_____ (round up to whole number)	X	_____	_____

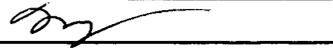
<u>Large Entity</u>		<u>Small Entity</u>		<u>Fee Description: Application size fee for each additional group of 50 sheets beyond initial 100 sheets (count spec &amp; drawings except sequences &amp; program listings):</u>
<u>Code</u>	<u>Fee (\$)</u>	<u>Code</u>	<u>Fee (\$)</u>	
1081	250	2081	125	Utility
1082	250	2082	125	Design
1083	250	2083	125	Plant
1084	250	2084	125	Reissue

**SUBTOTAL (3) \$ \_\_\_\_\_**

**FEE CALCULATION (continued)****4. OTHER FEE(S)**

				<b>Fees Paid (\$)</b>
<b>Non-English Specification, \$130 fee (no small entity discount)</b>				<u>          </u>
<b>Large Entity</b>		<b>Small Entity</b>		
<b>Fee Code</b>	<b>Fee (\$)</b>	<b>Fee Code</b>	<b>Fee (\$)</b>	<b>Fee Description</b>
1051	130	2051	65	Surcharge - late filing fee or oath
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet
1053	130	1053	130	Non-English specification
1812	2,520	1812	2,520	For filing a request for ex parte reexamination
1813	8,800	1813	8,800	Request for inter parties reexamination
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action
1251	120	2251	60	Extension for reply within first month
1252	450	2252	225	Extension for reply within second month
1253	1,020	2253	510	Extension for reply within third month
1254	1,590	2254	795	Extension for reply within fourth month
1255	2,160	2255	1,080	Extension for reply within fifth month
1401	500	2401	250	Notice of Appeal
1402	500	2402	250	Filing a brief in support of an appeal
1403	1,000	2403	500	Request for oral hearing
1451	1,510	1451	1,510	Petition to institute a public use proceeding
1452	500	2452	250	Petition to revive - unavoidable
1453	1,500	2453	750	Petition to revive - unintentional
1501	1,400	2501	700	Utility issue fee (or reissue)
1502	800	2502	400	Design issue fee
1503	1100	2503	550	Plant issue fee
1462	400	1462	400	Petitions to the Commissioner (CFR 1.17(f) Group I)
1463	200	1463	200	Petitions to the Commissioner (CFR 1.17(g) Group II)
1464	130	1464	130	Petitions to the Commissioner (CFR 1.17(h) Group III)
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)
1806	180	1806	180	Submission of Information Disclosure Stmt
8021	40	8021	40	Recording each patent assignment per property (times number of properties)
1809	790	2809	395	For filing a submission after final rejection (see 37 CFR 1.129(a))
1814	130	2814	65	Statutory Disclaimer
1810	790	2810	395	For each additional invention to be examined (see 37 CFR 1.129(b))
1801	790	2801	395	Request for Continued Examination (RCE)
1802	900	1802	900	Request for expedited examination of a design application
1504	300	1504	300	Publication fee for early, voluntary, or normal pub.
1505	300	1505	300	Publication fee for republication
1803	130	1803	130	Request for voluntary publication or republication
1808	130	1808	130	Processing fee under 37 CFR 1.17(i) (except provisionals)
1454	1,370	1454	1,370	Acceptance of unintentionally delayed claim for priority
Other fee (specify) <u>Fee for 10 copies of Issued Patent</u>				<u>30.00</u>
Other fee (specify) _____				_____
<b>SUBTOTAL (4)</b>				<b>\$ <u>1,730.00</u></b>

\*Reduced by Basic Filing Fee Paid

**SUBMITTED BY:**Typed or Printed Name: Michael J. MallieSignature: Date: 2/8/05Reg. Number: 36,591Telephone Number: 408-720-8300

Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



*u*

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
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P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

**NOTICE OF ALLOWANCE AND FEE(S) DUE**

008791 7590 11/08/2004

BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
12400 WILSHIRE BOULEVARD  
SEVENTH FLOOR  
LOS ANGELES, CA 90025-1030

EXAMINER

HO, ALLEN C

ART UNIT PAPER NUMBER

2882

DATE MAILED: 11/08/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666

TITLE OF INVENTION: RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1370	\$300	\$1670	02/08/2005

**THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATEN PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHT THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPO PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.**

**THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM TH MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. TH STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (O AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.**

**HOW TO REPLY TO THIS NOTICE:**

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

- A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.
- B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

- A. Pay TOTAL FEE(S) DUE shown above, or
- B. If applicant claimed SMALL ENTITY status before, or is n claiming SMALL ENTITY status, check box 5a on Part B - Fee Transmittal and pay the PUBLICATION FEE (if required) and 1 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) w your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance Mail Stop ISSUE FEE unless advised to the contrary.

**IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.**

**PART B - FEE(S) TRANSMITTAL**

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**  
**Commissioner for Patents**  
**P.O. Box 1450**  
**Alexandria, Virginia 22313-1450**  
**or Fax (703) 746-4000**

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

008791 7590 11/08/2004

**BLAKELY SOKOLOFF TAYLOR & ZAFMAN**  
**12400 WILSHIRE BOULEVARD**  
**SEVENTH FLOOR**  
**LOS ANGELES, CA 90025-1030**

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**Certificate of Mailing or Transmission**

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (703) 746-4000, on the date indicated below.

_____ (Depositor's name)
_____ (Signature)
_____ (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666

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EXAMINER	ART UNIT	CLASS-SUBCLASS
HO, ALLEN C	2882	378-065000

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 Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.  
 "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a **Customer Number** is required.

2. For printing on the patent front page, list  
 (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, \_\_\_\_\_ 1  
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. \_\_\_\_\_ 2  
 \_\_\_\_\_ 3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)  
 PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE \_\_\_\_\_ (B) RESIDENCE: (CITY and STATE OR COUNTRY) \_\_\_\_\_

Please check the appropriate assignee category or categories (will not be printed on the patent):  Individual  Corporation or other private group entity  Government

4a. The following fee(s) are enclosed:  
 Issue Fee  
 Publication Fee (No small entity discount permitted)  
 Advance Order - # of Copies \_\_\_\_\_

4b. Payment of Fee(s):  
 A check in the amount of the fee(s) is enclosed.  
 Payment by credit card. Form PTO-2038 is attached.  
 The Director is hereby authorized by charge the required fee(s), or credit any overpayment Deposit Account Number \_\_\_\_\_ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)  
 a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.  b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above. NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other part interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature \_\_\_\_\_ Date \_\_\_\_\_  
 Typed or printed name \_\_\_\_\_ Registration No. \_\_\_\_\_

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 14 Alexandria, Virginia 22313-1450.

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UNITED STATES PATENT AND TRADEMARK OFFICE

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Table with 5 columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO.
Row 1: 10/033,327, 11/02/2001, Ulrich Martin Graf, 005513.P003, 9666
Row 2: 008791, 7590, 11/08/2004, [EXAMINER HO, ALLEN C], [ART UNIT 2882, PAPER NUMBER]

BLAKELY SOKOLOFF TAYLOR & ZAFMAN
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CA 90025-1030

DATE MAILED: 11/08/2004

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 190 day(s). If the issue fee is paid on the date that is three months after t mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a ha months) after the mailing date of this notice, the Patent Term Adjustmnet will be 190 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date th determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

<b>Notice of Allowability</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	10/033,327	GRAF, ULRICH MARTIN	
	<b>Examiner</b>	<b>Art Unit</b>	
	Allen C. Ho	2882	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1.  This communication is responsive to RCE filed on 30 September 2004.
2.  The allowed claim(s) is/are 1-26.
3.  The drawings filed on 06 October 2003 are accepted by the Examiner.
4.  Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
  - a)  All    b)  Some\*    c)  None    of the:
    1.  Certified copies of the priority documents have been received.
    2.  Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
    3.  Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.  
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5.  A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6.  CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.
  - (a)  including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached
    - 1)  hereto or 2)  to Paper No./Mail Date \_\_\_\_\_.
  - (b)  including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7.  DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. <input type="checkbox"/> Notice of References Cited (PTO-892)</li> <li>2. <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)</li> <li>3. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date <u>092004</u></li> <li>4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material</li> </ol> | <ol style="list-style-type: none"> <li>5. <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)</li> <li>6. <input type="checkbox"/> Interview Summary (PTO-413), Paper No./Mail Date _____.</li> <li>7. <input type="checkbox"/> Examiner's Amendment/Comment</li> <li>8. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance</li> <li>9. <input type="checkbox"/> Other _____.</li> </ol> |
|--|--|

**DETAILED ACTION**

*Allowable Subject Matter*

1. Claims 1-26 are allowed.
2. The following is an examiner's statement of reasons for allowance:

With respect to claims 1, 3-10, 12, and 13, the prior art fails to teach or fairly suggest an apparatus comprising a first therapeutic radiation source attached to a first gantry, a second rotatable gantry attached to the first gantry, and an imager attached to an articulable end of the second gantry as claimed.

With respect to claim 2, the prior art fails to teach or fairly suggest an apparatus comprising at least one second radiation source attached to the first gantry, and an imager attached to an articulable end of a second rotatable gantry as claimed.

With respect to claim 11, the prior art fails to teach or fairly suggest an apparatus comprising a second rotatable gantry that is capable of extending and retracting the second radiation source attached to the second gantry, and an imager attached to an articulable end of the second gantry as claimed.

With respect to claims 14-21, the prior art fails to teach or fairly suggest a method for applying radiation comprising positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic x-ray source, positioning a therapeutic radiation source to be in alignment with the target volume, and repositioning the imager to receive radiation from the therapeutic radiation source as claimed.

With respect to claims 22-25, the prior art fails to teach a method for imaging radiation comprising retracting the first radiation source and positioning a second radiation source along the first axis as claimed.

With respect to claim 26, the prior art fails to teach or fairly suggest an apparatus comprising a therapeutic energy source attached to a first gantry, a diagnostic x-ray energy source attached to a retractable end of a second gantry, a multiple-energy imaging unit attached to an opposite articulable end of the second gantry, and the first gantry and the second gantry independently pivotable and attached at a common axis as claimed.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

### *Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allen C. Ho whose telephone number is (571) 272-2491. The examiner can normally be reached on Monday - Friday from 8:00 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward J. Glick can be reached at (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Application/Control Number: 10/033,327  
Art Unit: 2882

Page 4

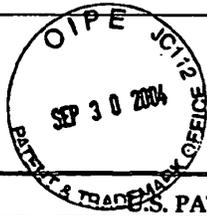
Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Allen C. Ho  
Patent Examiner  
Art Unit 2882

03 November 2004

Substitute for Form 1449A/PTO (Modified) (use as many sheets as necessary)	Attorney Docket No.: 005513.P003	Application Number: 10/033,327
	First Named Inventor: Ulrich Martin Graf	
	Filing Date: 11/2/01	



Exam. Initial*	Cite No. <sup>1</sup>	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code <sup>2</sup> (If known)			
ACH		5,956,382		Wiener-Avnear et al.	9/21/99	
ACH		20030007601A1		Jaffray et al.	1/9/03	

FOREIGN PATENT DOCUMENTS								
Exam. Initial*	Cite No. <sup>1</sup>	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>6</sup>
		Office <sup>3</sup> Code <sup>5</sup>	Number <sup>4</sup>	Kind (If known)				

Examiner Signature	<i>Allen C Ho</i>	Date Considered	03 Nov 2004
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\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup>Unique citation designation number. <sup>2</sup>See attached Kinds of U.S. Patent Documents. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard S.3). <sup>4</sup>For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup>Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, PO Box 1450, Alexandria, Virginia 22313-1450.

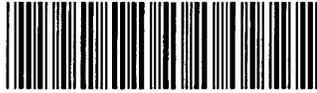
<b>Issue Classification</b> 	Application No.	Applicant(s)	
	10/033,327	GRAF, ULRICH MARTIN	
	Examiner	Art Unit	
	Allen C. Ho	2882	

ISSUE CLASSIFICATION										
ORIGINAL					CROSS REFERENCE(S)					
CLASS		SUBCLASS			CLASS		SUBCLASS (ONE SUBCLASS PER BLOCK)			
378		65			378		197			
INTERNATIONAL CLASSIFICATION										
A	6	1	N	5/10						
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   (Assistant Examiner) (Date)	 Allen C. Ho 03 Nov. 2004 (Primary Examiner) (Date)	<b>Total Claims Allowed: 26</b>  <table border="1" style="width: 100%;"> <tr> <td style="width: 50%;">O.G. Print Claim(s)</td> <td style="width: 50%;">O.G. Print Fig</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">3B</td> </tr> </table>	O.G. Print Claim(s)	O.G. Print Fig	1	3B
O.G. Print Claim(s)	O.G. Print Fig					
1	3B					

<input type="checkbox"/> Claims renumbered in the same order as presented by applicant		<input type="checkbox"/> CPA		<input type="checkbox"/> T.D.		<input type="checkbox"/> R.1.47			
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12	2		32		62		92		122
2	3		33		63		93		123
3	4		34		64		94		124
4	5		35		65		95		125
5	6		36		66		96		126
6	7		37		67		97		127
8	8		38		68		98		128
9	9		39		69		99		129
10	10		40		70		100		130
13	11		41		71		101		131
11	12		42		72		102		132
7	13		43		73		103		133
14	14		44		74		104		134
15	15		45		75		105		135
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**Index of Claims**



Application No.

10/033,327

Examiner

Allen C. Ho

Applicant(s)

GRAF, ULRICH MARTIN

Art Unit

2882

√	Rejected
=	Allowed

-	(Through numeral) Cancelled
+	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

Claim		Date			
Final	Original	11/3/04			
1	1	=			
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	Type	L #	Hits	Search Text	DBs	Time Stamp
1	BRS	L1	6327	(detector OR imager OR receptor OR (flat ADJ panel) OR (imaging ADJ sensor)) WITH (articulat\$4 OR pivot\$4)	US-PGPUB; USPAT; EPO; JPO; DERWE NT; IBM_TD B	2004/11/03 15:23
2	BRS	L2	25392	"378"/\$.ccls.	US-PGPUB; USPAT; EPO; JPO; DERWE NT; IBM_TD B	2004/11/03 15:24
3	BRS	L3	330	1 AND 2	US-PGPUB; USPAT; EPO; JPO; DERWE NT; IBM_TD B	2004/11/03 15:24

11/3/04, EAST Version: 2.0.1.4

**PATENT APPLICATION FEE DETERMINATION RECORD**  
Effective October 1, 2003

Application or Docket Number

**RCE** 10/033327  
423-04

**CLAIMS AS FILED - PART I**

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	
INDEPENDENT CLAIMS	minus 3 =	
MULTIPLE DEPENDENT CLAIM PRESENT	<input type="checkbox"/>	

\* If the difference in column 1 is less than zero, enter "0" in column 2

**CLAIMS AS AMENDED - PART II**

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	• 26	Minus • 27	= 1
Independent	• 6	Minus • 6	= 0
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM	<input type="checkbox"/>		

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
9/30/04			
Total	• 26	Minus • 27	= 1
Independent	• 6	Minus • 6	= 0
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM	<input type="checkbox"/>		

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	•	Minus •	=
Independent	•	Minus •	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM	<input type="checkbox"/>		

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.  
 \*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."  
 \*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."  
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SMALL ENTITY TYPE  OR OTHER THAN SMALL ENTITY

RATE	FEE	RATE	FEE
BASIC FEE	385.00	BASIC FEE	770.00
XS 9=		XS18=	
X43=		X86=	
+145=		+290=	
TOTAL		TOTAL	

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE	RATE	ADDITIONAL FEE
XS 9=	/	XS18=	/
X43=	/	X86=	/
+145=	/	+290=	/
TOTAL ADDIT. FEE		TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE	RATE	ADDITIONAL FEE
XS 9=	/	XS18=	/
X43=	/	X86=	/
+145=	/	+290=	/
TOTAL ADDIT. FEE		TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE	RATE	ADDITIONAL FEE
XS 9=		XS18=	
X43=		X86=	
+145=		+290=	
TOTAL ADDIT. FEE		TOTAL ADDIT. FEE	

RCE#  
efw

DIPE  
SEP 30 2004

### REQUEST FOR CONTINUED EXAMINATION (RCE) TRANSMITTAL

Address to: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450

Application No. 10/033,327  
Filing Date 09/27/04  
First Named Inventor Ulrich Martin Graf  
Art Unit 2882  
Examiner Name Ho, Allen C.  
Attorney Docket No. 005513.P003

This is a Request for Continued Examination (RCE) under 37 C.F.R. § 1.114 of the above-identified application. Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See instruction sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 C.F.R. § 1.114** – Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).
  - a.  Previously submitted If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
    - i.  Consider the amendment(s)/reply under 37 C.F.R. § 1.116 previously filed on \_\_\_\_\_  
(Any unentered amendment(s) referred to above will be entered. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
    - ii.  Consider the arguments in the Appeal Brief or Reply Brief previously filed on \_\_\_\_\_
    - iii.  Other \_\_\_\_\_
  - b.  Enclosed
    - i.  Amendment/Reply
    - ii.  Affidavit(s)/Declaration(s) 10/01/2004 MAHMED1 00000051 10033327
    - iii.  Information Disclosure Statement (IDS) 01 FC:1801 770.00 OP
    - iv.  Other \_\_\_\_\_
2. **Miscellaneous**
  - a.  Suspension of action on the above-identified application is requested under 37 C.F.R. § 1.103(c) for a period of \_\_\_\_\_ months. (Period of suspension shall not exceed 3 months. Fee under 37 C.F.R. § 1.17(i) required)
  - b.  Other \_\_\_\_\_
3. **Fees** The RCE fee under 37 C.F.R. § 1.17(e) is required by C.F.R. § 1.114 when the RCE is filed.
  - a.  The Director is hereby authorized to charge the following fees, or credit any overpayments, to Deposit Account No. 02-2666
    - i.  RCE fee required under 37 C.F.R. § 1.17(e)
    - ii.  Extension of time fee (37 C.F.R. §§ 1.136 and 1.17)
    - iii.  Processing fee under 37 CFR § 1.17(i) for Limited Suspension of Action
    - iv.  Other \_\_\_\_\_
  - b.  Check in the amount of \$ 770.00 enclosed
  - c.  Payment by credit card (Form PTO-2038 enclosed)

**WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**

#### SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

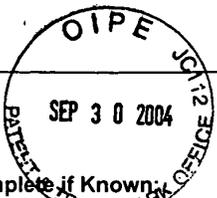
Name (Print/Type) Daniel E. Ovanezian Registration No. (Attorney/Agent) 41,236  
Signature [Signature] Date 9/27/04

#### CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450, or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below:

Name (Print/Type) JUANITA BRISCOE  
Signature [Signature] Date 9/27/04

Express Mail No. (only if applicable): \_\_\_\_\_



**FEE TRANSMITTAL FOR FY 2004**

(FY 2004 Begins 10/01/2003)

TOTAL AMOUNT OF PAYMENT (\$) \$1,633.00

Complete if Known:  
 Application No. 10/033,327  
 Filing Date 11/2/01  
 First Named Inventor Ulrich Martin Graf  
 Examiner Name Ho, Allen C.  
 Art Unit 2882  
 Attorney Docket No. 005513.P003

Applicant claims small entity status. See 37 CFR 1.27.

**METHOD OF PAYMENT (check all that apply)**

- Check  Credit Card  Money Order  Other  None
- Deposit Account  
 Deposit Account Number : 02-2666  
 Deposit Account Name: \_\_\_\_\_
- The Director is Authorized to do the following with respect to the above-identified Deposit Account:  
 Charge fee(s) indicated below.  
 Credit any overpayments.  
 Charge any additional fees during the pendency of this application.  
 Any concurrent or future reply that requires a petition for extension of time should be treated as incorporating an appropriate petition for extension of time and all required fees should be charged.  
 Charge fee(s) indicated below except for the filing fee.

**FEE CALCULATION**

**1. BASIC FILING FEE**

Large Entity		Small Entity		Fee Description	Fee Paid
Code	Fee (\$)	Code	Fee (\$)		
1001	770	2001	385	Utility application filing fee	_____
1002	340	2002	170	Design application filing fee	_____
1003	530	2003	265	Plant filing fee	_____
1004	770	2004	385	Reissue filing fee	_____
1005	160	2005	80	Provisional application filing fee	_____
SUBTOTAL (1) \$					_____

**2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE**

	Extra Claims	Fee from below	Fee Paid
Total Claims <u>26</u>	- 27** = <u>0</u>	X _____	= _____
Independent Claims <u>6</u>	- 7** = <u>0</u>	X _____	= _____
Multiple Dependent		_____	= _____

\*\*Or number previously paid, if greater; For Reissues, see below.

Large Entity		Small Entity		Fee Description	Fee Paid
Code	Fee (\$)	Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	_____
1201	86	2201	43	Independent claims in excess of 3	_____
1203	290	2203	145	Multiple dependent claim, if not paid	_____
1204	86	2204	43	**Reissue independent claims over original patent	_____
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent	_____
SUBTOTAL (2) \$					_____



**FEE CALCULATION (continued)**

**3. ADDITIONAL FEES**

<u>Large Entity</u>		<u>Small Entity</u>		<u>Fee Description</u>	<u>Fee Paid</u>
<u>Code</u>	<u>Fee (\$)</u>	<u>Code</u>	<u>Fee (\$)</u>		
1051	130	2051	65	Surcharge - late filing fee or oath	_____
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	_____
1053	130	1053	130	Non-English specification	_____
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	_____
1813	8,800	1813	8,800	Request for inter parties reexamination	_____
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	_____
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	_____
1251	110	2251	55	Extension for reply within first month	_____
1252	420	2252	210	Extension for reply within second month	_____
1253	950	2253	475	Extension for reply within third month	_____
1254	1,480	2254	740	Extension for reply within fourth month	_____
1255	2,010	2255	1,005	Extension for reply within fifth month	_____
1401	330	2401	165	Notice of Appeal	_____
1402	330	2402	165	Filing a brief in support of an appeal	_____
1403	290	2403	145	Request for oral hearing	_____
1451	1,510	1451	1,510	Petition to institute a public use proceeding	_____
1452	110	2452	55	Petition to revive - unavoidable	_____
1453	1,330	2453	665	Petition to revive - unintentional	_____
1501	1,330	2501	665	Utility issue fee (or reissue)	_____
1502	480	2502	240	Design issue fee	_____
1503	640	2503	320	Plant issue fee	_____
1460	130	1460	130	Petitions to the Commissioner	_____
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	_____
1806	180	1806	180	Submission of Information Disclosure Stmt	_____
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	_____
1809	770	2809	385	For filing a submission after final rejection (see 37 CFR 1.129(a))	_____
1814	110	2814	55	Statutory Disclaimer	_____
1810	770	2810	385	For each additional invention to be examined (see 37 CFR 1.129(b))	_____
1801	770	2801	385	Request for Continued Examination (RCE)	<u>\$770.00</u>
1802	900	1802	900	Request for expedited examination of a design application	_____
1504	300	1504	300	Publication fee for early, voluntary, or normal pub.	_____
1505	300	1505	300	Publication fee for republication	_____
1803	130	1803	130	Request for voluntary publication or republication	_____
1808	130	1808	130	Processing fee under 37 CFR 1.17(i) (except provisionals)	_____
1454	1,330	1454	1,330	Acceptance of unintentionally delayed claim for priority	_____
Other fee (specify) _____					_____
Other fee (specify) _____					_____
<b>SUBTOTAL (3) \$ 770.00</b>					

\*Reduced by Basic Filing Fee Paid

**SUBMITTED BY:**

Typed or Printed Name: Daniel E. Ovanezian  
 Signature: *[Signature]* Date: 9/27/04  
 Reg. Number: 41,236 Telephone Number: (408) 720-8300

Send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



Attorney's Docket No. 005513.P003

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of:	)	
	)	
Ulrich Martin Graf	)	Examiner: Ho, Allen C.
	)	
Application No.: 10/033,327	)	Art Unit: 2882
	)	
Filed: 11/2/01	)	
	)	
For: RADIOTHERAPY APPARATUS	)	
EQUIPPED WITH AN	)	
ARTICULABLE GANTRY FOR	)	
POSITIONING AN IMAGING	)	
UNIT	)	
	)	

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 or PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on 9/27/04

(Date of Deposit)

JUANITA BRISCOE

(Typed or printed name of person mailing correspondence)

(Signature of person mailing correspondence)

has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

X  37 C.F.R. §1.97(b).

\_\_\_\_\_ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

\_\_\_\_\_ A statement pursuant to 37 C.F.R. §1.97(e) or

\_\_\_\_\_ A check for \$180.00 for the fee under 37 C.F.R. § 1.17(p).

\_\_\_\_\_ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

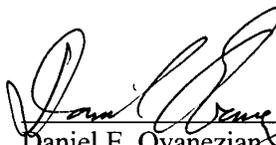
- (1) A statement pursuant to 37 C.F.R. §1.97(e); and
- (2) A check for \$180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.

If there are any additional charges, please charge Deposit Account No. 02-2666.

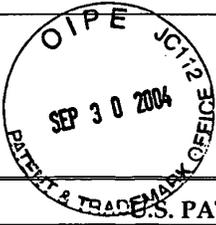
Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: 9/27, 2004

  
Daniel E. Ovanezian  
Reg. No. 41,236

12400 Wilshire Blvd.  
Seventh Floor  
Los Angeles, CA 90025  
(408) 720-8300

<b>Substitute for Form 1449A/PTO (Modified)</b> (use as many sheets as necessary)	<b>Attorney Docket No.:</b> 005513.P003	<b>Application Number:</b> 10/033,327
	<b>First Named Inventor:</b> Ulrich Martin Graf	
	<b>Filing Date:</b> 11/2/01	

U.S. PATENT DOCUMENTS						
Exam. Initial*	Cite No. <sup>1</sup>	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code <sup>2</sup> (If known)			
		5,956,382		Wiener-Avnear et al.	9/21/99	
		20030007601A1		Jaffray et al.	1/9/03	

FOREIGN PATENT DOCUMENTS								
Exam. Initial*	Cite No. <sup>1</sup>	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>6</sup>
		Office <sup>3</sup> Code <sup>5</sup>	Number <sup>4</sup>	Kind (If known)				

<b>Examiner Signature</b>		<b>Date Considered</b>	
---------------------------	--	------------------------	--

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup>Unique citation designation number. <sup>2</sup>See attached Kinds of U.S. Patent Documents. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard S.3). <sup>4</sup>For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup>Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, PO Box 1450, Alexandria, Virginia 22313-1450.



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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NOTICE OF ALLOWANCE AND FEE(S) DUE

008791 7590 06/28/2004
BLAKELY SOKOLOFF TAYLOR & ZAFMAN
12400 WILSHIRE BOULEVARD, SEVENTH FLOOR
LOS ANGELES, CA 90025

EXAMINER

HO, ALLEN C

ART UNIT PAPER NUMBER

2882

DATE MAILED: 06/28/2004

Table with 5 columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO.
10/033,327 11/02/2001 Ulrich Martin Graf 005513.P003 9666

TITLE OF INVENTION: RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

Table with 6 columns: APPLN. TYPE, SMALL ENTITY, ISSUE FEE, PUBLICATION FEE, TOTAL FEE(S) DUE, DATE DUE
nonprovisional NO \$1330 \$300 \$1630 09/28/2004

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

[ ] Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

**PART B - FEE(S) TRANSMITTAL**

**C** mplete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**  
**Commissioner for Patents**  
**P.O. Box 1450**  
**Alexandria, Virginia 22313-1450**  
**or Fax** **(703) 746-4000**

**INSTRUCTIONS:** This form should be used for transmitting the **ISSUE FEE** and **PUBLICATION FEE** (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

008791                      7590                      06/28/2004

**BLAKELY SOKOLOFF TAYLOR & ZAFMAN**  
**12400 WILSHIRE BOULEVARD, SEVENTH FLOOR**  
**LOS ANGELES, CA 90025**

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

**Certificate of Mailing or Transmission**

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666

TITLE OF INVENTION: **RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT**

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1330	\$300	\$1630	09/28/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
HO, ALLEN C	2882	378-065000

<p>1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).</p> <p><input type="checkbox"/> Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.</p> <p><input type="checkbox"/> "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.</p>	<p>2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.</p> <p>1 _____</p> <p>2 _____</p> <p>3 _____</p>
--	---

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE \_\_\_\_\_ (B) RESIDENCE: (CITY and STATE OR COUNTRY) \_\_\_\_\_

Please check the appropriate assignee category or categories (will not be printed on the patent);     individual     corporation or other private group entity     government

<p>4a. The following fee(s) are enclosed:</p> <p><input type="checkbox"/> Issue Fee</p> <p><input type="checkbox"/> Publication Fee</p> <p><input type="checkbox"/> Advance Order - # of Copies _____</p>	<p>4b. Payment of Fee(s):</p> <p><input type="checkbox"/> A check in the amount of the fee(s) is enclosed.</p> <p><input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.</p> <p><input type="checkbox"/> The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).</p>
---	---

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) \_\_\_\_\_ (Date) \_\_\_\_\_

**NOTE:** The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.** SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMIT THIS FORM WITH FEE(S)



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

Table with columns: APPLICATION NO., FILING DATE, FIRST NAMED INVENTOR, ATTORNEY DOCKET NO., CONFIRMATION NO., EXAMINER, ART UNIT, PAPER NUMBER. Includes application details for Ulrich Martin Graf and examiner HO, ALLEN C.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 190 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 190 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

any

<b>Notice of Allowability</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	10/033,327	GRAF, ULRICH MARTIN	
	<b>Examiner</b>	<b>Art Unit</b>	
	Allen C. Ho	2882	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1.  This communication is responsive to RCE filed on 23 April 2004.
2.  The allowed claim(s) is/are 1-26.
3.  The drawings filed on 06 October 2003 are accepted by the Examiner.
4.  Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
  - a)  All    b)  Some\*    c)  None    of the:
    1.  Certified copies of the priority documents have been received.
    2.  Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
    3.  Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.  
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5.  A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6.  CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.
  - (a)  including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached
    - 1)  hereto or 2)  to Paper No./Mail Date \_\_\_\_\_.
  - (b)  including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7.  DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- |  |  |
|--|--|
| 1. <input type="checkbox"/> Notice of References Cited (PTO-892)   | 5. <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)            |
| 2. <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 6. <input type="checkbox"/> Interview Summary (PTO-413),<br>Paper No./Mail Date _____. |
| 3. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08),<br>Paper No./Mail Date <u>032004, 042004</u> | 7. <input type="checkbox"/> Examiner's Amendment/Comment                               |
| 4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit<br>of Biological Material                                     | 8. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance   |
|  | 9. <input type="checkbox"/> Other _____.   |

## DETAILED ACTION

### *Allowable Subject Matter*

1. Claims 1-26 are allowed.
2. The following is an examiner's statement of reasons for allowance:

With respect to claims 1, 3-10, 12, and 13, the prior art fails to teach or fairly suggest an apparatus comprising a first therapeutic radiation source attached to a first gantry, a second rotatable gantry attached to the first gantry, and an imager attached to an articulable end of the second gantry as claimed.

With respect to claim 2, the prior art fails to teach or fairly suggest an apparatus comprising at least one second radiation source attached to the first gantry, and an imager attached to an articulable end of a second rotatable gantry as claimed.

With respect to claim 11, the prior art fails to teach or fairly suggest an apparatus comprising a second rotatable gantry that is capable of extending and retracting the second radiation source attached to the second gantry, and an imager attached to an articulable end of the second gantry as claimed.

With respect to claims 14-21, the prior art fails to teach or fairly suggest a method for applying radiation comprising positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic x-ray source, positioning a therapeutic radiation source to be in alignment with the target volume, and repositioning the imager to receive radiation from the therapeutic radiation source as claimed.

With respect to claims 22-25, the prior art fails to teach a method for imaging radiation comprising retracting the first radiation source and positioning a second radiation source along the first axis as claimed.

With respect to claim 26, the prior art fails to teach or fairly suggest an apparatus comprising a therapeutic energy source attached to a first gantry, a diagnostic x-ray energy source attached to a retractable end of a second gantry, a multiple-energy imaging unit attached to an opposite articulable end of the second gantry, and the first gantry and the second gantry independently pivotable and attached at a common axis as claimed.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

#### ***Response to Arguments***

3. Applicant's arguments filed 23 April 2004 with respect to the drawings have been fully considered and are persuasive. The objection of the drawings has been withdrawn.
4. Applicant's arguments filed 23 April 2004 with respect to objections of claims 4 and 5 have been fully considered and are persuasive. The objections of claims 4 and 5 have been withdrawn.
5. Applicant's arguments filed 23 April 2004 with respect to rejections of claims 1-27 under 35 U.S.C § 112 have been fully considered and are persuasive. The rejections of claims 1-27 under 35 U.S.C § 112 have been withdrawn.

6. Applicant's arguments filed 23 April 2004 with respect to rejections of claims 1, 3-10, 12, and 13 under 35 U.S.C § 103(a) have been fully considered and are persuasive. The rejections of claims 1, 3-10, 12, and 13 under 35 U.S.C § 103(a) have been withdrawn.

*Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allen C. Ho whose telephone number is (571) 272-2491. The examiner can normally be reached on Monday - Friday from 8:00 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward J. Glick can be reached at (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Allen C. Ho  
Patent Examiner  
Art Unit 2882

ACH

  
EDWARD J. GLICK  
SUPERVISORY PATENT EXAMINER

<b>STATEMENT BY APPLICANT</b> (use as many sheets as necessary)			Filing Date	November 2, 2001
			First Named Inventor	Ulrich Martin Graf
			Art Unit	2882
			Examiner Name	Ho, Allen C.
			Attorney Docket Number	5513P003
Sheet	1	of	5	

U.S. PATENT DOCUMENTS						
Examiner Initials*	Cite No.†	Document Number		Publication Date or Issue Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number - Kind Code* (if known)				
ACH		US-6,144,875		11-07-2000	Schweikard et al.	
ACH		US-6,041,097		03-21-2000	Roos et al.	
ACH		US-6,381,302		04-30-2002	Berestov	
ACH		US-6,385,286		05-07-2002	Fitchard et al.	
ACH		US-4,149,247		04-10-1979	Pavkovich et al.	
ACH		US-4,149,248		04-10-1979	Pavkovich et al.	
ACH		US-5,099,505		03-24-1992	Seppi et al.	
ACH		US-5,117,445		05-26-0992	Seppi et al.	
ACH		US-5,168,532		12-01-1992	Seppi et al.	
ACH		US-5,335,255		08-02-1994	Seppi et al.	
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ACH		US-6,222,901		04-24-2001	Meulenbrugge et al.	
ACH		US-2001/0008271		07-19-2001	Ikeda et al.	
ACH		US-5,438,991		08-08-1995	Yu et al.	
ACH		US-6,104,778		08-15-2000	Murad	
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		US-				
		US-				

FOREIGN PATENT DOCUMENTS							
Examiner Initials*	Cite No.†	Foreign Patent Document		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T*
		Country Code* - Number* - Kind Code* (if known)					
ACH		EP 0480035 B1		11-09-1994			

Examiner Signature	Allen C. Ho	Date Considered	11.06.2004
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†Applicant's unique citation designation number (optional). \*See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. †Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). \*For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. †Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 18 if possible. †Applicant is to place a check mark here if English language Translation is attached.

Based on PTO/SB/08A (08-03) as modified by Blakely, Sokoloff, Taylor & Zafman (wtr) 08/11/2003.

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**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor	Ulrich Martin Graf
Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513P003

Sheet **2** of **5**

**NON PATENT LITERATURE DOCUMENTS**

Examiner Initials*	Cite No. <sup>1</sup>	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T <sup>2</sup>
ACH		RAGAN, "Correction for Distortion in a Beam Outline Transfer Device in Radiotherapy CT-Based Simulation", Med. Phys. 20 (1), Jan/Feb 1993, pgs. 179-185.	
ACH		KUHN, "AIM Project A2003: COmputer VIsion in RAdiology (COVIRA)", Computer Methods and Programs in Biomedicine, 1994, Citation from Dissertation Abstracts, 1 page.	
ACH		KEYS, "A CCTV-Microcomputer Biostereometric System for Use in Radiation Therapy (Topography, Medical Physics, Tissue Compensators)", 1984, Citation from Energy Science and Technology, 1 page.	
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ACH		MOHAN, "Intersection of Shaped Radiation Beams with Arbitrary Image Sections", Comput Methods Programs Biomed, 1987, 1 page.	
ACH		BREWSTERFUAUF, "Automatic Generation of Beam Apertures", Medical Physics, 1993, 1 page.	
ACH		HARA et al., "Radiotherapeutic System", 00480035/EP-B1, Citation from World Patent, 1 page.	

1994

Examiner Signature	Allen C. Ho	Date Considered	11.06.2001
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<sup>1</sup>Applicant's unique citation designation number. <sup>2</sup>Applicant is to place a check mark here if English language Translation is attached.

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Substitute for form 1449A/PTO		<i>Complete if Known</i>	
<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b>		Application Number	10/033,327
		Filing Date	November 2, 2001
Sheet <span style="margin-left: 100px;">3</span> of <span style="margin-left: 100px;">5</span>		First Named Inventor	Ulrich Martin Graf
		Art Unit	2882
		Examiner Name	Ho, Allen C.
		Attorney Docket Number	5513P003

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.†	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T‡
ACH		MOORE, "Radiation Image Generating System and Method", 1992020202/WO-A1, 1 page.	
ACH		SEPEI, "Computed Tomography Apparatus Using Image Intensifier Detector", 1992000567/WO-A1, 1 page.	
ACH		BOVA, "Dosimetric Technique for Stereotactic Radiosurgery", 1990014129/WO-A1, 1 page.	
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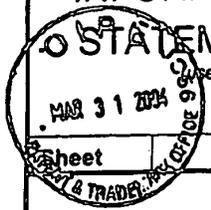
Examiner Signature	Allen C. Ho	Date Considered	11.06.2004
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Substitut for Form 1449A/PTO (Modified)		<b>C mplete if Known</b>	
<b>INFORMATION DISCLOSURE</b> <b>STATEMENT BY APPLICANT</b> <small>(Use as many sheets as necessary)</small>		Application Number	10/033,327
		Filing Date	November 2, 2001
		First Named Inventor:	Graf
		Group Art Unit	2882
		Examiner Name	Ho, Allen C.
		Attorney Docket Number	5513.0003
Sheet	4	of	5



**OTHER ART - NO PATENT LITERATURE DOCUMENTS**

Examiner Initials*	Cite No <sup>1</sup>	Include name of the author (In CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published	T <sup>2</sup>
ACH		BALTER, James M. et al., "Daily Targeting of Intrahepatic Tumors for Radiotherapy," Int. J. Radiation Oncology Biol. Phys., vol. 52, no. 1 (2002), pp. 266-271	
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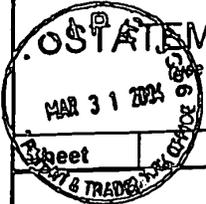
Examiner Signature	Allen C. Ho	Date Considered	11.06.2004
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<sup>1</sup>Unique citation designation number. <sup>2</sup>Applicant is to place a check mark here if English language Translation is attached.

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Substitute for Form 1449A/PTO (Modified)		<i>Complete if Known</i>	
<b>INFORMATION DISCLOSURE</b> <b>STATEMENT BY APPLICANT</b> <small>(Use as many sheets as necessary)</small>		Application Number	10/033,327
		Filing Date	November 2, 2001
		First Named Inventor:	Graf
		Group Art Unit	2882
		Examiner Name	Ho, Allen C.
		Attorney Docket Number	5513.P003
Sheet	5	of	5



**OTHER ART - NO PATENT LITERATURE DOCUMENTS**

Examiner Initials*	Cite No <sup>1</sup>	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published	T <sup>2</sup>
ACH		PISANI, Laura, M.S. et al., "Setup Error in Radiotherapy: On-line Correction Using Electronic Kilovoltage and Megavoltage Radiographs," Int. J. Radiation Oncology Biol. Phys., vol. 47, no. 3 (2000), pp. 825-839	
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ACH		FELDKAMP, L.A. et al. "Practical Cone-Beam Algorithm," J. Opt. Soc. Am. A., vol. 1, no. 6, June 1984; pp. 612-619	
ACH		SIEWERDSEN, Jeffery H. and JAFFRAY, David A., "Optimization of X-Ray Imaging Geometry (With Specific Application to Flat-Panel Cone-Beam Computed Tomography)," Med. Phys., vol. 27, no. 8, August 2000, pp. 1903-1914	
ACH		SIEWERDSEN, Jeffery H. and JAFFRAY, David A., "Cone-Beam Computed Tomography With a Flat-Panel Imager: Magnitude and Effects of X-Ray Scatter," Med. Phys., vol. 28, no. 2, February 2001, pp. 220-231	
ACH		CHO, Paul S. et al., "Cone-Beam CT for Radiotherapy Applications," Phys. Med. Biol., vol. 40 (1995), pp. 1863-1883	

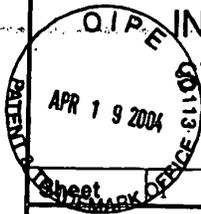
Examiner Signature	Allen C. Ho	Date Considered	11.06.2004
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<sup>1</sup>Unique citation designation number. <sup>2</sup>Applicant is to place a check mark here if English language Translation is attached.

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**INFORMATION DISCLOSURE STATEMENT BY APPLICANT**  
(use as many sheets as necessary)

**Complete if Known**

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor:	Ulrich Martin Graf
Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513P003

of 3

**U.S. PATENT DOCUMENTS**

Examiner Initials*	Cite No. <sup>1</sup>	Document Number		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code <sup>2</sup> (if known)				
ACH		US-	4,208,675	6/17/1980	Bajon et al.	
ACH		US-	4,521,808	6/4/1985	Ong et al.	
ACH		US-	4,593,967	6/10/1986	Haugen	
ACH		US-	4,675,731	6/23/1987	Takasu et al.	
ACH		US-	4,679,076	7/7/1987	Vikterlof et al.	
ACH		US-	4,741,621	5/3/1988	Taft et al.	
ACH		US-	4,825,393	4/25/1989	Nishiya	
ACH		US-	4,853,777	8/1/1989	Hupp	
ACH		US-	4,868,844	9/19/1989	Nunan	
ACH		US-	3,144,552	8/11/1964	Schonberg	
ACH		US-	5,080,100	1/14/1992	Trotel	
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**FOREIGN PATENT DOCUMENTS**

Examiner Initials*	Cite No. <sup>1</sup>	Foreign Patent Document			Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>o</sup>
		Country Code <sup>3</sup>	Number <sup>4</sup>	Kind Code <sup>5</sup> (if known)				
ACH		PCT	WO 85/03212 A1		8/1/1985	Michaels		
ACH		EP	0062941 B1		9/26/1984	De Vogel		
ACH		EP	0205720 A1		12/30/1986	Brahme		
ACH		FR	2 269 745					
ACH		FR	2 551 664					

Examiner Signature	<i>Allen C. Ho</i>	Date Considered	22.06.2004
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This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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Based on Form PTO/SB/08A (08-03) as modified by BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP on 09/10/03.





<b>Issu Classification</b> 	Application No.	Applicant(s)	
	10/033,327	GRAF, ULRICH MARTIN	
	Examiner	Art Unit	
Allen C. Ho	2882		

ISSUE CLASSIFICATION										
ORIGINAL					CROSS REFERENCE(S)					
CLASS	SUBCLASS				CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
378	65				378	197				
INTERNATIONAL CLASSIFICATION										
A	6	1	N	5/10						
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<i>Allen C. Ho</i> Allen C. Ho 11.06.2004 (Assistant Examiner) (Date)	<b>EDWARD J. GLICK</b> <b>SUPERVISORY PATENT EXAMINER</b> <i>Edward J. Glick</i> (Primary Examiner) (Date)	Total Claims Allowed: 26  O.G. Print Claim(s) 1  O.G. Print Fig 3B
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<input type="checkbox"/> Claims renumbered in the same order as presented by applicant		<input type="checkbox"/> CPA		<input type="checkbox"/> T.D.		<input type="checkbox"/> R.1.47	
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**Index of Claims**



Application No.

10/033,327

Examiner

Allen C. Ho

Applicant(s)

GRAF, ULRICH MARTIN

Art Unit

2882

√	Rejected
=	Allowed

-	(Through numeral) Cancelled
+	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

Claim		Date			
Final	Original	6/11/04			
1	1	=			
12	2	=			
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**PATENT APPLICATION FEE DETERMINATION RECORD**  
Effective October 1, 2003

Application or Docket Number

*RCE*

*10/033327*

**CLAIMS AS FILED - PART I**

*423.04*

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20=	*
INDEPENDENT CLAIMS	minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT <input type="checkbox"/>		

\* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE  OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL		OR	TOTAL	

**CLAIMS AS AMENDED - PART II**

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	* <i>26</i>	Minus ** <i>27</i>	= <i>1</i>
Independent	* <i>6</i>	Minus *** <i>6</i>	= <i>1</i>
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus **	=
Independent	*	Minus ***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus **	=
Independent	*	Minus ***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.  
 \*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."  
 \*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."  
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

**Index of Claims**



10/033,327

Examiner

Allen C. Ho

GRAF, ULRICH MARTIN

Art Unit

2882

✓	Rejected
=	Allowed

-	(Through numeral) Cancelled
+	Restricted

N	N n-Elected
I	Interference

A	Appeal
O	Objected

Claim	Date
Final	Original
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Image

RCE 2882

## REQUEST FOR CONTINUED EXAMINATION (RCE) TRANSMITTAL

Address to:  
Mail Stop RCE  
Commissioner for Patents  
P.O. 1450  
Alexandria, VA 22313-1450

Application No.	10/033,327
Filing Date	November 2, 2001
First Named Inventor	Ulrich Martin Graf
Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513P003

**This is a Request for Continued Examination (RCE) under 37 C.F.R. § 1.114 of the above-identified application.**  
Request for Continued Examination (RCE) practice under 37 CFR § 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 C.F.R. § 1.114** Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).
- a.  Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
    - i.  Consider the amendment(s)/reply under 37 C.F.R. § 1.116 previously filed on  
(Any unentered amendment(s) referred to above will be entered).
    - ii.  Consider the arguments in the Appeal Brief or Reply Brief previously filed on
    - iii.  Other \_\_\_\_\_
  - b.  Enclosed
    - i.  Amendment/Reply
    - ii.  Affidavit(s)/Declaration(s)
    - iii.  Information Disclosure Statement (IDS)
    - iv.  Other \_\_\_\_\_

2. **Miscellaneous**
- a.  Suspension of action on the above-identified application is requested under 37 C.F.R. § 1.103(c) for a period of months. (Period of suspension shall not exceed 3 months; Fee under 37 C.F.R. § 1.17(i) required)
  - b.  Other \_\_\_\_\_

3. **Fees** The RCE fee under 37 C.F.R. § 1.17(e) is required by 37 C.F.R. § 1.114 when the RCE is filed.
- a.  The Director is hereby authorized to charge the following fees, or credit any overpayments, to Deposit Account No. 02-2666.
    - i.  RCE fee required under 37 C.F.R. § 1.17(e) and any additional claims fee(s)
    - ii.  Extension of time fee (37 C.F.R. § 1.136 and 1.17)
    - iii.  Other: (\$00)
  - b.  Check in the amount of \$770.00 enclosed      04/26/2004 MANNED1 00000129 10033327      01 FC:1801      770.00 OP
  - c.  Payment by credit card (Form PTO-2038 enclosed)

**WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**

### SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Name (Print/Type)	Andre M. Gibbs	Registration No. (Attorney/Agent)	47,593
Signature		Date	April 20, 2004

### CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.  
April 20, 2004

Name (Print/Type)	Esther L. Campbell	Date	April 20, 2004
Signature		Date	April 20, 2004

Based on PTO/SB/30 (09-03) as modified by Blakely, Solokoff, Taylor & Ziffman (w/r) 02/10/2004.  
SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



# FEE TRANSMITTAL for FY 2004

Effective 10/01/2004. Patent fees are subject to annual revision.

Applicant claims small entity status. See 37 CFR 1.27.

**TOTAL AMOUNT OF PAYMENT** (\$) **770.00**

Complete if Known

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor	Ulrich Martin Graf
Examiner Name	Ho, Allen C.
Art Unit	2882
Attorney Docket No.	5513P003

## METHOD OF PAYMENT (check all that apply)

- Check   
  Credit card   
  Money Order   
  Other   
  None  
 Deposit Account

Deposit Account Number: **02-2666**

Deposit Account Name: **Blakely, Sokoloff, Taylor & Zafman LLP**

The Commissioner is authorized to: (check all that apply)

- Charge fee(s) indicated below   
  Credit any overpayments  
 Charge any additional fee(s) or underpayment of fees as required under 37 CFR §§ 1.16, 1.17, 1.18 and 1.20.  
 Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	
<b>SUBTOTAL (1)</b>					<b>(\$)</b>

### 2. EXTRA CLAIM FEES

Total Claims	27	-	27*	=	0	x	18.00	=	\$0.00
Independent Claims	7	-	7*	=	0	x	86.00	=	\$0.00
Multiple Dependent									

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	86	2201	43	Independent claims in excess of 3	
1203	290	2203	145	Multiple Dependent claim, if not paid	
1204	86	2204	43	**Reissue independent claims over original patent	
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent	
<b>SUBTOTAL (2)</b>					<b>(\$) 0.00</b>

\*\*or number previously paid, if greater. For Reissues, see below

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
2053	130	2053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for <i>ex parte</i> reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	1,210	2255	605	Extension for reply within fifth month	
1404	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	2451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	2460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	1809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	770.00
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify)					
<b>SUBTOTAL (3)</b>					<b>(\$) 770.00</b>

\*Reduced by Basic Filing Fee Paid

## SUBMITTED BY

Name (Print/Type)	<b>Andre M. Gibbs</b>	Registration No. (Attorney/Agent)	<b>47,593</b>	Telephone	<b>(408) 720-8300</b>
Signature		Date	<b>04/20/04</b>		

Based on PTO/SB/17 (10-03) as modified by Blakely, Sokoloff, Taylor & Zafman (w/r) 02/10/2004.  
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

005513P003  
042004/AMG:elc

Patent



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Application of:  
Ulrich Martin Graf  
Serial No. 10/033,327  
Filed: November 2, 2001  
Attorney Docket No. 005513P003  
For: RADIOTHERAPY APPARATUS  
EQUIPPED WITH AN  
ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

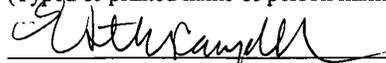
EXAMINER: HO, ALLEN C.  
ART UNIT: 2882

Mail Stop RCE  
Commissioner for Patents  
PO Box 1450  
Alexandria, Virginia 22313-1450

PRELIMINARY AMENDMENT

A Request for Continued Examination is filed herewith. It is respectfully requested that such examination be conducted after entry of the following amendments.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on April 20, 2004.

Esther L. Campbell  
(Typed or printed name of person mailing correspondence)  
  
(Signature of person mailing correspondence)

IN THE CLAIMS

1. (Previously presented) An apparatus comprising:  
a first therapeutic radiation source attached to a first gantry;  
at least one second radiation source;  
a second gantry that is rotatable, the second gantry is attached to the first gantry;  
and  
an imager attached to an articulable end of the second gantry.
  
2. (Previously presented) An apparatus comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source, wherein the at least one second radiation source is attached to the first gantry;  
a second gantry that is rotatable; and  
an imager attached to an articulable end of the second gantry.
  
3. (Original) The apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.
  
4. (Currently amended) The apparatus of claim 1, wherein the first therapeutic radiation source to propagate is capable of propagating therapeutic energy at a first energy level.

5. (Currently amended) The apparatus of claim 1, wherein at least one second radiation source to propagate is capable of propagating diagnostic energy at a second energy level.
6. (Original) The apparatus of claim 1, wherein the first gantry is rotatable.
7. (Original) The apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis.
8. (Original) The apparatus of claim 1, wherein the imager is a multiple-energy imaging unit.
9. (Currently amended) The apparatus of claim 1, wherein the articulable end comprises includes at least one pivot point between the second gantry and the imager.
10. (Currently amended) The apparatus of claim 1, wherein the articulable end comprises includes a sliding mechanism capable of translating the imager in a plane.
11. (Currently amended) An apparatus comprising:
  - a first radiation source attached to a first gantry;
  - at least one second radiation source;
  - a second gantry that is rotatable, wherein the second gantry is one of the at least one second radiation source is attached to a sliding mechanism capable of extending and

retracting the second radiation source attached to ~~from~~ the second gantry; and  
an imager attached to an articulable end of the second gantry.

12. (Original) The apparatus of claim 1, wherein the articulable end is capable of folding the imager against the second gantry.

13. (Original) The apparatus of claim 7, wherein the second gantry is nestled within the first gantry.

14. (Currently amended) A method for applying radiation, comprising:

positioning a diagnostic X-ray ~~radiation~~-source to be in alignment with a target volume;

positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic X-ray ~~radiation~~-source;

positioning a therapeutic radiation source to be in alignment with the target volume; and

re-positioning the imager to receive radiation from the therapeutic radiation source.

15. (Currently amended) The method of claim 14, further comprising:

propagating ~~the diagnostic~~ X-ray radiation from the diagnostic X-ray source toward the target volume;

receiving the diagnostic X-ray radiation by on the imager after passing through the target volume;

positioning the therapeutic radiation source is based on results of the diagnostic X-ray radiation to the imager;

propagating the therapeutic radiation into the target volume;

receiving the therapeutic radiation by the imager after passing through the target volume; and

generating verification data by the imager from the therapeutic radiation.

16. (Original) The method of claim 14, wherein the imager is a multiple-energy imaging unit.

17. (Currently amended) The method of claim 14, further comprising[[;]] placing an internal seed to act as a marker for the target volume.

18. (Currently amended) The method of claim 15, further comprising generating multiple diagnostic X-ray radiation slices using a fan X-ray beam to provide a 3-dimensional reconstruction of the target volume.

19. (Original) The method of claim 15, further comprising generating a cone X-ray beam where volumetric information can be constructed.

20. (Currently amended) The method of claim 15, wherein the diagnostic X-ray radiation can be operated continuously to provide real time a fluoroscopic image of moving internal anatomy.
21. (Currently amended) The method of claim 15, wherein the diagnostic X-ray radiation can be operated in a pulsed manner to provide a quasi-real time fluoroscopic image of moving internal anatomy.
22. (Original) A method for imaging radiation, comprising:  
positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level;  
propagating radiation by a first radiation source at the first energy level along the first axis;  
retracting the first radiation source and positioning a second radiation source along the first axis.  
maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source; and  
propagating radiation by the second radiation source.
23. (Original) The method of claim 22, further comprising:  
rotating the first radiation source until clear of the second radiation source;  
extending the first radiation source to be in line with the multiple-energy imaging unit;

propagating radiation at a first energy level toward the multiple-energy imaging unit.

24. (Original) The method of claim 22, further comprising pivoting two arms independently, the first arm attached to the first radiation source for propagating at the first energy level, and the second arm attached to the second radiation source for propagating at the second energy level.

25. (Original) The method of claim 24, wherein the multiple-energy imaging unit is attached to the second arm.

26. (Currently amended) An apparatus, comprising:

a therapeutic energy source attached to a first gantry;

a diagnostic X-ray energy source attached to a retractable ~~translatable~~ end of a second gantry;

a multiple-energy imaging unit attached to an opposite articulable end of the second gantry;

the first gantry and the second gantry independently pivotable and attached at a common axis;

a patient couch capable of translation, wherein the result of such pivoting and translation is to place a target volume of a patient between the multiple-energy imaging unit aligned with the diagnostic energy source or the therapeutic energy source.

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042004/AMG:elc

Patent

27. (Cancelled)

REMARKS

Applicant respectfully requests non-entry of the previously filed unentered amendment dated March 29, 2004.

Claims 4-5, 9-11, 14-15, 17-18, 20-21, and 26 have been amended to more properly define preexisting claim limitations and are supported by the specification. Claim 27 has been cancelled without prejudice. No new matter has been added. Claims 2, 11, and 14-24 are indicated as allowable. Therefore, the following comments are directed to the objected to and rejected claims.

***Objections to the Drawings and Specification***

The drawings were objected to under 37 CFR 1.83(a). Applicant submits that claims 11 and 26 as amended have overcome the objections. Accordingly, applicant requests this objection be withdrawn.

***Claims Objections***

Claims 4 and 5 were objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant submits that claims 4 and 5 as amended have overcome the objections. Accordingly, applicant requests this objection be withdrawn.

### **Rejections Under 35 U.S.C. § 112**

Claims 1-27 were rejected under 35 U.S.C. § 112, first paragraph, because the specification, while being enabling for a diagnostic X-ray source, does not reasonably provide enablement for a diagnostic radiation source.

Applicant submits claims 1-13 and 22-27 do not recite a diagnostic radiation source as rejected under 35 U.S.C. §112, first paragraph. Furthermore, applicant submits that a diagnostic radiation source is enabled by the specification. Nonetheless, claims 14, 15, 18, 20, 21, and 26 have been amended to claim a diagnostic X-ray source, which the Examiner has agreed is enabled, in order to obtain allowance of these claims. Therefore, applicant respectfully requests the rejection to claims 1-26 be withdrawn under 35 U.S.C. §112. Applicant notes that Applicant does not concede that claims 14, 15, 18, 20, 21 and 26 prior to amendment were not enabled and reserves its rights to file a continuation application containing such claims should Applicant so desire.

### **Rejections Under 35 U.S.C. § 103(a)**

Claims 1, 3-10, 12 and 13 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,104,780 of Hanover ("Hanover") in view of U.S. Patent No. 6,325,537 of Watanabe ("Watanabe").

Neither Hanover nor Watanabe, either alone or in combination, teach or suggest an apparatus having a therapeutic energy source, as claimed. Rather, both Hanover and Watanabe disclose use of a diagnostic apparatus. Specifically, Hanover discloses "imaging systems 12 and 14 include first and second X-ray sources 40 and 42 and first and second image receptors 44 and 46 as known generally *in the X-ray diagnostic art*,

mounted upon opposing locations, respectively, on the C-arms 12 and 14.” Emphasis added (Hanover, column 5, lines 19-23). Also, Watanabe discloses “*an X-ray diagnosis apparatus* capable of exactly and easily achieving various positioning and *applicable to a wide range of diagnostic uses.*” Emphasis added (Watanabe, column 2, lines 31-33).

A diagnostic X-ray typically has low energy X-rays, which are less harmful to healthy tissue and more useful to provide accurate diagnostic information because tissue in the human body is typically of low density. In contrast, therapeutic X-rays consist of high energy X-rays to treat unhealthy tissue, such as a cancerous tumor. Also, the images produced from therapeutic X-rays are of low contrast and insufficient quality. Both Hanover and Watanabe explicitly disclose the use of diagnostic X-rays, and *not a first therapeutic radiation source* attached to a first gantry, as recited in claim 1.

Accordingly, applicant respectfully submits that claim 1 is not obvious under 35 USC 103(a) over Hanover in view of Watanabe. Therefore, applicant respectfully requests the rejection to claims 1 and 26 be withdrawn. Claims 3-10, 12, and 13 are dependent (directly or indirectly) on claim 1. Therefore, applicant respectfully requests the rejection to claims 3-10, 12, and 13 be withdrawn, at least for the reasons stated above for claim 1.

In conclusion, applicant respectfully submits that in view of the arguments and amendments set forth herein, the applicable objections and rejections have been overcome. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact André Gibbs at (408) 720-8300.

005513P003  
042004/AMG:elc

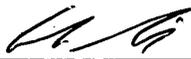
Patent

If there are any additional charges, please charge our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: April 20, 2004

  
\_\_\_\_\_  
André Gibbs  
Registration No. 47,593

12400 Wilshire Boulevard  
Seventh Floor  
Los Angeles, CA 90025-1026  
(408) 720-8300

**PATENT APPLICATION FEE DETERMINATION RECORD**  
Effective October 1, 2003

Application or Docket Number

10/033327

**CLAIMS AS FILED - PART I**

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	minus 20= *	
INDEPENDENT CLAIMS	minus 3 = *	
MULTIPLE DEPENDENT CLAIM PRESENT <input type="checkbox"/>		

SMALL ENTITY TYPE  OR OTHER THAN SMALL ENTITY

RATE	FEE	OR	RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
X\$ 9=		OR	X\$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL		OR	TOTAL	

\* If the difference in column 1 is less than zero, enter "0" in column 2

**CLAIMS AS AMENDED - PART II**

3/31/04

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT A	NE	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR
Total	* 27	Minus	** 27 =
Independent	* 6	Minus	*** 6 =
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR
Total	*	Minus	** =
Independent	*	Minus	*** =
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT C		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR
Total	*	Minus	** =
Independent	*	Minus	*** =
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>			

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.  
 \*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."  
 \*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."  
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

**Index of Claims**



Applicati n N .

10/033,327

Examiner

Allen C. Ho

Applicant(s)

GRAF, ULRICH MARTIN

Art Unit

2882

√	Rejected
=	Allowed

-	(Through numeral) Cancelled
+	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

Claim		Date			
Final	Original	1/2/04			
1	√				
2	√				
3	√				
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O I P E  
 APR 19 2004  
 PATENT & TRADEMARK OFFICE

*9802*

<b>TRANSMITTAL FORM</b> <i>(to be used for all correspondence after initial filing)</i>		Application No.	10/033,327
		Filing Date	November 2, 2001
		First Named Inventor	Ulrich Martin Graf
		Art Unit	2882
		Examiner Name	Ho, Allen C.
Total Number of Pages in This Submission	30	Attorney Docket Number	5513P003

ENCLOSURES (check all that apply)		
<input checked="" type="checkbox"/> Fee Transmittal Form <input checked="" type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment / Response <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input checked="" type="checkbox"/> Information Disclosure Statement <input checked="" type="checkbox"/> PTO/SB/08 <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Response to Missing Parts/Incomplete Application <input type="checkbox"/> Basic Filing Fee <input type="checkbox"/> Declaration/POA <input type="checkbox"/> Response to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation, Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s)	<input type="checkbox"/> After Allowance Communication to Group <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to Group (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">         21 Cited references and Return Receipt postcard       </div>
Remarks		

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT	
Firm or Individual name	Andre M. Gibbs, Reg. No. 47,593 BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
Signature	<i>[Signature]</i>
Date	April 14, 2004

CERTIFICATE OF MAILING/TRANSMISSION			
I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.			
Typed or printed name	Esther L. Campbell		
Signature	<i>[Signature]</i>	Date	April 14, 2004

Based on PTO/SB/21 (02-04) as modified by Blakely, Sokoloff, Taylor & Zafman (wlr) 02/10/2004.  
 SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



# FEE TRANSMITTAL for FY 2004

Effective 10/01/2004. Patent fees are subject to annual revision.

Applicant claims small entity status. See 37 CFR 1.27.

**TOTAL AMOUNT OF PAYMENT** (\$) **180.00**

Complete if Known

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor	Ulrich Martin Graf
Examiner Name	Ho, Allen C.
Art Unit	2882
Attorney Docket No.	5513P003

## METHOD OF PAYMENT (check all that apply)

- Check   
  Credit card   
  Money Order   
  Other   
  None  
 Deposit Account

Deposit Account Number: **02-2666**

Deposit Account Name: **Blakely, Sokoloff, Taylor & Zafman LLP**

The Commissioner is authorized to: (check all that apply)

- Charge fee(s) indicated below   
  Credit any overpayments  
 Charge any additional fee(s) or underpayment of fees as required under 37 CFR §§ 1.16, 1.17, 1.18 and 1.20.  
 Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	
SUBTOTAL (1)					(\$)

### 2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
27	27*	0	\$0.00
7	7*	86.00	\$0.00

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	86	2201	43	Independent claims in excess of 3	
1203	290	2203	145	Multiple Dependent claim, if not paid	
1204	86	2204	43	**Reissue independent claims over original patent	
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent	
SUBTOTAL (2)					(\$) 0.00

\*or number previously paid, if greater, For Reissues, see below

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
2053	130	2053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for <i>ex parte</i> reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	1,210	2255	605	Extension for reply within fifth month	
1404	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	2451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	2460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	180.00
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	1809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify)					
*Reduced by Basic Filing Fee Paid					
SUBTOTAL (3)					(\$) 180.00

## SUBMITTED BY

Name (Print/Type)	Andre M. Gibbs	Registration No. (Attorney/Agent)	47,593	Telephone	(408) 720-8300
Signature		Date	04/14/04		

Based on PTO/SB/17 (10-03) as modified by Blakely, Solokoff, Taylor & Zafman (w/r) 02/10/2004.  
 SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



Docket No.: 5513P003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:

ULRICH MARTIN GRAF

Application No.: 10/033,327

Filed: November 2, 2001

For: **Radiotherapy Apparatus Equipped with an  
Articulable Gantry for Positioning an  
Imaging Unit**

Art Group: 2882

Examiner: Ho, Allen C.

**INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. §1.97**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

In accordance with the duty of disclosure, enclosed is a copy of IDS Citation Form PTO/SB/08 or PTO-1449, together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed for applications filed after June 30, 2003). This IDS and IDS Citation Form are being submitted before the mailing of a Notice of Allowance. It is respectfully requested that the cited references be considered and that the enclosed copy of PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

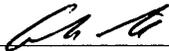
04/21/2004 #BERHE 00000009 10033327  
01 FC:1806 180.00 OP

The submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made in the subject application and is not to be construed as an admission that the information cited in this statement is material to patentability.

Respectfully submitted,

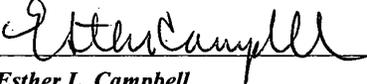
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: April 14, 2004

  
\_\_\_\_\_  
Andre M. Gibbs, Reg. No. 47,593

12400 Wilshire Boulevard, 7th Floor  
Los Angeles, CA 90025  
Telephone: (408) 720-8300

I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

  
\_\_\_\_\_  
*Esther L. Campbell*

04-14-04

*Date*



Substitute for Form 1449/PTO

Complete if Known



**INFORMATION DISCLOSURE STATEMENT BY APPLICANT**

(use as many sheets as necessary)

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor:	Ulrich Martin Graf
Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513P003

Sheet  of 3

**U.S. PATENT DOCUMENTS**

Examiner Initials*	Cite No. <sup>1</sup>	Document Number		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code <sup>2</sup> (if known)				
		US-	4,208,675	6/17/1980	Bajon et al.	
		US-	4,521,808	6/4/1985	Ong et al.	
		US-	4,593,967	6/10/1986	Haugen	
		US-	4,675,731	6/23/1987	Takasu et al.	
		US-	4,679,076	7/7/1987	Vikterlof et al.	
		US-	4,741,621	5/3/1988	Taft et al.	
		US-	4,825,393	4/25/1989	Nishiya	
		US-	4,853,777	8/1/1989	Hupp	
		US-	4,868,844	9/19/1989	Nunan	
		US-	3,144,552	8/11/1964	Schonberg	
		US-	5,080,100	1/14/1992	Trotel	
		US-				
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		US-				
		US-				

**FOREIGN PATENT DOCUMENTS**

Examiner Initials*	Cite No. <sup>1</sup>	Foreign Patent Document			Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>6</sup>
		Country Code <sup>3</sup>	Number <sup>4</sup>	Kind Code <sup>5</sup> (if known)				
			PCT WO 85/03212 A1		8/1/1985	Michaels		
			EP 0062941 B1		9/26/1984	De Vogel		
			EP 0205720 A1		12/30/1986	Brahme		
			FR 2 269 745					
			FR 2 551 664					

Examiner Signature		Date Considered	
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\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. <sup>1</sup>Applicant's unique citation designation number (optional). <sup>2</sup>See Kinds Codes of USPTO Patent Documents at [www.uspto.gov](http://www.uspto.gov) or MPEP 901.04. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</sup>For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. <sup>6</sup>Applicant is to place a check mark here if English language translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENT FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Substitute for Form 1449/PTO			<b>Complete if Known</b>	
 <b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> <i>(use as many sheets as necessary)</i>			Application Number	10/033,327
			Filing Date	November 2, 2001
			First Named Inventor:	Ulrich Martin Graf
			Art Unit	2882
			Examiner Name	Ho, Allen C.
Sheet	5513P003	3	Attorney Docket Number	5513P003

U.S. PATENT DOCUMENTS						
Examiner Initials*	Cite No. <sup>1</sup>	Document Number		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code <sup>2</sup> (if known)				
		US-				
		US-				
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FOREIGN PATENT DOCUMENTS								
Examiner Initials*	Cite No. <sup>1</sup>	Foreign Patent Document			Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>6</sup>
		Country Code <sup>3</sup>	Number <sup>4</sup>	Kind Code <sup>5</sup> (if known)				
		DE	42 23 488 A1					
		DE	196 14 643 A1					
		JP	HEI 5[1993]-57028	3/9/1993	Translated JP patent application			
		GB	1 328 033					

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. <sup>1</sup>Applicant's unique citation designation number (optional). <sup>2</sup>See Kinds Codes of USPTO Patent Documents at [www.uspto.gov](http://www.uspto.gov) or MPEP 901.04. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</sup>For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. <sup>6</sup>Applicant is to place a check mark here if English language translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SENT FEES OR COMPLETED FORMS TO THIS ADDRESS.

**SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.**  
 If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.





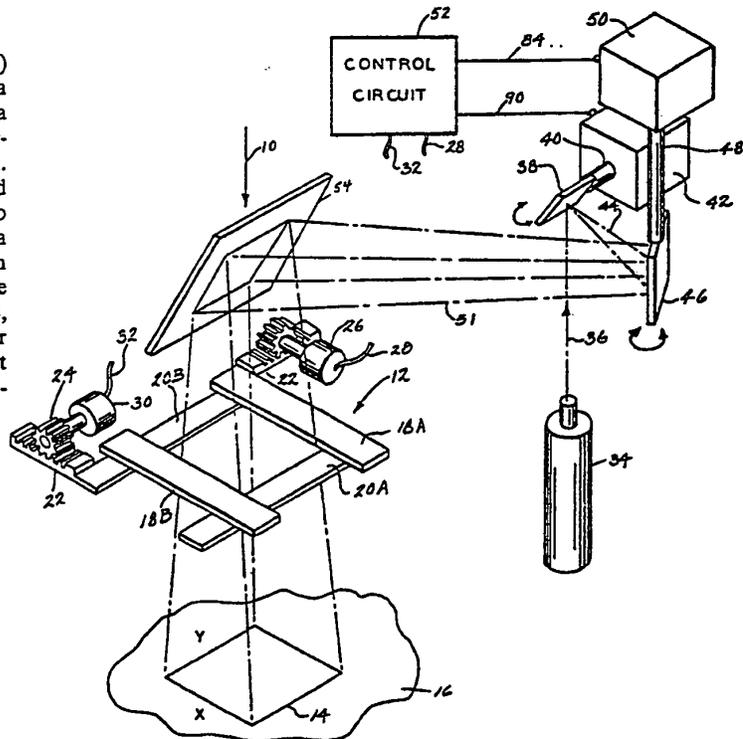
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>3</sup> : <b>A61B 6/08, G21F 5/04</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 85/ 03212</b> (43) International Publication Date: <b>1 August 1985 (01.08.85)</b></p>
<p>(21) International Application Number: <b>PCT/US84/00090</b> (22) International Filing Date: <b>18 January 1984 (18.01.84)</b> (71) Applicant: <b>LESCRENIER, Charles [US/US]; 660 Crescent Court, Wauwatosa, WI 53213 (US).</b> (72) Inventor: <b>MICHAELS, Terry, J. ; 9156 North 70th Street, Milwaukee, WI 53223 (US).</b> (74) Agents: <b>SCEALES, Merl, E. et al.; 735 North Water Street, Milwaukee, WI 53202 (US).</b> (81) Designated States: <b>AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</b></p>		<p><b>Published</b> <i>With international search report.</i></p>

(54) Title: **IMPROVED MEANS FOR VISUALLY INDICATING AN X-RAY FIELD**

(57) Abstract

A visual indicator for an X-ray field (14) includes a light generator (34) providing a beam of light (36). The light is provided to a first mirror (38) that moves about an axis normal to the beam of light to deflect the beam. The deflected beam (44) is applied to a second mirror (46) that moves about an axis normal to the first axis and applies the beam of light to a mirror (54) on the axis (10) of the X-ray beam for reflection onto the X-ray field (14). The mirrors (38, 46) are controlled by signals (28, 32) indicative of the field defining collimator leaves (18A, 18B, 20A, 20B) to cause the light beam to trace out the field defined by the collimator leaves.



***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GA	Gabon	MR	Mauritania
AU	Australia	GB	United Kingdom	MW	Malawi
BB	Barbados	HU	Hungary	NL	Netherlands
BE	Belgium	IT	Italy	NO	Norway
BG	Bulgaria	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland	ML	Mali		
FR	France				

Improved Means For Visually Indicating An X-ray Field

The present application is a continuation-in-part application of U.S. patent application Serial No. 406,217, filed August 9, 1982 and now

5 X-ray generators, particularly those used for medical purposes, employ a collimator that establishes the area or field exposed to the X-rays. Such a collimator typically includes a plurality of movable leaves that are opened and closed manually  
10 or automatically to establish the exposure area in accordance with the type of X-ray being taken, the size of film in the film cassette or magazine, the distance of the X-ray generator to the film, and other factors.

15 As the X-ray beam is not visible to the eye, it is necessary to provide some means of visually indicating the exposure field established by the collimator. In present X-ray collimators, the field is usually illuminated with visible light. An in-  
20 candescent lamp is so arranged in the collimator that the light illuminates the same area exposed to the X-rays. For this purpose, a mirror is mounted along the axis of the X-ray beam at a 45° angle to receive light from an adjacent lamp and shine it along the  
25 axis of the X-ray beam onto the area to be exposed. The size of the beam of light will be defined by the collimator leaves in the same manner as the X-ray beam so that the lighted area indicates the size of the X-ray field.

30 Such a system is simple since the same beam defining system is used for both the X-ray field and the lighted area. However, it has been difficult to obtain an adequate intensity of illumination of the lighted area. It has been particularly difficult to  
35 obtain adequate sharpness and definition at the edges of the field. And, it is the edges that actually define the limits of the field.



-2-

In an effort to provide sufficient intensity and sharpness, quartz-halogen lamps having very small filament size and high thermal dissipation must be used. The lamps are expensive and are best used only  
5 intermittently to limit heat buildup and extend service life. Even with such lamps, it is often difficult to see the edges of the X-ray beam, particularly at the ambient light levels often encountered during manual X-ray procedures.

10 It is, therefore, the object of the present invention to provide an improved apparatus for visually indicating an X-ray field that overcomes the foregoing shortcomings. The present invention provides a clear, accurate definition of the X-ray field,  
15 even in conditions of high ambient light. A particularly advantageous feature of the present invention is that it can sharply define the edges of the X-ray field without the need to illuminate the remaining, central portions of the field. The means  
20 of the present invention may be used as frequently or continuously as desired, without undesirable thermal or other effects or a lessening of service life.

Briefly, the present invention contemplates  
25 apparatus for visually indicating the field produced by an X-ray beam passing through an adjustable, field defining collimator of the X-ray equipment. The collimator contains a means for producing signals indicative of the dimensions of the field  
30 and the X-ray equipment has a mirror along the axis of the X-ray beam for reflecting a light beam onto the field.

The apparatus includes a light source generating a beam of light along the path. A first  
35 mirror receives the beam to reflect same at an angle to the path. A first drive means moves

the first mirror about an axis normal to the path of generation of the light beam responsive to a first signal to arcuately move the light beam. A second mirror receives the beam of light off the first mirror and further reflects same. A second drive means moves the second mirror about an axis parallel to the path of generation of the light beam responsive to a second signal to arcuately move the reflected light beam and to apply the reflected light beam to the mirror in the X-ray apparatus for reflection onto the field. A signal generator generates first and second signals to said first and second drive means responsive to the field dimension signals that cause said drive means to move the mirrors so that the light beam traces out the dimensions of the field defined by the collimator. The signal generating means may be of either the analog or digital type.

The invention will be further explained by the aid of the accompanying drawing in which:

Fig. 1 is a somewhat schematic, perspective view showing portions of the apparatus of the present invention;

Fig. 2 is a schematic circuit diagram showing circuitry incorporated in the apparatus of the present invention;

Fig. 3 is a graph of an output signal from the circuitry shown in Fig. 2;

Fig. 4 is a schematic diagram showing the operation of the visual indicating apparatus of the present invention in accordance with the signal shown in Fig. 3;

Fig. 5 is a graph, similar to Fig. 3, showing a pair of output signals of the circuitry of Fig. 2;

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Fig. 6 is a schematic diagram illustrating the operation of the visual indicating apparatus of the present invention in accordance with the signal shown in Fig. 5;

5 Fig. 7 is a schematic circuit diagram showing an alternative embodiment of the circuitry for the apparatus of the present invention;

Fig. 8 is a graph showing portions of the signals generated by the apparatus shown in Fig. 7;

10 Fig. 9 is a perspective, somewhat diagrammatic view showing modification of the apparatus to maintain correct optical distances;

Fig. 10 is a schematic view of a modification of the apparatus of the invention; and

15 Fig. 11 is a schematic circuit diagram showing a modification of the circuitry of Fig. 2 for use with the apparatus of Fig. 10.

In Fig. 1, an X-ray generator, not shown, provides an X-ray beam along axis 10 through collimator 12 to X-ray field 14 on the body of a patient 16. Collimator 12 contains two pairs of leaves 18A and 18B and 20A and 20B. The leaves of each pair are coordinately moved toward and away from each other by conventional means, not shown, so that each pair establishes one dimension of the X-ray field 14. For purposes of explanation, leaves 18 may be deemed to establish the Y dimension of field 14 and leaves 20, the X dimension.

25 For purposes hereinafter indicated, an electric signal is provided corresponding to the position of each pair of leaves, as by potentiometers driven by racks 22 and pinions 24. Potentiometer 26 provides a signal in conductor 28 indicative of the position of leaves 18 and the Y dimension of field 14 and potentiometer 30 provides a signal in conductor 32 indicative

of the position of leaves 20 and the X dimension of field 14. In the case of an automatic collimation system, the signals in conductors 28 and 32 may be the position feedback signals from the collimator leaves employed in the automatic system.

5

The visual indicating apparatus of the present invention includes a light source 34 that may typically comprises a laser of the helium-neon type. Light source 34 provides a narrow beam 36 of coherent light. In the illustrated exemplary embodiment, the beam 36 of light source 34 shines vertically upward.

10

The beam 36 of light source 34 is applied to a first mirror 38 to oscillate about a horizontal axis in either direction from a central position lying at 45° to light beam 36. Mirror 38 may be mounted on shaft 40 turned by electrodynamic drive 42. Drive 42 may comprise a galvanometric movement having a magnet and associated coil that is energized to rotate mirror 38. The rotary actuators sold by General Scanning, Inc. of Watertown, Massachusetts as the Series EM are suitable for use as drive 42. Other suitable drives are those used to drive pen motors in electrocardiographs and electroencephalographs. Drive 42 is energized in a manner hereinafter described to rotate shaft 40 and oscillate mirror 38. When in the central position mirror 38 will provide a horizontal beam of reflected light.

15

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25

The light 44 reflected off mirror 38 is applied to a second mirror 46 that oscillates about a vertical axis in either direction from a central position lying at 45° to the horizontal light beam 44. Mirror 46 may be mounted on shaft 48 turned by electrodynamic drive 50 that may be similar to drive 42.

30

The light beam 51 reflected off mirror 46 is applied to mirror 54 that is located along the axis 10

35



and lies at a 45° angle with respect thereto. Mirror 54 is transparent to the X-ray beam.

Fig. 2 shows circuitry 52 for energizing electrodynamic drives 42 and 50. An oscillator, or free running clock, 55 produces a square wave pulse train signal in conductor 56 to counter 58. Counter 58 may be a divide-by-four counter providing a decoded output at a plurality of output terminals, 60, 62, 64, and 66. With a decoded output, the output terminals each sequentially provide a divide-by-four output. Thus at a first pulse in the signal in conductor 56, output 60 provides an output pulse; for a second pulse in conductor 56, output 62 provides an output pulse; and the third and fourth pulses in conductor 56 provide output pulses in outputs 64 and 66, respectively. At the fifth pulse in conductor 56, output 60 again provides an output pulse. At the sixth pulse in conductor 56, output 62 again provides an output pulse, and so on. Counter 58 may comprise the circuit element sold by RCA under the designation CD4022 or that sold by Motorola Corporation under the designation MC14022.

Output 64 of counter 58 is connected to one input of NOR gates 68 and 70. Output 62 is connected to the other input of NOR gate 70 and output 66 is connected to the other input of NOR gate 68.

The outputs of counter 58 and NOR gates 68 and 70 are referenced to the negative voltage supply so that the outputs of each NOR gate is a bipolarity pulse train of 50% duty cycle.

NOR gate 68 is connected to operational amplifier 72 through resistor 74. Capacitor 76 is connected in the feedback of operational amplifier 72 so that the element functions as an integrator for the square wave pulses in conductor 56. The integration rate, or slope of the output signal of amplifier 72 is

determined by the relative magnitudes of resistor 74 and capacitor 76. Breakover Zener diodes 78 in parallel with capacitor 78 limit the output of operational amplifier 72.

5           The output of operational amplifier 72 is provided in conductor 80 to one input of a four quadrant multiplier 82. The other input to four quadrant multiplier 82 is the signal from potentiometer 26 in conductor 28. The designation "four quadrant" 10 indicates that the element performs algebraic multiplication, accounting for not only the magnitudes but also the algebraic signs of the signals in conductors 80 and 28. Multiplier 82 may comprise the element sold by RCA under the designation CA3080 or that sold by 15 Motorola under the designation MC1495. The output of four quadrant multiplier is provided in conductor 84 to coil 44 of electrodynamic drive 50. While termed a "multiplier" above, it will be appreciated that the magnitude of the signal in conductor 80 is fixed by 20 Zener diodes 78 so that the element 82 actually functions in the nature of a variable gain amplifier for the signal in conductor 28. In a similar manner, the output of NOR gate 70 is connected through an integrating operational amplifier 86 to one input to four 25 quadrant multiplier 88. The other input to four quadrant multiplier 88 comprises the signal in conductor 32 from potentiometer 30. the output of multiplier 88 is provided in conductor 90 to electrodynamic drive 42.

30           The output signals in conductors 84 and 90 are shown in Fig. 5 as signals 100 and 102, respectively. Signals 100 and 102 are phase displaced 90° through the operation of counter 58 and NOR gates 68 and 70. The magnitude of signals 100 and 102 are 35 determined by the signals in conductors 28 and 32,



respectively, indicative of the X and Y dimensions of field 14. The slope of the intermediate portions of the signal is determined by the integrators comprised of amplifiers 72, 86 and the associated R-C circuits.

5           The circuit described above has little d.c. drift and thus will possess a high degree of stability.

          The operation of the visual indicating apparatus shown in Figs. 1 and 2 is as follows. If neither electrodynamic drive 42 or electrodynamic drive  
10   50 is energized, mirrors 38 and 46 are in their central position. The light beam 36 is reflected off mirrors 38 and 46, as light beams 44 and 52 and is reflected off mirror 54 along the axis 10 of the X-ray beam to appear as a dot in the center of field 14.

15           Assume a condition in which electrodynamic drive 42 is energized by signal 100 in conductor 90 and there is no signal in conductor 84. At point A in signal 100, as shown in Fig. 3, the level of signal 100 is zero and mirror 38 will be in the central position  
20   in which it is at a 45° angle to light beam 36. As mirror 46 is in the central position, the light beam reflected from mirror 54 will be centered in field 14 to produce a dot of light shown in Fig. 4 as A. As signal 100 increases in magnitude in one polarity from  
25   A to B, electrodynamic drive 42 will become increasingly energized and will rotate mirror 38 in one direction from the central position. A corresponding deflection of the reflected light beam 44 from mirror 38 out of the horizontal plane will result. With mirrors 46 and  
30   54 stationary, the movement of mirror 38 will cause the light beam reflected off mirror 54 to trace out line A-B toward the edge of field 14, as shown in Fig. 4. The amount of movement of mirror 38 and the length of the trace A-B is determined by the magnitude of signal 100  
35   at point B, which, in turn, is determined by the magni-

tude of the signal in conductor 32 that indicates the position of collimator leaves 20 that determine the corresponding dimension of field 14. By appropriate scaling of one or more of the signal, as by a potentiometer or other means, or by adjustment of the operating parameters of circuit 52 or drive 42, point B may be caused to lie on the periphery of field 14.

From point B to point C, signal 100 and the energization of drive 42 is constant. This will retain mirror 30 in the deflected position and the light beam reflected off mirror 54 will be retained at point B-C to produce a stationary dot of light on one side of the periphery of field 14.

As the energization of drive 42 is returned to zero by the portion C-D of signal 100, mirror 38 moves from the deflected position back to the central position. This returns the reflected light beam 44 to the horizontal position and causes the light beam to trace out a line C-D back to the center of field 14. It will be appreciated that while lines A-B and C-D are shown slightly displaced in Fig. 4, they are actually congruent in field 14 in the operation of the visual indicating apparatus.

When signal 100 changes to the opposite polarity during the half cycle D, E, F, G, mirror 38 is rotated by electrodynamic drive in the opposite direction so that the light beam reflected off mirror 54 traces out a line in the opposite direction from the central position A-D in field 14, as shown by D-E-F-G in Fig. 4. The point E-F lies on the periphery of field 14 on the opposite side from point B-C. It will be appreciated from Fig. 4 that the light trace from B-C to E-F is an indication of the X dimension of field 14.



Figs. 5 and 6 show the use of output signals 100 and 102 to both electrodynamic drive 42 and electrodynamic drive 50 and the resulting operation of visual indication apparatus of the present invention in defining field 14. With signal 102 applied to electrodynamic drive 50, both mirror 38 and mirror 46 will be deflected. In a manner similar to that described above in connection with signal 100, the magnitude of signal 102 is determined by the magnitude of the signal in conductor 28. The magnitude of the signal in conductor 28 corresponds to the position of collimator leaves 18 that determines the Y dimension of field 14.

Assume a starting position H. At this point, signal 100 is at the maximum value deflecting mirror 38 to one extreme position. The value of signal 102 is zero so that mirror 46 is not deflected. By analogy to Fig. 3 and 4, it will be appreciated that the light beam reflected off mirror 54 will form a dot at point H in Fig. 6, that corresponding generally to point B-C in Fig. 4. Point H is on the periphery of field 14 at one end of the X dimension.

As signal 102 increases in the segment H-I, electrodynamic drive 50 will be energized to rotate mirror 46 out of the central position about the vertical axis. This deflection of mirror 46 moves the light beam along a trace from point H to Point I. Point I is at one end of Y dimension of field 14. The trace H-I forms a segment of the periphery of field 14 and point I marks a corner of field 14.

During the time interval I-J, both signals 100 and 102 are at maximum positive value. Mirrors 36 and 46 are held in their deflected position. There is no movement of the light beam reflected off mirror 54 and it remains at point I. This retention, or "dwell" of the light beam at point I assists in clearly demarcating the corners of field 14.

In the segment J-K of signal 100, that signal is decreasing in positive magnitude, to the zero signal condition at point K. The signal segment J-K causes electrodynamic drive 42 mirror 38 to return to the central, undeflected position. Mirror 46 remains in the deflected condition since the magnitude of signal 102 has not changed. The light beam reflected off mirror 54 traces out the segment J-K in Fig. 6 forming a segment of the periphery of field 14.

The polarity of signal 100 changes at point K. the opposite polarity signal 100 applied to electrodynamic drive 42 deflects mirror 38 in the opposite direction so that light beam 34 traces out the line K-L along the periphery of field 14 to complete the indication of the X dimension of field 14.

During the segment L-M, signal 100 is a constant magnitude negative signal. Signal 102 is a constant magnitude positive signal. There is no movement of mirrors 38 and 46 from their deflected positions due to the constant magnitude signals to electrodynamic drives 42 and 50 so that the light beam reflected off mirror 54 dwells at point L-M for this period to demarcate a second corner of field 14.

During the segment M-N, signal 102 is decreasing in magnitude to the zero condition at point N. This reduction in the energization of electrodynamic drive 50 causes mirror 46 to return to the central position. The light beam reflected off mirror 54 traces out the segment M-N.

The operation of electrodynamic drives 42 and 50 and mirrors 38 and 46 responsive to the energization by signals 100 and 102 occurring in the segments N-T are analogous to those described in detail above. The trace of the light beam reflected off mirror 54 in all of the segments shown in Fig. 6 completely defines the



periphery of field 14 and thus visually indicates the X-ray field established by collimator leaves 18 and 20.

5 The trace of the light beam repeats itself with the signals commencing at point H in Fig. 6 to repeat the visual indication of field 14. Signals 100 and 102 may typically have a frequency of between 15 and 30 Hz, for example 20 Hz, so that the rapidity of movement of the light beam in making the trace H and T exceeds that which the human eye can follow. The X-ray technician thus sees a square or rectangle of visible light clearly indicating the periphery of field 14. Light beam 36 may be made sufficiently intense that the trace can be easily seen in all ambient light levels likely to be encountered.

10 The dimensions of the pattern traced by the light reflected off mirror 54 are determined by the signals in conductors 28 and 32 from potentiometers 26 and 30 to multipliers 82 and 88. As the spacing between the collimator leaves 18 and 20 is varied, the amplitude of the signals to electrodynamic drives 42 and 50 from multipliers 82 and 88 are proportionately varied so that the pattern traced by the light beam reflected off mirror 54 always defines the periphery of the X-ray field 14.

15 The slope of the portions of signals 100 and 102 such as C-D-E is selected in accordance with the inertial properties of electrodynamic drives 42 and 50 as, for example, to provide constant velocity to the movement of mirrors 38 and 46, thereby to lessen or avoid undampened oscillations or other undesired conditions in electrodynamic drives 42 and 50.

20 Fig. 7 shows an alternative embodiment of the circuitry 52A for energizing electrodynamic drives 42 and 50 in which the signal values needed to position mirrors 38 and 46 for the X and Y dimensions of field

14 are digitally encoded and stored in a read only memory. These values generate signals for drives 42 and 50 as by their periodic supply to a pair of digital/analog converters to generate signals 100A and 102A shown in Fig. 8 and corresponding to signals 100 and 102 shown in Fig. 5.

In the circuitry shown in Fig. 7, the pulse train output of oscillator 200 in conductor 202 is connected to ripple or binary counter 204 that counts the pulses in conductor 202. Counter 204 may be that element sold by Motorola Corporation under the designation MC14024B. The output of ripple counter 204, indicative of the counting occurring in the counter, is provided in parallel conductors 206 to the address input of read only memory for the digitally encoded values for the X and Y dimensions of field 14. The digital values so accessed are provided at the output of read only memory 208 in parallel conductors 210. If read only memory 208 has a sufficiently large number of input and outputs, a digital value for both the X and Y dimensions, i.e. for signals 100A and 102A, may be simultaneously provided at the output of read only memory 208. For a small number of input and outputs, read only memory may be so addressed as to alternately provide the digitally encoded values for signal 100A (X dimension) and for signal 102A (Y dimension). For example, for even numbered counts in conductors 206, the digital value for signal 100A may be provided in conductors 210. For odd numbered counts in conductor 206, the digital values for signal 102A are provided in conductors 210. Fig. 7 shows circuitry incorporating this latter approach.

The output of read only memory 208 is provided in parallel to two latch circuits 210 and 214 in conductors 210 and 210A. Latch circuits 210 and 214

are alternately operated by the signal from counter 204 to latch 212 in conductor 216 and the signal from counter 204 in conductor 218 to latch 214. The signals in conductors 216 and 218 indicate whether the count in counter 204 is odd or even and operates one of the latches for all the odd numbers and the other of the latches for all the even numbers. Through the alternate odd-even operation of the latches, latch 212 accepts all digitally encoded values from read only memory 208 for signal 102A and latch 214 accepts all the digitally encoded values from read only memory 208 for signal 100A.

The digital output of latch 212 is provided in conductors 220 to multiplying digital/analog converter 224 that also receives the signal in conductor 28 from potentiometer 26 indicating the position of leaves 18. Digital/analog converter 224 generates signal 102A in conductor 84 to electrodynamic drive 50. As the analog signal produced responsive to the signal in conductors 220 has fixed magnitude properties, the output of digital analog converter 224 is directly proportional, in magnitude, to the signal in conductor 28 from collimator potentiometer 26. The digital output of latch 214 is provided in conductors 222 to multiplying digital/analog converter 226. Digital/analog converter 226 also receives the signal in conductor 32 from potentiometer 30 associated with collimator leaves 20. Digital/analog converter 226 generates signal 100A in conductor 90 to electrodynamic drive 42.

Fig. 8 is a fragmentary graph showing the signals 100A and 102A provided in conductors 90 and 84, respectively, by the circuitry of Fig. 7. The signals correspond to those of Fig. 5 except that they are incrementally formed by the digitally encoded values of

read only memory 208. As with signals 100 and 102 shown in Fig. 5 the magnitudes of the signals in conductors 28 and 32 so that the trace of the light beam reflected off mirror 54 visually indicates field 14.

5 The size of the incremental steps in signals 100A and 102 A is selected such that the inertia of the moving parts of electrodynamic drives 42 and 50 provides an electromechanical filtering action that smooths the incremental steps when mirrors 38 and 46 are operated.

10 The use of read only memory 208 provides additional flexibility in the formation of signals 100 and 102 over that which can be conveniently obtained with the analog circuitry of Fig. 2. For example, the values stored in read only memory 208 may be adjusted  
15 to compensate for non-linearity in the operation of electrodynamic drives 42 and 50 due to hysteresis in the galvanometric movements. The same is true of undampened oscillations in drives 42 and 50 termed "ringing". These typically occur in a transition from  
20 a rising or falling signal to a constant magnitude signal as at point R' in Fig. 8. The oscillation may be damped by providing the slight reduction 104 after point R' has been attained, as shown in Fig. 8.

25 Read only memory 208 may also contain digitally encoded values that provide signals to electrodynamic drives 42 and 50 to cause mirrors 38 and 46 to make light beam traces in field 14 other than about the periphery of the field. For example, read only memory 208 may operate drives 42 and 50 so that the mirrors 38  
30 and 46 generate a cross or other center marker for field 14. A signal in conductor 228 to counter 204 alters the output of counter 204 to provide a band of numbers accessing the portion of read only memory 208 containing the digitally encoded signals necessary for  
35 such a light beam trace. In a similar manner read only



memory 208 can contain digitally encoded values that generate light traces in the form of numbers, letters, or words, such as "no film" on field 14. And, circuitry 52A can switch between or among various forms of light beam traces.

To maintain the proper correlation between the position of collimator leaves 18 and 20 defining X-ray field 14 and the trace of the light beam reflected off mirror 54 visually indicating that field, it is necessary that the point of origin of the light beam be at an optical distance from mirror 54 equal to or less than the distance from the mirror to the X-ray source. If the point of origin of the light beam is further away than the point of origin of X-ray source, collimator 12 will block the light and it will not properly indicate field 14. For the X dimension, the point of origin is mirror 38. For the Y dimension, the point of origin is mirror 46. In a practical embodiment of the visual indicating apparatus, mirrors 38 and 46 may be quite close together so that the point of origin tend to be the same.

The necessary positioning of the visual indicating apparatus may create a physically awkward structure. It may be more convenient to place mirrors 38 and 46 and the associated electrodynamic drives 42 and 50, outside the X-ray equipment to facilitate the design, use, and maintenance of the apparatus. However, this may cause the optical distance of the points of origin to be too great.

In such a case, an optical spacer 110 made of the transparent material having a high index of refraction may be employed, as shown in Fig. 9. Such a material may be similar to that used in eyeglasses in which the index of refraction may approach 2.5. The use of such a material provides an effective shortening



of the optical path while allowing the physical path to be sufficiently long to permit external mounting of the light source.

Or, the appropriate compensation may be applied to the signals in conductors 84 and 90 used to drive electrodynamic drives 42 and 50.

In another modification of the invention, shown in Fig. 10, light source 34 may be placed at some convenient location away from the collimator and coupled to the remaining portions of the visual indicating apparatus by optical fiber cable 120 through lenses 122 and 124. The output end of cable 120 occupies the position of light source 34.

For safety purposes, the intensity of the light from a light source 34, such as a laser, to patient 16 is limited by regulation. When the dimensions of field 14 are small or the movement of light beam 36 by mirrors 38 and 46 is slow, the intensity of the light may exceed permissible values.

To reduce the intensity of the light applied to patient 16, an optical attenuator 126 may be placed along the light path, as at the output of light source 34 shown in Fig. 10. Attenuator 126 may include a neutral density filter 128 coupled to actuator 130 that inserts and removes it from the light path. To control actuator 130, the output signals from circuitry 52 or 52A in conductors 84 and 90 are applied to integrators 132 and 134, as shown in Fig. 11. The outputs of integrators 132 and 134 are connected to threshold detector 136, the output of which is connected to actuator 130. The circuitry shown in Fig. 11 can operate in a failsafe mode such that unless the dimensions of field 14 and the movement rate of mirrors 38 and 46 are above a certain level, as established by threshold detector 136, filter 128 is inserted in the light path.



-18-

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. Apparatus for providing a visual indication in the field produced by an X-ray beam having a mirror on the axis thereof for reflecting a light beam onto the field, said apparatus comprising:

5 a light source generating a light beam along a path;

a first means for receiving said beam and for deflecting same at an angle to said path, said first deflection means being responsive to a first signal for arcuately moving the light beam;

10 a second means for receiving the beam of light deflected by said first deflection means and for further deflecting same to apply said light beam to the mirror in the X-ray beam for reflection onto the field, said second deflection means being responsive to a second signal to arcuately move the light beam; and

20 signal generating means for generating the first and second signals for energizing said first and second deflection means to move the light beam about the field to provide the visual indication.

2. A visual indication apparatus of Claim 1 wherein said first and second deflection means comprise first and second mirrors and first and second signal response drive means.

3. The apparatus according to Claim 2 wherein said first drive means is further defined as moving said first mirror about an axis normal to the path of generation of the light beam and said second

-19-

5 drive means is further defined as moving said second mirror about an axis parallel to the path of generation of light beam.

4. The visual indication apparatus of Claim 3 wherein said drive means comprises electrodynamic drive means.

5. The visual indication apparatus of Claim 4 wherein said electrodynamic drive means comprise galvanometric means.

6. The visual indication apparatus of Claim 1 further defined as providing a visual indication of the field produced by the X-ray beam passing through a field defining collimator of X-ray equipment producing signals corresponding to the dimensions of the field and wherein said signal generating means generates the first and second signals responsive to the field dimension signals of the X-ray equipment for energizing said first and second deflection means to move the light beam about the field in a field defining manner.

7. The visual indication apparatus of Claim 6 wherein said signal generating means includes means for generating a pair of signals displaced by 90° and supplying one of said signals to each of said first and second deflection means.

8. The visual indication apparatus of Claim 4 wherein said signals are electric signals and wherein said signal generating means is responsive to said field dimension signal for controlling the magnitude of said signals to said first and second deflection means and the amount of deflection of said means.

9. The visual indication apparatus of Claim 7 wherein the field is rectilinear and said signal generating means so forms the displaced signals as to provide overlapping regions of constant magnitude signals that retain the reflected light beam in the corners of the field.



-20-

10. The visual indication apparatus of Claim 7 wherein said signal generating means comprises means providing a train of pulses; means generating a pair of signals displaced by 90° from said pulse train; means responsive to said field dimension signal for altering the magnitude of said pair of displaced signals in accordance therewith.

11. The visual indication apparatus of Claim 7 including means for providing a slope to said pair of signals intermediate constant magnitude portions.

12. The visual indication apparatus of Claim 10 wherein said means providing a pair of signals includes a counter coupled to said pulse train providing means, the output of said counter being provided to logic elements providing said pair of signals.

13. The visual indication apparatus of Claim 10 wherein said means for altering the magnitude of said signals comprises a multiplier.

14. The visual indication apparatus of Claim 11 wherein said means providing said slope comprises an operational amplifier having resistive-capacitive means operatively associated therewith.

15. The visual indication means of Claim 7 wherein said signal generating means generating a pair of signals comprises accessing means connected to a memory means generating said signals, said memory means being connected to circuit means providing said pair of signals, said field dimension signals being connected to said circuit means for altering the magnitude of said pair of signals.

16. The visual indication means of Claim 15 wherein said circuit means provides said pair of signals in digital form and said circuit means is

5 connected to digital-analog converters providing said pair of signals to said drive means.

17. The visual indication means of Claim 1 including optical spacer means in the path of one of the light beam or deflected beams.

18. The visual indication means of Claim 1 wherein said light source includes light conducting means for generating said light beam.

19. The visual indication means of Claim 1 including light attenuating means insertable in the path of said light beam.

20. The visual indication means of Claim 19 including means for operating said light attenuating means responsive to said first and second signals for inserting said light attenuating means in said light beam to control the intensity of the light beam.

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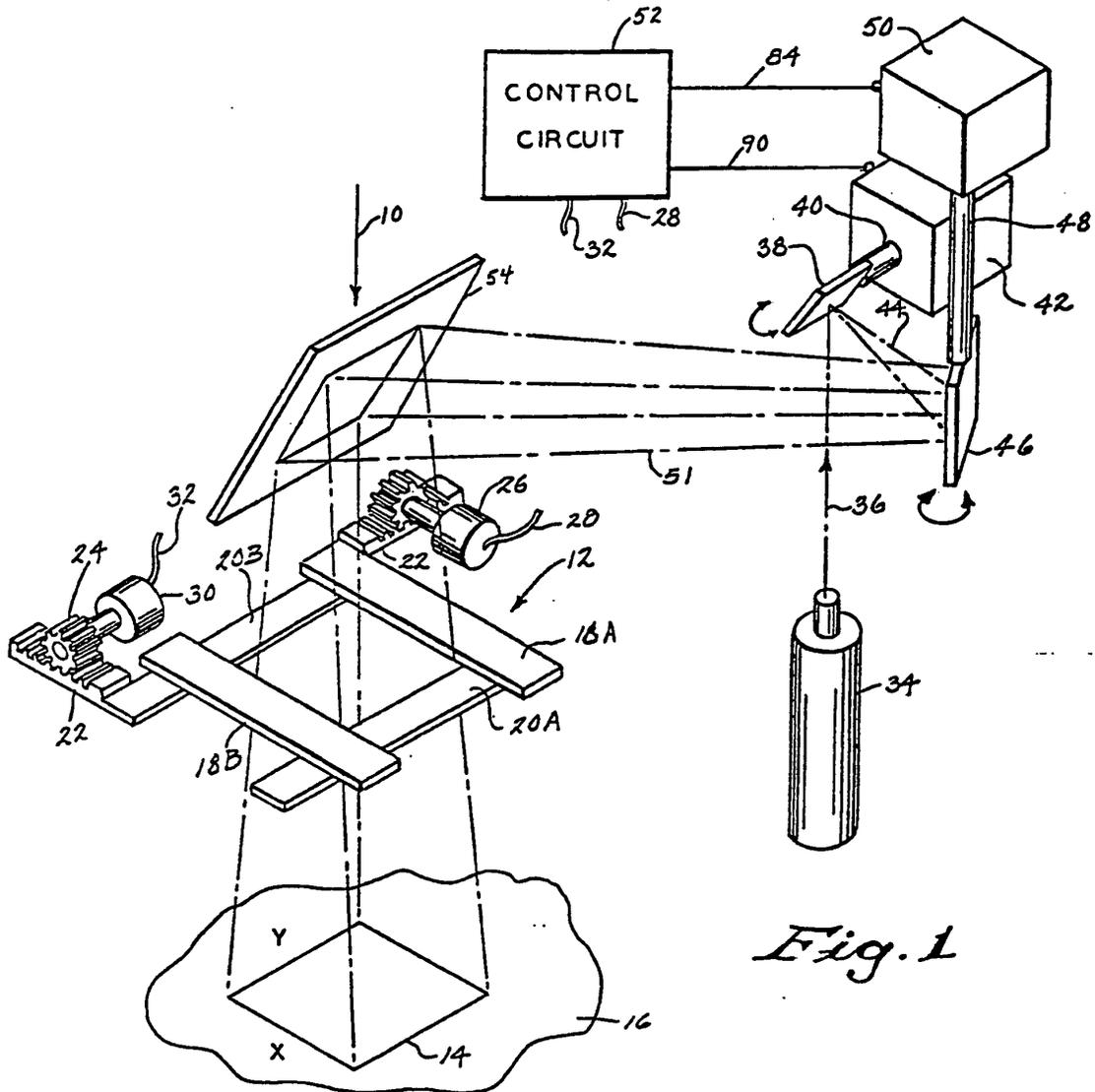


Fig. 1

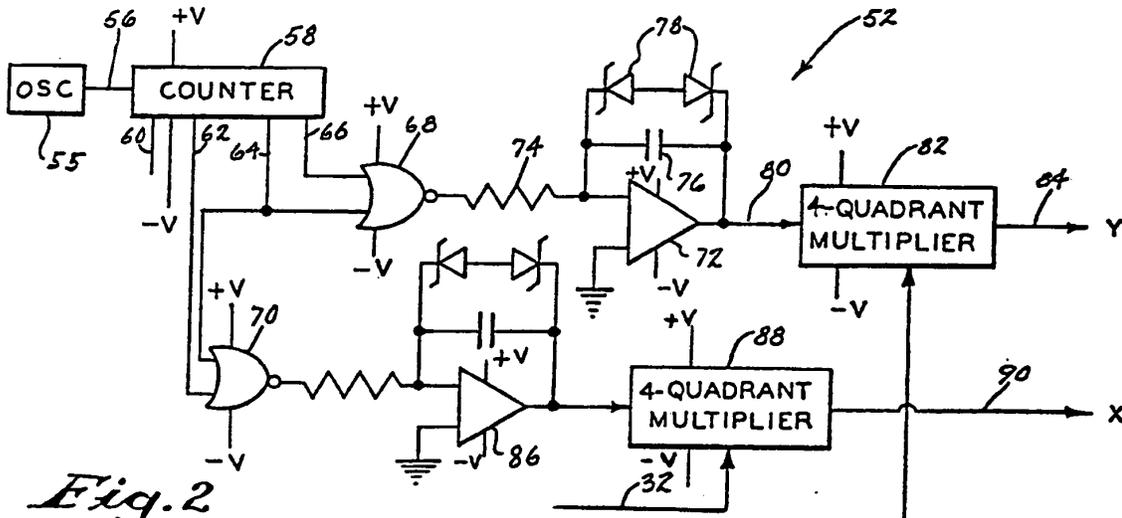


Fig. 2

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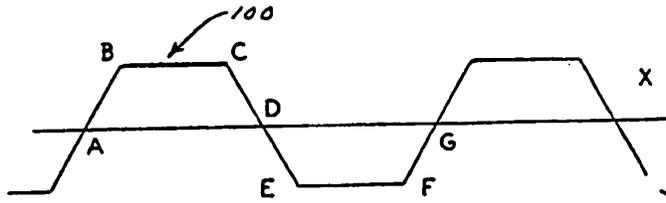


Fig. 3

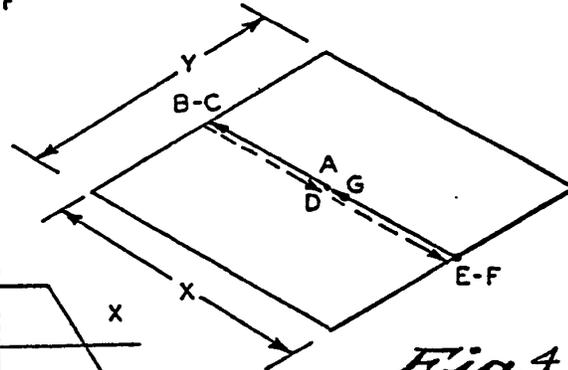


Fig. 4

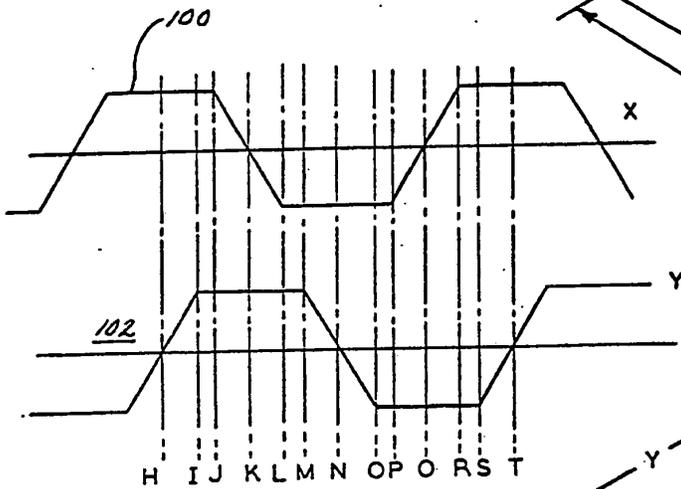


Fig. 5

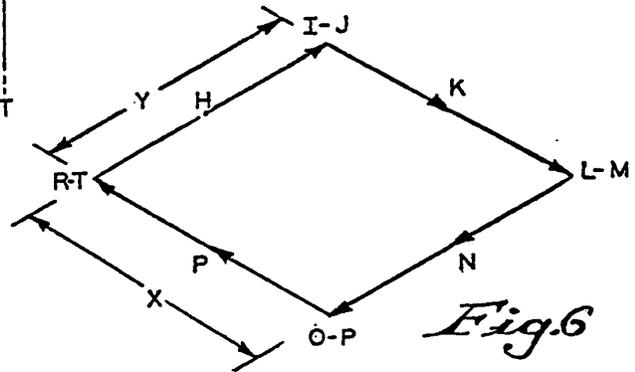


Fig. 6

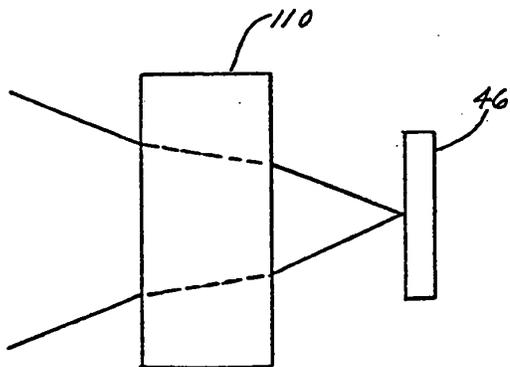


Fig. 9

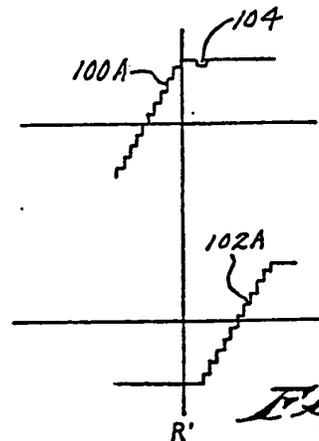


Fig. 8

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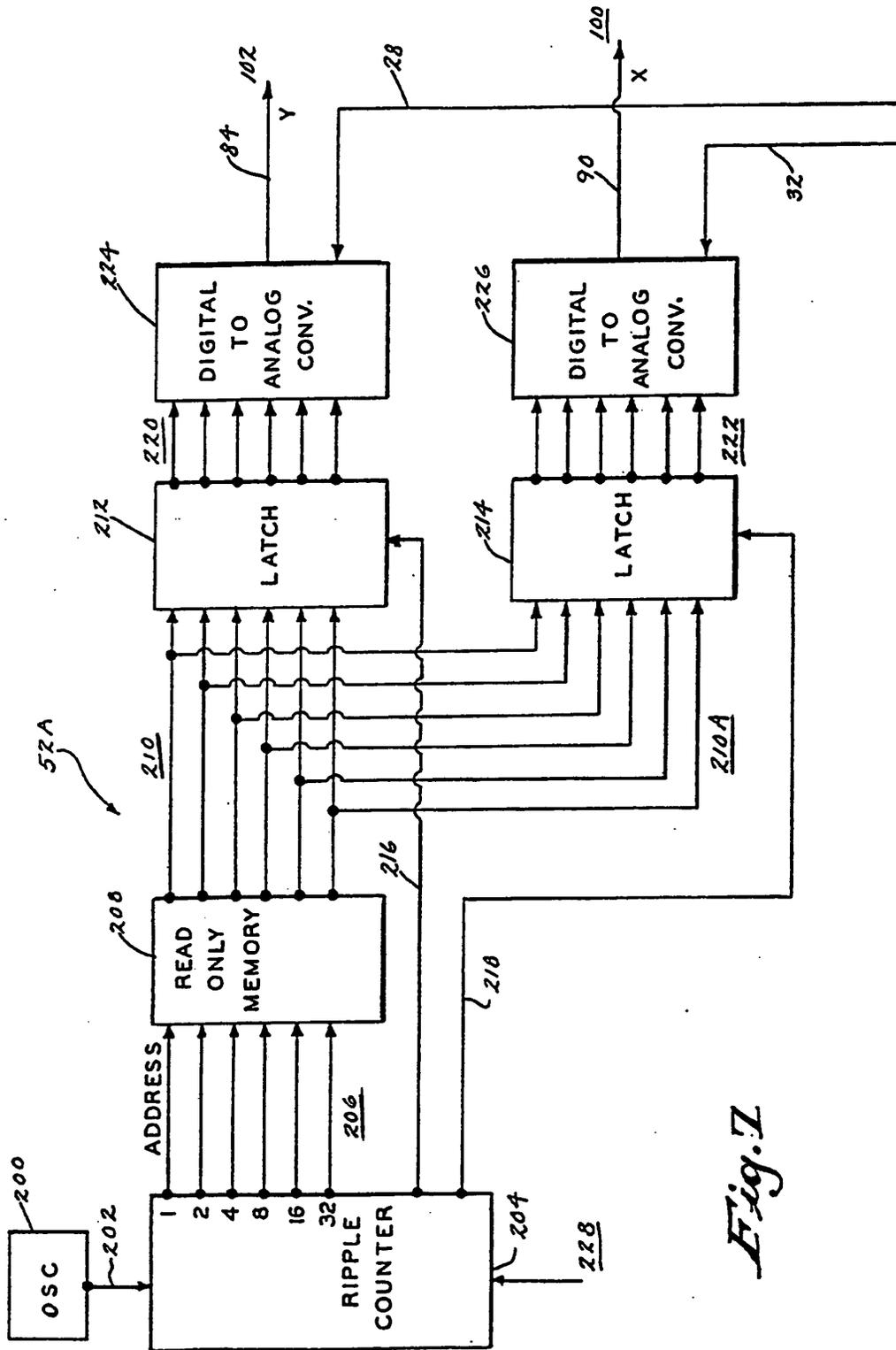


Fig. 1

SUBSTITUTE SHEET



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FIG. 10

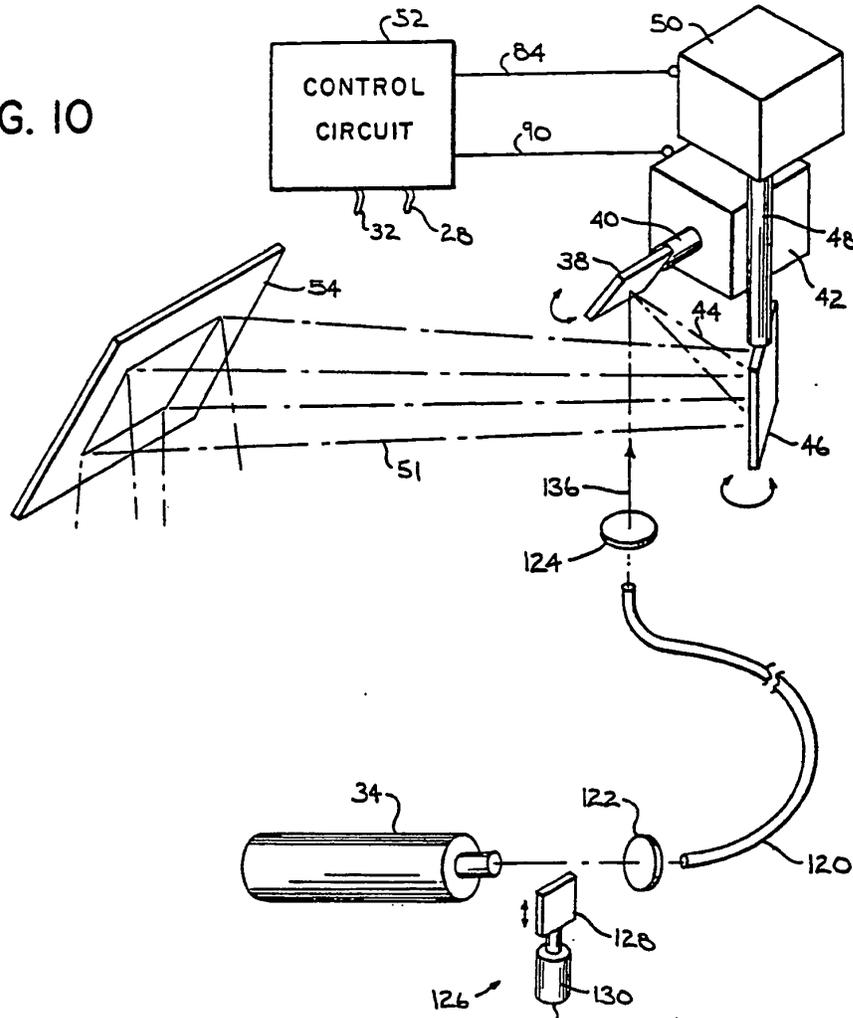
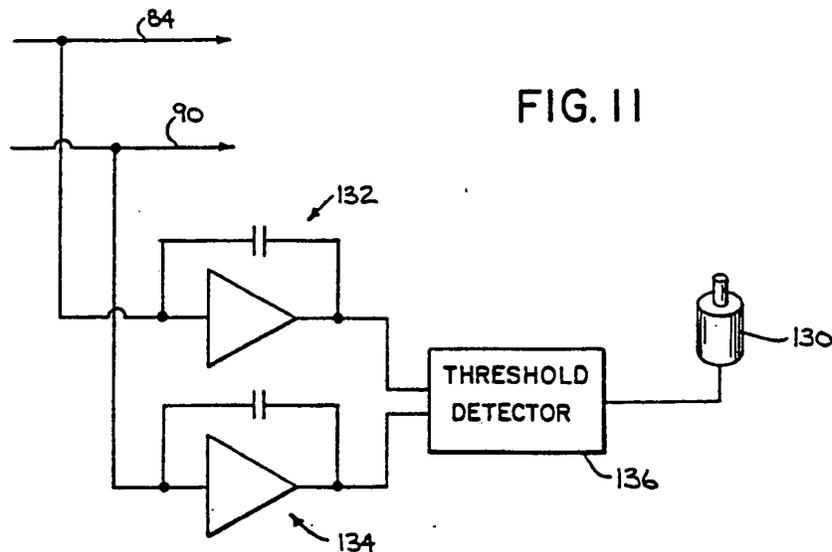


FIG. 11



RESTITUTE SHEET



# INTERNATIONAL SEARCH REPORT

International Application No PCT/US84/00090

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. <sup>3</sup> A61B 6/08;G21F 5/04		
U.S. CL. 378/206;378/091;378/150		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
U.S.	362/032;362/259 378/091, 150, 152, 206	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
A	US, A, 2,905,827 Published 22 September 1959 (GRAVES)	1-20
A	US, A, 3,947,689 Published 30 March 1976 (WAGNER)	1-20
A	US, A, 4,167,675 Published 11 September 1979 (STÖDBERG ET AL)	1-20
Y	US, A, 4,337,502 Published 29 June 1982 (LESCRENIER), Abstract, lines 2-5	18
<p><sup>15</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>19</sup>		Date of Mailing of this International Search Report <sup>19</sup>
11 April, 1984		16 APR 1984
International Searching Authority <sup>1</sup>		Signature of Authorized Officer <sup>20</sup>
ISA/US		Thomas N. Grigsby Thomas N. Grigsby

Form PCT/ISA/210 (second sheet) (October 1981)



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Publication number :

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B1**

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26.09.84

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G 01 B 11/24**

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20.10.82 Bulletin 82/42

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26.09.84 Bulletin 84/39

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56 References cited :  
GB-A- 692 923  
GB-A- 1 328 033  
NL-A- 7 605 264  
US-A- 3 950 096  
US-A- 4 242 587  
PHYSICS IN MEDICINE AND BIOLOGY, vol. 20, no. 4,  
July 1975, pages 627-631, Bristol (GB), S.C. LILLI-  
CRAP et al.: "A device for the automatic recording of  
patient outlines on the treatment simulator"

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**EP 0 062 941 B1**

Note : Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Jouve, 18, rue St-Denis, 75001 Paris, France

## Description

The invention relates to a device for recording object contours in which a contour of the object is marked and the marked contour is sensed and recorded optically.

A device of this kind is known from Physics In Medicine and Biology, vol. 20, n° 4, July 1975, pp. 627-631. Another device of this kind is known from GB 1,328,033. In a device described therein, a light spot is projected onto the object and a probe is automatically adjusted by the detection of reflected light so that the contour can be read during a rotation of the source and the detector about the object. It has been found that this device does not operate satisfactorily in practice. For example, for medical applications the measurement requires too much time and must be separately performed in advance. Differences in reflection from a surface and excessively abrupt angular variations also cause difficulties. The discrete measurement point form of notation required in this device is also considered to be a drawback.

The invention has for its object to mitigate these drawbacks and to provide a device for recording object contours in which a complete contour can be on-line recorded, even in the case of an apparatus in operation. To achieve this, a device of the kind set forth in accordance with the invention is characterized in that the device for the optical recording of a contour comprises a mirror system comprising at least three mirrors arranged about the object to cover the entire contour, a lens associated with each mirror to project sub-images of the marked contour onto a common collecting member to combine the sub-images for the formation of a single image of the marked contour and project it onto the input surface of an image sensing device which, together with the collecting member, is positioned on an isocentric axis.

In an apparatus comprising a device in accordance with the invention, a closed contour can always be displayed on-line on an image display device, without disturbing the measurement or treatment being carried out by the apparatus. Thus, an accurate readily reproducible and fast contour recording can be realized which enables further automatic processing to be simplified.

In a preferred embodiment in accordance with the invention, the optical system comprises, for each different viewpoint a mirror with a lens for forming an angle-corrected sub-image on an optical collecting member in order to form a faithful summed image on, for example, a target of a television camera tube. The optical collecting member may be constructed as a pyramidshaped mirror or as a prism with an entrance side face for each of the mirrors. A lens is arranged preferably, between the collecting member and each of the mirrors, but may alternatively be arranged between the collecting member and the image sensing device so that the sub-images are imaged

and combined to form a focussed, continuous and faithful image on the input screen of the image pick-up device.

In a preferred embodiment, the contour to be measured is illuminated by means of light projectors, the number and distribution along a circumference of which may be chosen so that substantially the entire contour will nevertheless be illuminated, even when one of the projector is shielded. A similar distribution may be chosen for the mirrors.

When a computer is included in a device in accordance with the invention, any desired contour can be recorded and used as a reference, for example, to compensate for movements of the object, to prevent a collision between the therapeutic or measuring equipment and the object, to reposition an object, and to monitor any variations in object shape, for example, regression during the irradiation of a patient.

Some preferred embodiments in accordance with the invention will be described in detail hereinafter with reference to the drawing. The single figure of the drawing shows a device in accordance with the invention for measuring body contours for controlling radiation therapy. In a radiation therapy apparatus, for example, a linear accelerator as described in Journal of Applied Medicine, Vol. 5, No. 6, pp. 445-454, the actual linear accelerator comprises a fixed section 1 which is provided with a displacement mechanism for a gantry 2 with an arm 3. The arm 3 is rotatable about a patient 6 arranged on a patient support 5. The patient is irradiated by a beam along a line 9 from a radiation source 7. To achieve this, the table may be provided with an opening 10 in the region of the beam path. By rotating the source about the patient, an anomaly inside the patient can be irradiated while applying a minimum radiation dose to surrounding organs and to the skin of the patient. In order to optimize the irradiation, it is necessary to determine the exact location of the anomaly and to correct for any displacement, and therefore the exact local contour 11 must be known. In order to measure the contour, light sources 12 which together illuminate the entire contour 11, are mounted, for example, on the walls of the room in which the accelerator is arranged. For the sake of clarity, the drawing shows only three light sources; this number may be sufficient for illuminating a closed contour, but it may be advisable to use a larger number of light sources. In the case of local shielding, for example, by additional equipment or by an operator, the entire contour can then remain illuminated; the distribution of the light sources over the circumference can also be adapted to the shielding arrangement which is expected to occur most frequently.

In order as far as possible to prevent shielding, notably by operating personnel, it is advantageous to arrange the light sources on the side of

the fixed section of the irradiation apparatus. However, this may have disadvantages because of shadows formed by the patient himself; for example, in the case of a contour of the throat, a shadow can readily be formed by the chin. This is avoided by arranging the light sources on the side away from the fixed section of the irradiation apparatus. If both advantages are to be utilized, use can be made of a twin system, so that, for example, a series of mirror systems is mounted on or near the fixed section 1 of the apparatus, and a further series is mounted remote therefrom. Reading can then take place from two directions at mutually equal angles. If a single optical collecting member is used, the optical beam path length must be made the same for both directions in order to obtain an unambiguous image. The device comprises at least three mirrors 13, and the embodiment shown comprises four mirrors. These mirrors may be secured to the walls of the room in such an arrangement that the entire contour can be seen from the combination of mirrors. The positions of the mirrors need not correspond to those of the light sources, but such correspondence need not be excluded. Each of the mirrors has associated with it a lens 14 which images that part of the contour line which is reflected by the mirror onto the entrance target 16 of a television camera 17 via an optical collecting member 15. The optical axis of the television camera and an optical centre 19 of the collecting member coincide with an axis 4 about which the source rotates and which is usually referred to as the isocentric axis. The television camera is preferably connected, via a switching device 20, to a television monitor 21 for displaying the contour. A contour thus sensed and measured can be stored in digital form in the memory of a computer 22 or in analog form on a magnetic tape or on a disk 23. Once a contour of an object has been sensed, measured and stored, it can be used as a reference contour and a simple indicator 24 then suffices to signal any discrepancies occurring. If desired, the reference contour and a currently measured contour can be displayed together on the monitor. This enables a direct visual observation to be made of any discrepancy in the latest contour and, for example, an undesired shift of, for example, an arm of the patient can be corrected immediately. It is then also simple to add an automatic switch-off device for the irradiation apparatus which responds to a predetermined discrepancy in the contour. From a sensed and measured contour a circumscribed circle can be calculated whose coordinates can be used for controlling an anti-collision device included in the apparatus, which maintains a minimum clearance between the patient and the relevant parts of the patient support or the equipment used during therapy, for example, a detector or radiation shield. An identified and recorded contour can also be used for repositioning the patient, for example, for repeating a course of radiation therapy.

For the present embodiment it has been as-

sumed that the light sources and the mirrors each occupy a fixed position. If the mirrors are secured to a rotating part, for example, the arm 3, it is desirable that the lenses, the collecting member and the camera should also be secured thereto. In that case, the light sources may be arranged to be stationary or to be rotatable, as desired. In the case of an arrangement involving camera rotation, it may be advantageous to apply image rotation to the monitor display, so that the orientation of the picture on the screen remains fixed. In order to reduce the disturbing effect of ambient light on the measurement, use can be made of light sources generating light having a specific wavelength to which the measuring device is adapted. The detection device of the described embodiment comprises a television camera. Instead of a television camera, use can be made of an alternative image pick-up device which may be cheaper because its resolution need not be very high. A suitable detector in this respect could be a self-scanning semiconductor detector.

The invention has been described with reference to a medical therapeutic apparatus, notably a linear accelerator. It will be apparent that the invention has a much wider field of application, for example, other medical equipment where the separate measurement of a contour is important, for example, in scanners in cobalt irradiation apparatus, neutron irradiation apparatus and the like. The invention can also be successfully used for non-medical applications, such as for the measurement of objects or workpieces to be treated and for determining shape variations caused in objects by physical effects. A device in accordance with the invention can also be used for the fast and accurate testing of workpieces with respect to given dimensions, and the profiles of moulds used for moulding, can be simply determined and recorded. In the foregoing, a contour marked by light sources has been assumed. Even though this is a convenient method, use can alternatively be made of a contour marked in a different manner, for example, by the application of a dye, a fluorescent substance or a series of luminescent devices. In that case the scanning section may still have the described construction. Therefore, the invention can also be used for sensing and measuring contour marks which already form part of an object such as a workpiece or a mould.

#### Claims

1. A device for recording object contours in which a contour of an object is marked and the marked contour is sensed and recorded optically, characterized in that an optical system of the device comprises a mirror system comprising at least three mirrors (13) arranged about the object to cover the entire contour, a lens (14) associated with each mirror to project sub-images of the marked contour onto a common collecting member (15) to combine the sub-images for the

formation of a single image of the marked contour and project it onto the input surface of an image sensing device (17) which, together with the collecting member, is positioned on an isocentric axis (4).

2. A device as claimed in Claim 1, characterized in that the lenses (4) form an angle-corrected faithful sub-image of a contour portion on the optical collecting member which forms from the sub-images a focussed, faithful image of the contour on the image-forming device.

3. A device as claimed in Claim 2, characterized in that the mirror system is of duplicate construction with mutually equal reading angles and mutually equal optical beam path lengths to a common optical collecting member.

4. A device as claimed in Claim 1, 2 or 3, characterized in that the image-sensing device comprising a television camera to which a monitor is adapted.

5. A device as claimed in Claim 4, characterized in that a video memory is associated therewith.

6. A device as claimed in Claim 4 or 5, characterized in that an analog-to-digital converter and a computer are associated therewith for the recording and comparison of contours.

7. A medical irradiation apparatus comprising a device for recording object contours as claimed in any one of the preceding Claims.

8. An apparatus for a treatment of work pieces, comprising a device for recording object contours as claimed in any one of Claims 1 to 6.

#### Ansprüche

1. Gerät zum Aufzeichnen von Umrissen, wobei der Umriss eines Objekts markiert ist und der markierte Umriss optisch abgetastet und aufgezeichnet wird, dadurch gekennzeichnet, dass ein optisches System des Geräts ein Spiegelsystem mit zumindest drei um das Objekt herum angeordneten Spiegeln (13) zum Erfassen des ganzen Umrisses und eine Linse (14) enthält, die jedem Spiegel zugeordnet ist und Teilbilder des markierten Umrisses auf ein gemeinsames Sammelement (15) zum Kombinieren der Teilbilder zur Bildung eines einzigen Bildes des markierten Umrisses und zum Projizieren dieses Bildes auf die Eintrittsfläche eines Bildabstastgeräts (17) projiziert, das zusammen mit dem Sammelement auf einer isozentrischen Achse (4) angeordnet ist.

2. Gerät nach Anspruch 1, dadurch gekennzeichnet, dass die Linsen (4) ein winkelnkorrigiertes getreues Teilbild eines Umrisstells auf dem optischen Sammelement bilden, das aus den Teilbildern ein fokussiertes, getreues Bild des Umrisses auf dem Bildformungsgerät formt.

3. Gerät nach Anspruch 2, dadurch gekennzeichnet, dass das Spiegelsystem in zweifacher Ausführung mit gleichen Lesewinkeln und gleichen optischen Bündelweglängen zu einem

gemeinsamen optischen Sammelement aufgebaut ist.

4. Gerät nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, dass das Bildabstastgerät eine Fernsehkamera enthält, an die ein Monitor angeschlossen ist.

5. Gerät nach Anspruch 4, dadurch gekennzeichnet, dass ein Videospeicher zugeordnet ist.

6. Gerät nach Anspruch 4 oder 5, dadurch gekennzeichnet, dass ein Analog/Digital-Wandler und ein Computer zum Aufzeichnen und Vergleichen der Umrisse angeschlossen sind.

7. Medizinisches Strahlungsgerät mit einer Einrichtung zum Aufzeichnen von Umrissen nach einem oder mehreren der vorangehenden Ansprüche.

8. Apparat für die Werkstückbehandlung, mit einem Gerät zum Aufzeichnen von Umrissen nach einem der Ansprüche 1 bis 6.

#### Revendications

1. Dispositif pour enregistrer des contours d'objet dans lequel un contour d'un objet est marqué et le contour marqué est détecté et enregistré par voie optique, caractérisé en ce qu'un système optique comprend un système de miroirs comprenant au moins trois miroirs (13) disposés autour de l'objet afin de couvrir tout son contour, un objectif (14) associé à chaque miroir pour projeter les sous-images du contour marqué sur un élément collecteur commun (15) afin de combiner les sous-images en vue de former une seule image du contour marqué et la projeter sur la surface d'entrée d'un dispositif détecteur d'image (17) qui, en même temps que l'élément collecteur, est positionné sur un axe isocentrique (4).

2. Dispositif suivant la revendication 1, caractérisé en ce que les objectifs (4) forment une sous-image fidèle angulairement corrigée d'une partie du contour sur l'élément collecteur optique qui forme à partir des sous-images une image fidèle et focalisée du contour sur le dispositif formateur d'image.

3. Dispositif suivant la revendication 2, caractérisé en ce que le système à miroirs est de construction double et présente des angles de lecture réciproquement égaux et des longueurs de trajets de faisceaux optiques réciproquement égales vers un élément collecteur optique commun.

4. Dispositif suivant la revendication 1, 2 ou 3, caractérisé en ce que le dispositif détecteur d'image comprend une caméra de télévision à laquelle est adapté un moniteur.

5. Dispositif suivant la revendication 4, caractérisé en ce qu'une mémoire vidéo y est associée.

6. Dispositif suivant la revendication 4 ou 5, caractérisé en ce qu'un convertisseur analogique-numérique et un ordinateur y sont associés pour l'enregistrement et la comparaison de contours.

7. Appareil d'irradiation médical comprenant un dispositif pour enregistrer des contours d'objet suivant l'une quelconque des revendications précédentes.

8. Appareil pour le traitement d'ouvrage, comprenant un dispositif pour enregistrer des contours d'objet suivant l'une quelconque des revendications 1 à 6.

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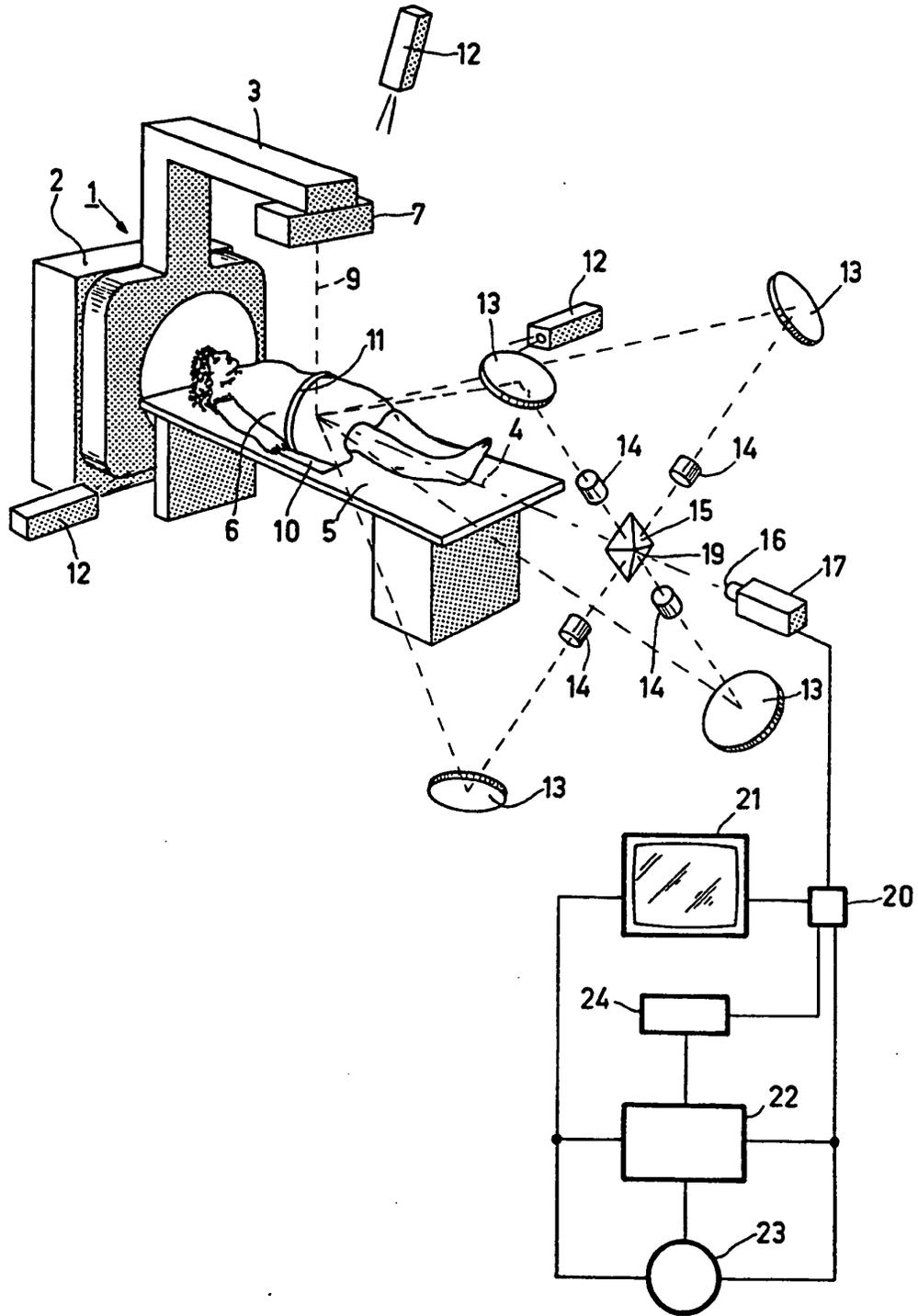
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**EUROPEAN PATENT APPLICATION**

⑰ Application number: 85850224.8

⑤① Int. Cl.<sup>4</sup>: **A 61 B 6/03, A 61 N 5/10**

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④③ Date of publication of application: 30.12.86  
Bulletin 86/52

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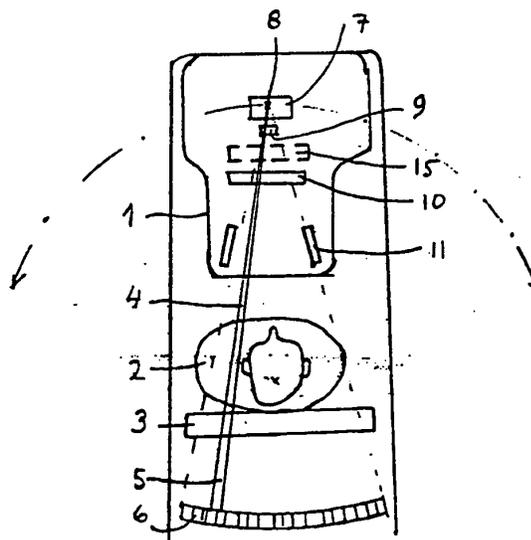
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④④ Designated Contracting States: **AT BE CH DE FR GB IT LI**  
**LU NL SE**

⑦④ Representative: **Svanfeldt, Hans-Ake et al, DR. LUDWIG**  
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⑤④ **CT scanner for radiation therapy planning.**

⑤⑦ A device for making photon CT images with the patient in radiation therapy position. A narrow pencil shaped beam of photons (5) the energy of which is of the order of about 3 up to about 50 MeV is scanned transversally over the patient. During scanning the photons transmitted through the patient's body are measured by the detector array (6). A computer (13) then reconstructs a CT-image of the body from the photon transmission data and the position data of the scanning beam (5). The CT image thus determined is used for planning the patient treatment in a separate dose planning computer (16). The patient is then treated by scanning the beam over the treatment volume and in so doing using the recorded position data to position the beam and the absorption data to vary the scan pattern of the beam such that the desired dose distribution in the tumor volume is obtained.



**EP 0 205 720 A1**

A CT SCANNER FOR RADIATION THERAPY

5 The present invention relates to a method and device of making  
photon CT images with the patient in the radiation therapy  
position by subjecting the patient to the therapy radiation  
beam. The photon radiation used for taking the CT images is  
also used for the therapy radiation. At first the CT images  
are taken and are computer processed and then, some minutes  
later while the patient still is resting on the patient couch,  
10 the radiation therapy is performed. This method is generally  
known from Med.Phys.9(4), July/Aug 1982, Am. Assoc. Phys. Med.  
wherein R.G. Simpson et al. in a technical report entitled "A  
4-MV CT scanner for radiation therapy: The prototype system."  
is describing the novel concept referred to above.

15 In the known system a flat fan like photon beam is directed  
towards the patient and a photon detector array, placed under  
the patient's couch, is providing electrical signals  
representing the photon transmission along a sectional view of  
the patient's body. The gantry, which provides the fan like  
20 photon beam, is rotated in small steps around the patient's  
body and for each gantry setting the electrical signals are  
stored in a computer which out of the data so collected forms  
a CT image of the sectional view of the patient. The main  
advantage with this known concept is that no separate  
25 diagnostic-energy CT scanner is required. Moreover, the  
contrast to the images obtained with the known 4-MV CT scanner  
is improved, particularly the contrast to body tissue, Also  
the dose planning is more accurate. Previously the attenuation  
coefficients of the tissue, taken with diagnostic radiation  
30 energy of typically 70 keV has to be extrapolated to those  
expected to be present at the therapy radiation energies,  
which typically may be in the order of about 5 MeV. An  
extrapolation over such a wide range is uncertain.

35 Before the Simpson concept was desired conventionally the  
therapy treatment was preceded by an X-ray screening -  
performed by a conventional CT-scanner - in order to localize

the tumor volume. Thereafter the patient was moved to the couch of a therapy apparatus the radiation field of which was set (by a collimator) on basis of the CT-image. Apparently the coordinate system of the therapy apparatus is different from what of the CT-scanner making it difficult to exactly position the therapy apparatus on the tumor volume. With the Simpson concept such positioning arrows of the tumor volume are obviated.

The Simpson CT-scanner referred to above have some inherent drawbacks among which the following are apparent:

- The flat, broad fan like beam radiates a "slice" of the patient's body simultaneously implying that a detector included in the detector ray under the patient's couch further to electrones which pass the volume immediately above the detector and secondary electrones generated by said volume also will detect secondary electrones generated in the volume surrounding said volume immediately above the said detector. This degrades the resolution of the final CT-image.

- Dynamic radiation treatment of the tumor volume to the desired dose rate is difficult to perform. While rotating the gantry of the treatment apparatus the field collimator must be continuously readjusted to adapt its field to the shape of the tumor volume as seen from the gantry.

- The radiation is of a specific energy (4 MeV). Should a different energy be used then a different beam flattening filter must be used. Such beam flattening filters further to being large and heavy unevitable absorbs the high energy electrones included in the primary beam from the accelerator.

The present invention is directed to a method and apparatus for reducing the deficiencies inherent in the known Simpson CT-scanner, particularly:

- The resolution of the CT-image should be improved, - dynamic

radiation treatment should be possible to perform in an easy way, - a spectrum of different radiation energies should be available thereby making it possible to take CT-images at a desired beam energy without using beam flattening filters which inevitable absorbs the high energy electrones, that is exactly those electrones which in accordance with the present invention should be used to make the CT images.

The above objects of the invention are achieved with a method and device as defined in the accompanying patent claims.

A preferred embodiment of the invention should be described in conjunction with the accompanying drawings wherein:

Fig. 1 is a diagram showing the absorption cross section for different tissues versus the energy of the photon beam,

Fig. 2 is an end view of the apparatus in accordance with the present invention,

Fig. 3 schematically shows the electrical signal obtained at the photon detector array for the specific position (Fig. 3a) of the scanned beam in accordance with the present invention, and for the next following position (Fig. 3b) of the scanning beam,

Fig. 4 is a corresponding electrical signal obtained at the photon detector of the known Simpson device and this figure has been incorporated in order to illustrate the differences between the known device and that of the present invention,

Fig. 5 illustrates the format in which position and photon transmission data are stored in the memory of a micro computer, and

Fig. 6 illustrates a block diagram of the apparatus in accordance with the present invention.

In Fig. 1 the absorption curves for bone, muscles and fatty tissues respectively are shown for varying photon energies. When the difference between the attenuation of the radiation in e.g. bone and fatty tissues is large, indicated with vertical double edged arrows, then the contrast of the CT image taken at the indicated radiation energi, is large. The larger the contrast the better the image quality. From Fig. 1 and the left vertical arrow it is apparent why conventional CT scanners are operating with an acceleration voltage of less than about 1 MV. From the right vertical arrow in Fig. 1 it is also apparent that for radiation energies over about 50 MV the contrast is high. The Simpson concept referred to above did take advantage of this fact. Moreover, the dose planning, as suggested by Simpson, was more accurate since the CT image taken with this high energy radiation showed exactly how the organs within the body absorbed the radiation and from this CT image it was possible to compute the real attenuation coefficients of the organs without relying on extrapolation from 70 kV CT images to teraphy radiation energies in the order of 4 MV and above. Such extrapolation is commonly done with the aid of curves similar to that shown in Fig. 1.

In Fig. 2 there is shown a principal set up of the apparatus in accordance with the present invention. From a gantry 1 a patient 2 resting on a patient's couch 3 is radiated with a pencil like, well united, beam 4 of photons, some of which 5, penetrates the body and are detected by a detector array 6.

A proton beam generated by an accelerator not shown, e.g. a race track microtron, enters the gantry 1 which comprises a pair of scanning electromagnets 7 which are energized by a varuing dc-current in order to scan the proton beam in the plane of the drawing between the end of positions shown in broken lines. The scanning system is preferably of the kind described in our U.S. Patent Serial No. 4 442 352. Generally at the scanning centre 8 of the proton beam there is a target 9 of tantal or other metarial known per se which produces photons of generally the same energy as that of the proton

beam. Further down in the gantry there is a transmission ion chamber 10 measuring the beam current and a pair of collimator blocks 11 for beam collimation.

5 The beam is pulsed which means it comprises pulses of about 1-5  $\mu$  duration with a repetition frequency of 50-250 MHz. Due to the pulse nature of the beam the detector array is of integrating type, that is rather than counting each photon requiring a very fast responding detector it integrates the number of photons which are detected over a time period. The  
10 detector array comprises a linear array of a number of Bismuthgermanate crystals arranged in a side by side relationship and each optically coupled to a photodiode which delivers an electrical signal proportional to the said integral, which in turn therefor is proportional to the  
15 transmission of the radiated body tissue.

In Figure 3A there is shown the detector array 6 and its separate detectors  $x_i$ . In the shown embodiment the physical length of the detector is about 60 cm comprising 128 detectors each made of a crystal Bismuthgermanate allowing for a  
20 picture resolution about 5 mm which a beam which is about 2 cm in square. When the beam is at crystal  $x_n$  at time  $t_n$  the photon transmission has a value of  $T_n$ . In Figure 3B the beam has moved to  $x_{n+1}$  at time  $t_{n+1}$  and the transmission is  $T_{n+1}$ . The transmission values are arranged within a grey scale comprise 16 grey levels 0 corresponding to white and 16 to  
25 black. From the above it is clear that the linear array 6 is used as a coordinate system for the beam. For each position  $x_i$  there is a transmission value  $T_i$  which is allocated  $x_i$ . The position and transmission data for each scan of the beam over  
30 the array is recorded in a micro computer which preferably is of the 16 bit type; allowing convenient format for storing said data. This format is shown in Figure 5 from which it appears that high order byte stores the position of the beam while the low order byte stores the corresponding transmission  
35 values. After each scan of the beam over the array the gantry is rotated together with the array through a predetermined

angel around the patient's couch which is at rest and a new scan is made and new position and transmission data values are recorded. This is repeated for each angular setting of the gantry until finally a completed  $360^{\circ}$  rotation of the gantry has been made. The data so collected and recorded is processed in a manner known per se in a frame computer shown at 12 in Figure 6 in order to reconstruct a CT image of the "slice" of the patient's body just irradiated. Thereafter either the patient's couch or the beam or both are moved a predetermined distance in the longitudinal direction of the couch and a new CT image of the body is taken while rotating the gantry around the patient's body.

Instead of assigning a transmission value  $T_i$  to each of the positions  $x_i$  by taking a separate reading at each detector which for example is done by using a multiplexer the output of which is connected to a scan and detector computer 13 shown in Figure 6 connected to a common output conductor via an A/D converter 14, the outputs of each of the detectors in the array one connected to a common conductor connected to said scan and detector computer 13; said common conductor in this case carrying a composite signal of the kind indicated in Figure 4.

For reference and for monitoring the incident photon beam a second photon detector 15 is inserted between the target 9 and the transmission ion chamber 10. Should the photon fluence vary during the scanning, the transmission values are correspondingly modified.

In accordance with the present invention the energy of the photons should be in the order of 50 Mev in order to produce pair production which gives a significant improvement in the contrast of the CT image.

From the quotient of the incident photon fluence to the recorded transmission value the attenuation coefficient is determined for each position  $x_i$  of the beam. This is made in a

separate dose planning computer 16. The tumor is identified either by inspection of the CT-images taken by the apparatus in accordance with the present invention or by inspection of CT-images taken by a conventional (70-140 kV) CT-scanner. In  
5 both cases the dose is then planned with the aid of the dose planning computer 16.

If the dose is planned with the aid of a conventional CT-scanner image then the latter image is copied within the frame computer on the photon CT-image taken with the apparatus in  
10 accordance with the present invention. The resultant image will thus contain - for each pixel - (picture element of the image)

1) The position of each pixel (and therefore the position of the corresponding part of the patient's organ/tissue) expressed in the coordinate system of the CT scanner in  
15 accordance with the present invention and

2) the absorption coefficient of the corresponding part of the patient's organ(tissue, that is how much of the irradiation beam that is absorbed in different parts of the  
20 patient's body.

This will improve the dose planning since no extrapolation of the kind referred to above is needed. Moreover, no positioning errors will encounter. The dose planning is a matter of minutes and during this time the patient remains resting at  
25 the couch.

The radiation may also very easily perform dynamic radiation treatment of the target volume. In Figure 7 the target volume, for example a part of the throat of a patient, is shown at 17. The target volume should be treated with a constant dose rate.  
30 The overlying tissue, shown at 18, has varying thickness (shown at D1 och D2 respectively).

The incident radiation, shown at the vertical arrows, will therefore be absorbed in different rates in the tissue 13 leading to an uneven dose rate in the target volume 17. The

broken line 19 indicates the position of the dose maximum should the target 17 be radiated with a constant dose. As appears the maximum dose is situated beneath the target volume 17 when the position D2 is radiated from above. This is unwanted, since you want the dose maximum to lye at the same level as in portion D1. To compensate for this a smaller dose should be given in the thinner disuse D2 than in the thicker D1. By varying the speed of the scanning beam so that it is residing a longer time in the thicker tissue the dose rate in the target volume 17 is made constant over the target volume. For how long the beam should reside for example in the tissue is determined from the computed absorbation coefficient for the coresponding portion of the thicker tissue and is made under program control from the dose planning computer.

## CLAIMS

1. A method of making photon CT images with the patient in radiation therapy position by subjecting the patient to the therapy position by subjecting the patient to the therapy radiation beam, comprising the steps of:

- scanning a narrow pencil shaped beam of photons or neutrons the energy of which is of the order of about 3 up to about 50 MeV transversly over the patient,
- during said scanning measuring and recording - with a photon detector array located under the patient - the photons transmitted through the patient's body,
- allocating the current position of the scanning beam to the photon transmission - as measured - at said position,
- processing the data so recorded in order to form a photon CT image comprising the photon absorption properties of the patient's body at the photon energy used,
- using the photon absorption data CT image thus determined for planning the patient treatment,
- irradiating the patient by scanning the beam over the treatment volume and in so doing using the recorded position data to position the beam and said absorption data to vary the scan pattern of the beam such that the desired dose distribution in the tumor volume is obtained.

2. A method in accordance with claim 1, characterized by copying the absorption data CT image on an image formed by conventional CT apparatus and during said copy using the coordinate system of the recorded position data of the absorption data CT image to obtain accurate absorption data of each point of the tumor to be irradiated, and using the information so obtained during the scanning of the treatment beam to allocate each point of the tumor volume a desired irradiation dose.

3. A method in accordance with claim 2, characterized in that said scan pattern is varied by varying the speed of which the beam is scanned over the tumor volume during the radiation

teraphy.

4. A device for making photon CT image with the patient in the radiation therapy position by subjecting the patient to the therapy radiation, comprising:

- 5 - an accelerator producing a beam of high energy electrons,
- an electromagnetically operated beam scanning system for scanning the beam at least in a transverse direction over the patient's body,
- 10 - a target for the electron beam, said target being arranged generally at the scanning centre of the scanning system so as to produce a narrow, pencil formed beam of photons,
- a photon detector array positioned under the patient's body,
- 15 - first signal processor means connected to the photon detector array for producing first electrical signals representing the photons transmitted through the target volume at each current position of the scanned photon beam,
- second signal processor means for producing second electrical signals representing the current position of the scanning beam,
- 20 - computer means to store data relating to the photon attenuation of the target volume and obtained from said first electrical signals, to store data relating to the position said beam had when each first signal was generated,
- 25 - and frame computer means for planning the dose at each position of the target volume using said attenuation and position data and for controlling the movement and the speed of the scanned beam during therapy radiation by using said dose data and said previously stored position data.

5. A device in accordance with claim 4, characterized in  
30 that the energy of the photons is in the order of about 3MeV up to about 50 MeV.

6. A device in accordance with claim 4, characterized in  
35 that the photon detector array comprises bitmuthgermanate crystals arranged in a side by side relationship along a curved surface the centre of curvature of which coincides with

the scanning center of the scanning system.

7. A device in accordance with claim 6, characterized by means for moving the detector array in the longitudinal direction of the patient.

8. A device in accordance with claim 4, characterized by the fact that the second signal processor means comprise current sensors connected to an ion transmission chamber inserted between the target and a collimator included in the gantry which also houses the scanning magnets of the scanning system for the beam.

9. A device in accordance with claim 4, characterized in that the energy of the photons is high enough to produce pair generation effect in the tissue of the tumor volume.

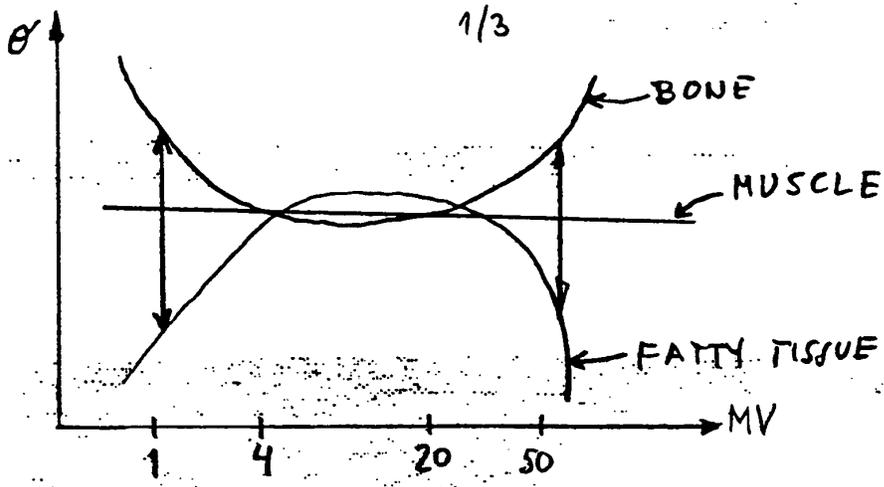


FIG 1

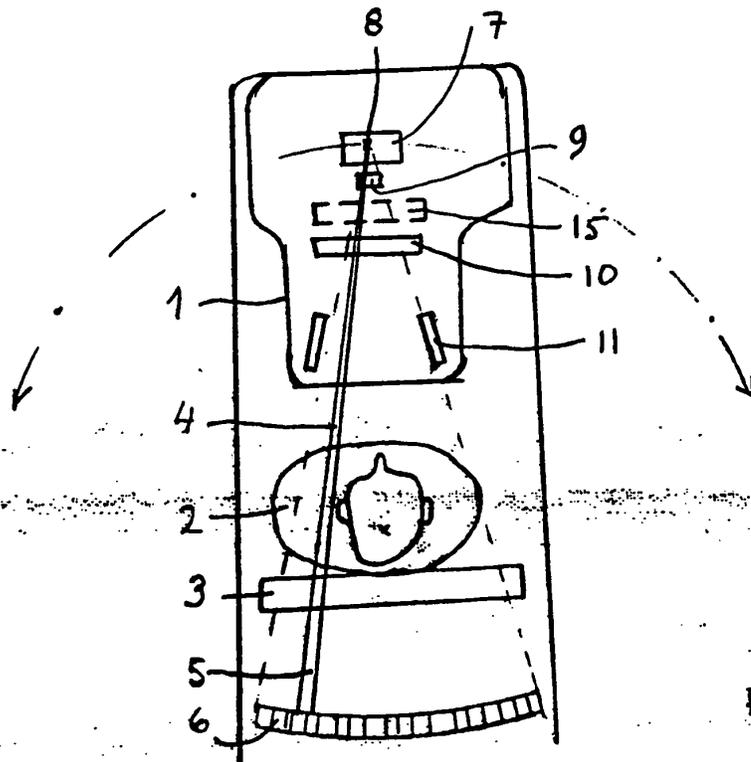
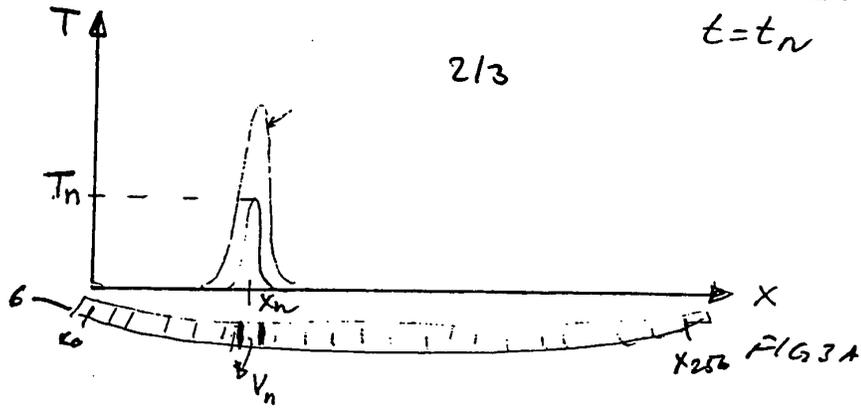


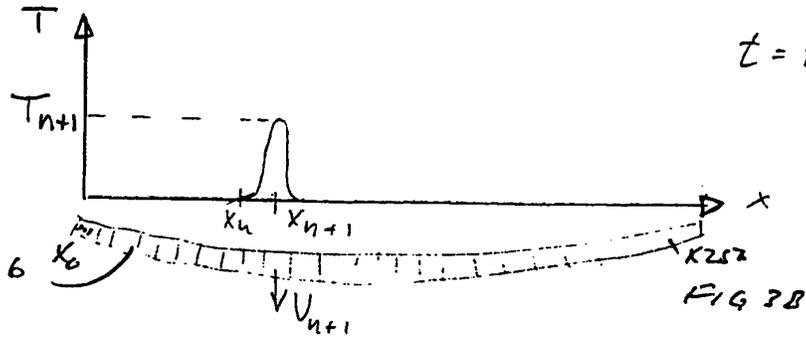
FIG 2

2/3

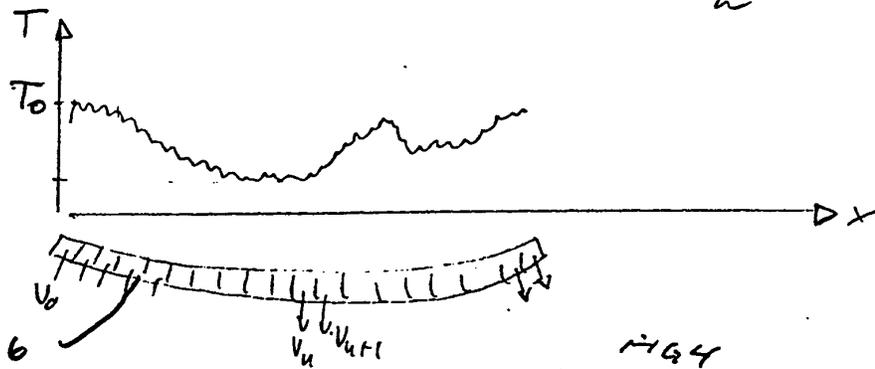
$t = t_n$



$t = t_{n+1}$



$t = t_n$





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European Patent Office

**PARTIAL EUROPEAN SEARCH REPORT**  
 which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application number

EP 85 85 0224

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D, Y	MEDICAL PHYSICS, vol.9, no.4, July/August 1982, pages 574-579; New York, US R.G. SIMPSON et al.: "A 4-MV CT scanner for radiation therapy: The prototype system."		A 61 B 6/03 A 61 N 5/10
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A	US-A- 4 118 631 (FROGGATT)		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
	* Figures 1-4; column 2, line 8 - column 4, line 55 *	1,2	A 61 B A 61 N
<b>INCOMPLETE SEARCH</b> --- ./.			
<p>The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims.</p> <p>Claims searched completely: 4-9          Claims searched incompletely: 1-3          Claims not searched:</p> <p>Reason for the limitation of the search:</p> <p>Method for treatment of the human or animal body by surgery or therapy (see art. 52(4) of the European Patent Convention).</p>			
Place of search		Date of completion of the search	Examiner
The Hague		28-02-1986	CHEN
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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PARTIAL EUROPEAN SEARCH REPORT

Application number  
EP 85 85 0224  
- 2 -

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	MEDICAL PHYSICS, vol.10, no.3, May/June 1983, pages 347-351; New York, US W. SWINDELL: "A 4-MV CT scanner for radiation therapy; spectral properties of the therapy beam."  * Abstract; page 348, figure 1 * -----	4,6	
A	US-A- 4 045 672 (WATANABE)  * Figures 1,2,5; column 1, line 65 - column 4, line 7 * -----	4,7	
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EPO Form 1505.3 06.78

A1

**DEMANDE  
DE BREVET D'INVENTION**

②

**N° 74 15016**

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⑤④ Procédé et dispositif de repérage et de maintien de position.

⑤① Classification internationale (Int. Cl.?). **G 05 D 3/04//A 61 N 5/00.**

②② Date de dépôt ..... 30 avril 1974, à 15 h 22 mn.

③③ ③② ③① Priorité revendiquée :

④① Date de la mise à la disposition du  
public de la demande ..... **B.O.P.I. — «Listes» n. 48 du 28-11-1975.**

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⑦① Déposant : **LESCRENIER Charles, résidant en aux États-Unis d'Amérique.**

⑦② Invention de :

⑦③ Titulaire : *Idem* ⑦①

⑦④ Mandataire : **Cabinet Regimbeau, Corre, Paillet, Martin & Schrimpf.**

La présente invention a trait à une technique d'établissement et de maintien d'une relation de position entre deux objets dont l'un au moins est mobile par rapport à l'autre.

5 En radiothérapie, un faisceau de radiations à haute énergie est formé à partir d'une source de radiations telle que du cobalt 60 ou qu'un accélérateur linéaire. Un patient est placé sur un lit, et la partie du corps du patient qui doit être traitée est placée dans le faisceau pendant une durée d'exposition prédéterminée.

10 Dans le passé, on a affectué le positionnement du patient en peignant une cible sur la peau du patient sur l'étendue de la zone devant être irradiée. Un tracé lumineux, par exemple en forme d'X est établi le long du trajet du faisceau de radiations, et le lit du patient est déplacé de façon à amener la cible peinte  
15 en alignement avec le tracé lumineux.

Même si la position initiale du patient par rapport à la source du faisceau de radiations est correcte, il est fréquent que le patient change de position au cours du traitement et que le faisceau ne soit donc plus appliqué à la partie désirée du corps  
20 du patient, et la radiothérapie est moins efficace qu'elle devrait l'être.

L'objet de la présente invention est par conséquent de proposer un dispositif et un procédé pour établir une relation de position entre deux objets ainsi que pour rétablir et conserver  
25 cette relation en cas de modification de l'emplacement de l'un des objets.

Plus spécifiquement, le but de la présente invention est de proposer un dispositif et un procédé pour établir une relation d'alignement entre patient et faisceau de radiations et pour  
30 rétablir et conserver cette relation dans le cas où le patient bouge.

En substance, la présente invention fait appel à un faisceau de lumière à configuration concentrique présentant une intensité variable de son centre à ses extrémités. Une cible réfléchissante est placée sur le patient ou autre objet de façon à réfléchir  
35 le faisceau de lumière à configuration concentrique. La lumière réfléchie est captée pour fournir un signal proportionnel à son intensité. Ce signal est utilisé pour agir sur des moyens de

commande en vue d'indiquer la relation spatiale entre le patient ou autre objet et le faisceau de lumière et de rétablir et conserver une relation désirée.

5 Les caractéristiques et avantages de l'invention ressortiront de la description donnée ci-après à titre d'exemple en référence aux dessins annexés, sur lesquels :

- la figure 1 est une vue en perspective illustrant une source de faisceau de radiations et un lit déplaçable pour la réception du patient, lit en association avec lequel la présente invention peut être mise en oeuvre,

10 - la figure 2 est une vue schématique illustrant une partie du dispositif de positionnement selon la présente invention,

- la figure 3 est un schéma illustrant d'autres parties du dispositif de positionnement selon l'invention,

15 - la figure 4 est une vue schématique illustrant une variante de réalisation du dispositif de positionnement selon l'invention, et,

- la figure 5 est une vue schématique illustrant une autre variante de réalisation du dispositif de positionnement selon l'invention.

20 La figure 1 illustre un exemple-type de mise en oeuvre du dispositif selon la présente invention dans son application au positionnement d'un patient par rapport à un faisceau de radiations.

25 Le faisceau de radiations est engendré par une source 10 de tout type couramment en usage. La source 10 comporte une potence 12 qui supporte une tête 14 d'émission de radiations. La potence 12 est déplaçable suivant une course curviligne avec le tambour 16.

30 Le patient est positionné sur le lit 20 sur le trajet des radiations. Le lit 20 comprend une couche 22 pour la réception du patient. La couche 22 est déplaçable suivant trois axes mutuellement orthogonaux dénommés ci-après axe X, axe Y et axe Z. Comme indiqué sur la figure 1, on considère comme déplacement  
35 suivant l'axe X le déplacement latéral de la couche 22 face au tambour 16, comme déplacement suivant l'axe Y le mouvement de rapprochement et d'éloignement de la couche 22 par rapport au tambour 16, et comme déplacement suivant l'axe Z le mouvement

de montée et de descente de la couche 22. Pour les besoins de l'exposition des considérations qui vont suivre, le sens de déplacement le long des axes est exprimé en termes de sens + et -, comme indiqué sur la figure 1.

5 Le lit 20 comporte des roues 24 entraînées par moteur pour déplacer le lit dans les deux sens le long de l'axe X. la couche 22 peut être montée sur le lit 20 sur des guides 26 parallèles à l'axe Y, et son déplacement peut être obtenu au moyen d'un mécanisme 28 à vis-mère entraînée par un moteur. Les guides 26 sont  
10 déplaçables verticalement par rapport au lit 20 par une vis-mère 30 à entraînement par moteur pour assurer la montée et la descente de la couche 22 suivant l'axe Z. Les moteurs électriques de commande sont alimentés par raccordement à un câble d'alimentation 32.

15 Une source de lumière 40 est prévue pour former un faisceau lumineux à configuration concentrique dont l'intensité varie entre son centre et ses extrémités. Cette source lumineuse peut être montée sur la tête 14 de façon à projeter un faisceau de lumière suivant globalement le trajet des radiations.

20 La source de lumière 40 peut comprendre un laser 50 ou une autre source appropriée d'énergie radiante telle que de la lumière visible ou infrarouge. Le terme "lumière" est utilisé dans le présent mémoire et dans les revendications ci-annexées pour désigner toutes formes appropriées d'énergie radiante. La lumière  
25 fournie par le laser 50 traverse une lentille de diffusion 52, laquelle crée le long de l'axe 43 le faisceau lumineux 42 à configuration concentrique de variation d'intensité. La lumière issue de la lentille 52 traverse un miroir semi-réfléchissant 54 orienté à 45° par rapport à la direction de projection de la  
30 lumière.

Comme on le verra plus loin, de la lumière est rétro-réfléchie le long de l'axe 43 lors du positionnement du patient. La lumière réfléchie est interceptée par le miroir semi-réfléchissant 54 et réfléchie sur un second miroir 56. L'image réfléchie  
35 tombe sur une cellule photoélectrique 60 après traversée d'une lentille de concentration 58. La cellule photoélectrique 60 fournit au conducteur 63 un signal électrique proportionnel à l'intensité de la lumière réfléchie.

Une cible réfléchissante 70 est placée sur la peau du patient dans la zone devant être irradiée, comme illustré sur la figure 3. Dans le cas général, cette cible est un petit morceau de bande du type rétro-réfléchissant qui réfléchit vers l'arrière  
5 suivant leur axe d'incidence les rayons lumineux incidents qu'il intercepte. La bande pour exploration photoélectrique fabriquée et commercialisée par la firme 3M Co, St Paul, Minnesota, U.S.A. sous la désignation n° 7900 est utilisable à cet effet.

La cellule photoélectrique 60 est reliée au moyen du  
10 conducteur 60 à des moyens de commande intercalés entre la cellule photoélectrique et les moyens d'entraînement du lit 20. Comme illustré sur la figure 3, les moyens de commande 72 comprennent un circuit 74 de commande d'axe X et un circuit 76 de commande d'axe Y. Le circuit 74 de commande d'axe X et le circuit 76  
15 de commande d'axe Y sont globalement d'agencement similaire et, pour la commodité de la description, on ne décrira en détail que le circuit 74 de commande d'axe X. Le circuit 74 de commande d'axe X comporte un amplificateur 78. L'amplificateur 78 peut être du type différentiel, en tant que pouvant être commandé par la  
20 différence des signaux appliqués à ses deux bornes d'entrée. La cellule photoélectrique 60 est reliée à une entrée de l'amplificateur différentiel 78 par l'intermédiaire des conducteurs 63 et 62 d'une résistance 80. L'armature supérieure d'un condensateur 82 est reliée à l'autre borne d'entrée de l'amplificateur différentiel 78 à travers une résistance 84. L'armature inférieure du  
25 condensateur 82 est reliée à la masse. Une diode 86 est montée entre les bornes d'entrée de l'amplificateur 78. La diode est orientée de façon à appliquer au condensateur 82 la tension du conducteur 62. Le signal de sortie de l'amplificateur différentiel 78 est disponible sur un conducteur 88.  
30

Aux bornes du condensateur 82 sont reliés l'émetteur et le collecteur d'un transistor 90 dont la base est polarisée à travers une résistance 92 et un condensateur 94 par le signal de sortie du conducteur 88.

35 Comme on le verra plus loin, le signal de sortie du conducteur 88 est de forme impulsionnelle et est appliqué à l'entrée d'une bascule 96 à complémentarité. Les sorties directe et inverse de la bascule 96 fournissent les signaux de sortie du

circuit de commande 74 d'axe X. La sortie directe ou sortie "Q" de la bascule 96 est reliée par un conducteur 97 et par le câble d'alimentation 32 aux moyens d'entraînement des roues 24 pour déplacer le lit 20 dans le sens positif de l'axe X. La sortie inverse ou sortie "Q" de la bascule 96 est reliée par un conducteur 99 et par le câble d'alimentation 32 aux moyens d'entraînement des roues 24 pour déplacer le lit 20 dans le sens négatif de l'axe X. Les conducteurs 97 et 99 traversent un commutateur 101 commandé par temporisateur.

L'agencement du circuit 76 de commande d'axe Y est similaire à celui du circuit 74 de commande d'axe X. Le signal transmis par les conducteurs 63 et 64 est appliqué à l'entrée d'un amplificateur différentiel 98. La sortie de l'amplificateur différentiel 98 est délivrée par l'intermédiaire d'une bascule à complémentation 100. La sortie directe de la bascule 100 est reliée aux moyens d'entraînement de la couche 22 de façon à déplacer celle-ci dans le sens positif de l'axe Y. Cette liaison est assurée par un conducteur 103 et par le câble d'alimentation 32. La sortie inverse de la bascule 100 est reliée par un conducteur 105 et par le câble d'alimentation 32 aux moyens d'entraînement de la couche 22 de façon à assurer le déplacement de celle-ci dans le sens négatif de l'axe Y. Les conducteurs 103 et 105 traversent un commutateur 107 commandé par temporisateur.

A des fins qui seront indiquées plus loin, le circuit 74 de commande d'axe X et le circuit 76 de commande d'axe Y sont interconnectés par une paire de temporisateurs. Le conducteur de sortie 88 de l'amplificateur différentiel 78 est relié à l'entrée du temporisateur 102 par un conducteur 104. La sortie du temporisateur 102 commande le commutateur 101. Le fonctionnement du temporisateur 102 est tel que, lorsqu'une impulsion est délivrée à son entrée par le conducteur 88, le temporisateur 102 ferme le commutateur 101 et le maintient fermé jusqu'à ce qu'au moins trois impulsions soient apparues sur le conducteur 88 dans un intervalle de temporisation prédéterminé. Lorsque cette condition est réalisée, le temporisateur 102 est également appliquée par le conducteur 106 au commutateur 107 prévu dans le circuit 76 de commande d'axe Y. Lorsque le temporisateur 102 ouvre le commutateur 101, il ferme le commutateur 107. Cette

action met en service le circuit 76 de commande l'axe Y.

Le circuit 76 de commande d'axe Y comprend un temporisateur 112 semblable au temporisateur 102 du circuit 74 de commande d'axe X. Le temporisateur 112 commande le commutateur 107 interposé sur le trajet des conducteurs 103 et 105. De plus, la sortie du temporisateur 112 est reliée à la source 10 de faisceau de radiations par un conducteur 111 pour commander l'émission de radiations par cette source.

Le fonctionnement du dispositif selon l'invention est le suivant. La cible réfléchissante 70 est placée sur le patient à l'emplacement devant être irradié. Cet emplacement peut par exemple être le torse, comme illustré sur la figure 3. Le patient est ensuite placé sur la couche 22. Celle-ci peut se trouver en un emplacement situé à l'écart de la source 10 de faisceau de radiations. La source de lumière 50 est mise en service pour fournir le faisceau lumineux 42 à intensité variable et configuration concentrique suivant l'axe du faisceau de radiations. Le patient étant sur la couche 22, l'opérateur actionne les moyens d'entraînement des roues 24 pour amener le lit dans le faisceau lumineux. A cet effet, les moyens d'entraînement peuvent être programmés de façon à amener le lit 20 en un emplacement fixe, tel que le centre de la zone de traitement. Il en résulte que le patient est placé dans le faisceau lumineux 42 à configuration concentrique.

Lorsque ce déplacement est achevé, les moyens de commande 72 sont rendus actifs. Dans leur état de fonctionnement initial, on peut supposer qu'un signal en provenance de la sortie directe de la bascule 96 du circuit 74 de commande d'axe X est délivré sur le conducteur 97 à travers le commutateur 101 fermé. Les moyens d'entraînement des roues 24 déplacent le lit 20 dans le sens positif de l'axe X. Il n'y a pas de signal sur le conducteur 88, de sorte que le temporisateur 102 n'est pas actif. Le commutateur 107 est ouvert. Il n'apparaît de signaux en provenance du circuit 76 de commande d'axe Y ni sur le conducteur 103 ni sur le conducteur 105, de sorte que le circuit 76 de commande d'axe Y est rendu inopérant.

Le patient étant dans le faisceau 42, la cible 70 renvoie des rayons réfléchis en direction de la source de lumière 40. Ces rayons réfléchis frappent les miroirs 54 et 56 en donnant lieu à l'éclairage de la cellule photoélectrique 60. Cette dernière  
5 délivre sur les conducteurs 63 et 62 un signal proportionnel à l'intensité lumineuse tombant sur la cible 70. Le signal délivré par le conducteur 62 est appliqué à travers la résistance 80 à une entrée de l'amplificateur 78. Le signal est également appliqué à travers la diode 86 pour charger le condensateur 82. Tant  
10 que les moyens d'entraînement déplacent le lit 20 dans un sens tel que le signal sur le conducteur 62 subisse une augmentation continue c'est-à-dire en rapprochant le lit de l'emplacement désiré, le signal appliqué à la résistance 80 reste toujours supérieur au signal appliqué à la résistance 84 par le condensateur 82. L'état  
15 de sortie de l'amplificateur différentiel 78 ne varie pas, et les moyens d'entraînement des roues 24 continuent à agir dans le même sens, c'est-à-dire dans le sens de déplacement positif le long de l'axe X.

A un certain instant, la lumière réfléchie provenant de la  
20 cible 70 passe par un maximum et diminue d'amplitude. Le signal appliqué à la résistance 80 devient inférieur au signal appliqué à la résistance 80 devient inférieur au signal appliqué à la résistance 84. Ceci donne lieu à l'apparition d'un signal de sortie sur le conducteur 88 en provenance de l'amplificateur  
25 opérationnel 78. Lorsqu'appliqué à la bascule 96, ce signal provoque l'excitation de la sortie inverse et la désexcitation de la sortie directe de la bascule. Ceci a pour effet d'inverser le sens de fonctionnement des moyens d'entraînement et de leur faire déplacer le lit 20 dans le sens négatif de l'axe X.

30 Le signal de sortie sur le conducteur 88 amorce le transistor 90, en déchargeant le condensateur 82 et en supprimant le signal appliqué à la résistance 84 et à l'entrée de l'amplificateur différentiel 78. Le signal appliqué à la résistance 80 redevient supérieur au signal appliqué à la résistance 84, ce qui  
35 supprime le signal de sortie de l'amplificateur différentiel 78 sur le conducteur 88. Ce signal de sortie présente par conséquent la forme d'une impulsion.

Au cours du déplacement du lit 20 dans le sens négatif de l'axe X, il vient un instant où la lumière réfléchiée par la cible 70 atteint un maximum. Le signal sur le conducteur 63 charge le condensateur 62 mais reste supérieur à la tension du condensateur, en maintenant l'amplificateur différentiel 78 dans l'état inactif et en empêchant l'apparition d'un signal de sortie sur le conducteur 88. Lorsque la lumière réfléchiée par la cible 70 franchit le maximum et diminue d'amplitude, l'amplificateur 78 réagit comme décrit plus haut pour fournir une autre impulsion sur le conducteur 88, laquelle inverse le sens de déplacement du lit 20.

Le processus ci-dessus décrit se poursuit jusqu'à ce que trois impulsions soient fournies par l'amplificateur différentiel 78 au temporisateur 102 dans un intervalle de temps prédéterminé, en indiquant que la cible 70 et le patient se rapprochent de l'emplacement désiré. Lorsque ce résultat est atteint, le temporisateur 102 réagit en ouvrant le commutateur 101 et en fermant le commutateur 107. Ceci fait cesser le déplacement du lit 20 le long de l'axe X et met en fonctionnement le circuit 76 de commande d'axe Y pour déplacer la couche 22 le long de l'axe Y. D'une façon analogue à celle décrite en ce qui concerne le circuit 74 de commande d'axe X, le circuit 76 de commande d'axe Y déplace la couche 22 en direction du maximum du faisceau lumineux 42. Lorsque trois impulsions ont été délivrées par l'amplificateur différentiel 98, le temporisateur 112 provoque l'ouverture du commutateur 107 et la désactivation des moyens de commande 72. A cet instant, les moyens de commande 72 peuvent transmettre par le conducteur 111 un signal à la source 10 de faisceau de radiations pour faire commencer l'exposition du patient aux radiations.

A moins d'être soumis à des perturbations extérieures, le lit 20 demeure dans la position vers laquelle il a été dirigé par les moyens de commande 72. Si le patient, et par conséquent la cible 70, viennent à bouger, un processus similaire à celui décrit en ce qui concerne la position initiale du patient a lieu, lequel replace le patient dans la position désirée par rapport au faisceau de radiations.

La commande du déplacement de la couche 22 dans l'axe Z peut être obtenue de diverses façons. Etant donné que le niveau de la lumière réfléchiée à intensité variable appliquée à la

cellule photoélectrique 60 varie globalement en raison inverse de la distance de la cible 70 à la cellule photoélectrique, le niveau de lumière réfléchi peut être utilisé pour commander le déplacement de la couche 22 le long de l'axe Z. A cet effet, un circuit 5 120 de commande d'axe Z est incorporé aux moyens de commande 72. Le circuit 120 de commande d'axe Z comporte un amplificateur de commande 122. L'un des signaux d'entrée de l'amplificateur de commande 122 est le signal fourni par la cellule photoélectrique 60 aux conducteurs 63 et 124. L'autre signal d'entrée est un signal de 10 référence engendré par un rhéostat 126 est réglable pour fournir à l'amplificateur de commande 122 un signal de référence d'amplitude égale à celle du signal fourni sur le conducteur 124 par un niveau d'intensité lumineuse correspondant à la position désirée de la couche 22 le long de l'axe Z. Les signaux d'entrée de l'amplificateur de commande 122 traversent un commutateur temporisé 15 125 qui est relié au temporisateur 112 par un conducteur 127. Les sorties de l'amplificateur de commande 122 par des conducteurs 130 et 132 sont reliées aux moyens d'entraînement de la vis-mère 30 prévue sur le lit 20 pour déplacer la couche 22 vers le haut 20 et vers le bas le long de l'axe Z. Un commutateur de détection de niveau 129 est inséré dans les conducteurs 130 et 132 pour détecter une condition de zéro de la sortie de l'amplificateur de commande 122. Le commutateur 129 est relié à la source 10 du faisceau de radiations par un conducteur 131.

25 En fonctionnement, l'amplificateur de commande 122 agit de façon à réguler la position de la couche 22 à la hauteur désirée le long de l'axe Z après achèvement de l'intervention du circuit 76 de commande d'axe Y. Cette régulation est obtenue au moyen des signaux de référence et de retour fournis à l'amplificateur 122 30 par le rhéostat 126 et le conducteur 124. Après achèvement de l'intervention du circuit 76 de commande d'axe Y, le temporisateur 112 ferme le commutateur 125 en appliquant ainsi à l'amplificateur de commande 122 le signal de retour disponible sur le conducteur 124 et le signal de référence issu du rhéostat 126. S'il advient 35 que l'amplitude du signal sur le conducteur 124 soit inférieur à celle du signal de référence fourni par le rhéostat 126, un signal est fourni par l'amplificateur de commande 122 sur le conducteur 130 aux moyens d'entraînement de la vis-mère 30 pour déplacer la

couche 22 dans le sens positif ou sens ascensionnel le long de l'axe Z, en accroissant la valeur du signal fourni par le conducteur 124. Lorsque celle-ci devient égale à celle du signal fourni à l'amplificateur de commande 122 par le rhéostat 126, le signal de sortie sur le conducteur 130 disparaît et le déplacement de la couche 22 dans le sens positif de l'axe Z cesse. Le commutateur 129 est actionné pour transmettre à la source 10 du faisceau de radiations par un conducteur 131 un signal destiné à faire commencer l'exposition du patient aux radiations.

10 S'il advient que l'amplitude du signal sur le conducteur 124 soit supérieure à celle du signal de référence fourni par le rhéostat 126, un signal en provenance de l'amplificateur de commande 122 est transmis par le conducteur 132 aux moyens d'entraînement de la vis-mère 30 pour déplacer la couche 22 dans le sens négatif ou sens de descente le long de l'axe Z en vue de réduire l'amplitude du signal sur le conducteur 124. Lorsque cette amplitude devient égale à celle du signal fourni par le rhéostat 126 à l'amplificateur de commande 122, le signal de sortie du conducteur 132 disparaît, et le commutateur 129 est actionné.

20 En variante, une seconde source de lumière 133 dont l'agencement est similaire à celui de la source de lumière 40 et qui est orientée dans un plan horizontal peut être disposée au voisinage du patient, une seconde cible 134 étant alors placée, par exemple, sur le flanc du patient comme illustré sur la figure 4. La source de lumière 133 peut être reliée à un circuit 136 de commande d'axe Z d'agencement similaire à celui du circuit 74 de commande d'axe X ou du circuit 76 de commande d'axe Y, pour commander le positionnement de la couche 22 le long de l'axe Z. Le positionnement de la couche 22 le long de l'axe Z peut également être  
30 utilisé pour corriger toute parallaxe susceptible d'exister entre la source de lumière 40 et le faisceau de radiations émis par la tête 14.

Bien que la description qui précède ait fait état de la mise en oeuvre de l'invention pour amener la couche 22 en un emplacement désiré par déplacement dans trois axes rectilignes mutuellement perpendiculaires, il est à noter que la position angulaire de la couche 22 par rapport à chacun des trois axes peut également être commandée. A cet effet, les moyens d'entraî-

nement de la couche 22 sont pourvus de moyens propres à faire pivoter la couche autour de chacun des trois axes. Pour commander le fonctionnement de ces portions des moyens d'entraînement, des sources lumineuses additionnelles sont utilisées, comme illustré sur la figure 5.

Une paire de cibles 140 et 142 sont prévues de chaque côté du torse du patient. Deux sources lumineuses 144 et 146 sont positionnées de chaque côté de la couche 22 et alignées avec les cibles 140 et 142 lorsque le patient est placé dans la position désirée sur la couche 22. Les sources lumineuses 144 et 146 sont reliées à un circuit de commande 148 dont l'agencement est similaire à celui des moyens de commande 72 illustrés sur la figure 3. Le circuit de commande 148 est relié aux moyens d'entraînement angulaire d'axe X de la couche 22 pour régler la position angulaire, positive ou négative, de la couche en agissant de la même manière que les moyens de commande 72 pour assurer le réglage de la position de la couche 22 en translation. Un déplacement angulaire peut être imprimé à la couche 22 en associant une paire de vis-mères 30 mobiles indépendamment l'une de l'autre à chacun des guides 26, comme illustré sur la figure 5.

Ainsi, si le patient placé sur la couche 22 vient à tourner latéralement le torse, les cibles 140 et 142 sortent de leur alignement avec les sources lumineuses 144 et 146. Les variations correspondantes de niveau de sortie des sources lumineuses 144 et 146 provoquent alors le pivotement de la couche 22 sous l'action du circuit de commande 148 pour ramener les cibles 140 et 142 en alignement avec les sources lumineuses 144 et 146 afin de rétablir la position du patient par rapport au faisceau de radiations. Des dispositifs et circuits similaires peuvent être prévus pour commander le déplacement angulaire de la couche 22 autour des axes Y et Z.

REVENDEICATIONS

1 - Dispositif pour établir l'emplacement d'un premier objet par rapport à un second objet, caractérisé en ce qu'il comprend des moyens à source lumineuse associés au premier objet pour engendrer un faisceau de lumière, une cible réfléchissante disposée  
 5 sur le second objet pour réfléchir le faisceau de lumière, un capteur de lumière propre à recevoir de la lumière réfléchie par la cible pour fournir un signal proportionnel à son intensité, et des moyens de commande sensibles au signal d'intensité lumineuse pour indiquer la relation de position entre le premier et le  
 10 second objets.

2 - Dispositif selon la revendication 1, caractérisé en ce que les moyens à source lumineuse précités sont adaptés à engendrer un faisceau de lumière à configuration concentrique dont l'intensité varie de son centre à ses extrémités.

3 - Dispositif selon la revendication 2, destiné à établir et à maintenir une relation de position entre les objets précités, caractérisé en ce qu'il comprend en outre des moyens d'entraînement associés à l'un desdits objets pour déplacer ledit objet, et en ce que les moyens de commande précités sont interposés entre ledit  
 20 capteur de lumière et lesdits moyens d'entraînement et sont sensibles au signal d'intensité lumineuse précité pour provoquer le déplacement de l'objet sous l'action desdits moyens d'entraînement de façon à placer la cible précitée au centre du faisceau de lumière à configuration concentrique précité.

4 - Dispositif selon la revendication 3, caractérisé en ce que les moyens d'entraînement précités sont associés au second objet précité de façon à déplacer ledit second objet dans une direction parallèle au faisceau de lumière, ledit déplacement modifiant les niveaux des signaux d'intensité lumineuse en fonction de l'emplacement du second objet dans ladite direction  
 30 parallèle, et en ce que les moyens de commande précités comportent des moyens sensibles aux niveaux des signaux d'intensité lumineuse pour faire amener ledit second objet par lesdits moyens d'entraînement en un emplacement désiré le long d'une course de déplacement parallèle au faisceau de lumière.

5 - Dispositif selon la revendication 3, caractérisé en ce qu'il comprend de seconds moyens à source lumineuse propres à engendrer un faisceau de lumière à configuration concentrique

présentant une orientation prédéterminée par rapport au premier faisceau de lumière, les moyens d'entraînement précités comportant en outre des moyens propres à déplacer ledit second objet dans ledit second faisceau de lumière dans un plan normal à celui-ci

5 une seconde cible réfléchissante disposée sur ledit second objet pour réfléchir le second faisceau de lumière à configuration concentrique et un second capteur de lumière propre à recevoir de la lumière réfléchiée par la seconde cible pour fournir un signal proportionnel à son intensité, et en ce que les moyens de commande

10 précités sont interposés entre ledit second capteur de lumière et lesdits moyens d'entraînement et sont sensibles au signal d'intensité lumineuse dudit second capteur de lumière pour faire déplacer ledit second objet par lesdits moyens d'entraînement de façon à placer la seconde cible au centre dudit second

15 faisceau de lumière à configuration concentrique.

6 - Dispositif selon la revendication 2, caractérisé en ce que le premier objet précité est un émetteur de faisceau de radiations et en ce que le second objet précité est une couche recevant un patient sur lequel est placée la cible réfléchissante.

20 7 - Procédé pour l'établissement et la conservation de la position d'un premier objet par rapport à un second objet, caractérisé en ce qu'il comprend les opérations consistant à placer une cible réfléchissante sur le second objet, à engendrer un faisceau de lumière à configuration concentrique présentant une

25 intensité variable de son centre à ses extrémités et une orientation prédéterminée par rapport au premier objet, à amener le second objet à évaluer la quantité de lumière réfléchiée par la cible pour déterminer l'emplacement du second objet.

8 - Procédé selon la revendication 7, caractérisé en ce que l'opération d'évaluation de la quantité de lumière réfléchiée est effectuée par détection d'un extremum de ladite quantité de lumière réfléchiée.

9 - Procédé selon la revendication 7, caractérisé en ce que l'opération d'amenée du second objet est effectuée par

35 déplacement dudit second objet dans le faisceau de lumière le long d'axes mutuellement perpendiculaires dans un plan normal au faisceau.

10 - Procédé selon la revendication 9, caractérisé en ce que l'opération d'évaluation de la quantité de lumière réfléchie est effectuée par détection des niveaux des signaux d'intensité lumineuse, et en ce que l'opération d'amenée du second objet dans le faisceau de lumière est effectuée par déplacement du second objet le long d'une course de déplacement parallèle au faisceau de lumière en fonction des niveaux des signaux d'intensité lumineuse.

11 - Procédé selon la revendication 10, caractérisé en ce que l'opération d'amenée du second objet est en outre effectuée par déplacement séquentiel du second objet le long d'un axe puis le long d'un autre axe.

12 - Procédé selon la revendication 8, caractérisé en ce que l'opération de génération d'un faisceau de lumière comprend la génération d'un second faisceau de lumière à configuration concentrique présentant une orientation prédéterminée par rapport au premier faisceau de lumière, ledit procédé comprenant en outre les opérations consistant à placer une seconde cible réfléchissante sur le second objet pour réfléchir le second faisceau de lumière, à amener le second objet dans le second faisceau de lumière et à évaluer la quantité de lumière réfléchie par la cible pour déterminer l'emplacement du second objet.

13 - Procédé selon la revendication 7, caractérisé en ce que le premier objet comprend un émetteur de faisceau de radiations et en ce que le second objet comprend un patient.

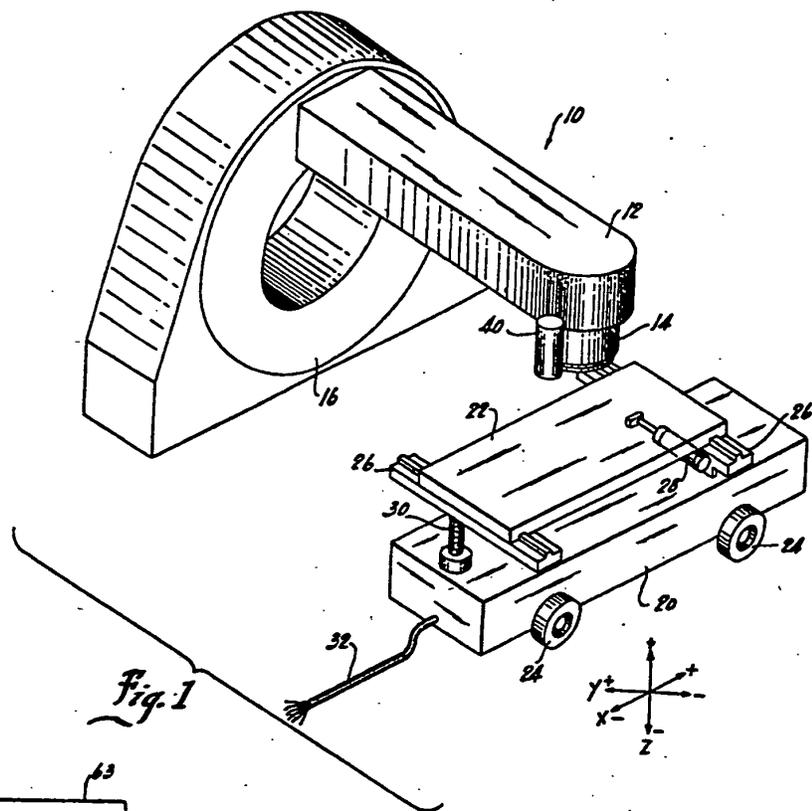


Fig. 1

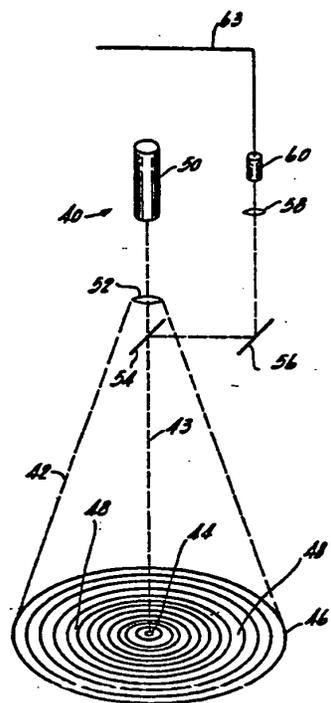


Fig. 2

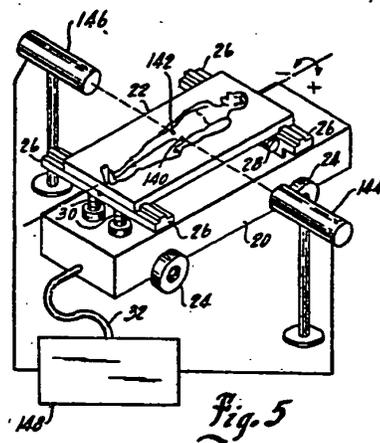
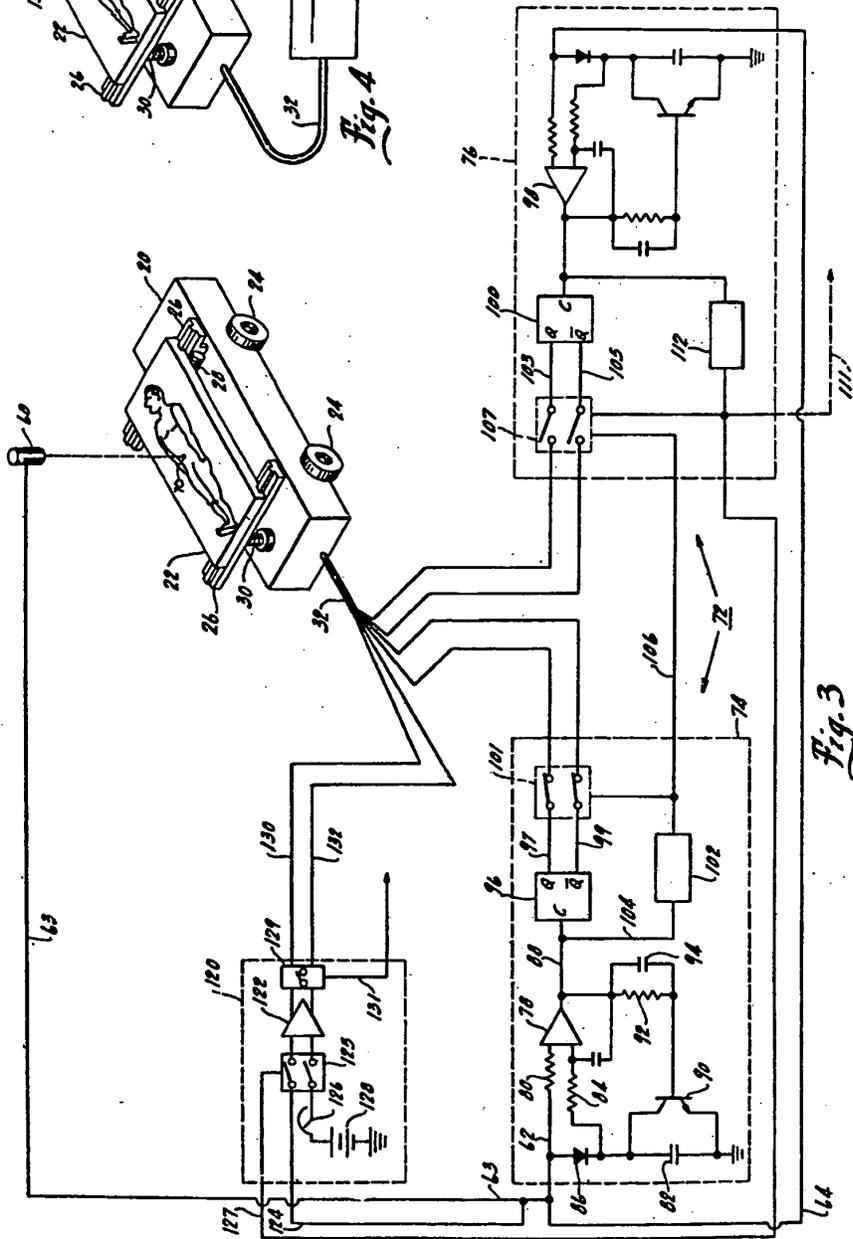
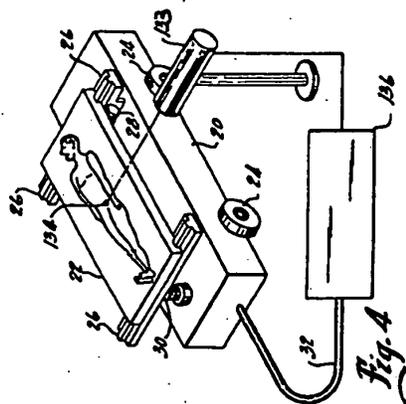


Fig. 5



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⑮ Int Cl<sup>4</sup> : A 61 N 5/10.

⑫ **DEMANDE DE BREVET D'INVENTION**

A1

⑲ Date de dépôt : 13 septembre 1983.

⑳ Priorité : US, 13 septembre 1983, n° 416,795.

④③ Date de la mise à disposition du public de la  
demande : BOPI « Brevets » n° 11 du 15 mars 1985.

⑥① Références à d'autres documents nationaux appa-  
rentés :

⑦① Demandeur(s) : Société dite : *VARIAN ASSOCIATES,  
INC. — US.*

⑦② Inventeur(s) : Philip Dean La Riviere.

⑦③ Titulaire(s) :

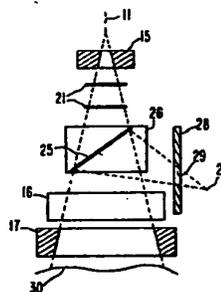
⑦④ Mandataire(s) : Cabinet Lavoix.

⑤④ Miroir mince d'éclairage de champ pour un accélérateur médical d'électrons.

⑤⑦ L'invention concerne un appareil médical d'irradiation  
comprenant un dispositif de visualisation du champ de traite-  
ment.

Le dispositif de visualisation comporte une source de lu-  
mière visible 27 positionnée à l'extérieur du trajet du faisceau  
et un miroir 25 monté de façon fixe dans le trajet du faisceau  
et orienté pour que la lumière visible de la source soit réfléchié  
afin d'éclairer le champ de traitement 30. Le miroir consiste en  
une mince pellicule de matière plastique métallisée avec un  
revêtement d'aluminium.

L'invention s'applique notamment à un appareil médical d'ir-  
radiation avec un faisceau d'électrons ou de rayons X.



FR 2 551 664 - A1

La présente invention se rapporte au domaine de la simulation visuelle du diagramme de rayonnement formé par un dispositif médical d'application de faisceau électrons et concerne plus particulièrement un miroir qui, dans ce but, peut être laissé fixe dans un faisceau de rayons X ou d'électrons comme une partie d'un système optique.

Pendant le fonctionnement d'un appareil à rayons X, il est souhaitable de pouvoir visualiser ses limites de rayonnement par un diagramme lumineux visible, et cela se fait généralement au moyen d'un dispositif optique comprenant une source de lumière visible située à une certaine distance du faisceau de rayons X et un réflecteur positionné dans le trajet du faisceau de manière que l'image virtuelle de la source lumineuse soit formée à l'origine du faisceau de rayons X. Ce réflecteur peut être à miroir de verre courant fixé dans le trajet du faisceau et un tel dispositif optique est décrit dans le brevet des Etats-Unis d'Amérique n° 3.767.931.

Mais, ce même dispositif optique ne peut être utilisé dans le cas d'un faisceau d'électrons car la perte d'énergie et la dispersion des électrons dans le miroir seraient intolérables. Des miroirs en matière plastique ont été utilisés dans des faisceaux d'électrons de haute énergie, dans la plage du GeV pour réfléchir la lumière visible, mais le taux d'absorption de l'énergie des électrons augmente généralement quand l'énergie du faisceau diminue. Dans le cas d'un appareil de traitement médical, l'énergie du faisceau d'électrons est généralement inférieure à 50 MeV et il n'est pas souhaitable qu'un miroir conçu pour une machine à faisceau d'électrons de haute énergie soit maintenue immobile dans le trajet d'un faisceau d'électrons de basse énergie comme celui d'un accélérateur médical d'électrons. Le miroir courant doit être rétractable ou l'ensemble du dispositif optique, y compris le miroir doit être monté de manière qu'il puisse être déplacé hors du trajet, que la machine fonctionne dans

le mode de traitement par rayons X ou par électrons. Mais ces procédés nécessitent des pièces mobiles entraînées, ils nécessitent des tolérances de repositionnement très serrées et les mécanismes sont coûteux à fabriquer.

5 Un but de l'invention est donc de proposer un miroir qui peut être laissé fixe dans un faisceau de rayons X ou d'électrons sans compromettre de façon notable les qualités du faisceau.

10 Un autre but de l'invention est de proposer un accélérateur d'électrons pour un traitement médical qui comporte un dispositif fixé dans le trajet du faisceau pour réfléchir la lumière visible afin de simuler le diagramme de rayonnement du champ.

15 D'autres caractéristiques et avantages de l'invention apparaîtront au cours de la description qui va suivre.

Au dessin annexé donné uniquement à titre d'exemple nullement limitatif :

20 La figure 1 est une coupe schématique partielle d'un dispositif médical d'application de faisceau avec un miroir positionné de façon non rétractable selon l'invention, lorsque le dispositif est utilisé dans le mode d'électrons,

25 La figure 2 est une coupe schématique du dispositif d'application de la figure 1, lorsqu'il est utilisé dans le mode de rayons X.

Les figures 1 et 2 représentent donc schématiquement un accélérateur médical d'électrons, pouvant fonctionner à la fois dans le mode d'électrons et le mode de rayons X. La figure représente particulièrement un  
30 dispositif optique selon l'invention au moyen duquel le champ à irradier peut-être simulé visuellement. Un accélérateur de particules chargées (non-représenté) produit un faisceau d'électrons 11 qui, quand la machine fonctionne dans le mode de rayons X comme selon la figure 2, bombarde  
35 une anticathode 12 qui produit un faisceau de rayons X de forme générale conique autour de la direction initiale de l'axe du faisceau. Quand la machine est utilisée dans le

mode d'électrons comme le montre la figure 1, l'anticathode 12 est extraite du trajet du faisceau 11 et le faisceau d'électrons 11 provenant de l'accélérateur s'étale dans une forme générale conique en raison de la répulsion électrostatique entre les électrons et des composantes transversales de leurs vitesses initiales.

Le faisceau est dirigé par une ouverture de forme conique dans un collimateur primaire 15. L'ouverture est un passage central conique qui, avec les mâchoires 10 réglables 16 et 17 servent à collimater le faisceau. Selon les figures 1 et 2, les mâchoires supérieures 16 et les mâchoires inférieures 17 sont positionnées sous un angle de 90° autour de la direction initiale du faisceau 11.

Un dispositif de régularisation destiné à 15 produire une intensité uniforme du faisceau dans toute sa section transversale est disposé dans le trajet du faisceau. Dans le mode de rayons X, un filtre correcteur 20 du type décrit dans le brevet des Etats-Unis d'Amérique n° 4.286.167 peut être utilisé. Dans le mode d'électrons, le filtre 20 correcteur 20 est rétracté et une ou plusieurs feuilles 21 sont introduites transversalement dans le trajet du faisceau, dans une ou plusieurs positions appropriées en fonction de l'énergie et d'autres caractéristiques du faisceau d'électrons.

25 Un miroir 25 est monté sur un cadre fixe 26 et il est orienté de façon appropriée pour que de la lumière visible provenant d'une source 27 située à l'extérieur de la structure d'enveloppe 28 traverse un passage 29 de position appropriée vers le miroir pour être 30 réfléchi sur l'objet 30 à irradier, de manière qu'une image virtuelle de la source lumineuse 27 soit formée au sommet du cône en lequel le faisceau 11 est transformé par le collimateur primaire 15 et les mâchoires 16 et 17. Dans le cas du mode de rayons X, le sommet peut être 35 considéré comme se trouvant sur l'anticathode 12. Dans le mode d'électrons, la même position peut être traitée comme le sommet et le collimateur 15 et les mâchoires 16 et 17 peuvent être réglés en conséquence bien que l'anticathode

12 soit retirée.

Dans le cas idéal, le miroir 25 serait complètement transparent aux faisceaux de rayons X et d'électrons. Etant donné que les miroirs de verre courants 5 ne sont pas suffisamment transparents aux électrons de faible énergie, le miroir 25 consiste en une mince pellicule d'une matière plastique métallisée avec un revêtement d'aluminium. Cette pellicule est faite en fixant une feuille de matière plastique sous tension sur un anneau circulaire 10 plat. L'épaisseur de la matière plastique est environ 0,05 mm (densité de surface d'environ 5 mg/cm<sup>2</sup>). L'épaisseur du revêtement d'aluminium est de l'ordre de la longueur d'onde de la lumière visible à réfléchir et elle est par conséquent négligeable comparativement à celle de la pellicule de 15 matière plastique. Un certain nombre de matières plastiques ou autres matières peuvent être utilisées pour produire cette pellicule, mais dans le présent mode de réalisation, la matière plastique Kapton<sup>TM</sup> de Dupont a été choisie en raison de sa résistance supérieure aux dommages par le 20 rayonnement.

L'invention a été décrite ci-dessus en regard d'un seul mode de réalisation. Mais cette description doit être considérée comme un exemple nullement limitatif, et l'invention doit être considérée plus largement. Par 25 exemple, il n'est pas nécessaire que le diagramme de rayonnements à simuler soit celui d'un faisceau d'électrons ou d'un faisceau de rayons X. Il faut envisager que l'accélérateur et l'anticathode 12 de la figure peuvent être remplacés par une matière radioactive de sorte que l'appareil 30 selon l'invention peut être utilisé avec un faisceau de rayons gamma. Il faut considérer également que la source de lumière visible 27 pourrait être remplacée par une source de lumière ultraviolette. Une grande variété de dispositifs de régularisation peuvent être utilisés pour 35 uniformiser l'intensité du rayonnement dans la section transversale du faisceau. Le dispositif peut également comporter une chambre à ions disposée près du filtre 20

pour mesurer l'intensité totale du rayonnement. Le miroir peut être fait de nombreux types différents de matière plastique, en fonction de leur transmission des faisceaux et de leur résistance aux dommages par le rayonnement.

- 5 Son épaisseur et sa forme peuvent être modifiées en fonction du cas, bien qu'une épaisseur de l'ordre de 0,025 à 0,125 mm soit généralement préférable. Des mâchoires et autres dispositifs pour collimater le faisceau peuvent être disposés de différentes manières.

10

## REVENDEICATIONS

1. Appareil médical destiné à irradier un champ de traitement avec un faisceau d'électrons, appareil caractérisé en ce qu'il comporte un dispositif pour visualiser ledit champ de traitement au moyen d'un champ  
5 de lumière visible, ledit dispositif de visualisation comprenant une source de lumière visible (27) positionnée à l'extérieur du trajet dudit faisceau et un miroir (25) fixé de façon non-rétractable dans le trajet dudit faisceau et orienté de manière que la lumière visible  
10 provenant de ladite source et réfléchié par ledit miroir éclaire ledit champ de traitement (30).

2. Appareil selon la revendication 1, caractérisé en ce que ledit miroir est une pellicule (25) de matière plastique métallisée avec un revêtement d'aluminium.

15 3. Appareil selon la revendication 2, caractérisé en ce que l'épaisseur de ladite pellicule (25) est de l'ordre de 0,025 à 0,075 mm.

4. Appareil selon la revendication 2, caractérisé en ce que la densité de surface de ladite pellicule est de l'ordre de 5 mg/cm<sup>2</sup>.

5. Appareil selon la revendication 2, caractérisé en ce que ladite matière plastique a une haute résistance aux dommages par des rayonnements.

25 6. Appareil selon la revendication 1, caractérisé en ce qu'il est également adapté pour irradier ledit champ de traitement avec un faisceau de rayons X.

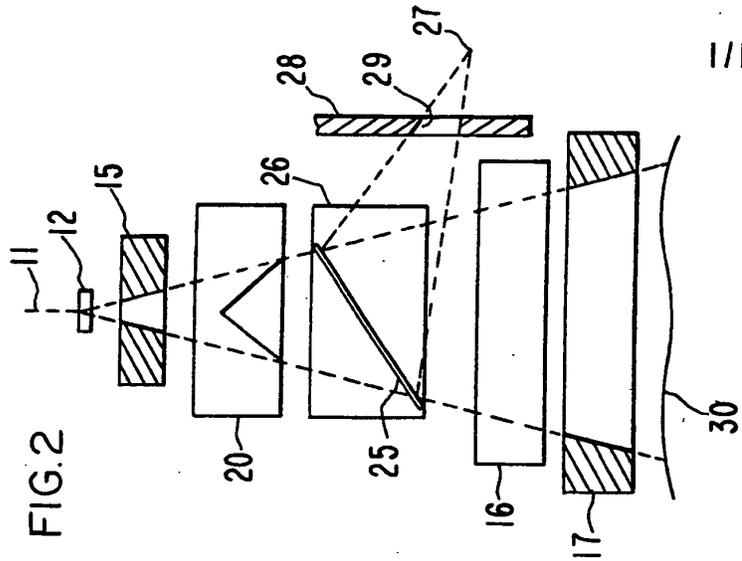


FIG. 2

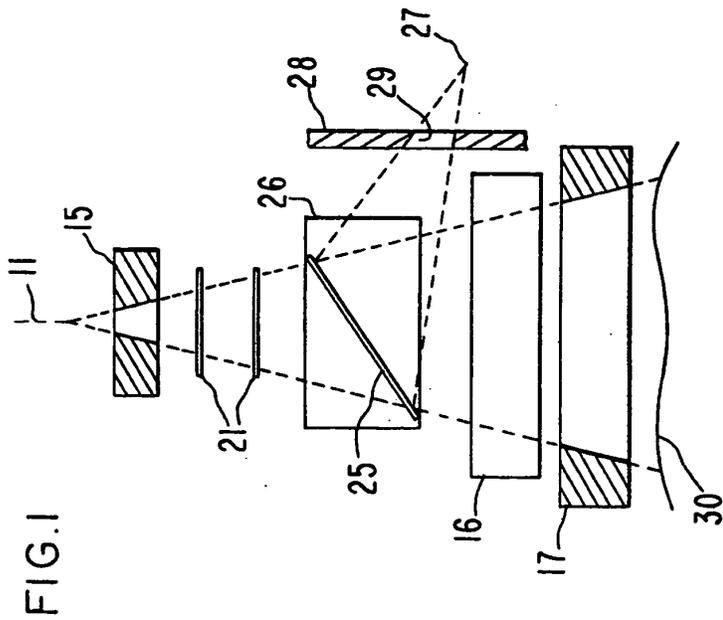


FIG. 1



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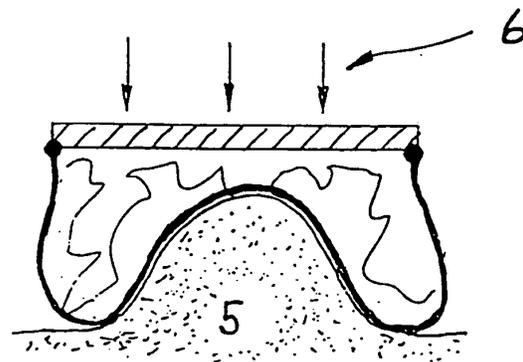
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Prüfungsantrag gem. § 44 PatG ist gestellt

54 Restituierbare Ausgleichsvorrichtung für die Strahlenbehandlung

57 Bei der Strahlentherapie von Mammakarzinomen ist es bekannt, durch Verwendung von individuell an den Patienten angepaßten Ausgleichsvorrichtungen unabhängig von der äußeren Form des zu bestrahlenden Körpers ein gleichmäßiges, in etwa planar angeordnetes Zielvolumen für die Bestrahlung zu gewährleisten. Die individuelle Anpassung erfordert allerdings einen erheblichen Zeit- und Kostenaufwand für Präparation und Entsorgung, da diese Vorrichtungen nicht wiederverwendbar sind. Die erfindungsgemäße Ausgleichsvorrichtung vermeidet diese Nachteile dadurch, daß als Füllmittel ein fließfähiges oder leicht verformbares Material bzw. Werkstoff vorgesehen ist, das bzw. der in einer gas- bzw. luftdicht abgeschlossenen Hülle eingebettet ist, die zumindest auf der der Strahlungsquelle zugewandten Seite einen definierten formstabilen Flächenbereich aufweist, dagegen auf der dem Körper zugewandten Seite leicht verformbar ist. Die Ausgleichsvorrichtung eignet sich insbesondere für die Bestrahlung von Mammakarzinomen.



DE 42 23 488 A 1

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

## Beschreibung

Die Erfindung betrifft eine restituierbare Ausgleichsvorrichtung für die Strahlenbehandlung von zumindest auf der zu bestrahlenden Seite unebenen Körpern, insbesondere menschlichen bzw. tierischen Körpern, mit elektromagnetischer Strahlung und/oder Teilchenstrahlen, welche die Unebenheiten durch Ausfüllen mit einem Füllmittel nivelliert, dessen Material bzw. Werkstoff demjenigen des zu bestrahlenden Körpers, zumindest im Bereich der Unebenheiten, angepaßt ist.

In der medizinischen Strahlentherapie nicht operabler oder bereits operierter Mammakarzinome ist es bekannt, an die jeweils zu bestrahlende Brust eine individuell angepaßte Ausgleichsvorrichtung anzubringen, worin diese während der Bestrahlung eingebettet ist. Dadurch wird erreicht, daß unabhängig von der äußeren Form der Brust ein homogenes und in etwa planar angeordnetes Zielvolumen für die Bestrahlung gewährleistet ist.

Eine Offenbarung dieser bekannten Vorrichtung findet sich beispielsweise in dem Forschungsbericht "ELECTRON-BEAM THERAPY OF CANCER OF THE BREST" von Florence C.H. Chu and others, Vol. 89, August 1977. Dort ist in Fig. 1 eine kastenförmige Ausgleichsvorrichtung dargestellt, die für jede Patientin individuell zu präparieren ist. Aus dieser Abbildung wird deutlich, daß bei der Bestrahlung mit Elektronen unabhängig von der Brustform — ein im Körperinneren nahezu konstantes Bestrahlungs-Zielvolumen erreicht wird.

Aus der von M. Niewald et al. in "Strahlentherapie und Onkologie", 162, 1986, 605—612, Nr. 10, veröffentlichten Arbeit "Moulagen der Brustwand in der Strahlentherapie des operierten Mammakarzinoms mit schnellen Elektronen: vergleichende Testung verschiedener Materialien" ist es ferner bekannt, bei der Bestrahlung der Brustwand mit schnellen Elektronen zur Prophylaxe und Therapie von Lokalrezidiven und Hautmetastasen eines operierten Mammakarzinoms den Tiefendosisverlauf der Elektronenstrahlung durch Brustauflagen verschiedener Kunststoffmaterialien in Richtung Körperoberfläche zu verschieben. Die Ergebnisse dieser Untersuchungen liefern somit eine Lehre dafür, wie die absolute Lage der Tiefendosiskurve der Strahlung bzw. der Teilchenstrahlen durch zusätzlich aufgebrachte Moulagen in vorgegebener Weise verändert werden kann. Auch bei den dort genannten Materialien und der vorgestellten Methode besteht die Notwendigkeit, diese Brustauflagen (Moulagen) für jeden Patienten individuell herzustellen.

Die bekannten Ausgleichsvorrichtungen sind daher nur sehr zeit- und kostenaufwendig herstellbar und führen insofern zu einem Abfallproblem, als die dort genannten Vorrichtungen nur schwer oder gar nicht wiederverwendbar sind.

Aus den genannten Problemen leitet sich nun die Aufgabenstellung der vorliegenden Erfindung her, nämlich eine wiederverwendbare Ausgleichsvorrichtung der eingangs genannten Art anzugeben, die sich neben den genannten Vorteilen besonders dadurch auszeichnet, daß die individuelle Anpassung der Vorrichtung, beispielsweise an den Patienten, ambulant vorgenommen werden kann, d. h. die bisher notwendigen Präparationszeiten entfallen.

Diese Aufgabe wird bei einer restituierbaren Ausgleichsvorrichtung der eingangs genannten Art dadurch gelöst, daß als Füllmittel ein fließfähiges(r) oder leicht

verformbares(r) Material bzw. Werkstoff vorgesehen ist, das bzw. der in einer gas- bzw. luftdicht abgeschlossenen Hülle eingebettet ist, die zumindest auf der der Strahlungsquelle zugewandten Seite einen definierten formstabilen Flächenbereich aufweist, dagegen auf der dem Körper zugewandten Seite leicht verformbar ist. Durch Einbettung des Füllmittels in eine gas- bzw. luftdicht abgeschlossene Hülle ist gewährleistet, daß das Füllmittel beliebig oft wiederverwendbar ist. Die Verwendung eines besonders fließfähigen Füllmittels gibt die Gewährleistung, daß bei Auflage dieser Ausgleichsvorrichtung auf den zu bestrahlenden unebenen Körper die Unebenheiten ohne jeglichen Kraftaufwand individuell ausgefüllt werden. Der der Strahlungsquelle zugewandte formstabile Flächenbereich schafft nun ein — unabhängig von der individuellen Körperform — definiertes Niveau, aufgrund dessen sich die Eindringtiefe der elektromagnetischen Strahlung bzw. der Teilchenstrahlen exakt vorherbestimmen läßt. Der gas- bzw. luftdichte Abschluß der Hülle verhindert, daß sich in dem Füllmittel Gas- bzw. Luftbläschen bilden. Diese Inhomogenitäten würden nämlich dazu führen, daß auch die Strahlung entsprechend inhomogen und damit schwer kalkulierbar in das Füllmittel eindringen würde. Die Lage der Tiefendosiskurve, d. h. das Zielvolumen bei der Bestrahlung, richtet sich hier nach der Dicke des formstabilen Flächenbereiches.

In den Unteransprüchen 2 bis 6 sind mögliche Materialien für das Füllmittel aufgeführt. Die Verwendung eines thermoplastischen Werkstoffes als Füllmittel kann sich insbesondere dann als besonders vorteilhaft erweisen, wenn die Plastizität bei der menschlichen Körpertemperatur von etwa 40°C einsetzt und somit erreicht wird, daß die Ausgleichsvorrichtung sich lediglich bei Vorliegen eines Körperkontaktes durch plastisches Fließen des Füllmittels an die jeweilige Körperform anpaßt und nach Abnehmen der Ausgleichsvorrichtung diese einen derart formstabilen Zustand annimmt, durch den die Ausgleichsvorrichtung für die Wiederverwendung an diesem Körper aufgewahrt werden kann.

Die erfindungsgemäße Ausgleichsvorrichtung kann weiter so ausgebildet sein, daß als Füllmittel ein in den strahlenabsorbierenden Eigenschaften besonders an den menschlichen bzw. tierischen Körper angepaßtes Material vorgesehen ist. Durch Verwendung eines in dieser Weise gearteten Füllmittels kann erreicht werden, daß der zu bestrahlende, zunächst unebene Körper sich nach der Applikation der erfindungsgemäßen Ausgleichsvorrichtung so verhält, als sei die der Strahlungsquelle zugewandte Oberfläche ideal plan. Aufgrund dieses nunmehr ideellen Körpers lassen sich beispielsweise die Dosisstiefen besonders einfach vorausberechnen.

Die erfindungsgemäße Ausgleichsvorrichtung kann weiter so ausgebildet sein, daß das Füllmittel gas- bzw. luftfrei in der Hülle eingebettet ist. Es ist also bereits bei der Herstellung der erfindungsgemäßen Ausgleichsvorrichtung ein besonderes Augenmerk darauf zu richten, daß die Füllung der Hülle keine Gas- bzw. Luftbläschen enthält, worauf in Anspruch 1 bereits in allgemeinem Zusammenhang hingewiesen wurde.

Die erfindungsgemäße Vorrichtung kann ferner so ausgebildet sein, daß das Füllmittel und/oder die Hülle optisch transparent sind. Damit kann die Strahlung bzw. der Teilchenstrahl vor der Bestrahlung mittels sichtbarem Licht auf der Körperoberfläche justiert bzw. ausgerichtet werden. Diese Ausrichtung kann dabei anhand von Markierungen auf der Körperoberfläche erfolgen. Ferner läßt sich auch der Strahlengang während der

Bestrahlung durchgehend verfolgen.

Die erfindungsgemäße Ausgleichsvorrichtung kann weiter so ausgebildet sein, daß die Hülle aus Kunststoff, z. B. Silikon, hergestellt ist. Dadurch kann beispielsweise eine sehr hygienische und einfach desinfizierbare Ausgleichsvorrichtung geschaffen werden, die darüber hinaus durch die Wahl eines entsprechenden Werkstoffes dem Patienten ein subjektiv angenehmes Gefühl beim Körperkontakt mit dieser geben kann. Hierbei bietet sich insbesondere Silikon an, da dieses Material bereits erfolgreich bei Brustimplantaten eingesetzt wird.

Die folgenden Ansprüche 12 bis 23 geben nun besonders vorteilhafte Ausführungsbeispiele des formstabilen Flächenbereichs der Hülle an. Ein ebenförmig ausgebildeter Flächenbereich bietet sich z. B. bei der Bestrahlung von Mammakarzinomen an. Demgegenüber kann eine Ausführungsform mit einem gekrümmten Flächenbereich besonders vorteilhaft bei der Bestrahlung von Patienten im Halsbereich, beispielsweise bei Vorliegen eines Kehlkopfkrebases, eingesetzt werden. In diesen und ähnlich gearteten Fällen kann es jedoch auch zweckmäßig sein, den formstabilen Flächenbereich dem generellen Formverlauf des zu bestrahlenden Körpers, unabhängig von lokalen Unebenheiten, anzupassen.

In den Unteransprüchen 15 bis 23 werden in unterschiedlicher Weise hergestellte Ausführungen der erfindungsgemäßen Ausgleichsvorrichtung genannt. Dabei kann der formstabile Flächenbereich der Hülle entweder aus dem Material der Hülle selbst oder durch eine zusätzlich angebrachte Platte gebildet sein. Diese Platte kann sich nun innerhalb oder außerhalb der Hülle befinden und entweder mit der Hülle fest oder lösbar verbunden sein. Eine lösbare Verbindung ist besonders in den Fällen indiziert, bei denen eine Austauschbarkeit der Hülle bei fest vorgegebener Platte erreicht werden soll. Hierbei kann daran gedacht werden, daß verschiedene vorgefertigte Hüllen verwendet werden, die sich im Füllungsgrad, in der Füllungsorte oder ihrer Größe unterscheiden. Ferner können Platte und Hülle eine Einheit bilden. Entsprechend der optischen Transparenz des Füllmittels und der Hülle kann es dabei zweckmäßig sein, auch die Platte optisch transparent auszuführen. Durch Verwendung beispielsweise einer Plexiglasplatte wird sichergestellt, daß die zu bestrahlende Körperoberfläche durch die Ausgleichsvorrichtung hindurch optimal und verzerrungsfrei eingesehen werden kann. Auf einer derartigen Platte können nun weitere Hilfsmittel, wie z. B. Linien für die Feinjustierung des Strahls, vorgesehen sein. Um eine Blasenbildung in dem Füllmittel zu verhindern, kann es ferner zweckmäßig sein, die Hülle gas- bzw. luftdicht mit der Platte zu verbinden.

Schließlich kann bei der erfindungsgemäßen Ausgleichsvorrichtung vorgesehen sein, daß der formstabile Flächenbereich der Hülle kastenförmig ausgebildet ist. Die Seitenbereiche einer derart ausgebildeten Vorrichtung können dabei als Halterungen an dem Bestrahlungstisch, dem Bestrahlungstubus oder dem zu bestrahlenden Körper dienen. Die Seitenwände des Kastens können dabei für eine mehrseitige Bestrahlung ausgelegt sein, die eine gleichzeitige Positionierung und Fixierung des zu bestrahlenden Körpers in dem zu bestrahlenden Bereich durch allseitige Fixierung in dem Kasten ermöglicht.

Im folgenden Teil wird die erfindungsgemäße Ausgleichsvorrichtung anhand von zwei Ausführungsbeispielen erläutert. Es zeigen:

Fig. 1a eine Schnittzeichnung einer Ausgleichsvorrichtung, bei der der formstabile Flächenbereich der

Hülle durch eine Plexiglasplatte gebildet ist (vor der Applikation) und

Fig. 1b eine entsprechende Darstellung einer bereits applizierten Ausgleichsvorrichtung während der Bestrahlung eines Mammakarzinoms;

Fig. 2a eine Schnittzeichnung einer Ausgleichsvorrichtung mit einer kastenförmigen Ausbildung des formstabilen Flächenbereichs der Hülle (vor der Applikation) und schließlich

Fig. 2b eine entsprechende Darstellung einer bereits applizierten Ausgleichsvorrichtung während der Strahlenbehandlung eines Mammakarzinoms.

Die in Fig. 1a dargestellte erfindungsgemäße restituierbare Ausgleichsvorrichtung hat ein Füllmittel 1, das in einer aus einer Silikonhülle 2 und einer Plexiglasplatte 3 gebildeten Hülle eingebettet ist. Als Füllmittel 1 kann z. B. ein Gel oder ein bei etwa 40°C thermoplastischer Werkstoff vorgesehen sein. Die Plexiglasplatte 3 ist in zur Papierebene senkrechter Richtung quadratisch ausgebildet. Die Silikonhülle 2 und die Plexiglasplatte 3 sind über eine Schweißnaht 4 gas- bzw. luftdicht miteinander verbunden.

In Fig. 1b ist nun die in Fig. 1a gezeigte Ausgleichsvorrichtung nach der Applikation an einem unebenen Körperbereich 5 dargestellt. Dieser Körperbereich 5 kann beispielsweise eine karzinome weibliche Brust darstellen. Die Plexiglasplatte 3, die hier den definierten formstabilen Flächenbereich darstellt, ist der Strahlungsquelle zugewandt, von der Strahlen 6 ausgehen. Aufgrund der quadratischen Form der Plexiglasplatte 3 wird lediglich der Brustbereich abgedeckt. Die dem Körper zugewandte Seite der Ausgleichsvorrichtung paßt sich fest anliegend und unter Vermeidung eines Zwischenraumes der Körperoberfläche an. Im Falle, daß das Füllmittel 1 ein den strahlungsabsorbierenden Eigenschaften des menschlichen Körpers angepaßtes Material darstellt, wird nach der Applikation der Ausgleichsvorrichtung ein etwa rechteckförmiges Zielvolumen im Körperinneren bestrahlt.

Die in Fig. 2a dargestellte Ausgleichsvorrichtung setzt sich aus einem aus Plexiglas gefertigtem Kasten 8 sowie einer Silikonhülle 8' zusammen. Der Plexiglaskasten 8 besitzt an den in der Papierebene liegenden Seiten jeweils Aussparungen (hier nicht dargestellt), innerhalb derer die Patientin zu liegen kommt. Der Plexiglaskasten 8 und die Silikonhülle 8' sind über eine Schweißnaht 9 fest miteinander verbunden. In die derart gebildete Hülle ist ein Füllmittel 7 eingebettet.

Die in Fig. 2a gezeigte Ausgleichsvorrichtung wird nun in Fig. 2b im applizierten Zustand dargestellt. Dabei ist der Plexiglaskasten 8 auf einer Unterlage 12, die beispielsweise ein Bestrahlungstisch sein kann, fest aufgelegt, wobei die Patientin 10 unter diesem Kasten 8 liegt. Bestrahlt wird in diesem Beispiel von drei Seiten 11. Der Kasten 8 erstreckt sich dabei lediglich über den Brustbereich des Patienten 10. Es ist jedoch auch denkbar, diesen Kasten mit der offenen Seite nach oben anzuordnen und den Patienten 10 darin hineinzulegen.

#### Patentansprüche

1. Restituierbare Ausgleichsvorrichtung für die Strahlenbehandlung von zumindest auf der zu bestrahlenden Seite unebenen Körpern, insbesondere menschlichen bzw. tierischen Körpern, mit elektromagnetischer Strahlung und/oder Teilchenstrahlen, welche die Unebenheiten durch Ausfüllen mit einem Füllmittel nivelliert, dessen Material bzw.

- Werkstoff demjenigen des zu bestrahlenden Körpers, zumindest im Bereich der Unebenheiten, angepaßt ist, **dadurch gekennzeichnet**, daß als Füllmittel ein fließfähiges(r) oder leicht verformbares(r) Material bzw. Werkstoff vorgesehen ist, das bzw. der in einer gas- bzw. luftdicht abgeschlossenen Hülle eingebettet ist, die zumindest auf der der Strahlungsquelle zugewandten Seite einen definierten formstabilen Flächenbereich aufweist, dagegen auf der dem Körper zugewandten Seite leicht verformbar ist.
2. Ausgleichsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als Füllmittel ein unter geringem mechanischem Druck plastisch verformbarer Werkstoff vorgesehen ist.
3. Ausgleichsvorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß als Füllmittel ein thermoplastischer Werkstoff vorgesehen ist.
4. Ausgleichsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als Füllmittel ein viskoses Material, z. B. ein Gel, vorgesehen ist.
5. Ausgleichsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als Füllmittel eine Flüssigkeit, z. B. Wasser, vorgesehen ist.
6. Ausgleichsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als Füllmittel eine fein- oder grobkörnige Schüttung, z. B. Sand, vorgesehen ist.
7. Ausgleichsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß als Füllmittel ein in den strahlenabsorbierenden Eigenschaften besonders an den menschlichen bzw. tierischen Körper angepaßtes Material vorgesehen ist.
8. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das Füllmittel gas- bzw. luftfrei in der Hülle eingebettet ist.
9. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das Füllmittel optisch transparent ist.
10. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Hülle optisch transparent ist.
11. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Hülle aus Kunststoff, z. B. Silikon, hergestellt ist.
12. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle eben ist.
13. Ausgleichsvorrichtung nach einem der Ansprüche 1 bis 11, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle gekrümmt ist.
14. Ausgleichsvorrichtung nach Anspruch 13, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle dem generellen Formverlauf des zu bestrahlenden Körpers an dessen zu bestrahlender Seite angepaßt ist.
15. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle aus dem Material der Hülle selbst gebildet ist.
16. Ausgleichsvorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle durch eine Platte gebildet ist.
17. Ausgleichsvorrichtung nach Anspruch 16' dadurch gekennzeichnet, daß die Platte innerhalb oder außerhalb der Hülle angebracht ist.
18. Ausgleichsvorrichtung nach Anspruch 16 oder

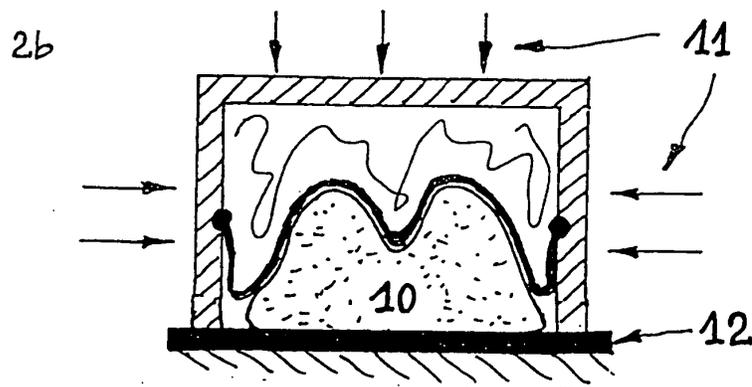
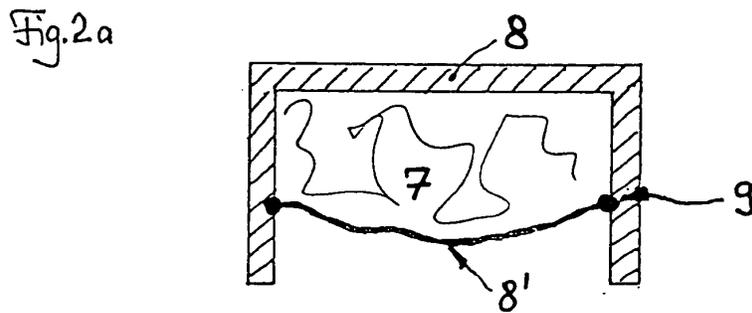
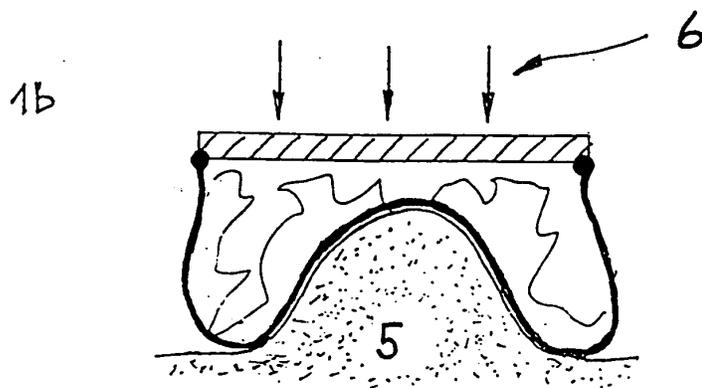
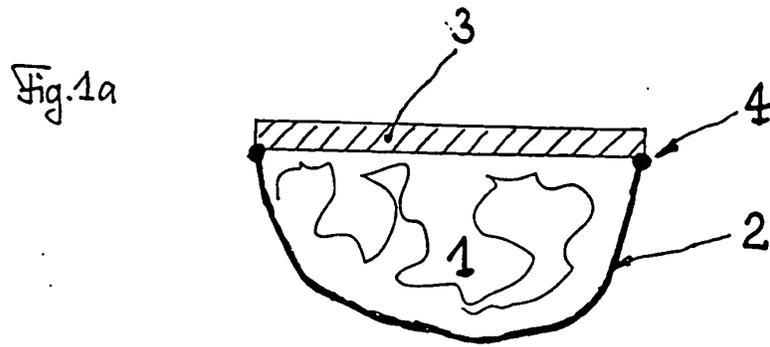
- 17, dadurch gekennzeichnet, daß die Platte außerhalb der Hülle angeordnet und mit dieser lösbar verbunden ist.
19. Ausgleichsvorrichtung nach Anspruch 16, dadurch gekennzeichnet, daß die Platte als ein Teil der Hülle ausgebildet ist.
20. Ausgleichsvorrichtung nach einem der Ansprüche 16 bis 19, dadurch gekennzeichnet, daß die Platte optisch transparent ist.
21. Ausgleichsvorrichtung nach einem der Ansprüche 16 bis 20, dadurch gekennzeichnet, daß als Werkstoff für die Platte Plexiglas vorgesehen ist.
22. Ausgleichsvorrichtung nach einem der Ansprüche 16 bis 21, dadurch gekennzeichnet, daß die Hülle gas- bzw. luftdicht mit der Platte verbunden ist.
23. Ausgleichsvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der formstabile Flächenbereich der Hülle kastenförmig ausgebildet ist.

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Hierzu 1 Seite(n) Zeichnungen

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- Leerseite -





19 BUNDESREPUBLIK  
DEUTSCHLAND



DEUTSCHES  
PATENTAMT

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54 Verfahren und Vorrichtung zur stereotaktisch gezielten Bestrahlung eines Zieles

57 Die Erfindung betrifft ein Verfahren zur stereotaktisch gezielten Strahlentherapie, bei dem ein Ziel (Target), z. B. ein Hirntumor, mittels eines Behandlungsstrahles einer Behandlungseinrichtung bestrahlt und der Patient um eine Achse gedreht wird, deren Richtung sich mit dem Behandlungsstrahl im sogenannten Isozentrum, in dem auch das Ziel plaziert bleiben soll, schneidet.  
Der Erfindung liegt daher die Aufgabe zugrunde, das eingangs genannte Verfahren bzw. die eingangs genannte Vorrichtung im Hinblick auf die Beibehaltung der Zielgenauigkeit während des Bestrahlungsvorganges selbst zu verbessern.  
Die Aufgabe wird in Verfahrenshinsicht erfindungsgemäß dadurch gelöst, daß während der Bestrahlungsdauer auftretende Auswanderungen des Zieles aus dem Isozentrum registriert und durch Rückführungen ausgeglichen werden.

DE 196 14 643 A 1

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

## Beschreibung

Die Erfindung betrifft ein Verfahren zur stereotaktisch gezielten Strahlentherapie, bei dem ein Ziel (Target), z. B. ein Hirntumor, mittels eines Behandlungsstrahles einer Behandlungseinrichtung bestrahlt und der Patient um eine Achse gedreht wird, deren Richtung sich mit dem Behandlungsstrahl im sogenannten Isozentrum, in dem auch das Ziel plaziert bleiben soll, schneidet.

Desweiteren betrifft die Erfindung eine Vorrichtung zur stereotaktisch gezielten Bestrahlung eines Zieles (Targets), z. B. eines Hirntumores eines Patienten, die eine Bestrahlungseinrichtung zur gezielten Aussendung eines Behandlungsstrahles und eine Patientenaufnahme, vorzugsweise einen Auflagetisch, aufweist, wobei die Patientenaufnahme bei der Bestrahlung um eine Achse drehbar ist, deren Axialrichtung sich mit der Behandlungsstrahlrichtung im sogenannten Isozentrum schneidet, in dem auch das Ziel zur Behandlung plaziert ist, vorzugsweise zur Durchführung des eingangs genannten Verfahrens.

Bei einem eingangs genannten Verfahren zur stereotaktisch gezielten Strahlentherapie wird ein zu bestrahlendes Ziel im sogenannten Isozentrum mit Hilfe einer Stereotaxieeinheit, beispielsweise einen vom Patientenkopf getragenen Stereotaxierahmen, plaziert. Danach wird das Ziel bestrahlt, beispielsweise mit einem Behandlungsstrahl eines Linearbeschleunigers. Während der Bestrahlung wird zumeist sowohl der Behandlungsstrahl selber um das Isozentrum geschwenkt, und zwar mittels eines drehbaren Beschleunigerstativs (Gantry), als auch der Patient, der z. B. auf einem um eine vertikale Achse drehbaren Auflagetisch liegt. Dadurch wird das zu bestrahlende Ziel von verschiedenen Seiten getroffen.

Um die Zielgenauigkeit auch bei diesen Schwenkbewegungen zu gewährleisten, sind sämtliche beteiligten Achsen und der Behandlungsstrahl selber auf das Isozentrum, das den Zielbereich darstellt, ausgerichtet.

Es kann aber durchaus vorkommen, daß insbesondere die Drehachse, um die der Patient bzw. die Patientenaufnahme, also z. B. ein Auflagetisch, drehbar ist, nicht präzise auf das Isozentrum ausgerichtet ist und deshalb bei einer Drehung des Patienten um diese Achse das in dem Patienten enthaltene Ziel aus dem Isozentrum herauswandert. Auch wenn die Achse prinzipiell gut justiert ist, kann aufgrund eines Lagerspieles durchaus eine entsprechenden Auswanderung des Zieles aus dem Isozentrum bei einer Drehung um die Achse bzw. die Drehlagerung geschehen. Eine derartige Lagerung wird entsprechend der einschlägigen DIN-Norm mit einer Toleranz von 1,5 mm Abweichung bei einer Drehung um 90° gefertigt. Eine solche Abweichung kann aber bei kleinen Behandlungszielen durchaus dazu führen, daß das Behandlungsziel gar nicht mehr oder jedenfalls nicht mehr korrekt getroffen wird.

Insgesamt stellt damit die Toleranz oder Ungenauigkeit bei der Drehung des Patienten die größte systematische Fehlerquelle bei der Bestrahlung dar.

Der Erfindung liegt daher die Aufgabe zugrunde, das eingangs genannte Verfahren bzw. die eingangs genannte Vorrichtung im Hinblick auf die Beibehaltung der Zielgenauigkeit während des Bestrahlungsvorganges selbst zu verbessern.

Die Aufgabe wird in Verfahrenshinsicht erfindungsgemäß dadurch gelöst, daß während der Bestrahlungsdauer auftretende Auswanderungen des Zieles aus dem

Isozentrum registriert und durch Rückführungen ausgeglichen werden.

Da eine Fertigungsgenauigkeit immer an ihre Grenzen stößt und somit Auswanderungen des Zieles aus dem Isozentrum nicht verhindert werden können, bietet die Erfindung die Möglichkeit, dennoch diese auftretenden Fehler zu korrigieren, indem während der gesamten Behandlungsdauer eventuelle Abweichungen des Zieles aus dem Isozentrum festgestellt und durch Gegensteuerung korrigiert werden.

Eine entsprechende erfindungsgemäße Vorrichtung, für die auch selbständiger Schutz beansprucht wird, zeichnet sich aus durch eine Kontroll- und Steuereinrichtung zur Registrierung und Korrektur von Auswanderungen des Zieles aus dem Isozentrum.

Zur Korrektur der festgestellten Auswanderung kommt am ehesten die ohnehin vorhandene Feinjustierung zur Ausrichtung des Patienten in Betracht, die zumeist in der Lage ist, den Patienten in drei axialen Raumrichtungen, zumindest aber in einer horizontalen Ebene bezüglich zweier Raumkomponenten bezüglich des Isozentrums zu justieren. Mit einer solchen Feinregelung können quasi automatisch die festgestellten Abweichungen korrigiert werden.

Nach einer Weiterbildung umfaßt die Kontroll- und Steuereinrichtung eine optische Lichtzeigereinrichtung als Bestandteil der Kontrolleinrichtung. Mit einer solchen Lichtzeigereinrichtung kann berührungslos und sehr genau eine entsprechende Kontrolle der Lage des Zieles bezüglich des Isozentrums vorgenommen werden. Da ein solcher Lichtzeiger innerhalb des Behandlungsraumes eine relativ weite Strecke Zurücklegen darf, können auch kleinere Änderungen durch den Lichtzeiger in relativ große und genau zu erfassende Lichtzeigerbewegungen umgesetzt werden.

Die Position des Lichtzeigers kann zur elektronischen Erfassung mittels einer für die Position empfindlichen Sensorfläche, einer sogenannten, an sich bekannten Position Sensitive Device, vorgenommen werden. Die Wanderung des Lichtzeigers entspricht, jedenfalls proportional, der Wanderung des Zieles bezüglich des Isozentrums und kann aufgrund der elektronischen Erfassung in einfacher Weise durch eine elektronische Gegensteuerung korrigiert werden.

Ein entsprechender Lichtzeiger kann beispielsweise dadurch erzeugt werden, daß in der Zielposition, beispielsweise auf einem Stereotaxierahmen, ein prismatischer Retroreflektor plaziert wird, der immer von einem entsprechenden Lichtstrahl zur Erzeugung eines Zeigers getroffen wird, wobei eine Wanderung des Retroreflektors zu einer Winkeländerung des Lichtzeigers führt, da bei einer Positionsänderung der Retroreflektor aus einem anderen Winkel vom Lichtstrahl getroffen wird und er durch seine Reflektion eine entsprechende Winkeländerung durch den Lichtzeiger wiedergibt.

Ein Ausführungsbeispiel, aus dem sich weitere erfinderische Merkmale ergeben, ist in der Zeichnung dargestellt.

Die einzige Figur zeigt schematisch in einer Seitenansicht einen Auflagetisch 1 im Bereich einer nicht näher dargestellten Strahlenbehandlungseinrichtung zur Auflage eines Patienten 2, der auf seinem Kopf einen Stereotaxierahmen 3 trägt und das zu bestrahlende Ziel 4, z. B. einen Hirntumor, in seinem Kopf hat. Mit Hilfe von Justierungseinrichtungen ist der Patient 2 mit der Tischplatte des Tisches 1 in eine z-Richtung 5 und eine dazu orthogonale x-Richtung 6 in horizontaler Ebene bewegbar und positionierbar, bis sich das Ziel 4 im so-

nannten Isozentrum der Behandlungseinrichtung befindet. Da der Patient 2 zudem um eine nicht näher dargestellte vertikale Achse während der Behandlung schwenkbar ist, könnte es vorkommen, daß sich das zunächst genau positionierte Ziel 4 aus dem Isozentrum, also dem Zielbereich des Behandlungsstrahles, entfernt.

Um dies zu kontrollieren und zu korrigieren, weist die erfindungsgemäße Vorrichtung eine schematisch dargestellte Lichtzeigereinrichtung 7 auf. Die Lichtzeigereinrichtung 7 umfaßt eine Lichtquelle 8, die Lichtstrahlen 9 aussendet. Es könnte sich beispielsweise um einen Laser bei der Lichtquelle 8 handeln.

Die Lichtstrahlen 9 fallen durch einen halbdurchlässigen Spiegel 10 und treffen auf einen Retroreflektor 11, der, beispielsweise in Verbindung mit dem Stereotaxierahmen 3 bezüglich des Zieles 4 genau positioniert ist, so daß eine Bewegung des Retroreflektors 11, jedenfalls in der horizontalen x-z-Ebene, genau einer entsprechenden Bewegung des Zieles 4 entspricht.

Die auf den Retroreflektor 11 auftreffenden Lichtstrahlen 9 werden von diesem genau in derselben Richtung reflektiert, in der die Lichtstrahlen 9 von dem Retroreflektor 11 empfangen werden, so daß die reflektierten Lichtstrahlen 12 bei einer Wanderung des Retroreflektors 11 unterschiedlich vom Spiegel 10 reflektiert werden, was mit Hilfe beispielsweise einer Sammellinse 13 auf einer lichtempfindlichen Sensorfläche 14 registriert werden kann, wodurch die jeweilige Position des Lichtzeigers bzw. Lichtstrahles 12 elektronisch bestimmt werden kann. Für eine solche Sensorfläche 14 in Betracht kommende, sogenannte Position Sensitive Device sind hinreichend aus anderen Einsatzzwecken bekannt. Es käme beispielsweise der Halbleiterchip einer CCD-Kamera in Betracht. Solange sich der Retroreflektor 11 in seiner Position nicht verändert, werden die Strahlen 9 in völlig gleicher Position und Richtung auf den halbdurchlässigen Spiegel 10 zurückgeworfen, was durch einen entsprechenden Doppelpfeil am Lichtstrahl 9 in der Zeichnung gekennzeichnet ist.

#### Patentansprüche

1. Verfahren zur stereotaktisch gezielten Strahlentherapie, bei dem ein Ziel (Target), z. B. ein Hirntumor, mittels eines Behandlungsstrahles einer Bestrahlungseinrichtung bestrahlt und der Patient um eine Achse gedreht wird, deren Richtung sich mit dem Behandlungsstrahl im sogenannten Isozentrum, in dem auch das Ziel plaziert bleiben soll, schneidet, dadurch gekennzeichnet, daß während der Bestrahlungsdauer auftretende Auswanderungen des Zieles aus dem Isozentrum registriert und durch Rückführungen ausgeglichen werden.
2. Vorrichtung zur stereotaktisch gezielten Bestrahlung eines Zieles (Targets), z. B. eines Hirntumores eines Patienten, die eine Bestrahlungseinrichtung zur gezielten Aussendung eines Behandlungsstrahles und eine Patientenaufnahme, vorzugsweise einen Auflagetisch, aufweist, wobei die Patientenaufnahme während der Bestrahlung um eine Achse drehbar ist, deren Axialrichtung sich mit der Behandlungsstrahlrichtung im sogenannten Isozentrum schneidet, in dem auch das Ziel zur Behandlung plaziert ist, vorzugsweise zur Durchführung des Verfahrens nach Anspruch 1, gekennzeichnet durch eine Kontroll- und Steuereinrichtung zur Registrierung und Korrektur von Auswanderungen des Zieles (4) aus dem Isozentrum.

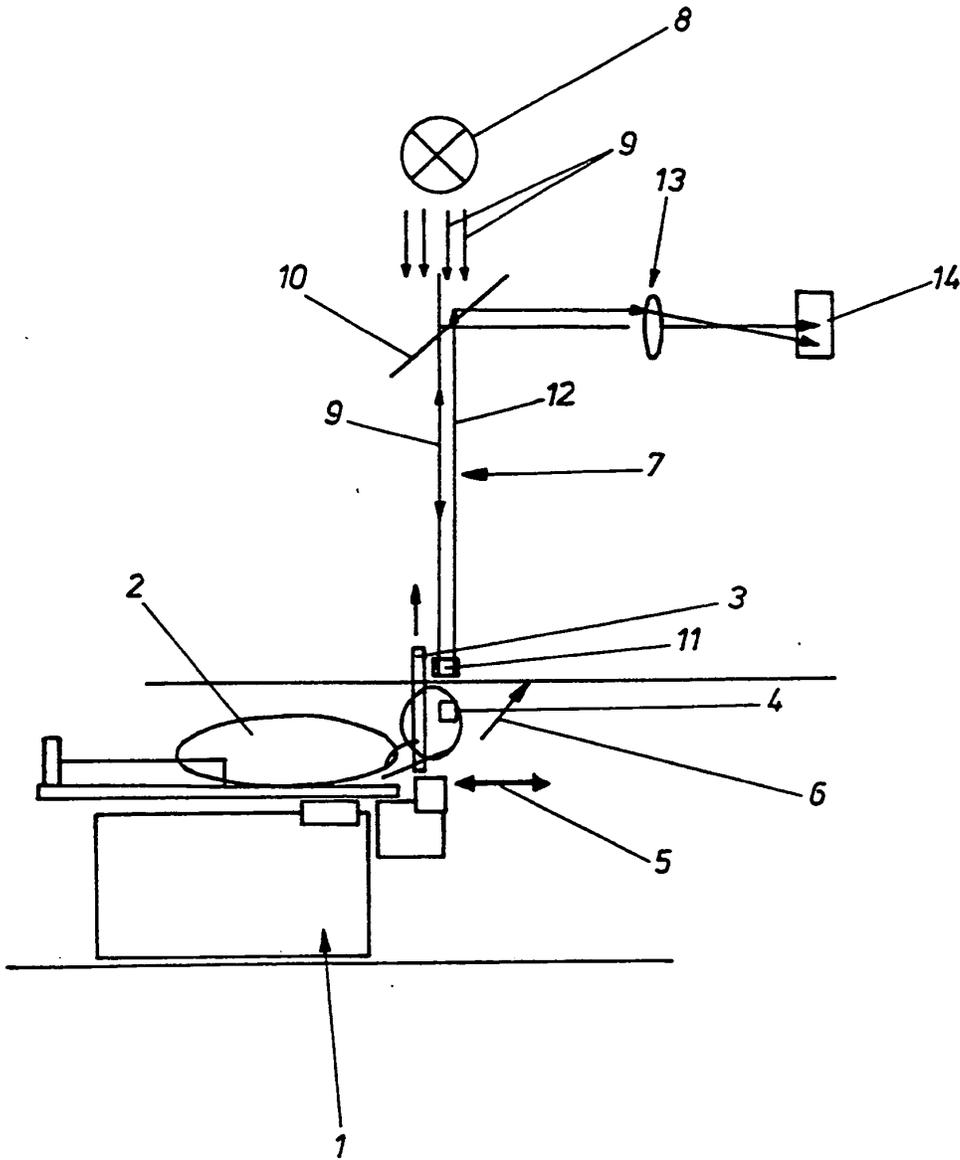
3. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Kontroll- und Steuereinrichtung eine optische Lichtzeigereinrichtung (7) als Bestandteil der Kontrolleinheit umfaßt.

4. Vorrichtung nach Anspruch 3, dadurch gekennzeichnet, daß zur elektronischen Erfassung der jeweiligen Position des Lichtzeigers (9, 12), die die Position des Zieles (4) bezüglich des Isozentrums wiedergibt, eine bezüglich dieser Position empfindliche Sensorfläche (14) (Position Sensitive Device) vorgesehen ist.

5. Vorrichtung nach Anspruch 3 oder 4, dadurch gekennzeichnet, daß zur proportionalen Umlenkung eines den Lichtzeiger bildenden Lichtstrahles (9, 12) als Reaktion auf eine Auswanderung des Zieles (4) ein vorzugsweise prismatischer Retroreflektor (11) vorgesehen ist, der in der Zielposition plaziert ist.

6. Vorrichtung nach einem oder mehreren der Ansprüche 2 bis 5, dadurch gekennzeichnet, daß ein an sich vorhandener Justierungsantrieb der Patientenaufnahme (Auflagetisch 1) als Steuereinrichtung zur Kompensierung einer Auswanderung des Zieles (4) mit der Kontrolleinrichtung (Lichtzeigereinrichtung 7) gekoppelt ist.

Hierzu 1 Seite(n) Zeichnungen



# PATENT SPECIFICATION

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1328 033

## DRAWINGS ATTACHED

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36X 36Y 403 407 426 428 42Y 436 438 43Y 447  
448 44Y 457 458 45Y 469 470 482 489 492 493  
567 568 575 691 752 761



## (54) APPARATUS FOR MEASURING THE SURFACE CONFIGURATION OF AT LEAST PART OF A BODY

- (71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 5 The invention relates to an apparatus for measuring the surface configuration of at least part of a body, which apparatus comprises a curved support capable of at least partially surrounding the body, and a carriage movable along the support, which carriage carries a sensing probe which is movable in a direction towards and away from the body.
- 10 Such an apparatus is described in "Physikalische und technische Grundlagen der Bestrahlungsplanung" by S. Matschke *et al.*, Leipzig 1968, pages 217 and 218. In the apparatus for measuring patients described in this book, a body girth of a patient is measured by moving a sensing probe, which may terminate, for example, in a ball, over the body with a given pressure. A pen secured to the sensing probe records the body girth.
- 15 When the body girth of a patient is measured for therapeutic purposes this method may be painful. Furthermore, the sliding or rolling contact between the sensing probe and the body limits the measuring rate. When a patient's girth is being measured, both the hurtful contact and the comparatively long duration of the measurement increase the likelihood of measuring errors due to movements of the patient during the measuring process.
- 20 It is an object of the invention to obviate the said disadvantages and for this purpose an apparatus of the type mentioned at the beginning of this specification is characterized in that it further comprises positioning means for automatically adjusting the position of the sensing probe during movement of the carriage along the curved support so as to maintain a fixed distance between the probe and the surface of the body; the sensing probe being provided with a source of radiation, a radiation guide, and a device for detecting radiation reflected from the surface of the body to be measured, radiation which emerges from the radiation guide causing the detection device to produce a detection signal whose value depends upon the spacing between the sensing probe and the surface of the body.
- 25 Since in the apparatus according to the invention the sensing probe follows the body outline without physical contact therewith, no pain is caused to the patients and measurements may be made at a fast rate. As a result, the likelihood of measuring errors due to body movements during measuring is greatly reduced.
- 30 To prevent the use of a mechanical writing device for recording the body outline from restricting the measuring rate, in a preferred embodiment of the invention this device is replaced by an electronic arrangement.
- 35 A preferred embodiment of an apparatus according to the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawing, in which:
- 40 Fig. 1 shows schematically a preferred embodiment using a circular support, and Fig. 2 shows schematically that end of a sensing probe with optical means for automatic adjustment of the position thereof in relation to the surface of the body.
- 45 The apparatus shown in Fig. 1 comprises a circular support 1. Depending upon the shape of the objects to be measured the support may alternatively be, for example, elliptical. Furthermore, for certain uses a sup-
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port curved through 180° only may suffice. For measuring the entire surface of an object the support may be given the form of a helical coil which extends at least throughout the length of the object. A carriage 2 is movable along the support 1 around the entire, or substantially the entire, circumference thereof. The carriage carries a rod-shaped sensing probe 3, a servo-motor 4, electric contacts, not shown, for the supply of currents for moving the carriage and for energising the servo-motor, and contacts from which electric signals may be taken. The contacts may be sliding contacts for electric conductors extending in the carrier 1. The sensing probe 3 is radially movable by actuating the servo-motor 4. The servo-motor is controlled by an adjusting mechanism which is mounted in an end 6 of the sensing probe facing a body 5 the surface configuration of which is to be measured. The end 6 of the sensing probe 3 is shown enlarged in Fig. 2. The sensing probe includes a radiation guide 7 which preferably comprises a bundle of optical fibres. At one end 8 the radiation guide is obliquely directed to a point aligned with a cylindrical recess 9 in the sensing probe. A bottom part 10 of the recess 9 carries two radiation detectors 11 and 12 which are mounted one behind the other with respect to the radiation guide 7. The two radiation detectors receive radiation which is emitted by a radiation source 13, guided by the radiation guide to the surface of the body and is reflected from the body surface, equality between the radiation portions received by each detector being achieved only at a given spacing between the sensing probe 3 and the surface of body 5, which spacing is determined by the geometry of the radiation guide 7 and the recess 9. When the spacing between the sensing probe and the surface of the body is greater or smaller than the said given spacing the detectors receive different amounts of radiation. In the arrangement shown schematically in Fig. 2 the detector 11 receives the greater part of the radiation when the spacing is greater, and the detector 12 receives the greater part when the spacing is smaller, than the said given spacing. A sensitive detection signal as a function of the spacing between the sensing probe and the surface of the body is obtainable from a signal which is the difference of the signals of the two detectors. This difference signal controls the servo-motor 4 and thus ensures automatic adjustment of the sensing probe to a predetermined constant spacing between the sensing probe and the surface of the body.

A layer of radiation-absorbing material 15 with which the cylindrical surface 14 of the recess 9 is coated prevents radiation from reaching the detectors by reflection at this surface. To avoid stray light, boundary surfaces 16 of the sensing probe which face the body to be measured may also be coated with the absorbing layer. The radiation detector may use simple photocells. By selecting detectors having a sensitivity outside the range of visible light, for example ultraviolet-sensitive detectors, and by adapting the radiation source 13 to this sensitivity, the mechanism for adjusting the sensing probe may simply be rendered insensitive to ambient light. This screening may be optimised by using detectors having a narrow range of spectral sensitivity and a radiation source adapted to this narrow range. The term "radiation" is used herein in a wide sense. It may include short-wave radiation and X-rays. Any radiation may be used which is sufficiently reflected from the surface of the object and is not adversely affected by it.

If a sensing probe of the described construction strikes the body surface, the detectors do not receive radiation and hence supply no signal for the servo-motor. To ensure that in this case a force repelling the sensing probe from the body surface is produced, a circuit element 18 responsive to mechanical stress is provided at a tip 17 of the sensing probe. This element 18 may, for example, be a plate of a piezo-electric material or a micro-switch.

The apparatus according to the invention enables body outlines to be measured at a faster rate than is possible with any known apparatus. Although the restriction imposed by the physical contact with the body to be measured has been removed, the measuring rate might still be limited by the mechanical recording of the body outline. In a preferred embodiment of the apparatus according to the invention mechanical recording is replaced by electronic recording. This also simplifies further processing of the measuring data. In the case of a circular support the position of the sensing probe in polar coordinates is determined by an angle  $\alpha$  measured along the support and by a radius  $r$  measured from the geometric centre 19 of the support. Both quantities are expressed in the form of electric signals during the measurement. The constant spacing 20 between the surface of the body and the sensing probe may simply be allowed for. Once the electric measuring signals have become available they may simultaneously be applied to a recorder and, by means of an analogue-digital converter, to a computer. In the computer the measuring data may be used, for example, to compute the optimum irradiation dose for a patient. The results may also be written in a store, for example, a punched card associated with a patient.

Although an apparatus of this type will mainly be used in measuring the body outlines of patients for therapeutic purposes, the field of application is not restricted to this

use. An example of another use is measuring a piece of stone. From the measuring results the computer may then determine the optimum manner of cutting at least one stone having a prescribed shape and/or size from the original piece. The data from the computer may be used to control a suitable programmed device for cutting the stone. The support for the sensing probe may in this case appropriately take the form of a helical coil encircling the entire stone.

WHAT WE CLAIM IS:—

1. Apparatus for measuring the surface configuration of at least part of a body, comprising a curved support capable of at least partially surrounding the body, and a carriage movable along this support, which carriage carries a sensing probe which is movable in a direction towards and away from the body positioning means for automatically adjusting the position of the sensing probe during movement of the carriage along the curved support so as to maintain a fixed distance between the probe and the surface of the body, the sensing probe being provided with a source of radiation, a radiation guide and a device for detecting radiation reflected from the surface of the body to be measured, radiation which emerges from the radiation guide causing the detection device to produce a detection signal which depends upon the spacing between the sensing probe and the surface of the body.

2. Apparatus as claimed in claim 1, characterized in that the support is a circular guide along which the carriage is movable through an angle of at least substantially 360°.

3. Apparatus as claimed in claim 1 or 2, characterized in that the sensing probe includes a servo-mechanism which is in a quiescent condition at a spacing between the surface of the body and the sensing probe, which spacing is determined by the geometry of the radiation guide relative to the detection device.

4. Apparatus as claimed in claim 3, characterized in that an end of the radiation guide is directed to a point aligned with the axis of a cylindrical recess in the sensing probe on the bottom of which two photocells are arranged one behind the other with respect to the radiation guide, a difference signal from the two photocells controlling the servo-mechanism.

5. Apparatus as claimed in any of the preceding claims, characterized in that the sensing probe at its end nearest to the body has a stress-sensitive circuit element which when actuated causes the sensing probe to move away from the body.

6. Apparatus as claimed in claim 5, characterized in that the circuit element comprises a plate of a piezo-electric material.

7. Apparatus as claimed in any of the preceding claims including means for producing electric signals in dependence upon the position of the sensing probe.

8. Apparatus as claimed in any of claims 2 to 7 wherein the said means produces an electric signal representative of the angular position of the sensing probe around the curved support and a further electrical signal dependent upon the distance between the geometric centre of the circular path and the sensing probe.

9. Apparatus as claimed in claim 7 or claim 8, characterized in that the apparatus is associated with an analogue-digital converter and with recording apparatus for professing the electric signals.

10. Apparatus for measuring the surface configuration of at least part of a body substantially as hereinbefore described with reference to the accompanying drawing.

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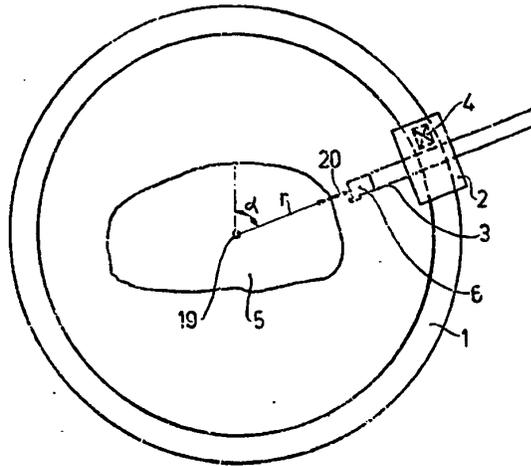


Fig.1

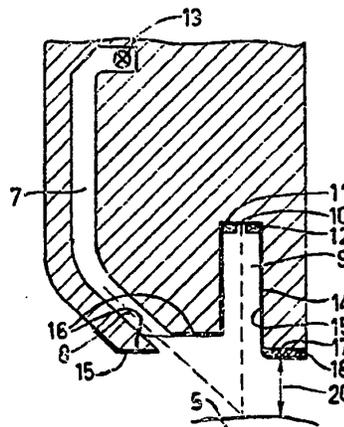


Fig.2



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002904/AMG:elc

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**RESPONSE UNDER 37 C.F.R. § 1.116  
-- EXPEDITED PROCEDURE --  
TECHNOLOGY CENTER 2882**

In re Application of:  
Ulrich Martin Graf  
Serial No. 10/033,327  
Filed: November 2, 2001  
Attorney Docket No. 005513P003  
For: RADIOTHERAPY APPARATUS  
EQUIPPED WITH AN  
ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

EXAMINER: HO, ALLEN C.  
ART UNIT: 2882

Mail Stop AF  
Commissioner for Patents  
PO Box 1450  
Alexandria, Virginia 22313-1450

AMENDMENT AND RESPONSE UNDER 37 C.F.R. § 1.116

In response to the Final Office Action mailed January 28, 2004, applicant respectfully requests the Examiner to consider the following remarks.

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Esther L. Campbell  
(Typed or printed name of person mailing correspondence)

*Esther Campbell*  
(Signature of person mailing correspondence)

IN THE CLAIMS

1. (Previously presented) An apparatus comprising:  
a first therapeutic radiation source attached to a first gantry;  
at least one second radiation source;  
a second gantry that is rotatable, the second gantry is attached to the first gantry;  
and  
an imager attached to an articulable end of the second gantry.
  
2. (Previously presented) An apparatus comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source, wherein the at least one second radiation source is attached to the first gantry;  
a second gantry that is rotatable; and  
an imager attached to an articulable end of the second gantry.
  
3. (Original) The apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.
  
4. (Currently amended) The apparatus of claim 1, wherein the first therapeutic radiation source to propagate is capable of propagating therapeutic energy at a first energy level.

5. (Currently amended) The apparatus of claim 1, wherein at least one second radiation source to propagate is capable of propagating diagnostic energy at a second energy level.
6. (Original) The apparatus of claim 1, wherein the first gantry is rotatable.
7. (Original) The apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis.
8. (Original) The apparatus of claim 1, wherein the imager is a multiple-energy imaging unit.
9. (Original) The apparatus of claim 1, wherein the articulable end comprises ~~includes~~ at least one pivot point between the second gantry and the imager.
10. (Original) The apparatus of claim 1, wherein the articulable end comprises ~~includes~~ a sliding mechanism capable of translating the imager in a plane.
11. (Currently amended) An apparatus comprising:
  - a first radiation source attached to a first gantry;
  - at least one second radiation source;
  - a second gantry that is rotatable, wherein the second gantry is one of the at least ~~one second radiation source is attached to a sliding mechanism~~ capable of extending and

retracting the second radiation source attached to ~~from~~ the second gantry; and  
an imager attached to an articulable end of the second gantry.

12. (Original) The apparatus of claim 1, wherein the articulable end is capable of folding the imager against the second gantry.

13. (Original) The apparatus of claim 7, wherein the second gantry is nestled within the first gantry.

14. (Currently amended) A method for applying radiation, comprising:

positioning a diagnostic X-ray radiation source to be in alignment with a target volume;

positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic X-ray radiation source;

positioning a therapeutic radiation source to be in alignment with the target volume; and

re-positioning the imager to receive radiation from the therapeutic radiation source.

15. (Currently amended) The method of claim 14, further comprising:

propagating ~~the diagnostic X-ray radiation~~ from the diagnostic X-ray source toward the target volume;

receiving the diagnostic X-ray radiation by on the imager after passing through the target volume;

positioning the therapeutic radiation source is based on results of the diagnostic X-ray radiation to the imager;

propagating the therapeutic radiation into the target volume;

receiving the therapeutic radiation by the imager after passing through the target volume; and

generating verification data by the imager from the therapeutic radiation.

16. (Original) The method of claim 14, wherein the imager is a multiple-energy imaging unit.

17. (Original) The method of claim 14, further comprising; placing an internal seed to act as a marker for the target volume.

18. (Currently amended) The method of claim 15, further comprising generating multiple diagnostic X-ray radiation slices using a fan X-ray beam to provide a 3-dimensional reconstruction of the target volume.

19. (Original) The method of claim 15, further comprising generating a cone X-ray beam where volumetric information can be constructed.

20. (Currently amended) The method of claim 15, wherein the diagnostic X-ray radiation can be operated continuously to provide real time a fluoroscopic image of moving internal anatomy.
21. (Currently amended) The method of claim 15, wherein the diagnostic X-ray radiation can be operated in a pulsed manner to provide a quasi-real time fluoroscopic image of moving internal anatomy.
22. (Original) A method for imaging radiation, comprising:  
    positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level;  
    propagating radiation by a first radiation source at the first energy level along the first axis;  
    retracting the first radiation source and positioning a second radiation source along the first axis.  
    maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source; and  
    propagating radiation by the second radiation source.
23. (Original) The method of claim 22, further comprising:  
    rotating the first radiation source until clear of the second radiation source;  
    extending the first radiation source to be in line with the multiple-energy imaging unit;

propagating radiation at a first energy level toward the multiple-energy imaging unit.

24. (Original) The method of claim 22, further comprising pivoting two arms independently, the first arm attached to the first radiation source for propagating at the first energy level, and the second arm attached to the second radiation source for propagating at the second energy level.

25. (Original) The method of claim 24, wherein the multiple-energy imaging unit is attached to the second arm.

26. (Currently amended) An apparatus, comprising:

a therapeutic energy source attached to a first gantry;

a diagnostic X-ray energy source attached to a retractable ~~translatable~~ end of a second gantry;

a multiple-energy imaging unit attached to an opposite articulable end of the second gantry;

the first gantry and the second gantry independently pivotable and attached at a common axis;

a patient couch capable of translation, wherein the result of such pivoting and translation is to place a target volume of a patient between the multiple-energy imaging unit aligned with the diagnostic energy source or the therapeutic energy source.

27. (Currently amended) An apparatus comprising:
- a first radiation source attached to a first gantry;
  - at least one second radiation source;
  - a second gantry that is rotatable, wherein the second gantry is one of the at least  
~~one second radiation source is attached to a mechanism~~ capable of extending and  
retracting the second radiation source attached to ~~from~~ the second gantry; and
  - an imager attached to an articulable end of the second gantry.

REMARKS

Claims 1-27 remain pending in the application. Claims 4, 5, 11, 14, 15, 18, 21, 26, and 27 have been amended to more properly define preexisting claim limitations and are supported by the specification. No new matter has been added. Claims 2, 11, and 14-24 are indicated as allowable. Therefore, the following comments are directed to the objected to and rejected claims.

***Objections to the Drawings and Specification***

The drawings were objected to under 37 CFR 1.83(a). Applicant submits that claims 11, 26, and 27 as amended have overcome the objections. Accordingly, applicant requests this objection be withdrawn.

***Claims Objections***

Claims 4 and 5 were objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant submits that claims 4 and 5 as amended have overcome the objections. Accordingly, applicant requests this objection be withdrawn.

**Rejections Under 35 U.S.C. § 112**

Claims 1-27 were rejected under 35 U.S.C. § 112, first paragraph, because the specification, while being enabling for a diagnostic X-ray source, does not reasonably provide enablement for a diagnostic radiation source.

Applicant submits claims 1-13 and 22-27 do not recite a diagnostic radiation source as rejected under 35 U.S.C. §112, first paragraph. Furthermore, applicant submits that a diagnostic radiation source is enabled by the specification. Nonetheless, claims 14, 15, 18, 20, 21, and 26 have been amended to claim a diagnostic X-ray source, which the Examiner has agreed is enabled, in order to obtain allowance of these claims. Therefore, applicant respectfully requests the rejection to claims 1-27 be withdrawn under 35 U.S.C. §112. Applicant notes that Applicant does not concede that claims 14, 15, 18, 20, 21 and 26 prior to amendment were not enabled and reserves its rights to file a continuation application containing such claims should Applicant so desire.

#### **Rejections Under 35 U.S.C. § 103(a)**

Claims 1, 3-10, 12 and 13 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,104,780 of Hanover ("Hanover") in view of U.S. Patent No. 6,325,537 of Watanabe ("Watanabe").

Neither Hanover nor Watanabe, either alone or in combination, teach or suggest an apparatus having a therapeutic energy source, as claimed. Rather, both Hanover and Watanabe disclose use of a diagnostic apparatus. Specifically, Hanover discloses “imaging systems 12 and 14 include first and second X-ray sources 40 and 42 and first and second image receptors 44 and 46 as known generally *in the X-ray diagnostic art*, mounted upon opposing locations, respectively, on the C-arms 12 and 14.” Emphasis added (Hanover, column 5, lines 19-23). Also, Watanabe discloses “*an X-ray diagnosis apparatus* capable of exactly and easily achieving various positioning and *applicable to a wide range of diagnostic uses.*” Emphasis added (Watanabe, column 2, lines 31-33).

A diagnostic X-ray typically has low energy X-rays, which are less harmful to healthy tissue and more useful to provide accurate diagnostic information because tissue in the human body is typically of low density. In contrast, therapeutic X-rays consist of high energy X-rays to treat unhealthy tissue, such as a cancerous tumor. Also, the images produced from therapeutic X-rays are of low contrast and insufficient quality. Both Hanover and Watanabe explicitly disclose the use of diagnostic X-rays, and *not a first therapeutic radiation source* attached to a first gantry, as recited in claim 1.

Accordingly, applicant respectfully submits that claim 1 is not obvious under 35 USC 103(a) over Hanover in view of Watanabe. Therefore, applicant respectfully requests the rejection to claims 1 and 26 be withdrawn. Claims 3-10, 12, and 13 are dependent (directly or indirectly) on claim 1. Therefore, applicant respectfully requests the rejection to claims 3-10, 12, and 13 be withdrawn, at least for the reasons stated above for claim 1.

In conclusion, applicant respectfully submits that in view of the arguments and amendments set forth herein, the applicable objections and rejections have been overcome. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact André Gibbs at (408) 720-8300.

If there are any additional charges, please charge our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

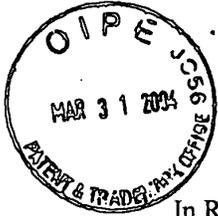
Dated: March 29, 2004



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André Gibbs  
Registration No. 47,593

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(408) 720-8300



Docket No.: 5513P003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:

ULRICH MARTIN GRAF

Application No.: 10/033,327

Filed: November 2, 2001

For: **Radiotherapy Apparatus Equipped with an  
Articulate Gantry for Positioning an  
Imaging Unit**

Art Group: 2882

Examiner: Ho, Allen C.

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. §1.97

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Alexandria, VA 22313-1450

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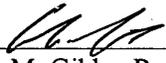
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Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: March 29, 2004

  
\_\_\_\_\_  
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\_\_\_\_\_  
*Esther L. Campbell*

*03-29-04*

*Date*





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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b>			Application Number	10/033,327	
			Filing Date	November 2, 2001	
			First Named Inventor	Ulrich Martin Graf	
			Art Unit	2882	
			Examiner Name	Ho, Allen C.	
			Attorney Docket Number	5513P003	
Sheet	2	of	5		

NON PATENT LITERATURE DOCUMENTS			
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		RAGAN, "Correction for Distortion in a Beam Outline Transfer Device in Radiotherapy CT-Based Simulation", Med. Phys. 20 (1), Jan/Feb 1993, pgs. 179-185.	
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			Filing Date	November 2, 2001
Sheet <u>3</u> of <u>5</u>			First Named Inventor	Ulrich Martin Graf
			Art Unit	2882
			Examiner Name	Ho, Allen C.
			Attorney Docket Number	5513P003

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		MOORE, "Radiation Image Generating System and Method", 1992020202/WO-A1, 1 page.	
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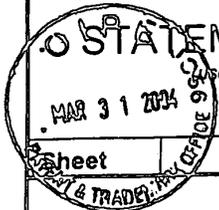
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**INFORMATION DISCLOSURE**

**STATEMENT BY APPLICANT**

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Filing Date	November 2, 2001
First Named Inventor:	Graf
Group Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513.P003

Sheet 4 of 5

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Filing Date	November 2, 2001
First Named Inventor:	Graf
Group Art Unit	2882
Examiner Name	Ho, Allen C.
Attorney Docket Number	5513.P003

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		PISANI, Laura, M.S. et al., "Setup Error in Radiotherapy: On-line Correction Using Electronic Kilovoltage and Megavoltage Radiographs," Int. J. Radiation Oncology Biol. Phys., vol. 47, no. 3 (2000), pp. 825-839	
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		CHO, Paul S. et al., "Cone-Beam CT for Radiotherapy Applications," Phys. Med. Biol., vol. 40 (1995), pp. 1863-1883	

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12 **EUROPEAN PATENT SPECIFICATION**

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54 **RADIOTHERAPEUTIC SYSTEM.**

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EP 0 480 035 B1

## Description

### TECHNICAL FIELD

The present invention relates to a radiotherapeutic system constituted of a radiotherapeutic apparatus and a therapeutic planning apparatus in combination.

### BACKGROUND ART

In the latter half of 1960's, a linear accelerator (hereinafter referred to as "linac") appeared as means for treating cancer. Because of its simple acceleration principle and enhanced reliability on its microwave source, it gained a high evaluation as practical radiotherapeutic apparatus and rapidly came into use. Then, with the development of various high-energy radiotherapies, great importance has come to be placed on highly accurate therapeutic planning. The overall process of a radiotherapy includes the following stages. The first is the stage of diagnosis, that is, to correctly detect position, size, shape, etc. of the diseased part by utilizing, for example, X-ray CT images. The second is the stage of making up a therapeutic plan, that is, to decide the kind of curing radiation, the dose, the direction of irradiation, the area to be irradiated, etc., on the basis of various data obtained at the time of diagnosis. The third is the stage of execution of the medical treatment, that is, to position the area of irradiation on the body of a person being examined, confirm it, and apply the radiation thereto. The fourth is the stage of management, that is, collation, recording, retention, etc. of data obtained in the stages of diagnosis, planning, and execution of medical treatment.

In order to define the area of irradiation for radiotherapy, tomographic images obtained by an X-ray CT etc. and a perspective image obtained by an X-ray simulator have so far been utilized. The interior of the body being examined can be shown with high contrast and resolution in the tomographic image by means of the X-ray CT, the diseased part (region of interest) can be specified in the tomographic image relatively easily. In the perspective image by means of the X-ray simulator, the visual point for perspective viewing is set in concurrence with the center of radiation of the curing radiation. Therefore, the region of interest in the perspective image can be easily brought into concurrence with the relative part on the surface of the body being examined. At the time of execution of the radiotherapy, the body being examined is moved onto the table of the therapeutic apparatus, the perspective image obtained by means of the X-ray simulator on a film is projected with light on the surface of the body being examined, the region of

diseased part to be treated is drawn on the body being examined by tracing the projected image with a felt-tip pen or the like, and then the collimator aperture at the radiation emitting window is adjusted to the region of the diseased part drawn on the body being examined, and thereafter, the radiation from the radiation source is applied to the body being examined.

Since, as described above, tomograms are taken with an X-ray CT, the body being examined is then moved into an X-ray simulator to have a photograph of perspective image taken, the body being examined is then moved onto the table of a therapeutic apparatus to have the perspective image in a film projected on the surface of the body being examined so that the region of diseased part to be treated is marked with a felt-tip, pen by tracing the projected image, that is, various operations are performed by the use of separate apparatuses, much labor and time have so far been taken. Further, many operations, such as the setting of the film of the perspective image on the therapeutic apparatus and the setting of the collimator of the therapeutic apparatus, have relied on manual work of the operator. Therefore, much time and labor have been required for such operations and this has been the cause of personal mistakes.

### DISCLOSURE OF THE INVENTION

An object of the present invention is to realize a radiotherapeutic system whereby the process from the stage of making a diagnosis of a body to be examined for obtaining information of position, size, shape etc. of the diseased part and making up a therapeutic plan of such items as the area to be irradiated by a radiation to the stage of positioning of the area to be irradiated on the body being examined and applying the radiation to the body can be reasonably executed with little trouble.

The present invention is characterized by that tomograms are taken by means of an X-ray CT, three-dimensional coordinates of the center position of the region of interest to which the radiotherapy is to be applied and a perspective image of the region of interest similar to the perspective image obtained by means of an X-ray simulator are obtained by calculation performed by a calculating device with image data of tomograms, the reference positions for application of the therapy are marked on the body being examined according to indications given by a positioning device on the basis of the three-dimensional coordinates of the center position of the region of interest, and the radiation collimator of the therapeutic apparatus is controlled by a therapeutic apparatus controller on the basis of the calculated perspective image of the region of interest.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the structure of an embodiment of the present invention;  
 FIG. 2 is a diagram showing an arrangement of projectors in a positioning apparatus;  
 FIG. 3 is a diagram of a radiation collimator of a therapeutic apparatus; and  
 FIG. 4 to FIG. 6 are explanatory diagrams of a method for obtaining a calculated perspective image.

## BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 is a block diagram showing the configuration of an embodiment of the present invention. Referring to FIG. 1, reference numeral 1 denotes an X-ray CT which is formed of a gantry 2, a table 3, and an operator console 4. Reference numeral 9 denotes a therapeutic apparatus, for which a linac is supposed to be used in the present example. Reference numeral 20 denotes a positioning device and 21 denotes a calculating device. The calculating device 21 receives tomographic image data of the body being examined obtained by the X-ray CT and the region-of-interest data specified by the diagnostician from the operator console 4 and obtains by calculation with these data three-dimensional coordinates of the center position of the region of interest and the perspective image of the region of interest. Reference numeral 22 denotes a controller included in the positioning device 20 for controlling positions of projectors 23, 24, and 25 in accordance with the coordinate data of the center of the region of interest supplied from the calculating device 21. The controller 22 moves the projectors 23, 24, and 25 through motors 26, 27, and 28, respectively. FIG. 2 shows relative arrangement between the projectors 23, 24, and 25 and the X-ray CT 1. The projector 23 is installed on the ceiling of the CT chamber and projects a cross mark on the body being examined on the table 3 from above, and it is arranged to be movable leftward and rightward in the drawing and positioned according to the y-coordinate data of the three-dimensional coordinate data. The projector 24 is installed on the left-hand wall of the CT chamber and the projector 25 is installed on the right-hand wall of the CT chamber and project cross marks on the left side and the right side of the body being examined, respectively, and they are arranged to be movable up and down in the drawing and positioned according to the z-coordinate data of the three-dimensional coordinate data. Reference numerals 29, 30, and 31 denote position sensors for detecting positions of the projectors 23, 24, and 25, respectively, and feeding back the detected data to

the controller 22. Reference numeral 32 denotes a display for displaying positions of the projectors 23, 24, and 25. Reference numeral 33 denotes a remote controller for externally inputting various conditions to the controller 22. Command signals from the remote controller are adapted to be input to the controller 22 in the form of infrared radiation or the like through a detector 34.

Reference numeral 36 denotes a therapeutic apparatus controller for controlling the aperture of the collimator at the radiation emitting window of the therapeutic apparatus 9 on the basis of a calculated perspective image of the region of interest received from the calculating device 21. An example of the collimator 41 is shown in FIG. 3. The collimator 41 is formed of lead and its several movable segments 42 of lead are adapted to form a variable aperture. By the control of the aperture of the collimator executed by the therapeutic apparatus controller 36, the area of irradiation can be made not only into a simple square form but also into a complex form corresponding to the form of the region of interest. In the therapeutic apparatus controller 36, there is provided a CRT (not shown), on which the three-dimensional coordinates of the center position of the region of interest and the perspective image calculated by the calculating device 21 are adapted to be displayed. The therapeutic apparatus controller 36 is supplied with a perspective image (linacgraphy) of the body being examined taken by the therapeutic apparatus 9 under the same conditions as the treating conditions and this image is also adapted to be displayed on the CRT. Thus, by comparing the calculated perspective image and the linacgraphy with one superposed on the other, it can be checked whether the positioning with respect to the body being examined is in accordance with the therapeutic plan, and it can also be checked, after the treatment has been finished, whether or not the treatment has been carried out in accordance with the therapeutic plan.

The calculating device 21 obtains the three-dimensional coordinates of the center position of the region of interest and the perspective image of the region of interest from the image data of the X-ray CT 1 according to the following method. FIG. 4 to FIG. 6 are explanatory diagrams of the calculating method. Referring to FIG. 4, reference numeral 44 denotes a body being examined and 5 denotes the pathologic part therein. Reference numeral 7 denotes the position of each of the multislices by the X-ray CT 1. In FIG. 5, reference numerals 70 denote a plurality of tomographic images by the X-ray CT 1, 50 denotes the image of the pathologic part in each tomographic image, and 8 denotes the region of interest established in the tomographic image 70 by the diagnostician. The calculating

device 21 obtains the three-dimensional image data for the body being examined as indicated by 71 in FIG. 6 by interpolating a plurality of tomographic images 70 and also obtains the three-dimensional image data 81 of the region of interest by interpolating a plurality of images of the region of interest 8 and further obtains the center position 85 of the three-dimensional region of interest. The above described positions of the projectors 23, 24, and 25 are adjusted according to the three-dimensional coordinates of the center position and three marks 6 are projected on the surface of the body being examined by three rays of light 60 as shown in FIG. 4. The calculating device 21 further sets up an imaginary center position of projection S at a finite distance SAD (Source Axis Distance) from the center 85 of the region of interest and sets up an imaginary plane of projection 10 perpendicular to the straight line connecting the center position of projection S and the center 85 of the region of interest. The center position of projection S is set up so as to have the same geographic relation to the center 85 of the region of interest as that of the radiation source of the radiotherapeutic apparatus 9. Based on such setting, the calculating device 21 obtains a projected image 11 of the body being examined by projecting the three-dimensional data of the body from the imaginary center position of projection S onto the plane of projection 10 and also obtains a projected image 12 of the region of interest by equally projecting the three-dimensional data of the same. This projected image 12, in fact, is the calculated perspective image. This calculated perspective image corresponds to the perspective image which has conventionally been obtained by means of an X-ray simulator. The calculated perspective image is obtained for each of irradiation directions of the therapeutic radiation.

With the described arrangement, the embodiment operates in the following manner. The body being examined is placed on the table 3 of the X-ray CT 1 and a multislice scan is performed. The collected X-ray radiographic data are sent from the gantry 2 to the operator console 4 and image reconstruction is performed by a processor within the operator console 4. The thus reconstructed multiple images are displayed on the display of the operator console and the region of interest is set up in these images by the diagnostician. The plural image data with the region of interest set up therein are transferred to the calculating device 21. The calculating device 21 obtains the three-dimensional coordinates of the center position of the region of interest and sends the y-coordinate and z-coordinate out of them to the controller 22 of the positioning device 20. The controller 22, based on the coordinate data from the calculating device 21, shifts the projector 23 so that the position of the

cross mark projected on the body being examined by the projector 23 concurs with the y-coordinate of the center position of the region of interest and also shifts the projectors 24 and 25 so that the positions of the cross marks projected on the body being examined by the projectors 24 and 25 concur with the z-coordinate of the center position of the region of interest. The x-coordinate of the center position of the region of interest is sent from the calculating device 21 to the operator console 4 of the X-ray CT 1. The operator console 4, based on the x-coordinate, shifts the table 3 so that the projected positions of the cross marks projected on the body being examined by the projectors 23, 24, and 25 concur with the x-coordinate. Thus, the positions of the cross marks projected on the body being examined by the three projectors are brought into alignment with the center position of the region of interest. Thereafter, marks are drawn with a felt-tip pen or the like on the surface of the body at three positions where the cross marks are being projected. Sometimes, there occur cases where it is difficult to draw the mark at the right position to be marked on account of the condition of the surface of the body there. In such case, the mark may be drawn at a position a predetermined known distance shifted from the right position.

Then, the body being examined is shifted onto the table of the therapeutic apparatus 9 and the position of the table is adjusted so that the center position of the region of interest determined by the above described three marks on the body being examined is aligned with the center of rotation of the therapeutic gantry. When a mark was drawn a predetermined known distance shifted from the center position of the region of interest, compensation is made for the shifted distance to achieve the alignment. The calculating device 21 transfers the calculated perspective image data of the region of interest to the therapeutic apparatus controller 36. The calculated perspective image is reduced by the scale corresponding to the distance between the radiation source and the collimator. The therapeutic apparatus controller 36, based on the calculated perspective image data supplied from the calculating device 21, moves the segments 42 of the collimator 41 so that the shape of its aperture is adjusted to the shape of the region of interest. Then, the therapeutic apparatus 9 emits the radiation for a short period of time and takes the linacgraphy determined by the shape of the collimator and transfer the video signal for that image to the therapeutic apparatus controller 36. The therapeutic apparatus controller 36 displays the linacgraphy superposed on the calculated perspective image supplied from the calculating device 21 on the CRT. The diagnostician confirms that the body being examined is placed in the right position

according to the condition of registration of the two images on the CRT and, thereafter, the radiation is emitted from the therapeutic apparatus 9 for giving treatment.

According to the present invention as described in the foregoing, the process from the stage of taking of tomographic images of a body being examined by means of the X-ray CT and the making up of a therapeutic plan on the basis of the results of the diagnosis to the stage of the treatment of a disease by the therapeutic apparatus can be performed on an on-line basis. Therefore, the work of the operator can be rationalized and mistakes by manual work can be decreased. Further, since the comparison between the linacgraphy and the calculated perspective image can be made easily, the reliability on the making up of the therapeutic plan and execution of the therapy can be enhanced.

Although only the aperture of the collimator of the therapeutic apparatus has been described to be controlled by the therapeutic apparatus controller in the above embodiment, angle, position, etc. of the gantry of the therapeutic apparatus may further be controlled by the same. The radiotherapeutic apparatus is not limited to the linac.

While the best mode for carrying out the present invention has been described above, it will be understood by those who have general knowledge in the field of art to which the present invention belongs that changes and variations can be made in the invention without departing from the scope of the appended claims.

#### Claims

1. A radiotherapeutic system comprising:
  - an X-ray CT (1) for giving a multislice scan (7) to a body (44) being examined placed on a movable table (3) to thereby take multiple tomographic images (70) of the body;
  - a calculating device (21) supplied with multiple tomographic image data of the body being examined with a region of interest (8) specified in each thereof for making calculation with the multiple tomographic image data to thereby obtain three-dimensional coordinates of the centre (85) of the region of interest and a perspective image of the region of interest seen from an imaginary center of projection (S) corresponding to the position of the source of radiation of a radiotherapeutic apparatus (9);
  - positioning device including projecting means (23, 24, 25) projecting at least three light marks (6) whose positions are shiftable on the surface of the body being examined placed on the table of said X-ray CT for projecting the light marks on the surface of the body at the

positions determined by the three-dimensional coordinate data supplied from said calculating device of the center of the region of interest of the body being examined;

said radiotherapeutic apparatus allowing the body being examined with marks drawn on the surface thereof at the positions on which the light marks were projected by said positioning device to be placed on its table such that the center position of the region of interest determined by the marks is in concurrence with the center of rotation of its gantry, said therapeutic apparatus having a collimator (41) with a variable aperture at its radiation emitting window and emitting radiation to the body being examined through the collimator; and

a therapeutic apparatus controller (36) supplied with calculated perspective image data from said calculating device for controlling the aperture of the collimator of said therapeutic apparatus in accordance with the supplied data.

2. A radiotherapeutic system as claimed in claim 1, wherein said therapeutic apparatus supplies the video signal of a perspective image taken by applying the radiation to the body being examined through the collimator to said therapeutic apparatus controller; and
  - said therapeutic apparatus controller displays the perspective image based on the video signal and the calculated perspective image for comparison with each other.

#### Patentansprüche

1. Ein Strahlentherapiegerät mit:
  - einer Röntgenröhre bzw. -CT (1), um eine Mehrscheibenabtastung (7) an einem Körper (44) zu liefern, der auf einem beweglichen Tisch (3) angeordnet untersucht wird, um dadurch mehrfache Tomographie-Bilder (70) des Körpers zu machen;
  - einer Berechnungsvorrichtung (21), die mit Daten mehrfacher Tomographie-Bilder des Körpers, der untersucht wird, versorgt wird, wobei ein interessierender Bereich (8) in jedem davon spezifiziert ist, um eine Berechnung mit den Daten mehrfacher Tomographie-Bilder vorzunehmen, um dadurch dreidimensionale Koordinaten der Mitte (85) des interessierenden Bereichs und eines perspektivischen Bildes des interessierenden Bereichs zu erhalten, welche von einem imaginären Zentrum einer Projektion (S) gesehen werden, das der Position der Strahlungsquelle eines Strahlentherapiegerätes (9) entspricht;
  - Positioniervorrichtung, die Projektionsmittel

(23, 24, 25) einschließt, welche mindestens drei Lichtmarkierungen (6) projizieren, deren Positionen auf der Oberfläche des Körpers, der auf dem Tisch des Röntgen-CTs angeordnet untersucht wird, verschoben werden können, um die Lichtmarkierungen auf die Oberfläche des Körpers bei den Positionen zu projizieren, die durch die von der Berechnungsvorrichtung zugeführten dreidimensionalen Koordinatendaten der Mitte des interessierenden Bereichs des Körpers, der untersucht wird, bestimmt werden;

wobei das Strahlentherapiegerät erlaubt, daß der Körper, der untersucht wird, mit Markierungen, die auf der Oberfläche davon bei den Positionen gezeichnet werden, auf die die Lichtmarkierungen durch die Positionier Vorrichtung projiziert werden, auf dessen Tisch derart angeordnet wird, daß die Mittenposition des interessierenden Bereichs, die durch die Markierungen bestimmt wird, mit dem Drehzentrum von dessen Rahmen bzw. Gerüst zusammenfällt, wobei das Therapiegerät einen Kollimator (41) mit einer variablen Apertur bei seinem strahlungsemitierenden Fenster aufweist und Strahlung zu dem Körper, der untersucht wird, durch den Kollimator emittiert; und einem Regler (36) für das Therapiegerät, der mit berechneten perspektivischen Bilddaten von der Berechnungsvorrichtung versorgt wird, um die Apertur des Kollimators des Therapiegerätes gemäß den zugeführten Daten zu regeln.

2. Ein Strahlentherapiegerät nach Anspruch 1, worin das Therapiegerät das Bildsignal eines perspektivischen Bildes, das durch Anwenden der Strahlung auf den Körper, der untersucht wird, durch den Kollimator gemacht wird, dem Regler für das Therapiegerät zuführt; und der Regler für das Therapiegerät das auf dem Bildsignal beruhende perspektivische Bild und das berechnete perspektivische Bild zum gegenseitigen Vergleich anzeigt.

#### Revendications

1. Un système de radiothérapie comportant :
  - un tomographe aux rayons X (1) assisté par ordinateur pour réaliser une exploration par tranches multiples (7) sur un corps (44) en examen placé sur une table mobile (3) pour prendre ainsi des images tomographiques multiples (70) du corps ;
  - un dispositif de calcul (21) recevant des données d'images tomographiques multiples du corps en examen, avec une région intéressée (8) spécifiée dans chacune d'elles pour

réaliser le calcul à l'aide des données d'images tomographiques multiples et donner ainsi les coordonnées tri-dimensionnelles du centre (85) de la région intéressée et une image en perspective de la région intéressée vue depuis un centre imaginaire de projection (S) correspondant à la position de la source de radiation d'un appareil de radiothérapie (9);

un dispositif de positionnement comportant des moyens de projection (23,24,25) projetant au moins trois repères lumineux (6) dont les positions sont déplaçables sur la surface du corps en examen placé sur la table du tomographe aux rayons X assisté par ordinateur pour projeter les repères lumineux sur la surface du corps en des emplacements déterminés par les données de coordonnées tri-dimensionnelles délivrées par le dispositif de calcul du centre de la région intéressée du corps en examen ;

ledit appareil de radiothérapie permettant au corps d'être examiné alors que des repères sont tracés sur sa surface en des emplacements sur lesquels les repères lumineux sont projetés par ledit dispositif de positionnement pour être placé sur la table de telle manière que la position centrale de la région intéressée déterminée par les repères coïncide avec le centre de rotation du portique, ledit appareil thérapeutique comportant un collimateur (41) avec une ouverture radiale à sa fenêtre d'émission de radiation et émettant une radiation sur le corps en examen à travers le collimateur ; et un dispositif (36) de commande de l'appareil thérapeutique recevant les données d'images en perspective calculées à partir dudit dispositif de calcul pour commander l'ouverture du collimateur dudit appareil thérapeutique en concordance avec les données fournies.

2. Un système de radiothérapie tel que revendiqué dans la revendication 1, dans lequel ledit appareil thérapeutique délivre audit dispositif de commande de l'appareil thérapeutique le signal vidéo d'une image en perspective prise en appliquant la radiation au corps en examen à travers le collimateur; et ledit dispositif de commande de l'appareil thérapeutique affiche l'image en perspective sur la base du signal vidéo et l'image en perspective calculée pour les comparer l'une avec l'autre.

FIG. 1

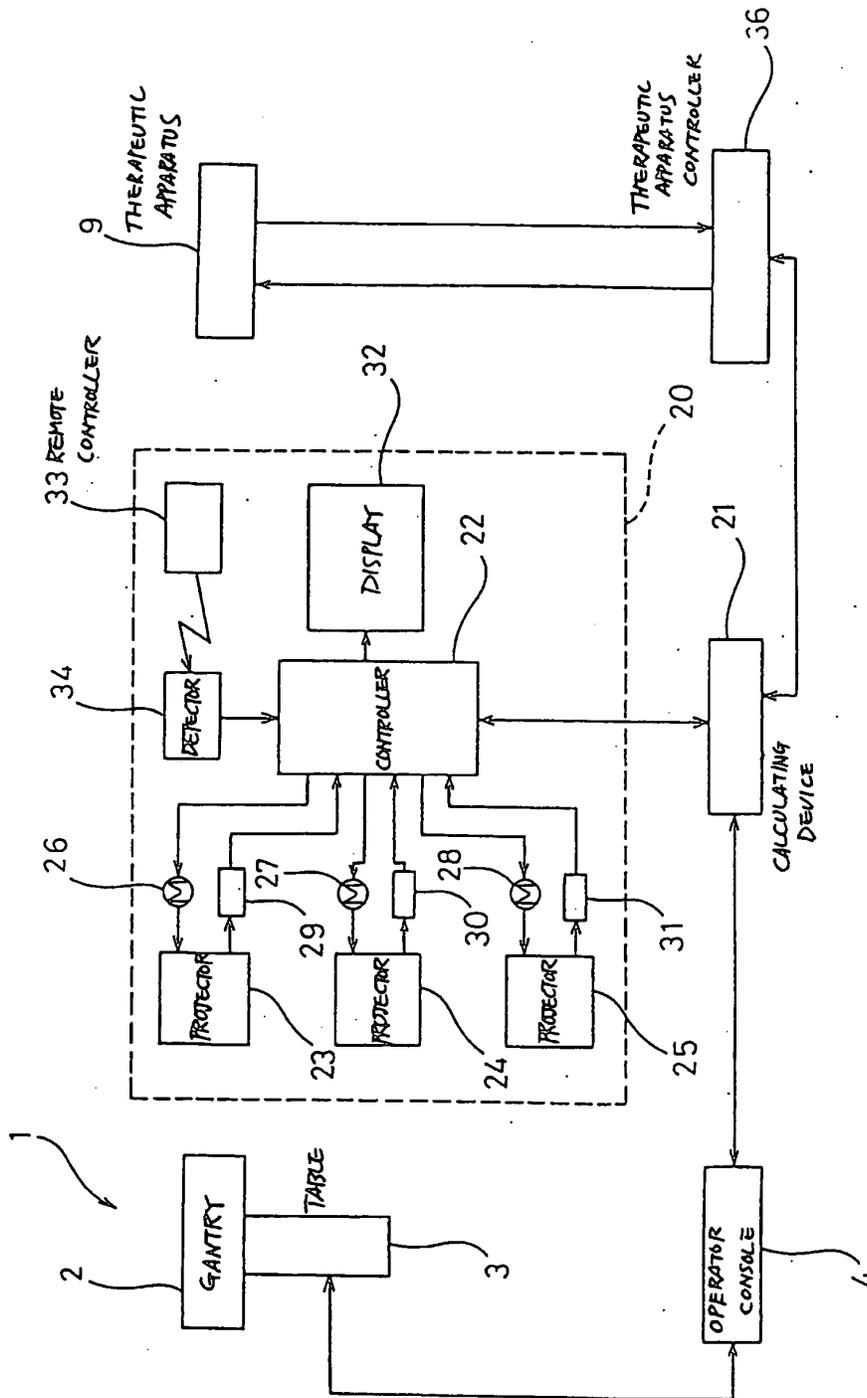


FIG. 2

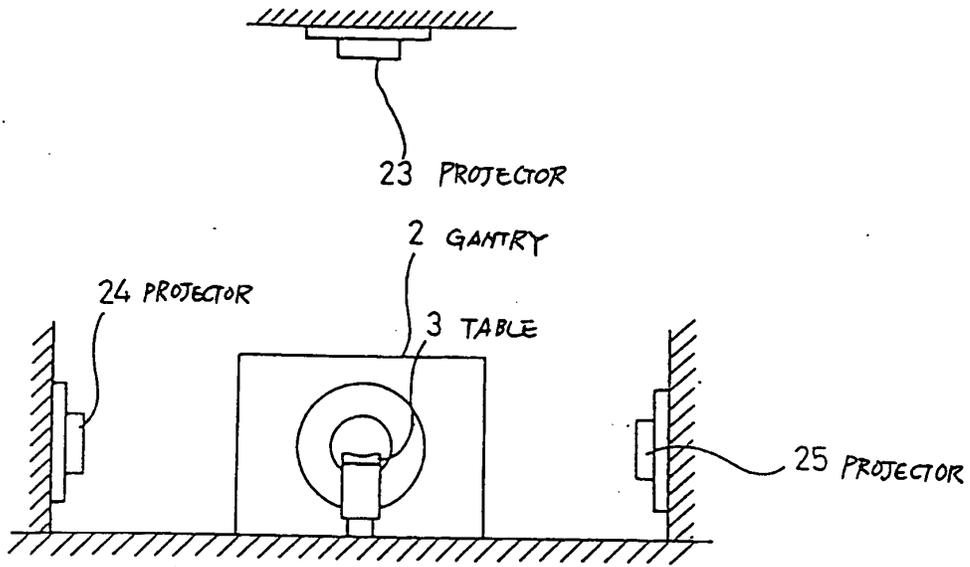


FIG. 3

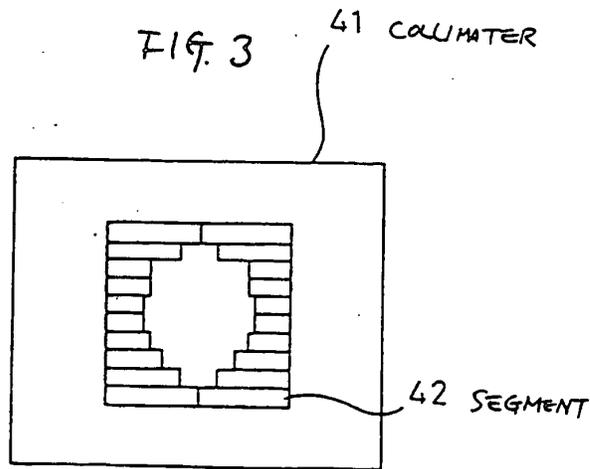


FIG. 4

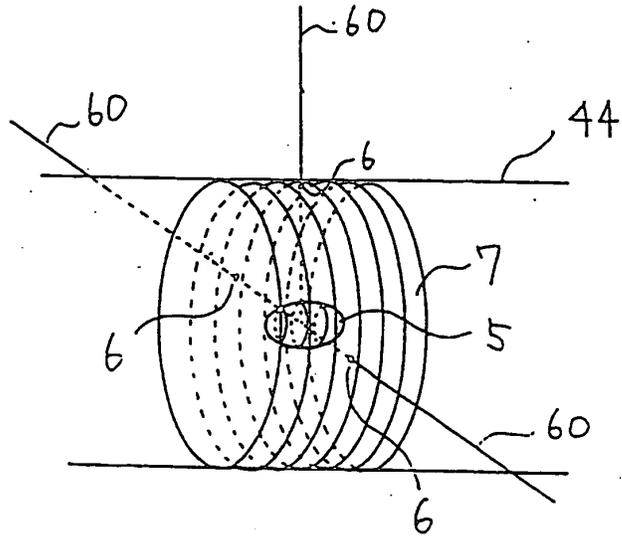


FIG. 5

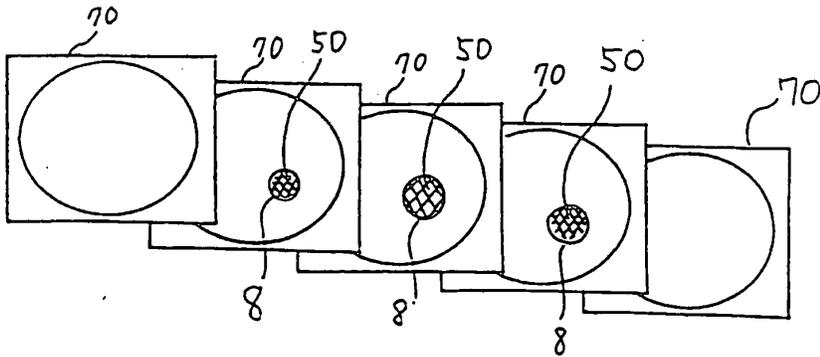


FIG. 6

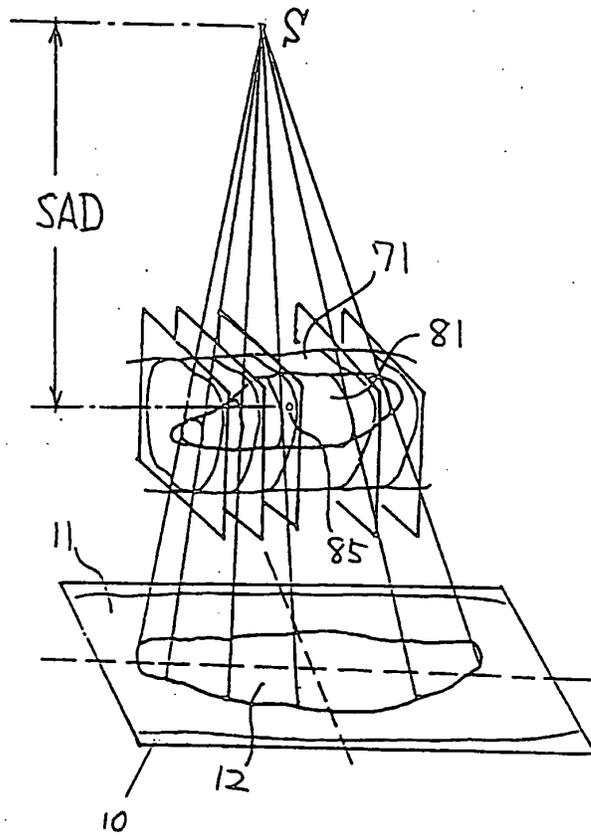




Image AF/2882 #

<b>TRANSMITTAL FORM</b> <i>(to be used for all correspondence after initial filing)</i>	Application No.	10/033,327	
	Filing Date	November 2, 2001	
	First Named Inventor	Ulrich Martin Graf	
	Art Unit	2882	
	Examiner Name	Ho, Allen C.	
Total Number of Pages in This Submission	23	Attorney Docket Number	5513P003

ENCLOSURES (check all that apply)		
<input checked="" type="checkbox"/> Fee Transmittal Form <input checked="" type="checkbox"/> Fee Attached <input checked="" type="checkbox"/> Amendment / Response <input checked="" type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input checked="" type="checkbox"/> Information Disclosure Statement <input checked="" type="checkbox"/> PTO/SB/08 <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Response to Missing Parts/Incomplete Application <input type="checkbox"/> Basic Filing Fee <input type="checkbox"/> Declaration/POA <input type="checkbox"/> Response to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s)	<input type="checkbox"/> After Allowance Communication to Group <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to Group (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): <div style="border: 1px solid black; padding: 5px; margin-top: 5px;">           Cited references and Return Receipt postcard         </div>
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Applicant claims small entity status. See 37 CFR 1.27.

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**Complete if Known**

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First Named Inventor	Ulrich Martin Graf
Examiner Name	Ho, Allen C.
Art Unit	2882
Attorney Docket No.	5513P003

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  Credit any overpayments  
 Charge any additional fee(s) or underpayment of fees as required under 37 CFR §§ 1.16, 1.17, 1.18 and 1.20.  
 Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account

**FEE CALCULATION**

**1. BASIC FILING FEE**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	
<b>SUBTOTAL (1)</b>					<b>(\$)</b>

**2. EXTRA CLAIM FEES**

Total Claims	Extra Claims	Fee from below	Fee Paid
27	27*	0	\$0.00
7	7*	0	\$0.00
Multiple Dependent			

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	86	2201	43	Independent claims in excess of 3	
1203	290	2203	145	Multiple Dependent claim, if not paid	
1204	86	2204	43	**Reissue independent claims over original patent	
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent	
<b>SUBTOTAL (2)</b>					<b>(\$)</b> <b>0.00</b>

\*or number previously paid, if greater. For Reissues, see below

**FEE CALCULATION** (continued)

**3. ADDITIONAL FEES**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
2053	130	2053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for <i>ex parte</i> reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	1,210	2255	605	Extension for reply within fifth month	
1404	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	2451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	2460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	180.00
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	1809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify) _____					
*Reduced by Basic Filing Fee Paid				<b>SUBTOTAL (3)</b>	<b>(\$)</b> <b>180.00</b>

**SUBMITTED BY**

Name (Print/Type)	<b>Andre M. Gibbs</b>	Registration No. (Attorney/Agent)	<b>47,593</b>	Telephone	<b>(408) 720-8300</b>
Signature		Date	<b>03/29/04</b>		

Based on PTO/SB/17 (10-03) as modified by Blakely, Sokoloff, Taylor & Zafman (w/r) 02/10/2004.  
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



UNITED STATES PATENT AND TRADEMARK OFFICE

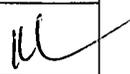
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666
8791	7590	01/28/2004	EXAMINER	
BLAKELY SOKOLOFF TAYLOR & ZAFMAN 12400 WILSHIRE BOULEVARD, SEVENTH FLOOR LOS ANGELES, CA 90025			HO, ALLEN C	
			ART UNIT	PAPER NUMBER
			2882	

DATE MAILED: 01/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/033,327	<b>Applicant(s)</b> GRAF, ULRICH MARTIN	
	<b>Examiner</b> Allen C. Ho	<b>Art Unit</b> 2882	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1)  Responsive to communication(s) filed on 10 November 2003.
- 2a)  This action is **FINAL**.                      2b)  This action is non-final.
- 3)  Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4)  Claim(s) 1-27 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5)  Claim(s) \_\_\_\_\_ is/are allowed.
- 6)  Claim(s) 1-27 is/are rejected.
- 7)  Claim(s) \_\_\_\_\_ is/are objected to.
- 8)  Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9)  The specification is objected to by the Examiner.
- 10)  The drawing(s) filed on 10 November 2003 is/are: a)  accepted or b)  objected to by the Examiner.  
    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11)  The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. §§ 119 and 120**

- 12)  Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
    a)  All    b)  Some \*    c)  None of:  
    1.  Certified copies of the priority documents have been received.  
    2.  Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
    3.  Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
    \* See the attached detailed Office action for a list of the certified copies not received.
- 13)  Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.  
    a)  The translation of the foreign language provisional application has been received.
- 14)  Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                             | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____  |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)         | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other:  |

## DETAILED ACTION

### *Drawings*

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, one of at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry as claimed in claim 11 must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.
2. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, a diagnostic energy source attached to a translatable end of a second gantry as claimed in claim 26 must be shown or the feature(s) canceled must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.
3. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, one of the at least one second radiation source is attached to a mechanism of extending and retracting the second radiation source from the second gantry as claimed in claim 27 must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

***Claim Objections***

4. Claims 4 and 5 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

Claims 4 and 5 recite the radiation source is capable of propagating energy. By definition, propagating energy is what a radiation source does.

***Claim Rejections - 35 USC § 112***

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 1-27 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a diagnostic x-ray source, does not reasonably provide enablement for a diagnostic radiation source. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention commensurate in scope with these claims.

As understood by persons skilled in the art, radiations comprise a broad spectrum of electromagnetic and particle fields. The only kind of diagnostic radiations generated by the apparatus disclosed by the applicants are x-rays in keV range. Specifically, x-rays are generated

by an x-ray source (paragraph [0029]). The applicant failed to describe performing diagnostic imaging using other forms of radiations.

***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 1, 3-10, 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hanover (U. S. Patent No. 6,104,780) in view of Watanabe (U. S. Patent No. 6,325,537 B1).

With regard to claim 1, Hanover *et al.* disclosed an apparatus (Fig. 2) comprising: a first therapeutic (x-ray is therapeutic) radiation source (140) attached to a first gantry (116); at least one second radiation source (142); a second gantry (118) that is rotatable, the second gantry is attached to the first gantry; and an imager (146).

However, Hanover *et al.* did not teach that the imager is attached to an articulable end of the second gantry.

Watanabe disclosed a C-shaped gantry (14) that comprises an imager (16) attached to an articulable end (20) of the gantry and a rotatable x-ray source (12). This arrangement makes the apparatus applicable to a wide range of clinical applications (column 4, lines 29-51).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the C-shaped gantry disclosed by Hanover *et al.* to include an

imager attached to an articulable end of the gantry and a rotatable x-ray source according to Watanabe, since a person would be motivated to use the same apparatus for as many different clinical applications as possible, which is less expensive than purchasing additional application-specific equipments.

With regard to claim 3, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.

With regard to claim 4, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein the first radiation source is capable of propagating therapeutic energy (x-rays could be used as therapeutic radiations).

With regard to claim 5, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein at least one second radiation source is capable of propagating diagnostic energy (x-ray).

With regard to claim 6, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein the first gantry is rotatable.

With regard to claim 7, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis (Hanover *et al.* 132).

With regard to claim 8, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein the imager is a multiple-energy imaging unit (all x-ray imagers are sensitive to a range of energies).

With regard to claim 9, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein the articulable end includes at least one pivot point between the second gantry and the imager (Watanabe Fig. 2).

With regard to claim 10, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 1, wherein the articulable end includes a sliding mechanism (Watanabe Fig. 9) capable of translating the imager in a plane.

With regard to claim 12, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the articulable end (Watanabe 20) is capable of folding the imager against the second gantry.

With regard to claim 13, Hanover *et al.* as modified by Watanabe disclosed the apparatus of claim 7, wherein the second gantry is nestled within the first gantry (Hanover *et al.* Fig. 2).

***Allowable Subject Matter***

9. Claims 2, 11, and 14-27 are allowed over prior art.

10. The following is a statement of reasons for the indication of allowable subject matter:

With regard to claim 2, the prior art fails to teach or fairly suggest at least one second radiation source is attached to the first gantry as claimed.

With regard to claim 11, the prior fails to teach or fairly suggest one of at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry as claimed.

With regard to claims 14-21, the prior art fails to teach or fairly suggest a step of positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic radiation source as claimed.

With regard to claims 22-25, the prior art fails to teach or fairly suggest a step of retracting the first radiation source and positioning a second radiation source along the first axis as claimed.

With regard to claim 26, the prior art fails to teach or fairly suggest that a diagnostic energy source is attached to a translatable end of a secondary gantry as claimed.

With regard to claim 27, the prior art fails to teach or fairly suggest one of the at least one second radiation source is attached to a mechanism capable of extending and retracting the second radiation source from the second gantry as claimed.

#### ***Response to Arguments***

11. With regard to the objection to the drawings under CFR 1.83(a) for failing to show internal seed acting as markers, the examiner agrees to withdraw the objection since this feature is not necessary for understanding the invention.

12. With regard to the objection to the drawings under CFR 1.83(a) for failing to show a diagnostic source attached to a translatable end of a second gantry, the objection is to be maintained since this feature is essential for understanding the invention.

13. With regard to claims 1, 3-10, 12, 13, the applicant argues that amended claim 1 is not obvious under 35 USC 103 (a) over Hanover in view of Watanabe. The examiner would like to point out that x-ray is a therapeutic radiation. Therefore, the rejections are being maintained.

14. With regard to claims 14-21, the rejections are withdrawn in response to the amendment.
15. With regard to claim 26, the examiner agrees to withdraw the rejection since there is a lack of motivation for providing a second gantry with a translatable end.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allen C. Ho whose telephone number is (571) 272-2491. The examiner can normally be reached on Monday - Friday from 8:00 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward J. Glick can be reached at (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (571) 272-1550.

Allen C. Ho  
Patent Examiner  
Art Unit 2882

ACH ACH 01.21.04

  
EDWARD J. GLICK  
SUPERVISORY PATENT EXAMINER

**Index of Claims**



Application No.

10/033,327

Examiner

Allen C. Ho

Applicant(s)

GRAF, ULRICH MARTIN

Art Unit

2882

√	Rejected
=	Allowed

-	(Through numeral) Cancelled
+	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

Claim		Date			
Final	Original	1/21/04			
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APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003

CONFIRMATION NO. 9666

008791

BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
 12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
 LOS ANGELES, CA 90025



Date Mailed: 10/31/2003

### Communication Regarding Rescission Of Nonpublication Request and/or Notice of Foreign Filing

Applicant's rescission of the previously-filed nonpublication request and/or notice of foreign filing is acknowledged. The paper has been reflected in the Patent and Trademark Office's (USPTO's) computer records so that the earliest possible projected publication date can be assigned.

The projected publication date is 02/05/2004.

If applicant rescinded the nonpublication request before or on the date of "foreign filing," then no notice of foreign filing is required.

If applicant foreign filed the application after filing the above application and before filing the rescission, and the rescission did not also include a notice of foreign filing, then a notice of foreign filing (not merely a rescission) is required to be filed within 45 days of the date of foreign filing. See 35 U.S.C. § 122(b)(2)(B)(iii), and Clarification of the United States Patent and Trademark Office's Interpretation of the Provisions of 35 U.S.C. § 122(b)(2)(B)(ii)-(iv), 1272 Off. Gaz. Pat. Office 22 (July 1, 2003).

If a notice of foreign filing is required and is not filed within 45 days of the date of foreign filing, then the application becomes abandoned pursuant to 35 U.S.C. § 122(b)(2)(B)(iii). In this situation, applicant should either file a petition to revive or notify the Office that the application is abandoned. See 37 CFR 1.137(f). Any such petition to revive will be forwarded to the Office of Petitions for a decision. Note that the filing of the petition will not operate to stay any period of reply that may be running against the application.

Questions regarding petitions to revive should be directed to the Office of Petitions at (703) 305-9282. Questions regarding publications of patent applications should be directed to the patent application publication hotline at (703) 605-4283 or by e-mail [pgpub@uspto.gov](mailto:pgpub@uspto.gov).

<sup>1</sup> Note, for purpose of this notice, that "foreign filing" means "filing an application directed to the same invention in another country, or under a multilateral international agreement, that requires publication of applications 18 months after filing".

PART 1 - ATTORNEY/APPLICANT COPY

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TAYLOR &  
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SUNNYVALE, CALIFORNIA 94086  
(408) 720-8598 (Telephone)  
(408) 720-9397 (Facsimile)

FACSIMILE TRANSMITTAL SHEET

Deliver to: Examiner Allen Ho

Firm Name: USPTO

Fax Number: 1-703-872-9306 703-308-6189 (phone)

From: Juanita Briscoe, secretary to Daniel Ovanezian

Date: 11/10/03 Time: \_\_\_\_\_

Operator: \_\_\_\_\_ Matter: 5513.P003

Number of pages including cover sheet: 28

Message: Regarding application no. 10/033,327, attached is a copy of the filed Response to Office Action mailed on July 11, 2003. On the Decision Granting Petition mailed October 31, 2003 (copy attached), it is stated that a response to the July 11, 2003 Office Action was not filed. Also attached is a copy of the PTO stamped postcard showing that it was received by the PTO on 10/6/03. I will call you on Friday to confirm receipt of this response, thank you.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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LOS ANGELES

Paper No. 8

*OSB-JCS*  
*Varian Medical*  
*STEMS*  
*JCS*

BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
LOS ANGELES, CA 90025

COPY MAILED

OCT 31 2003

OFFICE OF PETITIONS

In re Application of  
Ulrich Martin Graf  
Application No. 10/033,327  
Filed: November 2, 2001  
Attorney Docket No. 005513.P003

DECISION GRANTING PETITION  
UNDER 37 CFR 1.137(b)

This is a decision on the petition, filed October 6, 2003, which is being treated as a petition under 37 CFR 1.137(b) to revive the instant nonprovisional application for failure to timely notify the U.S. Patent and Trademark (USPTO) of the filing of an application in a foreign country, or under a multinational treaty that requires publication of applications eighteen months after filing. See 37 CFR 1.137(f).

The petition is **GRANTED**. ✓

Petitioner states that the instant nonprovisional application is the subject of an application filed in an eighteen month publication country on October 30, 2002. However, the USPTO was unintentionally not notified of this filing within 45 days subsequent to the filing of the subject application in an eighteen month publication country.

In view of the above, this application became abandoned pursuant to 35 U.S.C. § 122(b)(2)(B)(iii) and 37 CFR 1.213(c) for failure to timely notify the Office of the filing of an application in a foreign country or under a multilateral international agreement that requires publication of applications 18 months after filing.

A petition to revive an application abandoned pursuant to 35 U.S.C. 122(b)(2)(B)(iii) for failure to notify the USPTO of a foreign filing must be accompanied by:

- (1) the required reply which is met by the notification of such filing in a foreign country or under a multinational treaty;
- (2) the petition fee as set forth in 37 CFR 1.17(m); and
- (3) a statement that the entire delay in filing the required reply from the due date of the reply until the filing of a grantable petition was unintentional.

The instant petition has been found to be in compliance with 37 CFR 1.137(b). Accordingly, the failure to timely notify the USPTO of a foreign or international filing within 45 days after the date of filing of such foreign or international application as provided by 35 U.S.C. § 122(b)(2)(B)(iii) and 37 CFR 1.213(c) is accepted as having been unintentionally delayed.

The previous Request and Certification under 35 U.S.C. § 122(b)(2)(B)(i) has been rescinded. A Notice Regarding Rescission of Nonpublication Request which sets forth the projected publication date of February 5, 2004 accompanies this decision on petition.

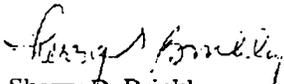
Application No. 10/033,327

Page 2

**There is no indication that a reply to the non-final Office action of July 11, 2003 has been filed. Accordingly, a shortened statutory period of three (3) months for reply to the non-final Office action of July 11, 2003 is restarted with the mailing date of this decision. Extensions of time pursuant to the provisions of 37 CFR 1.136(a) are permitted. Failure to timely reply within the period restarted by this decision will result again in the abandonment of this application.**

Any inquiries concerning this decision may be directed to the undersigned at (703) 305-9220.

This application is being returned to Technology Center Art Unit 2882 to await a reply to the non-final Office action mailed July 11, 2003, the period of which is restarted to run from the mailing date of this decision on petition as noted above.

  
Sherry D. Brinkley  
Petitions Examiner  
Office of Petitions  
Office of the Deputy Commissioner  
for Patent Examination Policy

ATTACHMENT: Notice Regarding Rescission of Nonpublication Request

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OCT 13 2003

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP  
LOS ANGELES

✓

Application No.: 10/033,327 Filing Date: 11/2/2001 Docket #: 005513.P003  
Date Mailed: 09/30/2003 Due Date(s): 10/11/2003  
Client: VARIAN MEDICAL SYSTEMS, INC. Atty/Sec: DEO/AMG/ejc  
Title: Radiotherapy Apparatus Equipped with an Articuable Gantry for Positioning an Imaging Unit

First Named Inventor: Ulrich Martin Graf

*The following has been received in the U.S.P.T.O. on the date stamped hereon:*

Amendment: Response (16 pgs)  
Certificate of Mailing  
Transmittal Letter  
Postcard

+ CHECK NO. 60410 FOR \$270.00

Assignee: Varian Medical Systems, Inc. + CHECK NO. 60506 FOR \$6.00



11/10/2003 12:07 FAX

BLAKELY SOKOLOFF TAYLOR

003

Application No.: 10/033,327 Filing Date: 11/2/2001 Docket #: 005513.P003  
Date Mailed: 09/30/2003 Due Date(s): 10/11/2003  
Client: VARIAN MEDICAL SYSTEMS, INC. Atty/Sec: DEO/AMG/elc  
Title: Radiotherapy Apparatus Equipped with an Articuable Gantry for Positioning an Imaging Unit

First Named Inventor: Ulrich Martin Graf

*The following has been received in the U.S.P.T.O. on the date stamped hereon:*

Amendment: Response (16 pgs)

Certificate of Mailing

Transmittal Letter

Postcard

+ CHECK NO. 60410 FAX \$270.00

Assignee: Varian Medical Systems, Inc. + CHECK NO. 60506 FAX \$6.00

11/10/2003 12:07 FAX

BLAKELY SOKOLOFF TAYLOR

004

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, LLP  
A PARTNERSHIP INCLUDING LAW CORPORATIONS  
1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94085-4040  
(408) 720-8598

COMERICA BANK - CALIFORNIA  
SUNNYVALE, CA 94086  
60506  
90-3750  
1211

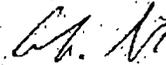
60506

October 1, 2003

PAY SIX & NO/100

DOLLARS \$ 6.00

TO THE ORDER OF  
Director of the United States  
Patent & Trademark Office



AUTHORIZED SIGNATURE

⑈060506⑈ ⑆121137522⑆ 1890⑈67366⑈6⑈

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1279 OAKMEAD PARKWAY  
SUNNYVALE, CA 94065-4040  
(408) 720-8598

COMERICA BANK - CALIFORNIA  
SUNNYVALE, CALIFORNIA 94086  
60410  
90-3750  
1211

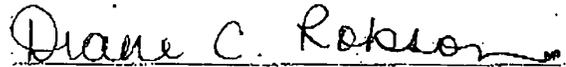
60410

September 30, 2003

PAY TWO HUNDRED SEVENTY & NO/100

DOLLARS \$ 270.00

TO THE ORDER OF  
Director of the United States  
Patent & Trademark Office



AUTHORIZED SIGNATURE

⑈060410⑈ ⑆121137522⑆ 1890⑈67366⑈6⑈

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DETACH AND RETAIN THIS STATEMENT  
THE ATTACHED CHECK IS IN PAYMENT OF ITEMS DESCRIBED BELOW.  
IF NOT CORRECT PLEASE NOTIFY US PROMPTLY. NO RECEIPT DES. FED.

Invoice: 09/30/2003 Amount: 270.00  
005513.P003 - Varian Medical Systems, Inc.  
AMG/elc  
Additional claims filing fee  
Serial No.: 10/033,327  
Inventors: Graf  
Title: Radiotherapy Apparatus Equipped with an Articulate  
Gantry for Positioning an Imaging Unit

60410



Paper No. 8

BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
LOS ANGELES, CA 90025

**COPY MAILED**

**OCT 31 2003**

**OFFICE OF PETITIONS**

In re Application of :  
Ulrich Martin Graf :  
Application No. 10/033,327 :  
Filed: November 2, 2001 :  
Attorney Docket No. 005513.P003 :

**DECISION GRANTING PETITION  
UNDER 37 CFR 1.137(b)**

This is a decision on the petition, filed October 6, 2003, which is being treated as a petition under 37 CFR 1.137(b) to revive the instant nonprovisional application for failure to timely notify the U.S. Patent and Trademark (USPTO) of the filing of an application in a foreign country, or under a multinational treaty that requires publication of applications eighteen months after filing. See 37 CFR 1.137(f).

The petition is **GRANTED**.

Petitioner states that the instant nonprovisional application is the subject of an application filed in an eighteen month publication country on October 30, 2002. However, the USPTO was unintentionally not notified of this filing within 45 days subsequent to the filing of the subject application in an eighteen month publication country.

In view of the above, this application became abandoned pursuant to 35 U.S.C. § 122(b)(2)(B)(iii) and 37 CFR 1.213(c) for failure to timely notify the Office of the filing of an application in a foreign country or under a multilateral international agreement that requires publication of applications 18 months after filing.

A petition to revive an application abandoned pursuant to 35 U.S.C. 122(b)(2)(B)(iii) for failure to notify the USPTO of a foreign filing must be accompanied by:

- (1) the required reply which is met by the notification of such filing in a foreign country or under a multinational treaty;
- (2) the petition fee as set forth in 37 CFR 1.17(m); and
- (3) a statement that the entire delay in filing the required reply from the due date of the reply until the filing of a grantable petition was unintentional.

The instant petition has been found to be in compliance with 37 CFR 1.137(b). Accordingly, the failure to timely notify the USPTO of a foreign or international filing within 45 days after the date of filing of such foreign or international application as provided by 35 U.S.C. § 122(b)(2)(B)(iii) and 37 CFR 1.213(c) is accepted as having been unintentionally delayed.

The previous Request and Certification under 35 U.S.C. § 122(b)(2)(B)(i) has been rescinded. A Notice Regarding Rescission of Nonpublication Request which sets forth the projected publication date of February 5, 2004 accompanies this decision on petition.

**There is no indication that a reply to the non-final Office action of July 11, 2003 has been filed. Accordingly, a shortened statutory period of three (3) months for reply to the non-final Office action of July 11, 2003 is restarted with the mailing date of this decision. Extensions of time pursuant to the provisions of 37 CFR 1.136(a) are permitted. Failure to timely reply within the period restarted by this decision will result again in the abandonment of this application.**

Any inquiries concerning this decision may be directed to the undersigned at (703) 305-9220.

This application is being returned to Technology Center Art Unit 2882 to await a reply to the non-final Office action mailed July 11, 2003, the period of which is restarted to run from the mailing date of this decision on petition as noted above.



Sherry D. Brinkley  
Petitions Examiner  
Office of Petitions  
Office of the Deputy Commissioner  
for Patent Examination Policy

ATTACHMENT: Notice Regarding Rescission of Nonpublication Request



## UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
 United States Patent and Trademark Office  
 Address: COMMISSIONER FOR PATENTS  
 P.O. Box 1450  
 Alexandria, Virginia 22313-1450  
 www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003

CONFIRMATION NO. 9666

008791  
 BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
 12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
 LOS ANGELES, CA 90025



\*OC00000011150601\*

Date Mailed: 10/31/2003

### Communication Regarding Rescission Of Nonpublication Request and/or Notice of Foreign Filing

Applicant's rescission of the previously-filed nonpublication request and/or notice of foreign filing is acknowledged. The paper has been reflected in the Patent and Trademark Office's (USPTO's) computer records so that the earliest possible projected publication date can be assigned.

The projected publication date is 02/05/2004.

If applicant rescinded the nonpublication request before or on the date of "foreign filing,"<sup>1</sup> then no notice of foreign filing is required.

If applicant foreign filed the application after filing the above application and before filing the rescission, and the rescission did not also include a notice of foreign filing, then a notice of foreign filing (not merely a rescission) is required to be filed within 45 days of the date of foreign filing. See 35 U.S.C. § 122(b)(2)(B)(iii), and Clarification of the United States Patent and Trademark Office's Interpretation of the Provisions of 35 U.S.C. § 122(b)(2)(B)(ii)-(iv), 1272 Off. Gaz. Pat. Office 22 (July 1, 2003).

If a notice of foreign filing is required and is not filed within 45 days of the date of foreign filing, then the application becomes abandoned pursuant to 35 U.S.C. § 122(b)(2)(B)(iii). In this situation, applicant should either file a petition to revive or notify the Office that the application is abandoned. See 37 CFR 1.137(f). Any such petition to revive will be forwarded to the Office of Petitions for a decision. Note that the filing of the petition will not operate to stay any period of reply that may be running against the application.

Questions regarding petitions to revive should be directed to the Office of Petitions at (703) 305-9282. Questions regarding publications of patent applications should be directed to the patent application publication hotline at (703) 605-4283 or by e-mail [pgpub@uspto.gov](mailto:pgpub@uspto.gov).

<sup>1</sup> Note, for purpose of this notice, that "foreign filing" means "filing an application directed to the same invention in another country, or under a multilateral international agreement, that requires publication of applications 18 months after filing".



Attorney Docket No. 005513P003  
093003/AMG:elc

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:  
Ulrich Martin Graf  
Serial No. 10/033,327  
Filed: November 2, 2001  
For: RADIOTHERAPY APPARATUS  
EQUIPPED WITH AN  
ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

EXAMINER: HO, ALLEN C.  
ART UNIT: 2882

Commissioner for Patents  
PO Box 1450  
Alexandria, Virginia 22313-1450

AMENDMENT TO OFFICE ACTION

Sir:

In response to the Office Action mailed July 11, 2003, Applicant respectfully requests the Examiner to enter the following amendments and consider the following remarks:

RECEIVED  
OCT 16 2003  
TECHNOLOGY CENTER 2800

10/09/2003 ZJUHR1 00000116 10033327  
01 FC:1201 258.00 OP  
02 FC:1202 18.00 OP

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to Mail Stop Non-Fee Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on October 1, 2003.

Esther L. Campbell  
(Typed or printed name of person mailing correspondence)  
  
(Signature of person mailing correspondence)



!!

2222  
#

<b>TRANSMITTAL FORM</b> <i>(to be used for all correspondence after initial filing)</i>		Application No.	10/033,327
		Filing Date	November 2, 2001
		First Named Inventor	Ulrich Martin Graf
		Art Unit	2882
		Examiner Name	Ho, Allen C.
Total Number of Pages in This Submission	20	Attorney Docket Number	5513P003

ENCLOSURES (check all that apply)		
<input checked="" type="checkbox"/> Fee Transmittal Form <input checked="" type="checkbox"/> Fee Attached <input checked="" type="checkbox"/> Amendment / Response <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input type="checkbox"/> PTO/SB/08 <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Response to Missing Parts/Incomplete Application <input type="checkbox"/> Basic Filing Fee <input type="checkbox"/> Declaration/POA <input type="checkbox"/> Response to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s)	<input type="checkbox"/> After Allowance Communication to Group <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to Group (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): <div style="border: 1px solid black; padding: 5px; margin-top: 5px;">         Return Receipt postcard  <div style="text-align: right; font-size: small;">           OCT 16 2003            TECHNOLOGY CENTER 2400         </div> </div>
Remarks		

RECEIVED

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT	
Firm or Individual name	Andre M. Gibbs, Reg. No. 47,593 <b>BLAKELY, SOKOLOFF, TAYLOR &amp; ZAFMAN LLP</b>
Signature	
Date	October 1, 2003

CERTIFICATE OF MAILING/TRANSMISSION			
I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.			
Typed or printed name	Esther L. Campbell		
Signature		Date	October 1, 2003

Based on PTO/SB/21 (08-03) as modified by Blakely, Sokoloff, Taylor & Zafman (w/r) 09/11/2003.  
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450



# FEE TRANSMITTAL for FY 2003

Effective 01/01/2003. Patent fees are subject to annual revision.

Applicant claims small entity status. See 37 CFR 1.27.

TOTAL AMOUNT OF PAYMENT (\$) 276.00

Complete if Known

Application Number	10/033,327
Filing Date	November 2, 2001
First Named Inventor	Ulrich Martin Graf
Examiner Name	Ho, Allen C.
Group/Art Unit	2882
Attorney Docket No.	5513P003

## METHOD OF PAYMENT (check all that apply)

Check  Credit card  Money Order  Other  None

Deposit Account

Deposit Account Number: 02-2666

Deposit Account Name: Blakely, Sokoloff, Taylor & Zafman LLP

The Commissioner is authorized to: (check all that apply)

Charge fee(s) indicated below  Credit any overpayments  
 Charge any additional fee(s) required under 37 CFR §§ 1.16, 1.17, 1.18 and 1.20.  
 Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	180	2005	80	Provisional filing fee	
SUBTOTAL (1)					(0)

### 2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
27	26	1 x 18.00	\$18.00
7	4	3 x 86.00	\$258.00

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	86	2201	43	Independent claims in excess of 3	
1203	280	2203	145	Multiple Dependent claim, if not paid	
1204	86	2204	43	**Reissue independent claims over original patent	
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent	
SUBTOTAL (2)					(0) 276.00

\*or number previously paid, if greater. For Reissues, see below

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
2053	130	2053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	* Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	* Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	476	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	1,210	2255	605	Extension for reply within fifth month	
1404	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	2451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	2460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	1809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee (specify)					
* Reduced by Basic Filing Fee Paid					
SUBTOTAL (3)					(0)

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## SUBMITTED BY

Name (Print/Type)	Andre M. Gibbs	Registration No. (Attorney/Agent)	47,593	Telephone	(408) 720-8300
Signature		Date	10/01/03		

Based on PTO/SB/17 (08-03) as modified by Blakely, Sokoloff, Taylor & Zafman (w/r) 08/11/2003.  
 SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

IN THE SPECIFICATION

Please replace paragraph [0028] with the following amended paragraph:

[0028] The imager can be a multiple-energy imaging unit and can be attached to the inner arm (second gantry) 208 at the end opposite from the diagnostic radiation source 204. The inner arm end 220 attached to the multiple-energy imaging unit 212 can articulate the multiple-energy imaging unit 212 into alignment with either radiation source 202 or 204. Attached to the second gantry 208, the multiple-energy imaging unit 212 is in natural alignment to receive radiation from an extended diagnostic radiation source 204. Fine adjustments to place the multiple-energy imaging unit into alignment with and at the proper distance from the radiation source 202 or 204 are also accomplished with the articulating portion of the second gantry ~~220~~ 208. Alternately, the diagnostic radiation source 204 can be retracted for clearance so that the inner arm ~~208~~ 220 can rotate and the multiple-energy imaging unit 212 articulate until the multiple-energy imaging unit 212 is in alignment to receive radiation from the other radiation source 202 or 204.

Please replace paragraph [0030] with the following amended paragraph:

[0030] **FIG. 2B** is an illustration of an alternate embodiment of the radiotherapy clinical treatment machine using the multiple-energy imaging unit. As shown in **FIG. 2B**, the therapeutic radiation source 202 and the diagnostic radiation source 204 can be

positioned adjacent to each other and attached at the same end of the first gantry 206.

The first gantry 206 can rotate about pivot axis 210 to position either the therapeutic radiation source 202 or the diagnostic radiation source 204 into alignment about the target volume 224. The second gantry, an inner arm-209, can be attached to the pivot axis 210 with an opposite end ~~227~~ 220 attached to the articulating multiple-energy imaging unit 212. The multiple-energy imaging unit 212 can be rotated and articulated until alignment with either radiation source 202 or 204 is achieved, maintaining the target volume 224 in between.

IN THE CLAIMS

1. (Currently Amended) An apparatus comprising:  
a first therapeutic radiation source attached to a first gantry;  
at least one second radiation source;  
a second gantry that is rotatable, the second gantry is attached to the first gantry;  
and  
an imager attached to an articulable end of the second gantry.
2. (Currently Amended) ~~An~~ The apparatus of claim 1, ~~wherein at least one second radiation source is attached to the first gantry.~~ comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source, wherein the at least one second radiation source is attached to the first gantry;  
a second gantry that is rotatable; and  
an imager attached to an articulable end of the second gantry.
3. (Original) The apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.
4. (Currently Amended) The apparatus of claim 1, wherein the first therapeutic radiation source is capable of propagating therapeutic energy.

5. (Original) The apparatus of claim 1, wherein at least one second radiation source is capable of propagating diagnostic energy.
  
6. (Original) The apparatus of claim 1, wherein the first gantry is rotatable.
  
7. (Original) The apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis.
  
8. (Original) The apparatus of claim 1, wherein the imager is a multiple-energy imaging unit.
  
9. (Original) The apparatus of claim 1, wherein the articulable end includes at least one pivot point between the second gantry and the imager.
  
10. (Original) The apparatus of claim 1, wherein the articulable end includes a sliding mechanism capable of translating the imager in a plane.
  
11. (Currently Amended) ~~An~~ The apparatus of claim 1, wherein ~~one of the at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry.~~ comprising:
  - a first radiation source attached to a first gantry;
  - at least one second radiation source;
  - a second gantry that is rotatable, wherein one of the at least one second radiation

source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry; and  
an imager attached to an articulable end of the second gantry.

12. (Original) The apparatus of claim 1, wherein the articulable end is capable of folding the imager against the second gantry.

13. (Original) The apparatus of claim 7, wherein the second gantry is nestled within the first gantry.

14. (Currently Amended) A method for applying radiation, comprising:  
positioning a diagnostic radiation source to be in alignment with a target volume;  
positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic radiation source;  
positioning a therapeutic radiation source to be in alignment with the target volume; and  
re-positioning the imager to receive radiation from the therapeutic radiation source.

15. (Original) The method of claim 14, further comprising:  
propagating the diagnostic radiation toward the target volume;  
receiving the diagnostic radiation by the imager after passing through the target volume;

positioning the therapeutic radiation source is based on results of the diagnostic radiation to the imager;  
propagating the therapeutic radiation into the target volume;  
receiving the therapeutic radiation by the imager after passing through the target volume; and  
generating verification data by the imager from the therapeutic radiation.

16. (Original) The method of claim 14, wherein the imager is a multiple-energy imaging unit.

17. (Original) The method of claim 14, further comprising; placing an internal seed to act as a marker for the target volume.

18. (Original) The method of claim 15, further comprising generating multiple diagnostic radiation slices using a fan X-ray beam to provide a 3-dimensional reconstruction of the target volume.

19. (Original) The method of claim 15, further comprising generating a cone X-ray beam where volumetric information can be constructed.

20. (Original) The method of claim 15, wherein the diagnostic radiation can be operated continuously to provide real time a fluoroscopic image of moving internal anatomy.

21. (Original) The method of claim 15, wherein the diagnostic radiation can be operated in a pulsed manner to provide a quasi-real time fluoroscopic image of moving internal anatomy.
22. (Original) A method for imaging radiation, comprising:  
positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level;  
propagating radiation by a first radiation source at the first energy level along the first axis;  
retracting the first radiation source and positioning a second radiation source along the first axis.  
maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source; and  
propagating radiation by the second radiation source.
23. (Original) The method of claim 22, further comprising:  
rotating the first radiation source until clear of the second radiation source;  
extending the first radiation source to be in line with the multiple-energy imaging unit;  
propagating radiation at a first energy level toward the multiple-energy imaging unit.

24. (Original) The method of claim 22, further comprising pivoting two arms independently, the first arm attached to the first radiation source for propagating at the first energy level, and the second arm attached to the second radiation source for propagating at the second energy level.
25. (Original) The method of claim 24, wherein the multiple-energy imaging unit is attached to the second arm.
26. (Original) An apparatus, comprising:  
a therapeutic energy source attached to a first gantry;  
a diagnostic energy source attached to a translatable end of a second gantry;  
a multiple-energy imaging unit attached to an opposite articulable end of the second gantry;  
the first gantry and the second gantry independently pivotable and attached at a common axis;  
a patient couch capable of translation, wherein the result of such pivoting and translation is to place a target volume of a patient between the multiple-energy imaging unit aligned with the diagnostic energy source or the therapeutic energy source.
27. (New) An apparatus comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source;

a second gantry that is rotatable, wherein one of the at least one second radiation source is attached to a mechanism capable of extending and retracting the second radiation source from the second gantry; and

an imager attached to an articulable end of the second gantry.

REMARKS

Applicant respectfully requests reconsideration of this application as amended.

Claims 1-27 remain pending in the application. Claims 22, 23, 24, and 25 are allowed. Claims 1, 2, 4, 11, and 14 have been amended. Claim 27 has been added. The amended claims are supported by the specification. No new matter has been added.

The specification has been amended to correct minor matters of form. No new matter has been added.

***Objections to the Drawings and Specification***

The Office Action requested correction of certain typographical errors in the specification and drawings under 37 CFR 1.84(p)(5). In response, Applicant has amended the specification and drawings accordingly. No new matter has been added.

Furthermore, the drawings were objected to under 37 CFR 1.83(a). Specifically, the Office Action states “the internal seed acting as a marker for the target volume must be shown or the feature(s) canceled from the claims(s).” Applicant respectfully reminds the Examiner that conventional features of the invention whose detailed illustration is not necessary to understand the invention do not have to be shown. Applicant respectfully submits that an illustration of the internal seed acting as a marker for the target volume is ***not necessary for understanding the invention*** (see 35 USC 113, MPEP §608.02) (emphasis added). The use of an internal seed in radiotherapy is well known to those of ordinary skill in the art and is supported in the specification, at least, on page 11 paragraph 0039. Accordingly, Applicant respectfully requests this objection be withdrawn.

Furthermore, the drawings were objected to under 37 CFR 1.83(a). Specifically, the Office Action states, "a diagnostic energy source attached to a translatable end of a second gantry must be shown or the feature(s) canceled from the claims(s)." Applicant respectfully submits a diagnostic energy source **204** is shown at least in Fig. 2A and is supported at least on page 4, paragraph 0009; page 7, paragraph 0027; and page 8, paragraphs 0028 and 0029. Accordingly, Applicant respectfully requests this objection be withdrawn.

***Claims Objections***

Claim 1 was objected to as being ambiguous as it fails to set forth the required interrelationship between the first and second gantries. Applicant respectfully submits that claim 1, as amended, has overcome this objection. Therefore, Applicant respectfully request the objection to the claim be withdrawn.

***Claim Rejections***

Claims 14, 15, 16, and 19 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,751,781 of Brown et al. ("Brown"). Applicant does not admit that Brown is prior art and reserves the right to swear behind the reference at a later date. Nonetheless, Applicant respectfully submits that Brown does not anticipate Claim 14 as amended, because it does not disclose each and every element as claimed.

Claim 14, as amended recites a method for applying radiation, comprising:  
positioning a diagnostic radiation source to be in alignment with a target volume;  
positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic radiation source;

positioning a therapeutic radiation source to be in alignment with the target volume; and

re-positioning the imager to receive radiation from the therapeutic radiation source.

Brown discloses a radiotherapy system having a hollow body with "an inner portion 501 and an outer portion 502, the two portions being rotatable with respect to each other by appropriate mechanical interconnection" (see column 14, lines 12-15). The outer portion 502 houses the radiotherapy source 4a, 4b, which may be a 6 MeV X-ray radiation source (see column 14, lines 19-31). A KeV imaging radiation source SO is also mounted on the outer portion 502 of the hollow body. Furthermore, the imaging device 100 is preferably mounted on bearing 106 so as to allow movement of the imaging device 100 relative to the inner portion 501 of the hollow body 50 so that movement is possible between a first position (Fig 12) in which the imaging device 100 is opposite the collimator 4d and a second position (Fig 10) in which the imaging device 100 is offset from the first position (see column 14, lines 43-51).

Brown does not disclose the limitation of "positioning an imager at one of a plurality of distances from the target volume to receive radiation from the diagnostic radiation source," as recited in claim 14. Since the imaging device 100 is mounted on the inner portion 501 of the hollow body 50, it cannot be positioned at a closer distance relative to the target volume. Rather, the imaging device may only rotate an equal distance around the target volume.

Accordingly, Applicant submits that claim 14, as amended, is not anticipated by Brown under 35 USC 102(a). Therefore, Applicant respectfully requests the rejection to

claim 14 be withdrawn. Claims 15, 16, and 19 are dependent (directly or indirectly) on claim 14 and therefore, the Applicant respectfully requests the rejection to claims 15, 16, and 19 be withdrawn, at least for the reasons stated above for claim 14.

Claims 1, 3-10, 12, 13, and 26 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,104,780 of Hanover ("Hanover") in view of U.S. Patent No. 6,325,537 of Watanabe ("Watanabe").

Applicant respectfully submits that claim 1, as amended, is not obvious under 35 USC 103(a) over Hanover in view of Watanabe. Claim 26 includes limitations similar to those described above for claim 1. Therefore, Applicant respectfully requests the rejection to claim 1 and 26 be withdrawn. Claims 3-10, 12, and 13 are dependent (directly or indirectly) on claim 1. Therefore, Applicant respectfully requests the rejection to claims 3-10, 12, and 13 be withdrawn, at least for the reasons stated above for claim 1.

Claim 17 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Brown as applied to claim 14 above, and further in view of U.S. Patent No. 6,307,914 of Kunieda et al. ("Kunieda").

As articulated above, claim 14 is patentable over Brown. Kunieda fails to show the underlying deficiencies of Brown, including the failure to disclose the limitation of "positioning an image at one of a plurality of distances from the target volume to receive radiation from the diagnostic radiation source," as claimed and discussed above. Hence, claim 17 is patentable over this combination of references. Claims 18, 20, and 21 recite

similar features to those found in claim 14 and are therefore patentable over these references.

***Allowable Subject Matter***

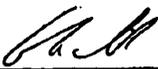
The Office Action indicates that claims 2 and 11 are objected to as being dependent upon a rejected base claim. Applicant respectfully submits that claims 2 and 11 have been rewritten in independent form including all of the limitations of the base claim. Therefore, Applicant respectfully requests the objection to claims 2 and 11 be withdrawn and the claims be allowed.

In conclusion, Applicant respectfully submits that in view of the arguments and amendments set forth herein, the applicable objections and rejections have been overcome. If the Examiner believes a telephone interview would expedite the prosecution of this application, the Examiner is invited to contact André Gibbs at (408) 720-8300.

If there are any additional charges, please charge our Deposit Account No. 02-2666.

Respectfully submitted,  
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: October 1, 2003

  
\_\_\_\_\_  
André Gibbs  
Registration No. 47,593

12400 Wilshire Boulevard  
Seventh Floor  
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(408) 720-8300

IN THE DRAWINGS

The attached sheet of drawings includes a change to Figure 3D. This sheet, which replaces the original sheet including Figure 3D. The Figure 3D has been amended to remove the label 316 based on a typographical error. It is respectfully submitted that the proposed amendment to the drawing does not add new matter.

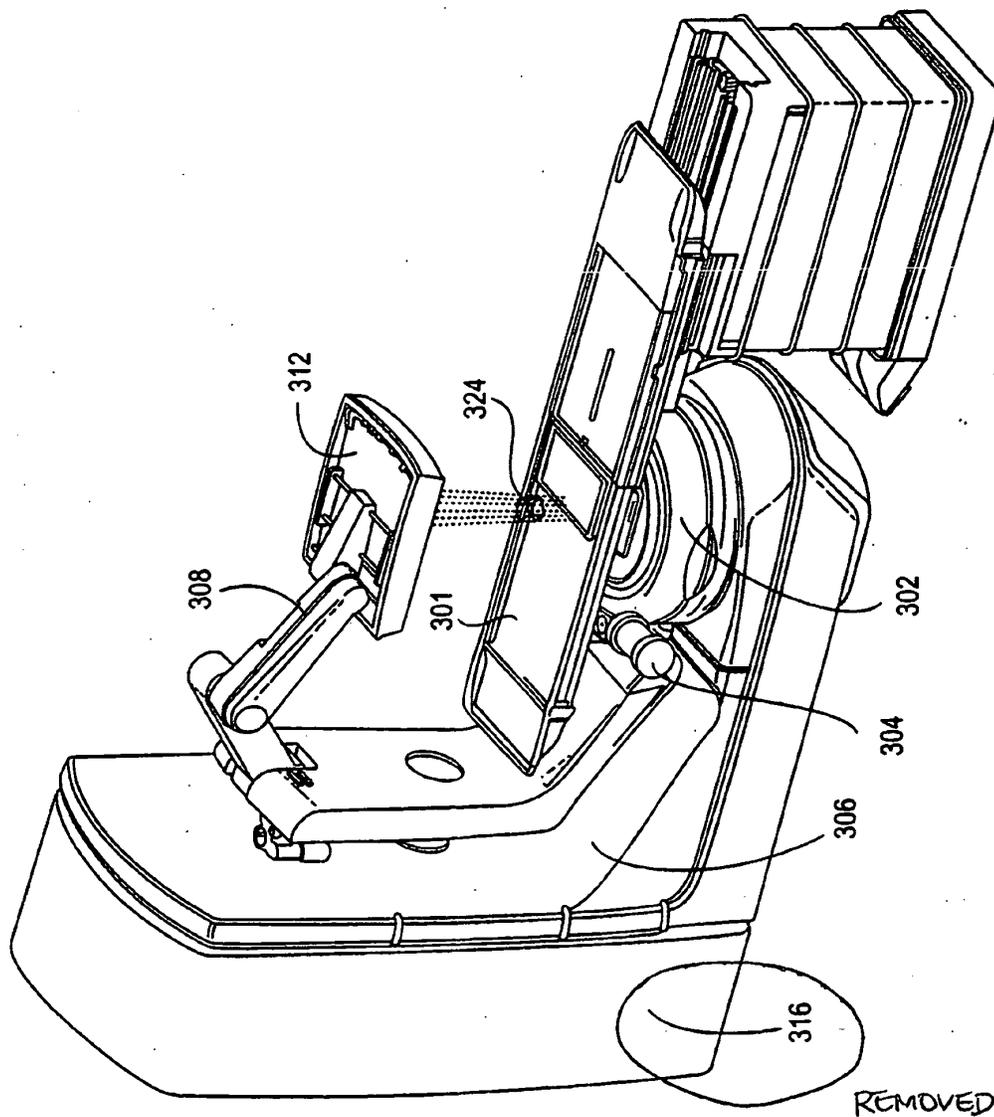
Attachment: Replacement Sheet

Annotated Sheet Showing Changes

Annotated Sheet Showing Changes

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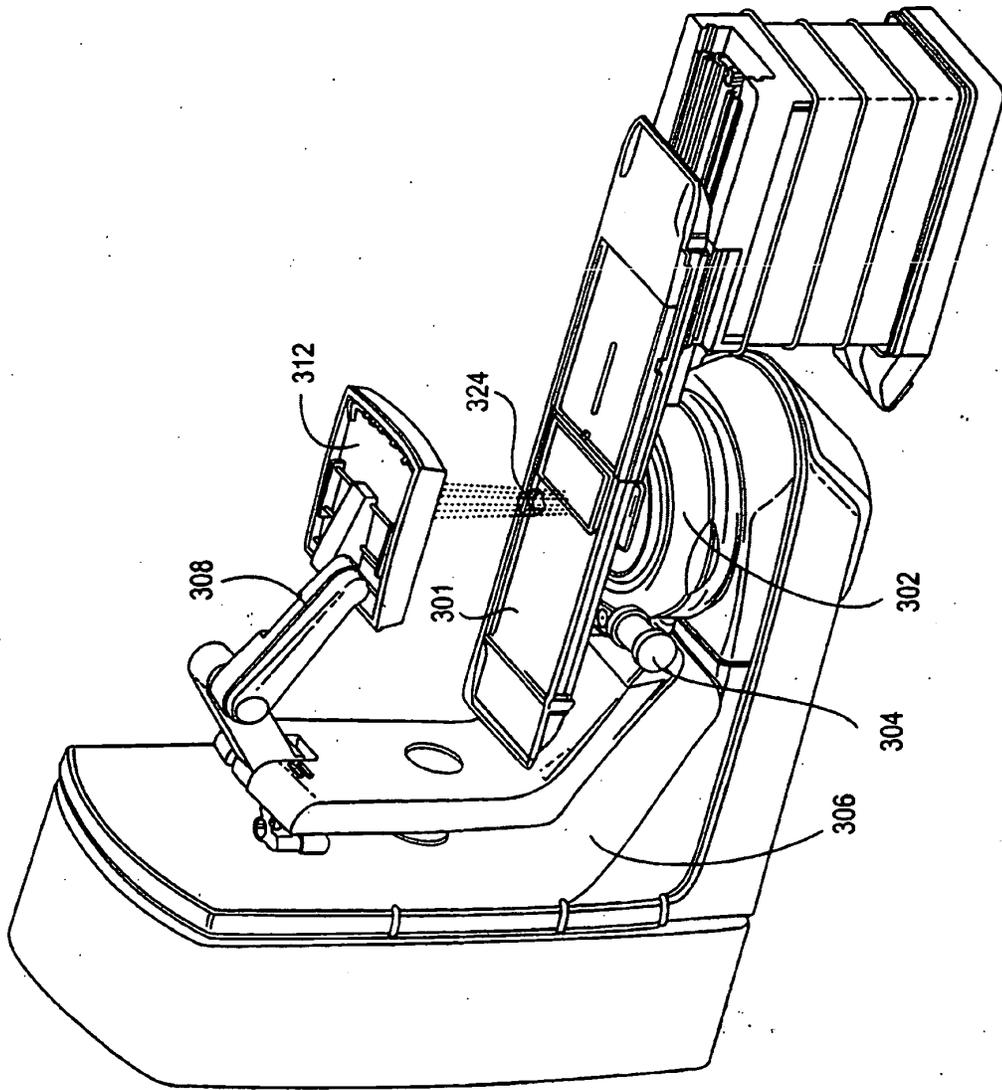
FIG. 3D



Replacement Sheet

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FIG. 3D







STATEMENT: The entire delay in filing the required notice of a foreign or international filing from the due date for the required notice until the filing of a grantable petition under 37 CFR 1.137(b) was unintentional. [NOTE: The United States Patent and Trademark Office may require additional information if there is a question as to whether either the abandonment or the delay in filing a petition under 37 CFR 1.137(b) was unintentional (MPEP 711.03(c), subsections (III)(C) and (D))].

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October 1, 2003  
Date

[Signature]  
Signature

Telephone Number: (408) 720-8300

André Gibbs  
Typed or Printed Name

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP  
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47,593  
Registration No.

- Enclosures:  Fee Payment  
 Additional Sheets containing statements establishing unintentional delay  
 Other: Submission of Petition for Revival

**CERTIFICATE OF MAILING OR TRANSMISSION [37 CFR 1.8(a)]**

I hereby certify that this correspondence is being:

- deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Petition, Commissioner for Patents P. O. Box 1450, Alexandria, VA 22313-1450.  
 transmitted by facsimile on the date shown below to the United States Patent and Trademark Office at (703) 308-6916.

10-1-03  
Date

[Signature]  
Signature

ESTHER CAMPBELL  
Typed or printed name of person signing certificate



**SUBMISSION OF PETITION FOR REVIVAL**

Docket Number:

005513.P003

First named inventor: Ulrich Martin Graf

Application No.: 10/033,327

Art Unit: 2882

Filed: 11/2/01

Examiner: Ho, Allen C.

Title: **RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT**

Attention: Office of Petitions

**Mail Stop Petition**

Commissioner for Patents

P. O. Box 1450

Alexandria, VA 22313-1450

FAX: (703) 308-6916

Applicant(s) believe(s) that the above-identified application may be regarded by the United States Patent and Trademark Office (USPTO) as abandoned. Accordingly, applicant(s) submit(s) herewith a Petition for Revival of An Application for Patent Abandoned for Failure to Notify the Office of a Foreign or International Filing in accordance with 37 CFR § 1.137(f). The Petition fee required under 37 CFR § 1.17(m) is submitted herewith. An extra copy of the Fee Transmittal is enclosed for deposit account charging purposes.

The above-identified application incorporates by reference another pending patent application that was foreign filed. Applicant(s) submit that the USPTO may misinterpret the requirements of 35 U.S.C. § 122, as requiring a notification of foreign filing in the above identified application due to the foreign filing of the incorporated patent application. If such is not the interpretation of the USPTO or if such an interpretation is not held by a court of proper jurisdiction, applicant(s) respectfully request a refund under 37 CFR § 1.26 for the fees under 37 CFR § 1.17(m) mistakenly required to be paid. The refund can be credited to Deposit Account No. 02-2666. If a refund is not forthcoming, applicant(s) reserve(s) the right to request a refund for the Petition fee based on a subsequent finding by the USPTO or a court of proper jurisdiction that the requirements of 35 U.S.C. § 122 have been misinterpreted.

October 1 2003

Date

Signature

Telephone

Number: (408) 720-8300

André Gibbs

Typed or Printed Name

**BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP**

12400 Wilshire Blvd.

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Los Angeles, CA 90025

Telephone Number: (408) 720-8300

47,593

Registration No.

**CERTIFICATE OF MAILING OR TRANSMISSION [37 CFR 1.8(a)]**

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- deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Petition, Commissioner for Patents P. O. Box 1450, Alexandria, VA 22313-1450.
- transmitted by facsimile on the date shown below to the United States Patent and Trademark Office at (703) 308-6916.

10-1-03

Date

Esther Campbell

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OCT 09 2003

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003	9666

8791 7590 07/11/2003

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EXAMINER

HO, ALLEN C

ART UNIT PAPER NUMBER

2882

DATE MAILED: 07/11/2003

Please find below and/or attached an Office communication concerning this application or proceeding.



## DETAILED ACTION

### *Drawings*

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: 209 (page 9, paragraph 30, line 7). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: 316 (Fig. 3D). A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
3. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the internal seed acting as a marker for the target volume must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.
4. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, a diagnostic energy source attached to a translatable end of a second gantry must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

***Specification***

5. The disclosure is objected to because of the following informalities:
- (1) Page 8, paragraph 28, line 9, "220" should be replaced by --208--.
  - (2) Page 9, paragraph 30, line 8, "227" should be replaced by --220--.

Appropriate correction is required.

***Claim Objections***

6. Claim 1 is ambiguous as it fails to set forth the required interrelationship between the first and the second gantries (MPEP 2172.01).

***Claim Rejections - 35 USC § 102***

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 14, 15, 16, and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by Brown *et al.* (U. S. Patent No. 5,751,781).

With regard to claim 14, Brown *et al.* disclosed a method (Figs. 10-12) for applying radiation, comprising: positioning a diagnostic radiation source (SO) to be in alignment with a target volume (2); positioning an imager (100) to receive radiation from the diagnostic radiation source; positioning a therapeutic radiation source (4) to be in alignment with the target volume; and re-positioning the imager to receive radiation from the therapeutic radiation source (Fig. 12).

With regard to claim 15, Brown *et al.* disclosed the method of claim 14, further comprising: propagating the diagnostic radiation (IB) toward the target volume; receiving the diagnostic radiation by the imager after passing through the target volume (Fig. 10); positioning the therapeutic radiation source is based on results of the diagnostic radiation to the imager (column 15, lines 3-5); propagating the therapeutic radiation into the target volume (Fig. 12); receiving the therapeutic radiation by the imager after passing through the target volume (Fig. 12); and generating verification data by the imager from the therapeutic radiation (column 15, lines 23-24).

With regard to claim 16, Brown *et al.* disclosed the method of claim 14, wherein the imager is a multiple-energy imaging unit (detecting radiations from a KeV diagnostic radiation source and an MeV therapeutic radiation source).

With regard to claim 19, Brown *et al.* disclosed the method of claim 15, further comprising generating a cone x-ray beam where volumetric information can be constructed (column 16, lines 39-45).

*Claim Rejections - 35 USC § 103*

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1, 3-10, 12, 13, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hanover (U. S. Patent No. 6,104,780) in view of Watanabe (U. S. Patent No. 6,325,537 B1).

With regard to claim 1, Hanover *et al.* disclosed an apparatus (Fig. 2) comprising: a first radiation source (140) attached to a first gantry (116); at least one second radiation source (142); a second gantry (118) that is rotatable; and an imager (146).

However, Hanover *et al.* did not teach that the imager is attached to an articulable end of the second gantry.

Watanabe disclosed a C-shaped gantry (14) that comprises an imager (16) attached to an articulable end (20) of the gantry and a rotatable x-ray source (12). This arrangement makes the apparatus applicable to a wide range of clinical applications (column 4, lines 29-51).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the C-shaped gantry disclosed by Hanover *et al.* to include an imager attached to an articulable end of the gantry and a rotatable x-ray source according to Watanabe, since a person would be motivated to use the same apparatus for as many different clinical applications as possible, which is less expensive than purchasing additional application-specific equipments.

With regard to claim 3, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.

With regard to claim 4, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the first radiation source is capable of propagating therapeutic energy (x-rays could be used as therapeutic radiations).

With regard to claim 5, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein at least one second radiation source is capable of propagating diagnostic energy (x-ray).

With regard to claim 6, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the first gantry is rotatable.

With regard to claim 7, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis (Hanover *et al.* 132).

With regard to claim 8, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the imager is a multiple-energy imaging unit (all x-ray imagers are sensitive to a range of energies).

With regard to claim 9, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the articulable end includes at least one pivot point between the second gantry and the imager (Watanabe Fig. 2).

With regard to claim 10, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the articulable end includes a sliding mechanism (Watanabe Fig. 9) capable of translating the imager in a plane.

With regard to claim 12, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 1, wherein the articulable end (Watanabe 20) is capable of folding the imager against the second gantry.

With regard to claim 13, Hanover *et al.* as modified Watanabe disclosed the apparatus of claim 7, wherein the second gantry is nestled within the first gantry (Hanover *et al.* Fig. 2).

With regard to claim 26, Hanover *et al.* as modified Watanabe disclosed all the elements except that the diagnostic energy source is attached to a translatable end of the second gantry.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to provide translational degrees of freedom to the diagnostic energy source, since a person would be motivated to maintain consistent image brightness by keeping the diagnostic energy source normal to the imaging unit. As disclosed by Watanabe, the entire body could be imaged by translating the imaging unit while rotating the source (Figs. 10 and 12). In doing so, however, the incident angle changes at different locations, thereby causing the source intensity to vary at different locations. A person skilled in the art would recognize this and provide a translation mechanism to the source so that the source could move in a plane parallel with the imaging unit in order to maintain the normal incident angle.

11. Claim 17 rejected under 35 U.S.C. 103(a) as being unpatentable over Brown *et al.* (U. S. Patent No. 5,751,781) as applied to claim 14 above, and further in view of Kunieda *et al.* (U. S. Patent No. 6,307,914 B1).

With regard to claim 17, Brown *et al.* disclosed the method of claim 14. However, Brown *et al.* did not teach placing an internal seed to act as a marker for the target volume.

Kunieda *et al.* disclosed an internal marker (17) for locating the position of a tumor for radiation treatment.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to place an internal marker for the target volume, since a person would be motivated to accurately locate and track the target volume for irradiation.

12. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brown *et al.* (U.S. Patent No. 5,751,781) as applied to claim 15 above.

With regard to claim 18, Brown *et al.* disclosed the method of claim 15. However, Brown *et al.* did not teach that the method further comprising generating multiple diagnostic radiation slices using a fan x-ray beam to provide a 3-dimensional reconstruction of the target volume.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to generate multiple diagnostic radiation slices using a fan x-ray beam to provide a 3-dimensional reconstruction of the target volume. While Brown *et al.* did not specifically teach using a fan beam for three-dimensional reconstruction of the target volume, a person skilled in the art would recognize that a fan beam is just a thin cone beam, which could be produced by narrowing the collimators in the slice direction. There might be times when the narrower dimension of a fan beam is more appropriate for specific situations or target volumes, and a person skilled in the art would be motivated to use a fan beam according to the circumstances.

13. Claims 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brown *et al.* (U. S. Patent No. 5,751,781) as applied to claim 15 above, and further in view of Kunieda *et al.* (U. S. Patent No. 6,307,914 B1).

With regard to claims 20 and 21, Brown *et al.* disclosed the method of claim 15. However, Brown *et al.* did not teach that the diagnostic radiation could be operated continuously or in a pulsed manner to provide a fluoroscopic image of moving internal anatomy.

Kunieda *et al.* disclosed a method for applying radiation, comprising operating the diagnostic radiation to provide a fluoroscopic image of moving internal anatomy.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to operate the diagnostic radiation to provide a fluoroscopic image of moving internal anatomy, since a person would be motivated to track the motion of a moving internal anatomy in order to direct the therapeutic radiation at the correct position.

Furthermore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to operate the diagnostic radiation continuously or in a pulsed manner, since a person would be motivated to refresh the image at rate that is comparable to the rate of change in the position of the moving internal anatomy in order to keep the x-ray dosage at a minimum. For instance, one might wish to update the image at a rate that is comparable to the heart rate when one is imaging the heart.

*Allowable Subject Matter*

14. Claims 2 and 11 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

15. The following is a statement of reasons for the indication of allowable subject matter:

With regard to claim 2, although the prior art discloses an apparatus of claim 1, it fails to teach or fairly suggest at least one second radiation source is attached to the first gantry.

With regard to claim 11, although the prior art discloses an apparatus of claim 1, it fails to teach or fairly suggest one of at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry.

16. Claims 22-25 are allowed.

17. The following is an examiner's statement of reasons for allowance:

With regard to claims 22-25, although the prior art discloses a method for imaging radiation comprising:

positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level,

propagating radiation by a first radiation source at the first energy level along the first axis,

position a second radiation source along the first axis,

maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source, and

propagating radiation by the second radiation source,  
it fails to teach or fairly suggest retracting the first radiation source.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

#### *Conclusion*

18. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

- (1) Oota (U. S. Patent No. 6,508,586 B2) disclosed an IVR-CT apparatus comprising two gantries and two radiation sources.
- (2) Danielsson *et al.* (U. S. Patent No. 6,429,578 B1) disclosed a multiple-energy imager.
- (3) Ivan *et al.* (U. S. Patent No. 6,031,888) disclosed a fluoro-assist feature for a diagnostic imaging device.
- (4) Shepherd *et al.* (U. S. Patent No. 5,537,452) disclosed a radiation therapy system comprising a CT apparatus.
- (5) Swerdloff *et al.* (U. S. Patent No. 5,392,452) disclosed a radiation therapy system comprising a diagnostic apparatus.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allen C. Ho whose telephone number is (703) 308-6189. The examiner can normally be reached on Monday - Friday from 8:00 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward J. Glick can be reached at (703) 308-4858. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0530.

Allen C. Ho  
Examiner  
Art Unit 2882

ACH  
June 25, 2003

  
EDWARD J. GLICK  
Supervisor Patent Examiner  
TECHNOLOGY CENTER 2800

<b>Notice of References Cited</b>	Application/Control No. 10/033,327	Applicant(s)/Patent Under Reexamination GRAF, ULRICH MARTIN	
	Examiner Allen C. Ho	Art Unit 2882	Page 1 of 1

**U.S. PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
A	US-6,508,586 B2	01-2003	Oota	378/196
B	US-6,429,578 B1	08-2002	Danielsson et al.	313/105 CM
C	US-6,325,537 B1	12-2001	Watanabe	378/197
D	US-6,307,914 B1	10-2001	Kunieda et al.	378/65
E	US-6,104,780	08-2000	Hanover et al.	378/92
F	US-6,031,888	02-2000	Ivan et al.	378/20
G	US-5,751,781	05-1998	Brown et al.	378/65
H	US-5,537,452	07-1996	Shepherd et al.	378/65
I	US-5,394,452	02-1995	Swerdloff et al.	378/65
J	US-			
K	US-			
L	US-			
M	US-			

**FOREIGN PATENT DOCUMENTS**

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
N					
O					
P					
Q					
R					
S					
T					

**NON-PATENT DOCUMENTS**

*	Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
U	
V	
W	
X	

\*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)  
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

#4

Substitute for Form 1449A/PTO (Modified) (use as many sheets as necessary)	Attorney Docket No.: 005513.P003	Application Number: Not yet assigned
	First Named Inventor: Ulrich Martin Graf	
	Filing Date: Herewith (11/2/01)	

JCS79 U.S. PTO  
10/033327  
11/02/01

**U.S. PATENT DOCUMENTS**

Exam. Initial*	Cite No. <sup>1</sup>	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code <sup>2</sup> (If known)			
ACH	A	3,133,227		Lawrence E. Brown and Craig S. Nunan	05-12-1964	
ACH	B	3,193,717		Craig S. Nunan	07-06-1965	
ACH	C	4,209,706		Craig S. Nunan	06-24-1980	
ACH	D	4,726,046		Craig S. Nunan	02-16-1988	
ACH	E	5,471,516		Craig S. Nunan	11-28-1995	

**FOREIGN PATENT DOCUMENTS**

Exam. Initial*	Cite No. <sup>1</sup>	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T <sup>6</sup>
		Office <sup>3</sup>	Number <sup>4</sup>	Kind Code <sup>5</sup> (If known)				

Examiner Signature	<i>Allen C. Ho</i>	Date Considered	<i>6/19/03</i>
--------------------	--------------------	-----------------	----------------

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup>Unique citation designation number. <sup>2</sup>See attached Kinds of U.S. Patent Documents. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard S.3). <sup>4</sup>For Japanese patent documents, the indication of the year of reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup>Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

	Type	L	Hits	Search Text	DBs	Time Stamp
1	BRS	L1	1689	(megavolt\$3 OR (mega ADJ volt\$3) OR MV OR MeV) WITH (kilovolt\$3 OR (kilo ADJ volt\$3) OR KV OR KeV)	USPA T; US-PG PUB; EPO; JPO; DERW ENT; IBM_ TDB	2003/06/20 14:05
2	IS&R	L2	398	(378/65).CCLS.	USPA T; US-PG PUB; EPO; JPO; DERW ENT; IBM_ TDB	2003/06/20 14:03
3	BRS	L3	20	1 AND 2	USPA T; US-PG PUB; EPO; JPO; DERW ENT; IBM_ TDB	2003/06/20 14:03
4	BRS	L4	135	(megavolt\$3 OR (mega ADJ volt\$3) OR MV OR MeV) WITH (kilovolt\$3 OR (kilo ADJ volt\$3) OR KV OR KeV) WITH (detector OR sensor OR imag\$3)	USPA T; US-PG PUB; EPO; JPO; DERW ENT; IBM_ TDB	2003/06/20 14:14

06/20/2003, EAST Version: 1.03.0002

#5/A

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Attorney's Docket No. 005513.P003  
Confirmation No.: 9666

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Patent Application of: )  
 )  
Ulrich Martin Graf )  
 )  
Application No.: 10/033,327 )  
 )  
Filed: November 2, 2001 )  
 )  
For: RADIO THERAPY APPARATUS )  
EQUIPPED WITH AN ARTICULABLE )  
GANTRY FOR POSITIONING AN )  
IMAGING UNIT )

Examiner: Not yet assigned  
Art Unit: 2882

I hereby certify that this correspondence is being deposited in the United States Postal Service as first class mail with sufficient postage in an envelope addressed to Box Non-Fee Amendment, Commissioner for Patents, Washington, D.C. 20231

Box Non-Fee Amendment  
Commissioner for Patents  
Washington, D.C. 20231

On August 6, 2002  
By: Dianne Neathery  
Dianne Neathery

PRELIMINARY AMENDMENT TO APPLICATION

Sir:  
Prior to the examination of the above-referenced application, the Applicant respectfully request the Examiner to enter the following amendment:

IN THE SPECIFICATIONS:

On page 12, please replace paragraph 41 with the following:

[0041] A multiple-energy imaging unit can display results from radiation from either a higher energy source, such as, for example, as used in therapeutic treatment or from radiation by a lower energy source such as, for example, as used in diagnostic purposes. A-Si imagers convert the optical signal from the overlaying phosphor, which acts together with a thin metal plate as an x-ray detector, to charge and store that charge on the pixel capacitance. To form an image, the charge on the pixels is read out line by line. Multiple-energy a-Si imagers may use a conversion screen design within the imager for multiple energy data unit collection

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AI  
end

from the two radiation sources. This specialized design can result in different spectral efficiency detection. One design is to use two or more conversion screen/a-Si detector layers, one on top of the other with a combined filter/grid design. Each screen layer will produce an image data unit for a particular radiation energy. One embodiment of a multiple-energy imaging unit, as discussed in US patent application No. 10/013,199, titled "X-Ray Image Acquisition Apparatus", filed November 2, 2001, and assigned with this application to a common owner at the date of filing, hereby incorporated by reference, may be used. Alternatively other imaging units may be used.

Applicant believes there is no fee; however, if there are any additional fees or charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: August 6, 2002

  
\_\_\_\_\_  
Michael D. Graham  
Reg. No. P-51,751

Customer No. 008791  
12400 Wilshire Blvd.  
Seventh Floor  
Los Angeles, CA 90025-1026  
(408) 720-8300

**MARKED-UP VERSION SHOWING CHANGES**

[0041] A multiple-energy imaging unit can display results from radiation from either a higher energy source, such as, for example, as used in therapeutic treatment or from radiation by a lower energy source such as, for example, as used in diagnostic purposes. A-Si imagers convert the optical signal from the overlaying phosphor, which acts together with a thin metal plate as an x-ray detector, to charge and store that charge on the pixel capacitance. To form an image, the charge on the pixels is read out line by line. Multiple-energy a-Si imagers may use a conversion screen design within the imager for multiple energy data unit collection from the two radiation sources. This specialized design can result in different spectral efficiency detection. One design is to use two or more conversion screen/a-Si detector layers, one on top of the other with a combined filter/grid design. Each screen layer will produce an image data unit for a particular radiation energy. One embodiment of a multiple-energy imaging unit, as discussed in US patent application No. 10/013,199, titled "X-Ray Image Acquisition Apparatus", filed November 2, 2001, and assigned with this application to a common owner at the date of filing, hereby incorporated by reference, may be used. Alternatively other imaging units may be used.

MT

MP

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Attorney's Docket No.: 005513.P003  
Confirmation No.: 9666

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re Application of:	)	
Ulrich Martin Graf	)	Examiner: Not yet assigned
Application No.: 10/033,327	)	Art Unit: 2882
Filed: November 2, 2001	)	
For: <u>RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT</u>	)	

Box Missing Parts  
Commissioner for Patents  
Washington, D.C. 20231

**RESPONSE TO NOTICE TO FILE MISSING PARTS OF APPLICATION  
(FILING DATE GRANTED)**

Sir:

In response to the Notice to File Missing Parts of Application filed under CFR 1.53(b) (Filing Date Granted) date mailed February 21, 2002, please find enclosed:

- (1) a duly executed Declaration and Power of Attorney with respect to the above-referenced patent application;
- (2) a check in the amount of \$130.00 in payment of the surcharge of 37 C.F.R. § 1.16(e);
- (3) a copy of the Notice to File Missing Parts of Application;

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to: Box Missing Parts, Commissioner for Patents, Washington, D.C. 20231

on April 10, 2002

Dianne Neathery

(Name of Person Mailing Correspondence)

Dianne Neathery  
(Signature)

4-10-02  
(Date of Signature)

Response to Notice to File Missing  
Docket No. 005513.P003

If any additional fee is required, please charge Deposit Account No. 02-2666.  
A duplicate of this Response is enclosed for deposit account charging purposes.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Dated: April 10, 2002

  
\_\_\_\_\_  
Daniel E. Ovanezian  
Reg No. 41,236

Customer No. 008791  
12400 Wilshire Blvd.  
Seventh Floor  
Los Angeles, CA 90025-1030  
(408) 720-8300



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WASHINGTON, D.C. 20231  
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003

CONFIRMATION NO. 9666

008791  
BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
LOS ANGELES, CA 90025

FORMALITIES LETTER



\*OC00000007515412\*

Date Mailed: 02/21/2002

**NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION**

**FILED UNDER 37 CFR 1.53(b)**

***Filing Date Granted***

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is unsigned.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(f) of \$130 for a non-small entity, must be submitted with the missing items identified in this letter.
- The balance due by applicant is \$ 130.

*A copy of this notice **MUST** be returned with the reply.*

*S. Givens*

Customer Service Center  
Initial Patent Examination Division (703) 308-1202

PART 2 - COPY TO BE RETURNED WITH RESPONSE

04/23/2002 HUUONG1 00000047 10033327  
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01 FC:105



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Attorney's Docket No.: 5513.P003

PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

the specification of which

is attached hereto.

X was filed on (MM/DD/YYYY) November 2, 2001 as United States Application Number 10/033,327 or PCT International Application Number \_\_\_\_\_ and was amended on (MM/DD/YYYY) \_\_\_\_\_ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>			<u>Priority Claimed</u>	
<u>Number</u>	<u>Country</u>	<u>(Foreign Filing Date - MM/DD/YYYY)</u>	<u>Yes</u>	<u>No</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

Application Number \_\_\_\_\_ (Filing Date - MM/DD/YYYY)  
Application Number \_\_\_\_\_ (Filing Date - MM/DD/YYYY)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Number	(Filing Date – MM/DD/YYYY)	Status -- patented, pending, abandoned
Application Number	(Filing Date – MM/DD/YYYY)	Status -- patented, pending, abandoned

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Daniel E. Ovanezian, BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct telephone calls to Daniel E. Ovanezian, (408) 720-8300.  
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Ulrich Martin Graf  
 Inventor's Signature  Date March 27 2002  
 Residence Leigruppenstrasse 49, Switzerland Citizenship Switzerland  
 (City, State) (Country)  
 Post Office Address Leigruppenstrasse 49  
8932 Mettmenstetten, Switzerland

Full Name of Second/Joint Inventor \_\_\_\_\_  
 Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_  
 Residence \_\_\_\_\_ Citizenship \_\_\_\_\_  
 (City, State) (Country)  
 Post Office Address \_\_\_\_\_

APPENDIX A

William E. Alford, Reg. No. 37,764; Farzad E. Amini, Reg. No. 42,261; Peggy S. Avalos, Reg. No. 42,274; William Thomas Babbitt, Reg. No. 39,591; Carol F. Barry, Reg. No. 41,600; Jordan Michael Becker, Reg. No. 39,602; Lisa N. Benado, Reg. No. 39,995; Bradley J. Berezna, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; R. Alan Burnett, Reg. No. 46,149; Gregory D. Caldwell, Reg. No. 39,926; Jae-Hee Choi, Reg. No. 45,288; Thomas M. Coester, Reg. No. 39,637; Robert P. Cogan, Reg. No. 25,049; Donna Jo Coningsby, Reg. No. 41,684; Florin Corie, Reg. No. 46,244; Mimi Diemmy Dao, Reg. No. 45,628; Dennis M. deGuzman, Reg. No. 41,702; Stephen M. De Klerk, Reg. No. 46,503; Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Justin M. Dillon, Reg. No. 42,486; Sanjeet Dutta, Reg. No. 46,145; Matthew C. Fagan, Reg. No. 37,542; Tarek N. Fahmi, Reg. No. 41,402; Thomas S. Ferrill, Reg. No. 42,532; Mark J. Fink, Reg. No. 45,270; George Fountain, Reg. No. 37,374; Andre Gibbs, Reg. No. 47,593; James Y. Go, Reg. No. 40,621; Alan Heimlich, Reg. No. P48,808; James A. Henry, Reg. No. 41,064; Libby H. Ho, Reg. No. 46,774; Willmore F. Holbrow III, Reg. No. 41,845; Sheryl Sue Holloway, Reg. No. 37,850; George W. Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; William W. Kidd, Reg. No. 31,772; Sang Hui Kim, Reg. No. 40,450; Walter T. Kim, Reg. No. 42,731; Eric T. King, Reg. No. 44,188; Steve Laut, Reg. No. 47,736; George Brian Leavell, Reg. No. 45,436; Samuel S. Lee, Reg. No. 42,791; Gordon R. Lindeen III, Reg. No. 33,192; Jan Carol Little, Reg. No. 41,181; Julio Loza, Reg. No. 47,758; Joseph Lutz, Reg. No. 43,765; Michael J. Mallie, Reg. No. 36,591; Andre L. Marais, Reg. No. 48,095; Paul A. Mendonsa, Reg. No. 42,879; Clive D. Menezes, Reg. No. 45,493; Richard A. Nakashima, Reg. No. 42,023; Stephen Neal, Reg. No. 47,815; Chun M. Ng, Reg. No. 36,878; Thien T. Nguyen, Reg. No. 43,835; Thinh V. Nguyen, Reg. No. 42,034; Robert B. O'Rourke, Reg. No. 46,972; Daniel E. Ovanezian, Reg. No. 41,236; Kenneth B. Paley, Reg. No. 38,989; Gregg A. Peacock, Reg. No. 45,001; Marina Portnova, Reg. No. 45,750; Michael A. Proksch, Reg. No. 43,021; Randol W. Read, Reg. No. 43,876; William F. Ryann, Reg. No. 44,313; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Jeffrey S. Schubert, Reg. No. 43,098; George Simion, Reg. No. P47,089; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Judith A. Szepesi, Reg. No. 39,393; Ronald S. Tamura, Reg. No. 43,179; Edwin H. Taylor, Reg. No. 25,129; Lance A. Termes, Reg. No. 43,184; John F. Travis, Reg. No. 43,203; Kerry P. Tweet, Reg. No. 45,959; Mark C. Van Ness, Reg. No. 39,865; Tom Van Zandt, Reg. No. 43,219; Lester J. Vincent, Reg. No. 31,460; Archana B. Vittal, Reg. No. 45,182; Glenn E. Von Tersch, Reg. No. 41,364; John Patrick Ward, Reg. No. 40,216; Mark L. Watson, Reg. No. 46,322; Thomas C. Webster, Reg. No. 46,154; and Norman Zafman, Reg. No. 26,250; my patent attorneys, and Firasat Ali, Reg. No. 45,715; Charles P. Landrum, Reg. No. 46,855; Suk S. Lee, Reg. No. 47,745; and Raul Martinez, Reg. No. 46,904, Brent E. Vecchia, Reg. No. P48,011; Lehua Wang, Reg. No. P48,023; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and James R. Thein, Reg. No. 31,710, my patent attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

## APPENDIX B

### Title 37, Code of Federal Regulations, Section 1.56 Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

( ) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS  
 UNITED STATES PATENT AND TRADEMARK OFFICE  
 WASHINGTON, D.C. 20231  
 www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/033,327	11/02/2001	Ulrich Martin Graf	005513.P003

008791  
 BLAKELY SOKOLOFF TAYLOR & ZAFMAN  
 12400 WILSHIRE BOULEVARD, SEVENTH FLOOR  
 LOS ANGELES, CA 90025

CONFIRMATION NO. 9666

FORMALITIES LETTER



\*OC000000007515412\*

Date Mailed: 02/21/2002

**NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION**

FILED UNDER 37 CFR 1.53(b)

***Filing Date Granted***

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is unsigned.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(l) of \$130 for a non-small entity, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is \$ 130.**

*A copy of this notice **MUST** be returned with the reply.*

  
 \_\_\_\_\_  
 Customer Service Center  
 Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

1-2-02

A

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PTO/SB/05 (11-00)

Approved for use through 10/31/2002. OMB 0651-0032

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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11/02/01  
11025 U.S. PTO

10/033327  
11/02/01

**UTILITY PATENT APPLICATION TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 005513.P003

(maximum 12 characters)

First Named Inventor Ulrich Martin Graf

Title: RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

Express Mail Label No. EL 672 750 138 US

ADDRESS TO: **Box Patent Application  
Commissioner for Patents  
Washington, D. C. 20231**

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

1.  **Fee Transmittal Form (e.g., PTO/SB/17)**  
(Submit an original, and a duplicate for fee processing)
2.  **Applicant Claims Small Entity Status. (37 CFR 1.27)**
3.  **Specification (Total Pages 19)**  
(preferred arrangement set forth below)
  - Descriptive Title of the Invention
  - Cross Reference to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference sequence listing, a table,  
or a computer program listing appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
4.  **Drawings(s) (35 USC 113) (Total Sheets 10)**
5.  **Oath or Declaration (Total Pages 5)**
  - a.  Newly Executed (Original or Copy)
  - b.  Copy from a Prior Application (37 CFR 1.63(d))  
(for Continuation/Divisional with Box 18 completed)
    - i.  DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
  - c.  Unsigned.
6.  **Application Data Sheet. (37 CFR 1.76)**
7.  CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8.  Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
  - a.  Computer Readable Form (CRF)
  - b.  Specification Sequence Listing on:
    - i.  CD-ROM or CD-R (2 copies); or
    - ii.  paper
  - c.  Statement verifying identity of above copies

10033327 110201

2/15/01

- 1 -



**REQUEST AND CERTIFICATION UNDER 35 U.S.C. 122(b)(2)(B)(i)**

First Named Inventor Ulrich Martin Graf

Title Radiotherapy Apparatus Equipped with an Articulate Gantry for Positioning an Imaging Unit

Attorney Docket No. 005513.P003

I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral agreement, that requires publication at eighteen months after filing. I hereby request that the attached application not be published under 35 U.S.C. 122(b).

11/2/01  
Date

  
Signature

Daniel E. Ovanezian  
Typed or Printed Name

41,236  
Registration No.

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application **upon filing.**

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months after the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant **must** notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of filing of such foreign or international application. **Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).**

Send to: Assistant Commissioner for Patents, Washington, D.C. 20231

FOOTNOTES

FOR FEE

Serial/Patent No.: Not yet assigned Filing/Issue Date: Herewith (11/2/01)  
Client: Varian Medical Systems, Inc.  
Title: Radiotherapy Apparatus Equipped with an Articulate Gantry for Positioning an Imaging Unit  
BSTZ File No.: 005513.P003 Atty/Secty Initials: DEO/MDG/den  
Date Mailed: November 2, 2001 Docket Due Date: \*\*\*

- The following has been received in the U.S. Patent & Trademark Office on the date stamped hereon:
- |  |  |
|--|--|
| <input type="checkbox"/> Amendment/Response (____ pgs.)  | <input checked="" type="checkbox"/> Express Mail No.: <u>EL672750138US</u> <input checked="" type="checkbox"/> Check No. <u>46289</u>    |
| <input type="checkbox"/> Appeal Brief (____ pgs.) (in triplicate)  | <input type="checkbox"/> _____ Month(s) Extension of Time Amt: <u>\$932.00</u>   |
| <input checked="" type="checkbox"/> Application - Utility ( <u>19</u> pgs., with cover and abstract)   | <input checked="" type="checkbox"/> Information Disclosure Statement & PTO 149 ( <u>3</u> pgs.) <input type="checkbox"/> Check No. _____ |
| <input type="checkbox"/> Application - Rule 1.53(b) Continuation (____ pgs.)   | <input type="checkbox"/> Issue Fee Transmittal Amt: _____  |
| <input type="checkbox"/> Application - Rule 1.53(b) Divisional (____ pgs.)   | <input type="checkbox"/> Notice of Appeal  |
| <input type="checkbox"/> Application - Rule 1.53(b) CIP (____ pgs.)  | <input type="checkbox"/> Petition for Extension of Time  |
| <input type="checkbox"/> Application - Rule 1.53(d) CPA Transmittal (____ pgs.)  | <input type="checkbox"/> Petition for _____  |
| <input type="checkbox"/> Application - Design (____ pgs.)  | <input checked="" type="checkbox"/> Postcard   |
| <input type="checkbox"/> Application - PCT (____ pgs.)   | <input type="checkbox"/> Power of Attorney (____ pgs.)   |
| <input type="checkbox"/> Application - Provisional (____ pgs.)   | <input type="checkbox"/> Preliminary Amendment (____ pgs.)   |
| <input type="checkbox"/> Assignment and Cover Sheet  | <input type="checkbox"/> Reply Brief (____ pgs.)   |
| <input checked="" type="checkbox"/> Certificate of Mailing <u>5</u> <b>postcard Express</b> <input type="checkbox"/> Response to Notice of Missing Parts | <input type="checkbox"/> Small Entity Declaration for Indep. Inventor/Small Business   |
| <input checked="" type="checkbox"/> Declaration & POA ( <u>5</u> pgs.) <b>unsigned</b> <input type="checkbox"/> Transmittal Letter, in duplicate         | <input checked="" type="checkbox"/> Fee Transmittal, in duplicate  |
| <input type="checkbox"/> Disclosure Docs & Orig. & Copy of Inventor's Signed Letter (____ pgs.)  |  |
| <input checked="" type="checkbox"/> Drawings: <u>10</u> # of sheets includes <u>10</u> figures   |  |

Other: Request and Certification Under 35 U.S.C.122(b)(2)(B)(i); and Copies of cited references (5)

**EXPRESS MAIL CERTIFICATE OF MAILING**

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Date of Deposit: November 2, 2001

I hereby certify that I am causing this paper or fee, and the documents indicated on the postcard above, to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to: Box Patent Application, Commissioner for Patents, Washington, D. C. 20231

Dianne Neathery  
(Typed or printed name of person mailing paper or fee)  
Dianne Neathery 11-2-01  
(Signature of person mailing paper or fee, and date of signature)

**FEE TRANSMITTAL FOR FY 2002**TOTAL AMOUNT OF PAYMENT (\$) \$932.00

## Complete if Known:

Application No. Not yet assigned  
 Filing Date Herewith (Nov. 2, 2001)  
 First Named Inventor Ulrich Martin Graf  
 Group Art Unit Not yet assigned  
 Examiner Name Not yet assigned  
 Attorney Docket No. 005513.P003

## METHOD OF PAYMENT (check one)

1.  The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number 02-2666  
 Deposit Account Name \_\_\_\_\_

- Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

- Applicant claims small entity status. See 37 CFR 1.27

2.  Payment Enclosed:  Check  
 Money Order  
 Other

## FEE CALCULATION

## 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
101	740	201	370	Utility application filing fee	<u>740.00</u>
106	330	206	165	Design application filing fee	_____
107	510	207	255	Plant filing fee	_____
108	740	208	370	Reissue filing fee	_____
114	160	214	80	Provisional application filing fee	_____
SUBTOTAL (1)					<u>\$ 740.00</u>

## 2. EXTRA CLAIM FEES

		Extra Claims	Fee from below	Fee Paid
Total Claims	<u>26</u>	- 20** = <u>6</u>	X <u>18.00</u>	= <u>108.00</u>
Independent Claims	<u>4</u>	- 3** = <u>1</u>	X <u>84.00</u>	= <u>84.00</u>
Multiple Dependent				= _____

\*\*Or number previously paid, if greater; For Reissues, see below.

Large Entity		Small Entity		Fee Description
Fee Code	Fee (\$)	Fee Code	Fee (\$)	
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) \$ 192.00

**FEE CALCULATION (continued)**

**3. ADDITIONAL FEES**

<u>Large Entity</u>		<u>Small Entity</u>		<u>Fee Description</u>	<u>Fee Paid</u>
<u>Fee Code</u>	<u>Fee (\$)</u>	<u>Fee Code</u>	<u>Fee (\$)</u>		
105	130	205	65	Surcharge - late filing fee or oath	_____
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	_____
139	130	139	130	Non-English specification	_____
147	2,520	147	2,520	For filing a request for ex parte reexamination	_____
099	8,800	099	8,800	Request for inter parties reexamination	_____
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	_____
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	_____
115	110	215	55	Extension for reply within first month	_____
116	400	216	200	Extension for reply within second month	_____
117	920	217	460	Extension for reply within third month	_____
118	1,440	218	720	Extension for reply within fourth month	_____
128	1,960	228	980	Extension for reply within fifth month	_____
119	320	219	160	Notice of Appeal	_____
120	320	220	160	Filing a brief in support of an appeal	_____
121	280	221	140	Request for oral hearing	_____
138	1,510	138	1,510	Petition to institute a public use proceeding	_____
140	110	240	55	Petition to revive - unavoidable	_____
141	1,280	241	640	Petition to revive - unintentional	_____
142	1,280	242	640	Utility issue fee (or reissue)	_____
143	460	243	230	Design issue fee	_____
144	620	244	310	Plant issue fee	_____
122	130	122	130	Petitions to the Commissioner	_____
123	50	123	50	Processing fee under 37 CFR 1.17(q)	_____
126	180	126	180	Submission of Information Disclosure Stmt	_____
581	40	581	40	Recording each patent assignment per property (times number of properties)	_____
146	740	246	370	For filing a submission after final rejection (see 37 CFR 1.129(a))	_____
148	110	248	55	Statutory Disclaimer	_____
149	740	249	370	For each additional invention to be examined (see 37 CFR 1.129(b))	_____
179	740	279	370	Request for Continued Examination (RCE)	_____
169	900	169	900	Request for expedited examination of a design application	_____
195	300	195	300	Publication fee for early, voluntary, or normal pub.	_____
196	300	196	300	Publication fee for republication	_____
194	130	194	130	Request for voluntary publication or republication	_____
098	130	098	130	Processing fee under 37 CFR 1.17(i) (except provisionals)	_____
091	1,280	091	1,280	Acceptance of unintentionally delayed claim for priority	_____
Other fee (specify) _____					_____
Other fee (specify) _____					_____
<b>SUBTOTAL (3) \$</b>					<b>_____ .00</b>

\*Reduced by Basic Filing Fee Paid

**SUBMITTED BY:**

Typed or Printed Name: Daniel E. Ovanezian  
 Signature: *Daniel E. Ovanezian* Date: 11/2/01  
 Reg. Number: 41,236 Telephone Number: (408) 720-8300

FOOTNOTES

UNITED STATES PATENT APPLICATION

FOR

RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

INVENTOR:

ULRICH MARTIN GRAF

PREPARED BY:

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BSTZ DOCKET NO.: 005513.P003

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Dianne Neathery  
(Typed or printed name of person mailing paper or fee)

Dianne Neathery 11-2-01  
(Signature of person mailing paper or fee)

Application  
Express Mail Label EL 672 750 138 US

Docket: 005513.P003

## RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

### FIELD OF THE INVENTION

**[0001]** The present invention pertains in general to oncology radiation therapy. In particular, the invention involves an X-ray and electron radiotherapy machine used in radiation treatment applications.

### BACKGROUND OF THE INVENTION

**[0002]** The use of linear accelerators for the generation of either electron radiation or X-ray radiation is well known. After generating a stream of electrons, components in the radiotherapy machine can convert the electrons to X-rays, a flattening filter can broaden the X-ray beam, the beam can be shaped with a multileaf collimator, and a dose chamber can be arranged at the exit of an accelerator. A detector is mounted and is mechanically or electronically scanned synchronously with the mechanically or electronically scanned paraxial X-ray beam, providing continuous monitoring of alignment of the patient's anatomy. These systems typically provide either static fixed field radiation therapy or fully dynamic intensity modulated radiation therapy (IMRT) used by the medical community in the treatment of cancer.

**[0003]** One of the challenges inherent in radiotherapy treatment is the accurate positioning of the tumor in the radiation field. The main sources of the problem result from the fact that there is a natural motion of organs inside the body, which can range, for example, from approximately a millimeter in the case of the brain inside the skull, to several centimeters for the organs in the trunk above the diaphragm. Another factor relates to changes which occur in the tumor over time because of successful treatment. Over the course of treatment and as the tumor shrinks in volume, normal tissue which had been displaced returns to its original position within the treatment volume.

**[0004]** To accurately verify tumor positioning, detectors such as X-ray films or electronic X-ray imaging systems are commonly used in the radiation treatment

diagnostic process. In the case of electronic imaging, the megavolt therapeutic X-rays emerging from the patient can be used to generate images. However, these methods at target location deliver images of low contrast and insufficient quality. As a result, imaging with megavoltage radiation is used primarily for verification, that is to confirm that the target volume has been radiated. These problems associated with utilizing high energy X-rays produced by a megavolt electron beam are the result of interacting with matter mostly due to Compton scattering, in which the probability of interactions is proportional to the electron density. Low energy X-rays typically have energies of about 125 peak kilovolts (kVp) or below, where a significant portion of the interactions with matter is photoelectric and the interactions are proportional to the cube of electron density. Low energy X-rays are more useful to provide accurate targeting or diagnostic information because tissue in the human body is typically of low density and as a result, the contrast achieved in low energy X-rays is far superior to that obtained with megavoltage X-rays. Therefore, distinctions of landmark features and the imaging of other features not perceptible with high energy X-rays are possible using kV energy. As a result, two separate imagers, each sensitive to an energy range, i.e. either the megavolt source or the kV source are used in treatment.

**[0005]** One method taught is to incorporate a low energy X-ray source inside the treatment head of the accelerator capable of positioning itself to be coincident with the high energy X-ray source. With this approach, a high energy X-ray target is modified to include a compact 125 kV electron gun to be mounted to a moveable flange at the base of the high energy source with the cathode of the gun operably coupled to the upstream end of a drift tube. By engaging an actuator, the electron gun can be provide target information for diagnostic imaging. An imager can be used that is sensitive to kV range radiation energies and positioned opposite the kV electron gun with the target volume in between. Therapeutic treatment can then be started or resumed by positioning the high-energy or megavolt electron beam trajectory to be in line with the target volume. A second imager is positioned opposing the megavolt source that is more sensitive to the radiation energy used in the therapeutic and verification procedure.

**[0006]** **FIGS. 1A & 1B** are illustrations of a radiotherapy clinical treatment machines to provide therapeutic and diagnostic radiation, each directed to a different imager.

FOOTNOTES

**FIG.1A** is an illustration of the radiotherapy machine having a single diagnostic X-ray source directed to a single imager. The radiotherapy machine has a therapeutic radiation source directed to a therapeutic imager along a first axis and the diagnostic X-rays are directed to the second imager along an axis that is 90° from the first axis. This apparatus places the therapeutic radiation source capable of propagating radiation in the megavoltage (MV) energy range and the kilovoltage (kV) diagnostic radiation source on different support structures. Each radiation source has an imager opposing that is in line to the respective radiation source along an axis.

**[0007] FIG. 1B** is an illustration of the radiotherapy machine having dual diagnostic X-ray sources, each directed to a separate diagnostic imager. The radiotherapy machine has a therapeutic radiation source capable of propagating a therapeutic radiation beam along an axis to a therapeutic imager. Attached to support structures are two diagnostic radiation sources that can propagate diagnostic X-rays at off-angles from the therapeutic radiation axis. Each radiation source has an imager in line to receive the radiation. The entire structure of radiation sources and imagers can be pivoted together by a common base.

**[0008]** Cancer patients usually need to lie on their backs for radiation treatment and the patient's anatomy can shift markedly from supine to prone positions. In order to irradiate the target volume from different directions without turning the patient over, 360° rotation of the support structure holding the radiation source is needed. For convenience in setting up the patient, the isocenter around which the equipment rotates should not be too high above the floor. Adequate space must be provided between the isocenter and the radiation head for radiation technologist access to the patient and for rotation clearance around the patient. This leaves a quite limited amount of space for the various components such as the radiation shielding in the radiation head, and particularly for the magnet system. To a significant extent, the design challenge over the years has been to stay within this space, to reduce cost where possible, and while making major advances in the clinical utility of machines.

## SUMMARY OF THE INVENTION

**[0009]** A radiotherapy clinical treatment machine can have a therapeutic radiation source on a first pivotable gantry. A second pivotable gantry can have a single imager mounted on an articulable end of the second gantry and a diagnostic radiation energy source can be mounted on a retractable opposing end of the second gantry. The first gantry and the second gantry may pivot on a common centerline. The imager can be a multiple-energy imaging unit which can be naturally in line with the diagnostic radiation source or the second gantry can pivot to place the multiple-energy imaging unit in line with the therapeutic radiation source. Pivoting the second gantry may require the diagnostic radiation source first be retracted to provide clearance where it rotates past the therapeutic radiation energy source.

**[0010]** This arrangement for positioning the multiple-energy imaging unit to be in line with either one of the radiation sources can provide improved imaging useful in directing the treatment beams used in radiation therapy. A first energy level in the kV range can radiate a target volume to provide diagnostic quality image information from the multiple-energy imaging unit. The diagnostic information can be used to better direct radiation at a second energy level in the MV range for therapeutic radiation of the target volume and from which verification information from the multiple-energy imaging unit can then be acquired. The second gantry can pivot, extend/retract, and/or articulate to receive diagnostic radiation or therapeutic radiation. The application of therapeutic radiation and diagnostic radiation can alternate in any combination to provide diagnostic imaging and verification imaging as a result of the degrees of freedom available to position the single multiple-energy imaging unit.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

[0012] **FIG. 1A** is an illustration of the radiotherapy machine having a single diagnostic X-ray source directed to a single imager.

[0013] **FIG. 1B** is an illustration of the radiotherapy machine having dual diagnostic X-ray sources, each directed to a separate diagnostic imager.

[0014] **FIG. 2A** is an illustration of a radiotherapy clinical treatment machine in one embodiment using a multiple-energy imaging unit.

[0015] **FIG. 2B** is an illustration of an alternate embodiment of the radiotherapy clinical treatment machine using the multiple-energy imaging unit.

[0016] **FIG. 3A** is an illustration in one embodiment of the starting position for the radiotherapy clinical treatment machine.

[0017] **FIG. 3B** is an illustration in one embodiment of a diagnostic radiation source in use.

[0018] **FIG. 3C** is an illustration in one embodiment of the diagnostic radiation source providing multiple-slices of a target volume.

[0019] **FIG. 3D** is an illustration in one embodiment of a therapeutic radiation source providing radiation to the target volume.

[0020] **FIG. 3E** is an illustration in one embodiment of the therapeutic radiation source rotated to a new position to provide radiation to the target volume.

[0021] **FIG. 3F** is an illustration in one embodiment of another rotation of the first gantry and dose of therapeutic radiation applied to the target volume from another position.

## DETAILED DESCRIPTION

**[0022]** A method and apparatus for a radiotherapy clinical treatment machine for positioning an imager to oppose one or more radiation sources is disclosed. For purposes of discussing the invention, it is to be understood that various terms are used by those knowledgeable in the art to describe apparatus, techniques, and approaches.

**[0023]** In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one skilled in the art that the present invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in gross form rather than in detail in order to avoid obscuring the present invention. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, mechanical, electrical, and other changes may be made without departing from the scope of the present invention.

**[0024]** In one embodiment, a method and apparatus is disclosed for an X-ray and electron radiotherapy clinical treatment machine. The apparatus and method can position and re-position a single imager to receive radiation from more than one radiation source. Imagers can generally provide high quality imaging from one radiation energy range and less quality imaging from other radiation energy ranges and such an imager can be incorporated into this invention. However, in this embodiment, the imager can be capable of receiving and displaying high quality imaging information from multiple energies (multiple-energy imaging unit). One of the energies can be a source of therapeutic energy and another a source of diagnostic X-rays, both of which can alternately activate the multiple-energy imaging unit for high quality verification imaging and high quality diagnostic imaging respectively. The radiotherapy machine can generate an electron beam, generally in the 4 to 25 megavolt (MV) range, to provide electrons or X-rays to a volume within a patient undergoing treatment, i.e. a target volume. The multiple-energy imaging unit can display radiographic information from the

megavolt radiation sufficient to provide verification that the target volume is being radiated.

**[0025]** This single multiple-energy imager can also be optimized to work with energy in the kilovolt (kV) range. The multiple-energy imaging unit can receive X-rays in the kV range to provide more accurate diagnostic information on the size, shape, and location of the target volume. Repeated X-ray shots with kV energy that alternate with therapeutic radiation can reduce target error such as by directing a continuous adjustment of the beam shaping by a dynamic multileaf collimator and by providing targeting information to the therapeutic radiation source.

**[0026]** The diagnostic radiation source can be rotated about the target volume for CT single or multiple CT images using a fan x-ray beam, or by using a cone x-ray beam where volumetric information can be constructed. Also, if a partial data set is acquired from a limited number of images taken at specific angles around the target volume, enough information can be obtained with the help of previously acquired volumetric information to provide the 3D reconstruction of the anatomy of interest. As a result, imaging from the diagnostic X-rays can provide targeting information to accurately direct the therapeutic X-rays to the target volume from any angle while effectively excluding healthy tissue from injury. Furthermore, the diagnostic source can be operated either in a continuous or pulsed manner to provide a real time or quasi-real time fluoroscopic image of moving internal anatomy. This fluoroscopic image can be used to provide information to track the motion of anatomy being treated. Normal respiration or unwanted voluntary or involuntary patient movement may cause such motion. This motion tracking information can in turn be used to adjust treatment parameters or gate the treatment beam off and on such that the anatomy intended to be treated is always in the intended position within the treatment beam.

**[0027]** **FIG. 2A** is an illustration of one embodiment of an imager positioning gantry on a radiotherapy clinical treatment machine where the imager can be a multiple-energy imaging unit. As shown in **FIG. 2A**, the radiotherapy clinical treatment machine 200 can have an imager positioning gantry to position the multiple-energy single imager to oppose one or more radiation sources. A therapeutic radiation source 202 and a diagnostic radiation source 204 can be positioned on separate arms (gantries), 206 and

208, where one arm (second gantry) 208 is nestled within the other (first gantry) 206, and with both arms 206 and 208 on a common pivot axis 210. The two arms 206 and 208 can pivot 210 independently and in addition, the inner arm (second gantry) 208 can extend and retract the diagnostic radiation source 204 for positioning and clearance. The therapeutic radiation source 202 can be positioned on the first arm (first gantry) 206 which can be pivotally attached to a vertical stand or base 216 to allow an effective 360° rotation of the therapeutic radiation source 202 about the target volume 224.

**[0028]** The imager can be a multiple-energy imaging unit and can be attached to the inner arm (second gantry) 208 at the end opposite from the diagnostic radiation source 204. The inner arm end 220 attached to the multiple-energy imaging unit 212 can articulate the multiple-energy imaging unit 212 into alignment with either radiation source 202 or 204. Attached to the second gantry 208, the multiple-energy imaging unit 212 is in natural alignment to receive radiation from an extended diagnostic radiation source 204. Fine adjustments to place the multiple-energy imaging unit into alignment with and at the proper distance from the radiation source 202 or 204 are also accomplished with the articulating portion of the second gantry 220. Alternately, the diagnostic radiation source 204 can be retracted for clearance so that the inner arm 208 can rotate and the multiple-energy imaging unit 212 articulate until the multiple-energy imaging unit 212 is in alignment to receive radiation from the other radiation source 202 or 204.

**[0029]** The first gantry 206 and the second gantry 208 can have a “C” shape (C-Arm) and the second gantry 208 can have a smaller radius of curvature and be nestled within the first gantry 206. The diagnostic X-ray source 204 can be mounted on one end 218 of the second gantry 208 and the multiple-energy imaging unit 212 to oppose on the other end 220. The radiation source end 218 of the second gantry 208 can extend or retract the diagnostic X-ray source 204 to provide clearance around the therapeutic radiation geometry (head) 222 on the first gantry 206. The diagnostic X-ray source 204 can also be extended and retracted, along with second gantry 208 rotation, to place the diagnostic X-ray source 204 in positions about the target volume 224. The articulating end 220 can be attached to an opposite end 220 of the second gantry C-arm 208 to hold and position the multiple-energy imaging unit 212. In one embodiment, the

FOOTNOTES

articulating end 220 can pivot at three points 226, 227, and 228 the multiple-energy imaging unit 212 along two independent axes 230 in a plane. The articulating end 220 can contain any number of pivot points from single plane pivots to ball joints having 360 degrees of rotation for positioning the multiple-energy imaging unit. The translatable 230 portion of the articulating joint can be a set of sliding mechanisms that include gears and motors which are well known to one skilled in the art. The result of such articulation can be to place the multiple-energy imaging unit in alignment with, and at a distance from, either of the radiation sources 202 and 204 with the target volume 224 positioned in between. Further, the articulating end 220 can retract to position the multiple-energy imaging unit 212 into a stowed position.

**[0030]** FIG. 2B is an illustration of an alternate embodiment of the radiotherapy clinical treatment machine using the multiple-energy imaging unit. As shown in FIG. 2B, the therapeutic radiation source 202 and the diagnostic radiation source 204 can be positioned adjacent to each other and attached at the same end of the first gantry 206. The first gantry 206 can rotate about pivot axis 210 to position either the therapeutic radiation source 202 or the diagnostic radiation source 204 into alignment about the target volume 224. The second gantry, an inner arm 209, can be attached to the pivot axis 210 with an opposite end 227 attached to the articulating multiple-energy imaging unit 212. The multiple-energy imaging unit 212 can be rotated and articulated until alignment with either radiation source 202 or 204 is achieved, maintaining the target volume 224 in between.

**[0031]** FIGS. 3A – 3E illustrate the operation of one embodiment of the radiographic clinical treatment machine. FIGS. 3B –3E retain the target volume 324 but have the patient outline 303 removed for clarity. FIG. 3A is an illustration of a starting position for the radiotherapy clinical treatment machine. A couch 301 can place a patient 303 in a starting position. The patient 303 can contain a volume within the body that constitutes the targeted volume 324. The first gantry 306 can be in an upright position, and the second gantry 308 can be upright with the diagnostic radiation source 304 in a retracted position. The multiple-energy imaging unit 312 can be unstowed and positioned beneath the couch 301.

10033997-40007

[0032] FIG. 3B is an illustration of the diagnostic radiation source in use. The second gantry 308 can first rotate to provide clearance for the diagnostic radiation source 304 from the therapeutic radiation source 302. Once the diagnostic radiation source 304 is clear, the second gantry 308 can further rotate and extend the diagnostic radiation source 304 to be in alignment with the target volume 324 and maintain clearance between interfering geometries, i.e. 302 and 304. The multiple-energy imaging unit 312 can be further articulated and the couch 301 translated and raised or lowered until a proper alignment and distance is set relative to the target volume 324. When in position, the diagnostic radiation source 304 can direct an X-ray beam to the target volume 324 and then to the multiple-energy imaging unit 312.

[0033] FIG. 3C is an illustration of the diagnostic radiation source providing another X-ray view of the target volume (not shown) at a new position. The diagnostic radiation source 304 and the multiple-energy imaging unit 312 can be rotated together by rotating any combination of either the first gantry 306 or the second gantry 308 to provide multiple X-ray views at different angles that can be assembled to generate 3-dimensional images of the target volume.

[0034] FIG. 3D is an illustration of the therapeutic radiation source providing radiation to the target volume. After target volume definition has been provided by the diagnostic radiation step, the diagnostic radiation source 304 can be retracted for clearance and the second gantry 308 rotated until the multiple-energy imaging unit 312 opposes the therapeutic radiation source 302. The therapeutic radiation source 302 can be positioned to radiate the target volume 324 based on information gained from the diagnostic radiation step. At this point, the target volume 324 can receive a therapeutic dose of radiation and the multiple-energy imaging unit 312 can generate verification data from this same radiation.

[0035] FIG. 3E is an illustration of the therapeutic radiation source rotated to a new position to provide radiation to the target area 324. The first gantry 306 can be rotated, along with the multiple-energy imaging unit 312, to reposition the therapeutic radiation source 302 to radiate the target volume 324 from the new angle.

[0036] FIG. 3F is an illustration of another rotation of the first gantry 306, and the multiple-energy imaging unit 312, to generate another dose of therapeutic radiation to

the target volume 324 from yet another position. With each new position of the therapeutic radiation source 302, the multiple-energy imaging unit 312 and the couch 301 can be repositioned, new diagnostic imaging performed and another dose of therapeutic radiation initiated.

**[0037]** It is to be appreciated that, with this apparatus to position a single imager, it is possible to alternate therapeutic radiation with diagnostic radiation in several ways. In one method, the diagnostic radiation can provide imaging of a 2-dimensional nature. For therapeutic targeting, the therapeutic radiation source may be required to position itself at the same axis used by the diagnostic radiation source. In other methods, when multiple slices are taken or when using imaging data from a cone beam, a 3-dimensional construction is possible of the target area and therapeutic radiation can be targeted from any axis angle as a result.

**[0038]** In one embodiment, radiation at a first energy level can radiate a target volume along a first axis to provide diagnostic information to a multiple-energy imaging unit. Diagnostic information from the multiple-energy imaging unit can direct radiation at a second energy level along a second axis to provide therapeutic radiation to the target volume and verification information to the multiple-energy imaging unit. The first energy level can be in the kV energy range and the second energy level can be in the MV energy range. At any time during treatment, the first axis of radiation and the second axis of radiation can be the same or different. Diagnostic radiation and therapeutic radiation can alternate in any combination to provide diagnostic imaging and verification imaging by a single multiple-energy imaging unit for the overall radiation therapy of one or more target volumes.

**[0039]** The accuracy of diagnostic information can be improved by placing internal seeds to act as markers for the target volume. Placement of these markers can be accomplished by performing a needle biopsy. This is a commonly performed procedure normally required to gain tumor grading information needed to plan the therapy. These markers can provide higher contrast for the multiple-energy imaging unit for some tissues that might otherwise be difficult or impossible to discern. This can determine a more accurate location of the target volume and/or edges of the target volume. Marker

data can be stored and recalled later to provide anatomical landmark definition to enhance position information on target volume during radiotherapy.

**[0040]** The multiple-energy imaging unit is a common portal imager capable of receiving radiation from the two radiation sources, each having a different energy level or range. One radiation source can provide energy in the megavolt range for treatment (therapeutic) and coarse target or verification information while the other radiation source can provide energy in the kilovolt range for determining a more precise location of target volumes (diagnostic) for periodically directing the megavolt energy source. The multiple-energy imaging unit can be a flat-panel amorphous silicon (a-Si) portal imaging device. A-Si flat-panel imagers can consist of a two-dimensional array of imaging pixels which are configured as photodiodes.

**[0041]** A multiple-energy imaging unit can display results from radiation from either a higher energy source, such as, for example, as used in therapeutic treatment or from radiation by a lower energy source such as, for example, as used in diagnostic purposes. A-Si imagers convert the optical signal from the overlaying phosphor, which acts together with a thin metal plate as an x-ray detector, to charge and store that charge on the pixel capacitance. To form an image, the charge on the pixels is read out line by line. Multiple-energy a-Si imagers may use a conversion screen design within the imager for multiple energy data unit collection from the two radiation sources. This specialized design can result in different spectral efficiency detection. One design is to use two or more conversion screen/a-Si detector layers, one on top of the other with a combined filter/grid design. Each screen layer will produce an image data unit for a particular radiation energy. One embodiment of a multiple-energy imaging unit, as discussed in US patent application titled "X-Ray Image Acquisition Apparatus", filed November 2, 2001, and assigned with this application to a common owner at the date of filing, hereby incorporated by reference, may be used. Alternatively other imaging units may be used.

**[0042]** With this invention, the multiple-energy imaging unit can receive kV radiation that passes through the target volume. The multiple-energy imaging unit can then provide detailed location information for targeting by the therapeutic radiation source. During the application of therapeutic radiation, the multiple-energy imaging unit can be

repositioned to receive megavoltage energy to provide verification information. A single imager can reduce the amount of space taken up in the treatment area by elements of a radiotherapy machine. In addition, a single imager can reduce cost and complexity for an overall IMRT system.

**[0043]** Thus a method and apparatus for a radiotherapy clinical treatment machine having a single imager attached to a pivotable and articulable gantry have been described. Although the present invention has been described with reference to specific exemplary embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the invention as set forth in the claims. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

FOOTER FOOT

## CLAIMS

What is claimed is:

1. An apparatus comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source;  
a second gantry that is rotatable; and  
an imager attached to an articulable end of the second gantry.
2. The apparatus of claim 1, wherein at least one second radiation source is attached to the first gantry.
3. The apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.
4. The apparatus of claim 1, wherein the first radiation source is capable of propagating therapeutic energy.
5. The apparatus of claim 1, wherein at least one second radiation source is capable of propagating diagnostic energy.
6. The apparatus of claim 1, wherein the first gantry is rotatable.
7. The apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis.
8. The apparatus of claim 1, wherein the imager is a multiple-energy imaging unit.
9. The apparatus of claim 1, wherein the articulable end includes at least one pivot point between the second gantry and the imager.

10. The apparatus of claim 1, wherein the articulable end includes a sliding mechanism capable of translating the imager in a plane.
  
11. The apparatus of claim 1, wherein one of the at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry.
  
12. The apparatus of claim 1, wherein the articulable end is capable of folding the imager against the second gantry.
  
13. The apparatus of claim 7, wherein the second gantry is nestled within the first gantry.
  
14. A method for applying radiation, comprising:
  - positioning a diagnostic radiation source to be in alignment with a target volume;
  - positioning an imager to receive radiation from the diagnostic radiation source;
  - positioning a therapeutic radiation source to be in alignment with the target volume; and
  - re-positioning the imager to receive radiation from the therapeutic radiation source.
  
15. The method of claim 14, further comprising:
  - propagating the diagnostic radiation toward the target volume;
  - receiving the diagnostic radiation by the imager after passing through the target volume;
  - positioning the therapeutic radiation source is based on results of the diagnostic radiation to the imager;
  - propagating the therapeutic radiation into the target volume;
  - receiving the therapeutic radiation by the imager after passing through the target volume; and
  - generating verification data by the imager from the therapeutic radiation.

16. The method of claim 14, wherein the imager is a multiple-energy imaging unit.
17. The method of claim 14, further comprising; placing an internal seed to act as a marker for the target volume.
18. The method of claim 15, further comprising generating multiple diagnostic radiation slices using a fan X-ray beam to provide a 3-dimensional reconstruction of the target volume.
19. The method of claim 15, further comprising generating a cone X-ray beam where volumetric information can be constructed.
20. The method of claim 15, wherein the diagnostic radiation can be operated continuously to provide real time a fluoroscopic image of moving internal anatomy.
21. The method of claim 15, wherein the diagnostic radiation can be operated in a pulsed manner to provide a quasi-real time fluoroscopic image of moving internal anatomy.
22. A method for imaging radiation, comprising:
  - positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level;
  - propagating radiation by a first radiation source at the first energy level along the first axis;
  - retracting the first radiation source and positioning a second radiation source along the first axis.
  - maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source; and
  - propagating radiation by the second radiation source.

FOOTER "SEED"

- 23. The method of claim 22, further comprising:
  - rotating the first radiation source until clear of the second radiation source;
  - extending the first radiation source to be in line with the multiple-energy imaging unit;
  - propagating radiation at a first energy level toward the multiple-energy imaging unit.
  
- 24. The method of claim 22, further comprising pivoting two arms independently, the first arm attached to the first radiation source for propagating at the first energy level, and the second arm attached to the second radiation source for propagating at the second energy level.
  
- 25. The method of claim 24, wherein the multiple-energy imaging unit is attached to the second arm.
  
- 26. An apparatus, comprising:
  - a therapeutic energy source attached to a first gantry;
  - a diagnostic energy source attached to a translatable end of a second gantry;
  - a multiple-energy imaging unit attached to an opposite articulable end of the second gantry;
  - the first gantry and the second gantry independently pivotable and attached at a common axis;
  - a patient couch capable of translation, wherein the result of such pivoting and translation is to place a target volume of a patient between the multiple-energy imaging unit aligned with the diagnostic energy source or the therapeutic energy source.

ABSTRACT OF THE DISCLOSURE

An apparatus including a first radiation source attached to a first gantry, at least one second radiation source, a second gantry that is rotatable; and an imager attached to an articulable end of the second gantry.

FOR SEEN

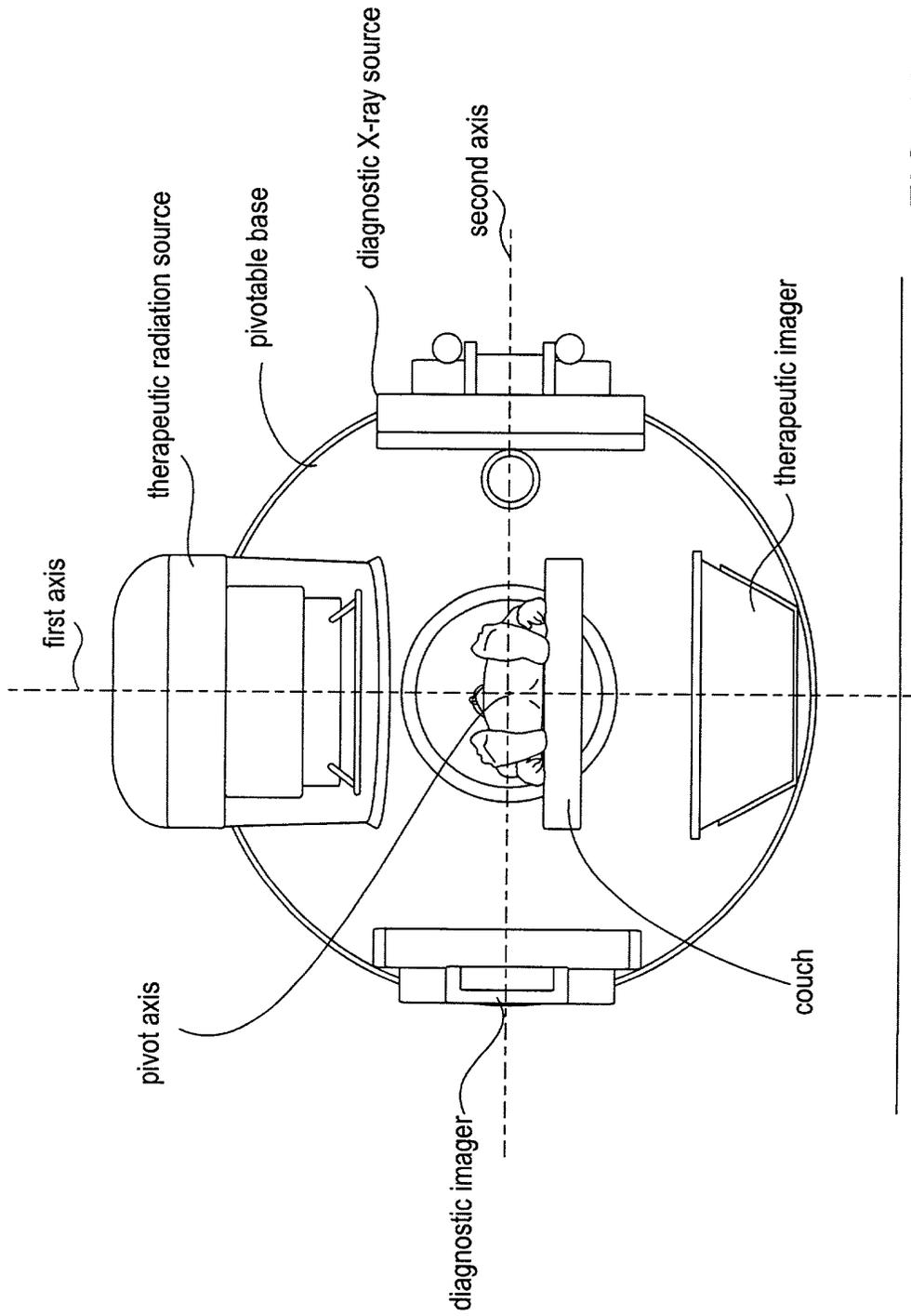


FIG. 1A  
(Prior Art)

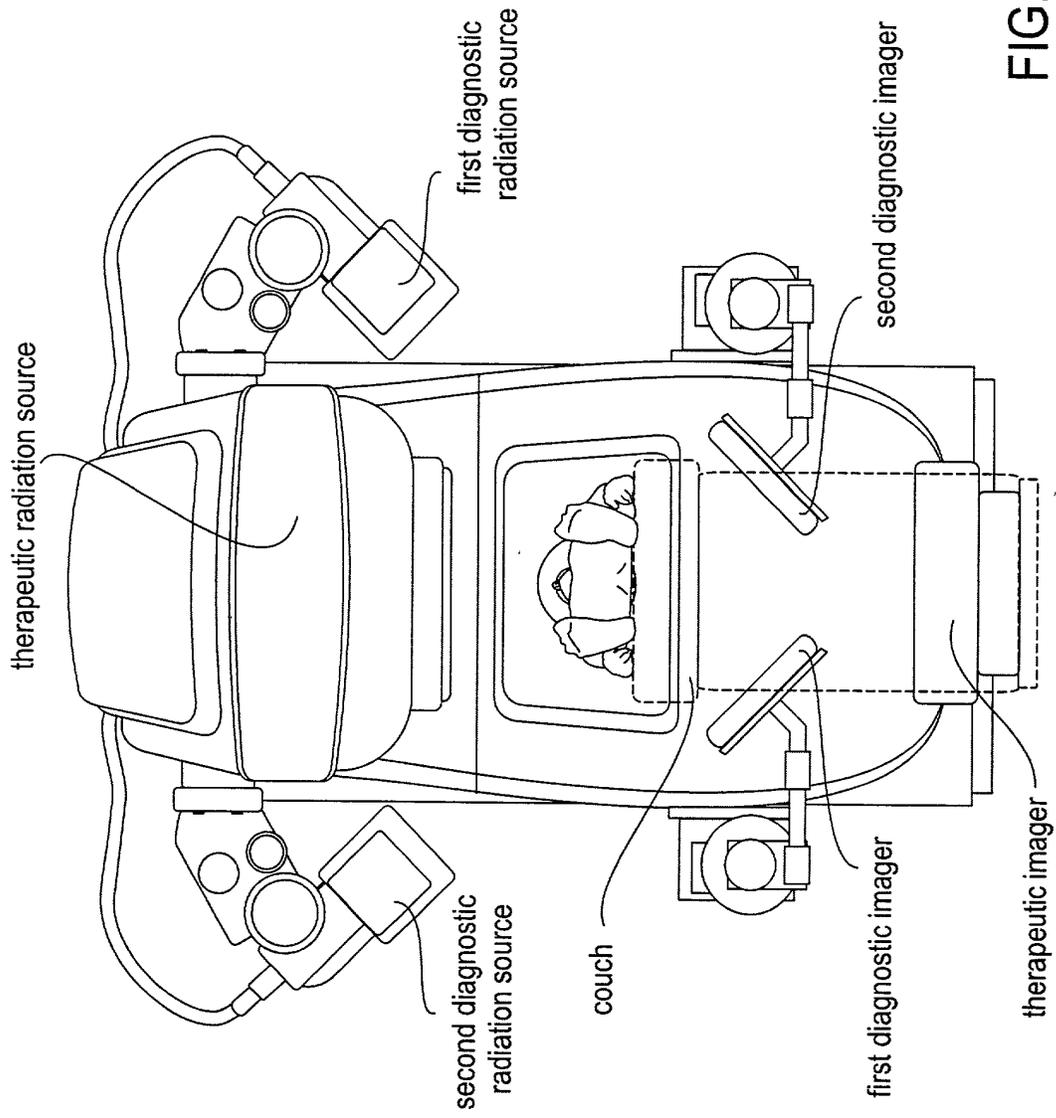


FIG. 1B  
(Prior Art)

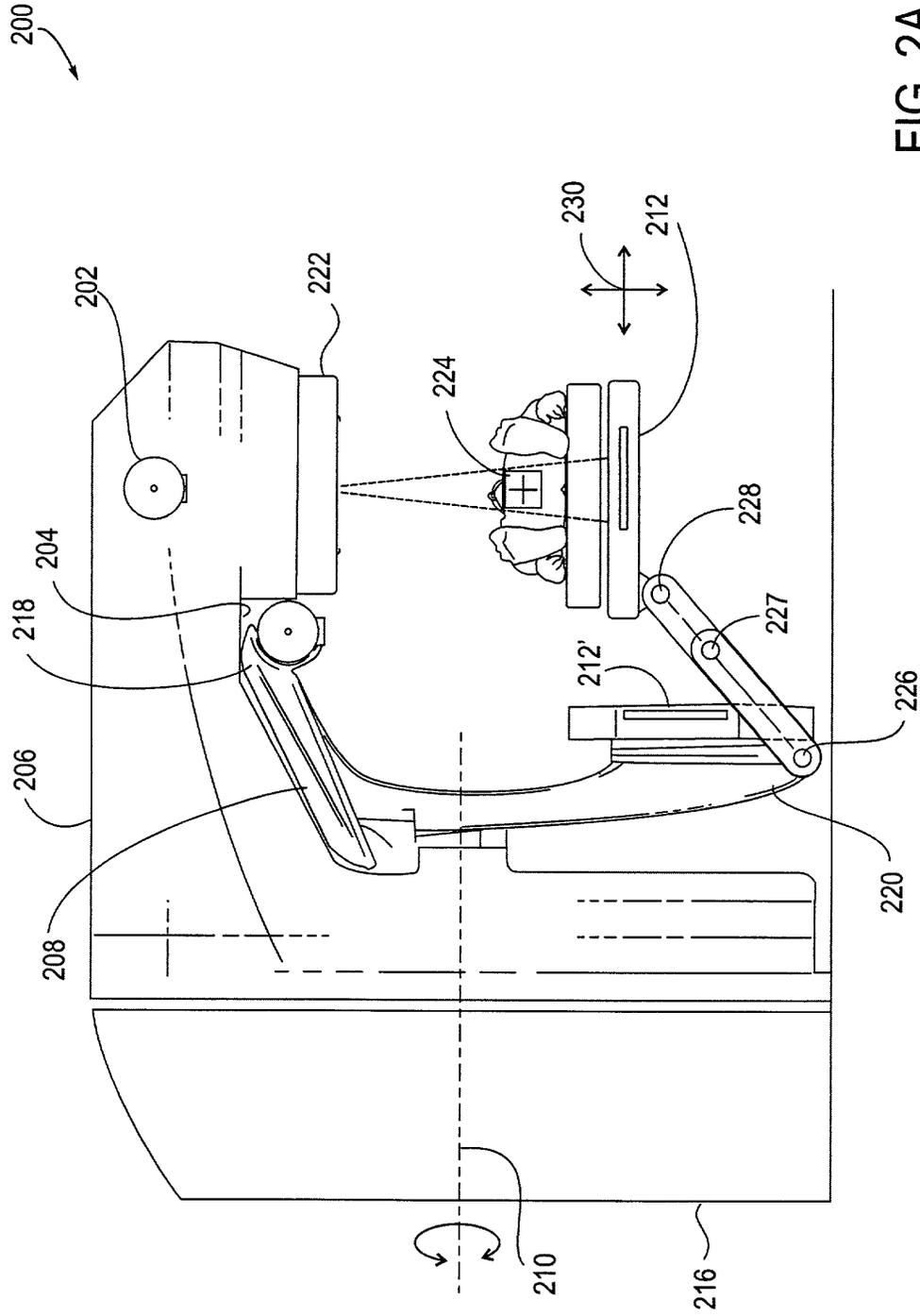


FIG. 2A

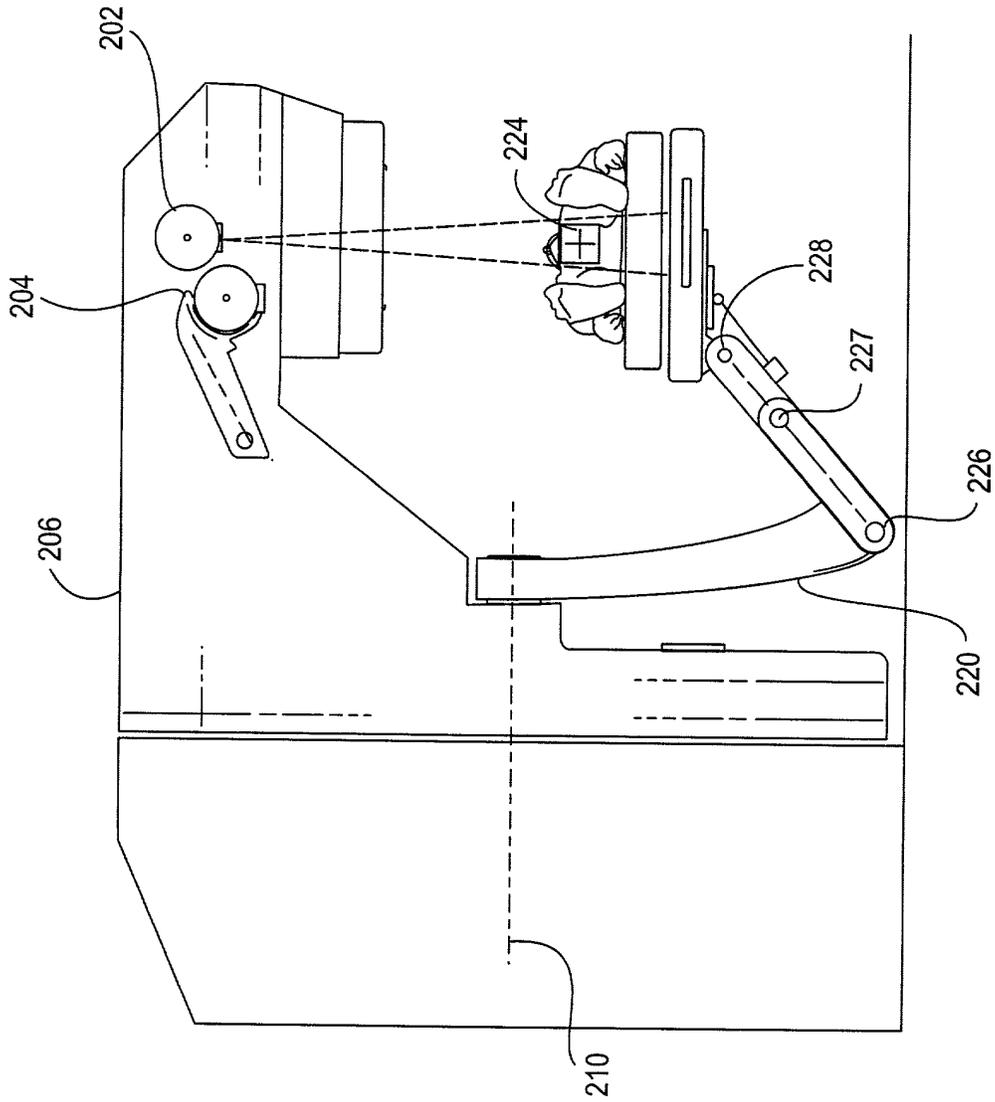


FIG. 2B

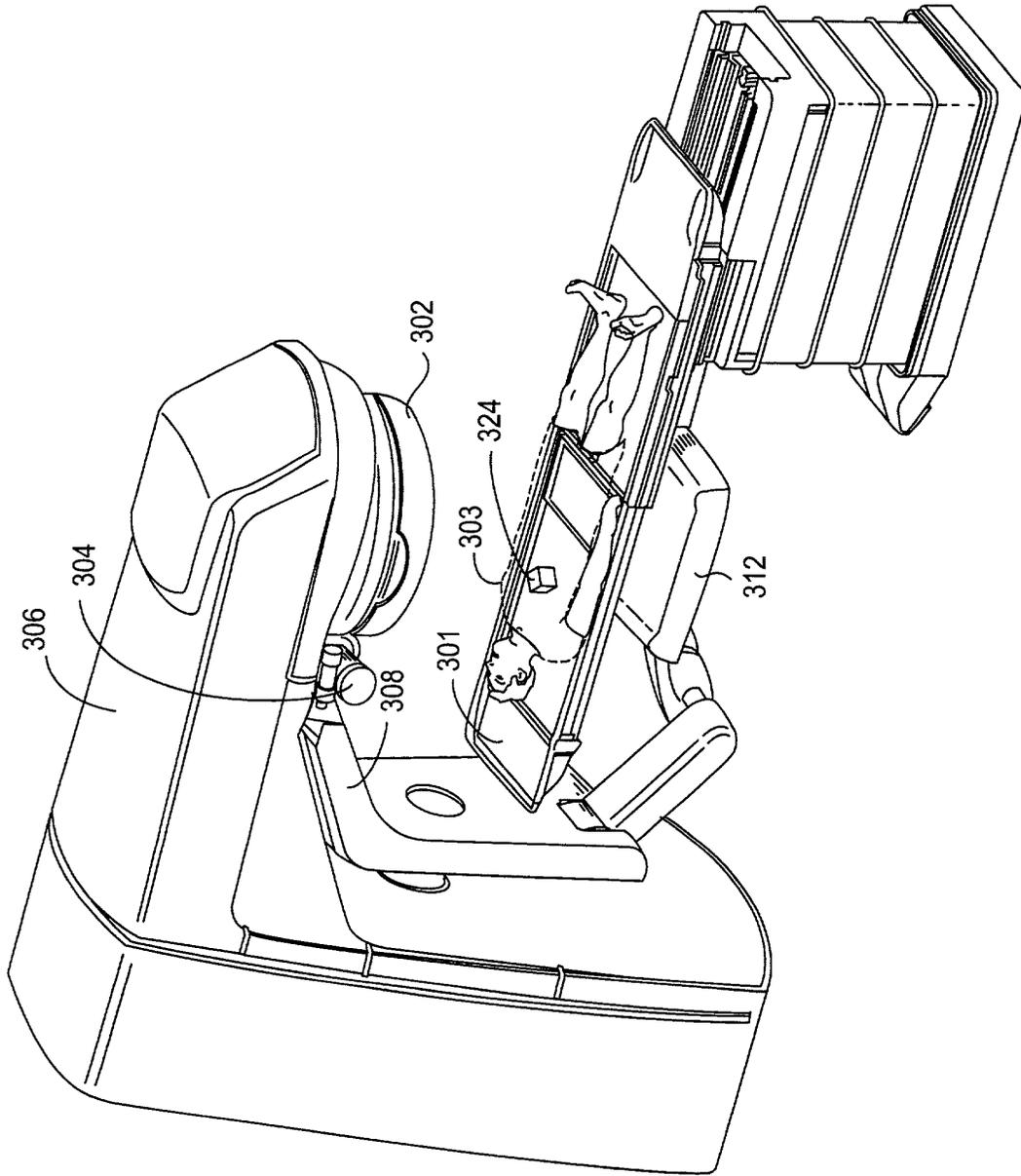


FIG. 3A

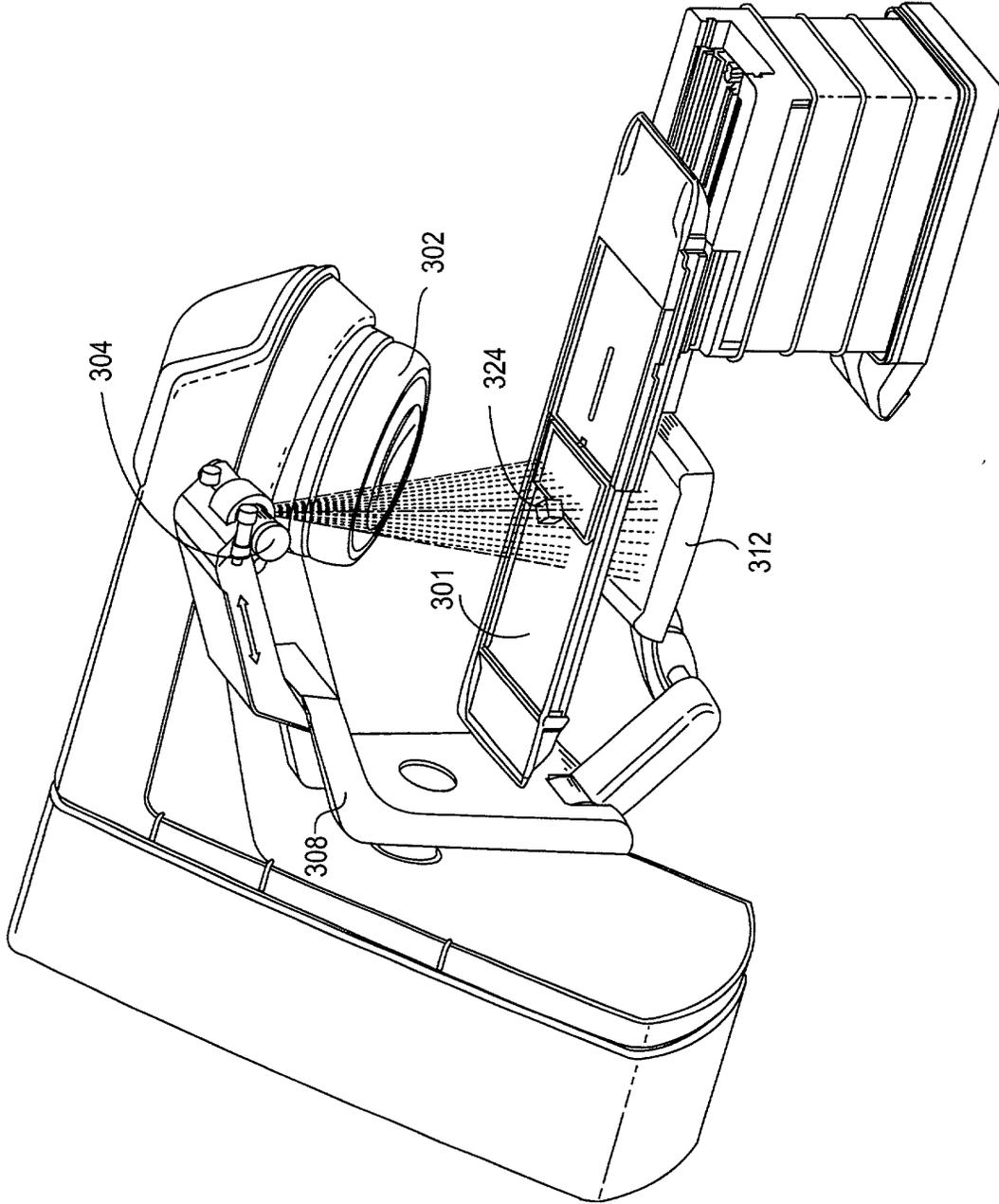


FIG. 3B

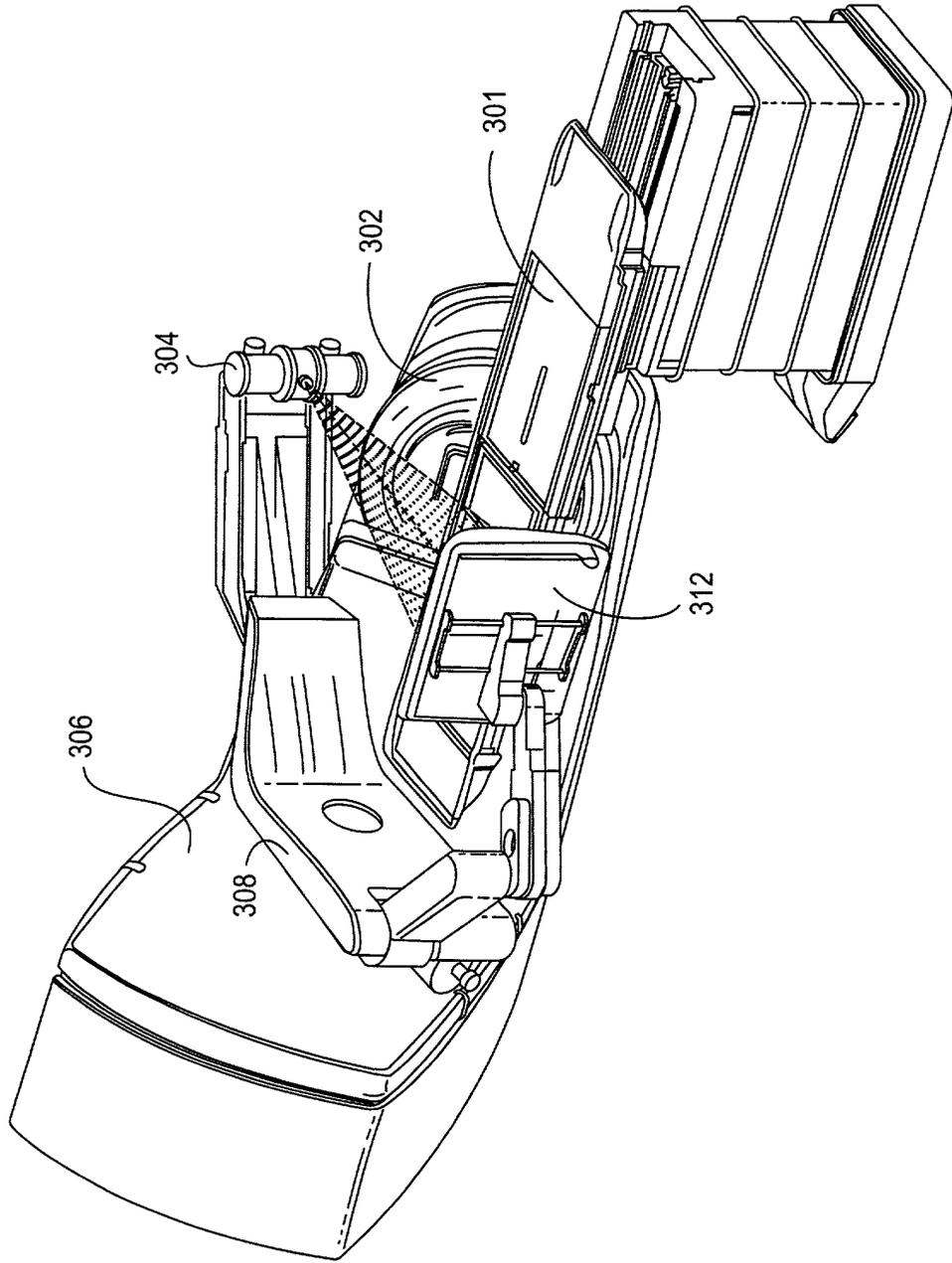


FIG. 3C



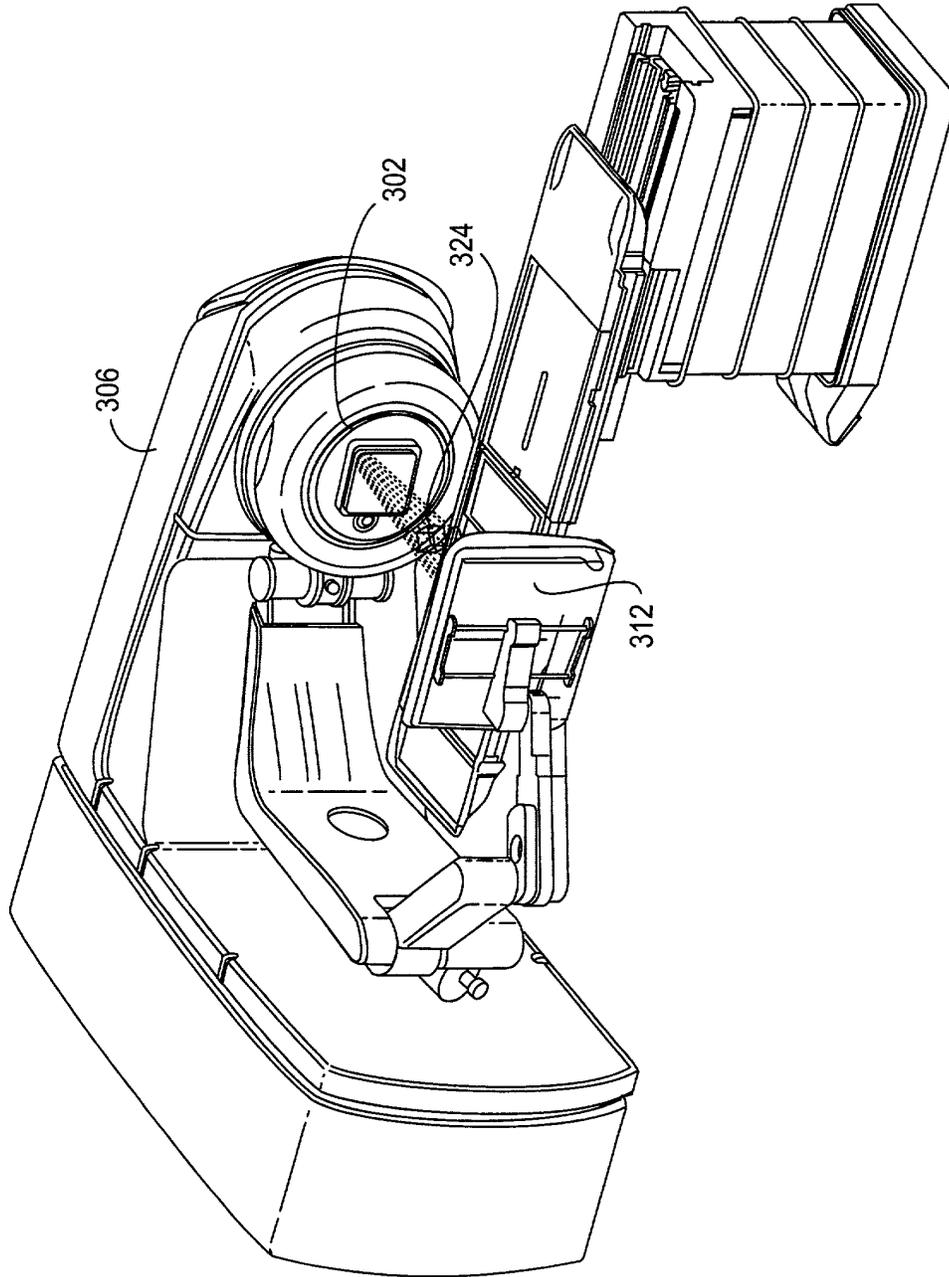


FIG. 3E

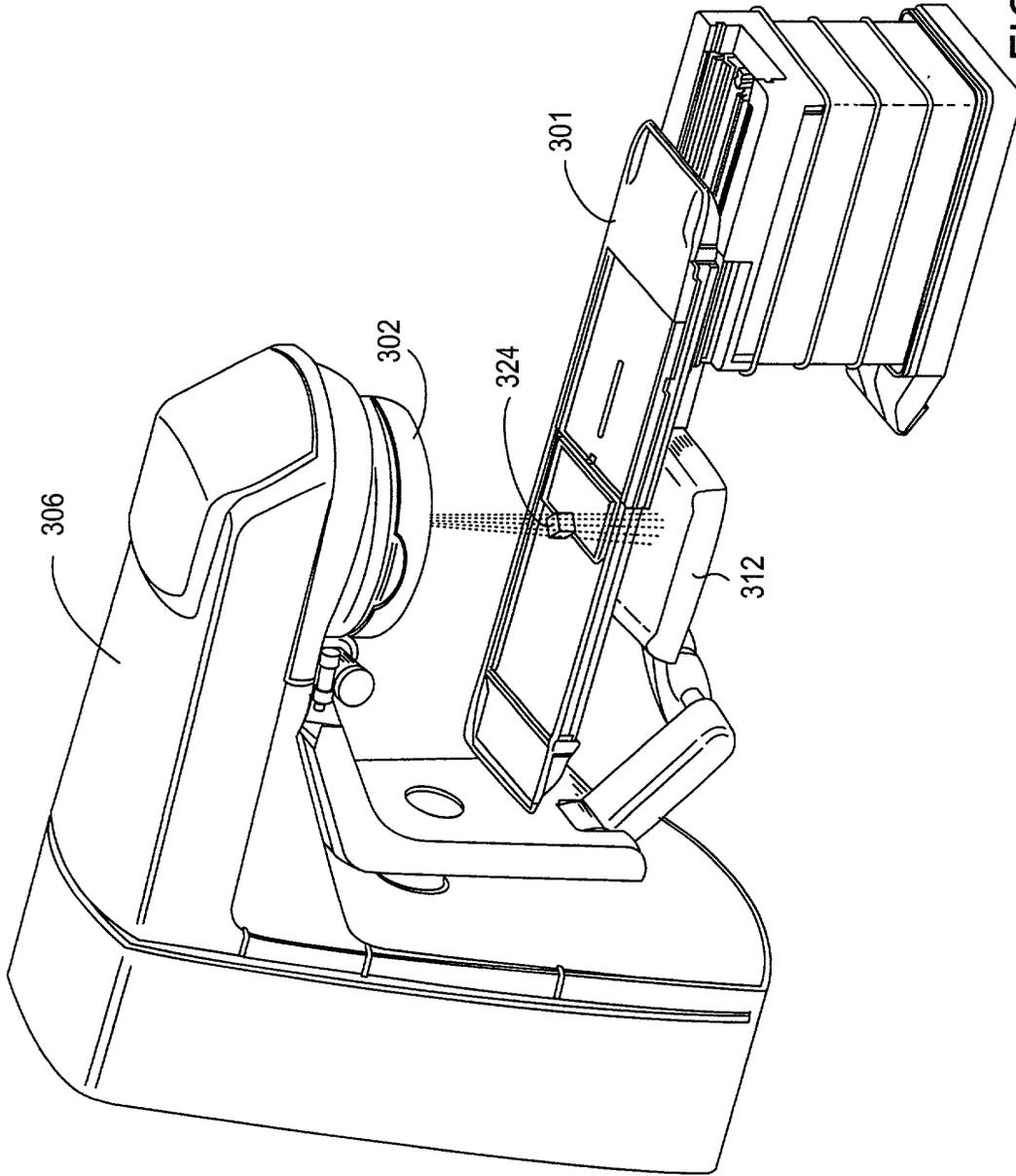


FIG. 3F

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT the specification of which

X is attached hereto.  
\_\_\_\_\_ was filed on (MM/DD/YYYY) \_\_\_\_\_ as  
United States Application Number \_\_\_\_\_  
or PCT International Application Number \_\_\_\_\_  
and was amended on (MM/DD/YYYY) \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application. I do not know and do not believe that the claimed invention was in public use or on sale in the United States of America more than one year prior to this application, nor do I know or believe that the invention has been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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FOOTNOTES

<u>Prior Foreign Application(s)</u>			<u>Priority Claimed</u>	
<u>(Number)</u>	<u>(Country)</u>	<u>(Foreign Filing Date - MM/DD/YYYY)</u>	<u>Yes</u>	<u>No</u>
<u>(Number)</u>	<u>(Country)</u>	<u>(Foreign Filing Date - MM/DD/YYYY)</u>	<u>Yes</u>	<u>No</u>
<u>(Number)</u>	<u>(Country)</u>	<u>(Foreign Filing Date - MM/DD/YYYY)</u>	<u>Yes</u>	<u>No</u>

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

<u>(Application Number)</u>	<u>(Filing Date – MM/DD/YYYY)</u>
<u>(Application Number)</u>	<u>(Filing Date – MM/DD/YYYY)</u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

<u>(Application Number)</u>	<u>(Filing Date – MM/DD/YYYY)</u>	<u>(Status -- patented, pending, abandoned)</u>
<u>(Application Number)</u>	<u>(Filing Date – MM/DD/YYYY)</u>	<u>(Status -- patented, pending, abandoned)</u>

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Daniel E. Ovanezian, **BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025** and direct telephone calls to Daniel E. Ovanezian, (408) 720-8300.  
 (Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_

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\_\_\_\_\_

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Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_

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Post Office Address \_\_\_\_\_  
\_\_\_\_\_

Full Name of Fourth/Joint Inventor \_\_\_\_\_

Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_

Residence \_\_\_\_\_ Citizenship \_\_\_\_\_  
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Post Office Address \_\_\_\_\_  
\_\_\_\_\_

FOOTNOTES

APPENDIX A

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TAYLOR & ZAFMAN

## APPENDIX B

### Title 37, Code of Federal Regulations, Section 1.56 Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

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PATENT NUMBER and  
ISSUE DATE

U.S. UTILITY Patent Application

10033327  
1077

APPL NUM 10033327	FILING DATE 11/02/2001	CLASS 378	SUBCLASS 65	GAU 2876 2002	EXAMINER <i>[Signature]</i>
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\*\*APPLICANTS: Graf Ulrich;

\*\*CONTINUING DATA VERIFIED:

\*\* FOREIGN APPLICATIONS VERIFIED:

PG-PUB  DO NOT PUBLISH  RESCIND

Foreign priority claimed  yes  no  
 35 USC 119 conditions met  yes  no  
 Verified and Acknowledged Examiners's initials **ACH**

ATTORNEY DOCKET NO  
005513.P003

TITLE : Radiotherapy apparatus equipped with an articulable gantry for positioning an imaging unit  
U.S. DEPT. OF COM. / PAT. & TM-PTO-436L (Rev. 12-94)

<b>NOTICE OF ALLOWANCE MAILED</b>		<b>CLAIMS ALLOWED</b>	
		Total Claims	Print Claim for O.G.
<b>ISSUE FEE</b>		<b>DRAWING</b>	
Amount Due	Date Paid	Sheets Drawg.	Figs. Drawg. Print Fig.
		Application Examiner	
<input type="checkbox"/> <b>TERMINAL DISCLAIMER</b>		<b>PREPARED FOR ISSUE</b>	
<b>WARNING:</b> The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35, Sections 122, 181 and 368, Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.			

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(Attached in pocket on right inside flap)

### SEARCH

Class	Sub.	Date	Exmr.
378	65	6/26/03	ACH
	195		
	196		
	197		
	198		
	19		
	98.8		
250	374		

### INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.

### SEARCH NOTES

(List databases searched. Attach search strategy inside.)

	Date	Exmr.
Consulted with		
Constantine Hinder	6/19/03	ACH
(class 250)		
EAST BRS	6/20/03	ACH

BEST AVAILABLE COF



1-2-02

A

Please type a plus sign (+) inside this box [+]

PTO/SB/05 (11-00)

Approved for use through 10/31/2002. OMB 0651-0032  
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

**UTILITY PATENT APPLICATION TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 005513.P003

(maximum 12 characters)

First Named Inventor Ulrich Martin Graf

Title: RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT

Express Mail Label No. EL 672 750 138 US

DC979 U.S. PTO  
10/03/01

11/02/01

ADDRESS TO: **Box Patent Application  
Commissioner for Patents  
Washington, D. C. 20231**

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

1.  **Fee Transmittal Form (e.g., PTO/SB/17)**  
(Submit an original, and a duplicate for fee processing)
2.  **Applicant Claims Small Entity Status. (37 CFR 1.27)**
3.  **Specification (Total Pages 19)**  
(preferred arrangement set forth below)
  - Descriptive Title of the Invention
  - Cross Reference to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference sequence listing, a table,  
or a computer program listing appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
4.  **Drawings(s) (35 USC 113) (Total Sheets 10)**
5.  **Oath or Declaration (Total Pages 5)**
  - a.  Newly Executed (Original or Copy)
  - b.  Copy from a Prior Application (37 CFR 1.63(d))  
(for Continuation/Divisional with Box 18 completed)
    - i.  **DELETIONS OF INVENTOR(S)** Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
  - c.  Unsigned.
6.  **Application Data Sheet. (37 CFR 1.76)**
7.  **CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)**
8.  **Nucleotide and/or Amino Acid Sequence Submission**  
(if applicable, all necessary)
  - a.  Computer Readable Form (CRF)
  - b.  Specification Sequence Listing on:
    - i.  CD-ROM or CD-R (2 copies); or
    - ii.  paper
  - c.  Statement verifying identity of above copies

11/02/01  
11025 U.S. PTO

10033327 110201

2/15/01

- 1 -

**ACCOMPANYING APPLICATION PARTS**

- 9.  **Assignment Papers (c v r she t & d cuments(s))**
- 10.  a. Separate 37 CFR 3.73(b) Statement (where there is an assignee)
- b. Power of Attorney
- 11.  English Translation Document (if applicable)
- 12.  a. Information Disclosure Statement (IDS)/PTO-1449
- b. Copies of IDS Citations
- 13.  **Preliminary Amendment**
- 14.  **Return Receipt Postcard (MPEP 503) (Should be specifically itemized)**
- 15.  Certified Copy of Priority Document(s) (if foreign priority is claimed)
- 16.  **Request and Certification under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.**
- 17.  Other: Express Mail Certificate (w/postcard)

**18A. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:**

Continuation       Divisional       Continuation-in-part (CIP)  
 Of Prior Application No.: \_\_\_\_\_ Examiner \_\_\_\_\_ Group Art Unit \_\_\_\_\_  
 (which is a \_\_\_ continuation/ \_\_\_ divisional/ \_\_\_ CIP of prior application no. \_\_\_\_\_,  
 which is a \_\_\_ continuation/ \_\_\_ divisional/ \_\_\_ CIP of prior application no. \_\_\_\_\_) (List entire chain of priority)

**Applicant(s): Also include a Preliminary Amendment to amend the specification to claim priority. For CONTINUATION AND DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.**

**18B. Statement under 37 CFR 3.73(b) for continuing application:**

The undersigned states that \_\_\_\_\_ (name of assignee) is the assignee of the entire right, title, and interest in the accompanying patent application by virtue of an assignment recorded in the Patent and Trademark Office at Reel. No. \_\_\_\_\_ Frame No. \_\_\_\_\_ (or a copy of which is attached).

**19. Correspondence Address**

Customer Number or Bar Code Label 008791  
 or (Insert Customer No. or Attach Bar Code Label here)  
 Correspondence Address Below

NAME Daniel E. Ovanezian

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

ADDRESS 12400 Wilshire Boulevard  
Seventh Floor

CITY Los Angeles STATE California ZIP CODE 90025-1030

Country U.S.A. TELEPHONE (408) 720-8300 FAX (408) 720-8383

Name (PRINT/TYPE): Daniel E. Ovanezian Registration No.: 41,236

Signatur : *Daniel E. Ovanezian* Dat : 11/2/01

FOOTNOTES

**REQUEST AND CERTIFICATION UNDER 35 U.S.C. 122(b)(2)(B)(i)**

First Named Inventor Ulrich Martin Graf  
Title Radiotherapy Apparatus Equipped with an Articulate Gantry for Positioning an Imaging Unit

Attorney Docket No. 005513.P003

I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral agreement, that requires publication at eighteen months after filing. I hereby request that the attached application not be published under 35 U.S.C. 122(b).

11/2/01  
Date

  
Signature

Daniel E. Ovanezian  
Typed or Printed Name

41,236  
Registration No.

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application **upon filing**.

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months after the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant **must** notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of filing of such foreign or international application. **Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).**

Send to: Assistant Commissioner for Patents, Washington, D.C. 20231

FOOT " 4266007 10033327 110201

FOR "423501"

Serial/Patent No.: Not yet assigned Filing/Issue Date: Herewith (11/2/01)  
Client: Varian Medical Systems, Inc.  
Title: Radiotherapy Apparatus Equipped with an Articulable Gantry for Positioning an Imaging Unit

BSTZ File No.: 005513.P003 Atty/Secty Initials: DEO/MDG/den  
Date Mailed: November 2, 2001 Docket Due Date: \*\*\*

The following has been received in the U.S. Patent & Trademark Office on the date stamped hereon:

- Amendment/Response (\_\_\_ pgs.)
- Appeal Brief (\_\_\_ pgs.) (in triplicate)
- Application - Utility (19 pgs., with cover and abstract)
- Application - Rule 1.53(b) Continuation (\_\_\_ pgs.)
- Application - Rule 1.53(b) Divisional (\_\_\_ pgs.)
- Application - Rule 1.53(b) CIP (\_\_\_ pgs.)
- Application - Rule 1.53(d) CPA Transmittal (\_\_\_ pgs.)
- Application - Design (\_\_\_ pgs.)
- Application - PCT (\_\_\_ pgs.)
- Application - Provisional (\_\_\_ pgs.)
- Assignment and Cover Sheet
- Certificate of Mailing w/postcard Express unsigned
- Declaration & POA (5 pgs.)
- Disclosure Docs & Orig & Copy of Invention Signed Letter (\_\_\_ pgs.)
- Drawings: 10 # of sheets includes 10 figures
- Express Mail No.: EL672750138US Check No.: 46289
- \_\_\_ Month(s) Extension of Time Amt: \$932.00
- Information Disclosure Statement & PTO 449 (3 pgs.) Check No. \_\_\_ Amt: \_\_\_
- Issue Fee Transmittal
- Notice of Appeal
- Petition for Extension of Time
- Petition for \_\_\_
- Postcard
- Power of Attorney (\_\_\_ pgs.)
- Preliminary Amendment (\_\_\_ pgs.)
- Reply Brief (\_\_\_ pgs.)
- Response to Notice of Missing Parts
- Small Entity Declaration for Indep. Inventor/Small Business
- Transmittal Letter, in duplicate
- Fee Transmittal, in duplicate

Other: Request and Certification Under 35 U.S.C.122(b)(2)(B)(i); and Copies of cited references (5)

**EXPRESS MAIL CERTIFICATE OF MAILING**

"Express Mail" mailing label number: EL 672 750 138 US  
Date of Deposit: November 2, 2001

I hereby certify that I am causing this paper or fee, and the documents indicated on the postcard above, to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to: Box Patent Application, Commissioner for Patents, Washington, D. C. 20231

Dianne Neathery  
(Typed or printed name of person mailing paper or fee)

Dianne Neathery 11-2-01  
(Signature of person mailing paper or fee, and date of signature)

**FEE TRANSMITTAL FOR FY 2002**TOTAL AMOUNT OF PAYMENT (\$) \$932.00

## Complete if Known:

Application No. Not yet assigned  
 Filing Date Herewith (Nov. 2, 2001)  
 First Named Inventor Ulrich Martin Graf  
 Group Art Unit Not yet assigned  
 Examiner Name Not yet assigned  
 Attorney Docket No. 005513.P003

## METHOD OF PAYMENT (check one)

1.  The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number 02-2666  
 Deposit Account Name \_\_\_\_\_

- Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

- Applicant claims small entity status. See 37 CFR 1.27

2.  Payment Enclosed:  Check  
 Money Order  
 Other

## FEE CALCULATION

## 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
101	740	201	370	Utility application filing fee	<u>740.00</u>
106	330	206	165	Design application filing fee	_____
107	510	207	255	Plant filing fee	_____
108	740	208	370	Reissue filing fee	_____
114	160	214	80	Provisional application filing fee	_____
SUBTOTAL (1)					<u>\$ 740.00</u>

## 2. EXTRA CLAIM FEES

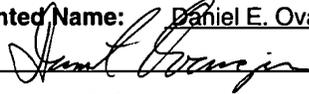
		Extra Claims	Fee from below	Fee Paid
Total Claims	<u>26</u>	- 20** = <u>6</u>	X <u>18.00</u>	= <u>108.00</u>
Independent Claims	<u>4</u>	- 3** = <u>1</u>	X <u>84.00</u>	= <u>84.00</u>
Multiple Dependent				= _____

\*\*Or number previously paid, if greater; For Reissues, see below.

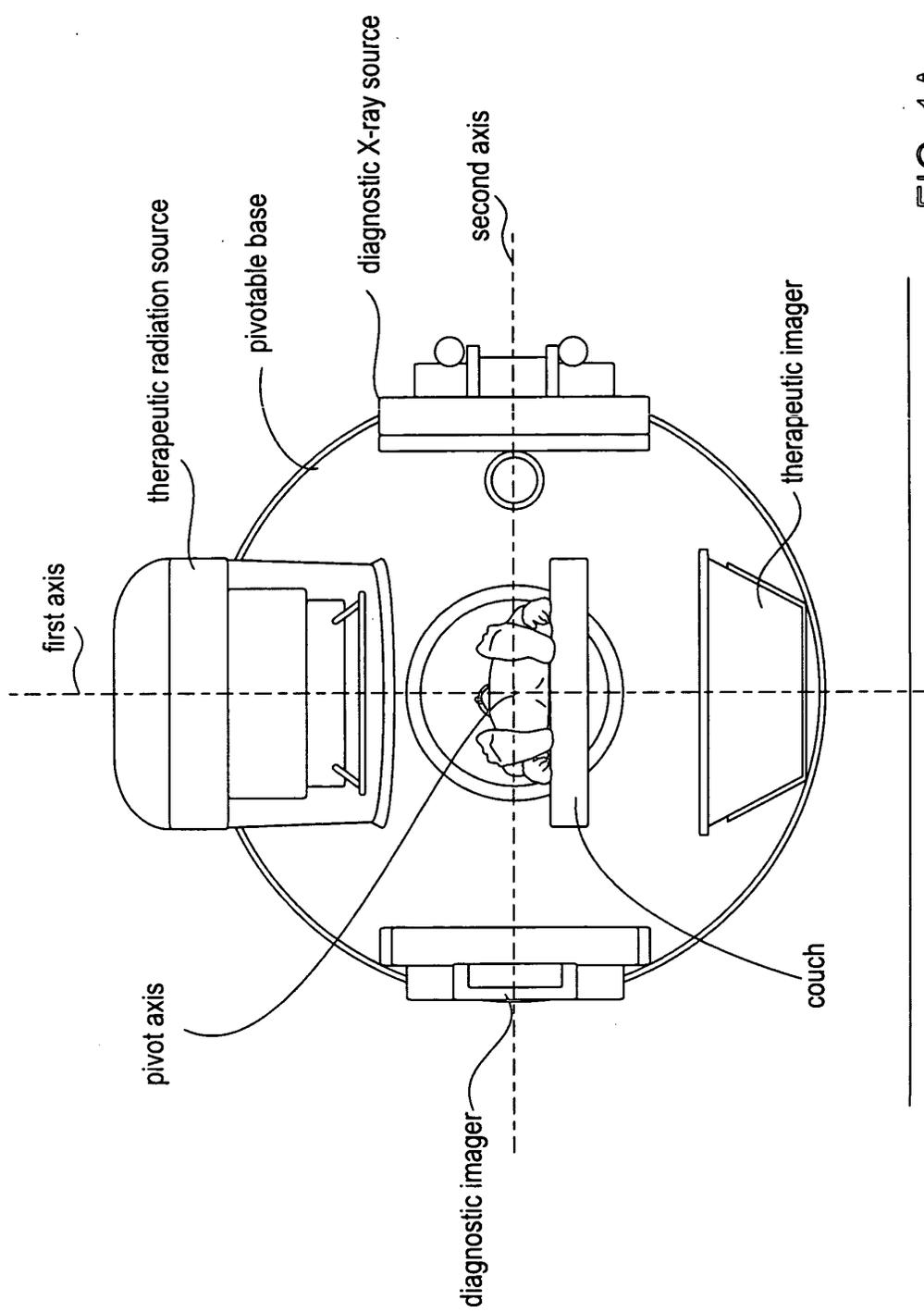
Large Entity		Small Entity		Fee Description
Fee Code	Fee (\$)	Fee Code	Fee (\$)	
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) \$ 192.00

FOOTNOTES

<b>FEE CALCULATION (continued)</b>					
<b>3. ADDITIONAL FEES</b>					
<u>Large Entity</u>		<u>Small Entity</u>		<u>Fee Description</u>	<u>Fee Paid</u>
<u>F</u>	<u>Fee</u>	<u>Code</u>	<u>Fee</u>		
105	130	205	65	Surcharge - late filing fee or oath	_____
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	_____
139	130	139	130	Non-English specification	_____
147	2,520	147	2,520	For filing a request for ex parte reexamination	_____
099	8,800	099	8,800	Request for inter parties reexamination	_____
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	_____
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	_____
115	110	215	55	Extension for reply within first month	_____
116	400	216	200	Extension for reply within second month	_____
117	920	217	460	Extension for reply within third month	_____
118	1,440	218	720	Extension for reply within fourth month	_____
128	1,960	228	980	Extension for reply within fifth month	_____
119	320	219	160	Notice of Appeal	_____
120	320	220	160	Filing a brief in support of an appeal	_____
121	280	221	140	Request for oral hearing	_____
138	1,510	138	1,510	Petition to institute a public use proceeding	_____
140	110	240	55	Petition to revive - unavoidable	_____
141	1,280	241	640	Petition to revive - unintentional	_____
142	1,280	242	640	Utility issue fee (or reissue)	_____
143	460	243	230	Design issue fee	_____
144	620	244	310	Plant issue fee	_____
122	130	122	130	Petitions to the Commissioner	_____
123	50	123	50	Processing fee under 37 CFR 1.17(q)	_____
126	180	126	180	Submission of Information Disclosure Stmt	_____
581	40	581	40	Recording each patent assignment per property (times number of properties)	_____
146	740	246	370	For filing a submission after final rejection (see 37 CFR 1.129(a))	_____
148	110	248	55	Statutory Disclaimer	_____
149	740	249	370	For each additional invention to be examined (see 37 CFR 1.129(b))	_____
179	740	279	370	Request for Continued Examination (RCE)	_____
169	900	169	900	Request for expedited examination of a design application	_____
195	300	195	300	Publication fee for early, voluntary, or normal pub.	_____
196	300	196	300	Publication fee for republication	_____
194	130	194	130	Request for voluntary publication or republication	_____
098	130	098	130	Processing fee under 37 CFR 1.17(i) (except provisionals)	_____
091	1,280	091	1,280	Acceptance of unintentionally delayed claim for priority	_____
Other fee (specify) _____					_____
Other fee (specify) _____					_____
<b>SUBTOTAL (3)</b>					<b>\$ _____ .00</b>
*Reduced by Basic Filing Fee Paid					
<b>SUBMITTED BY:</b>					
Typed or Printed Name: <u>Daniel E. Ovanezian</u>					
Signature: <u></u> Date: <u>11/2/01</u>					
R g. Number: <u>41,236</u> T leph n Numb r: <u>(408) 720-8300</u>					

FOOT 22500T



**FIG. 1A**  
(Prior Art)

FIG. 1B

VED. O.G. FIG.  
CLASS. SUBC.  
BY  
DRAFTSMAN

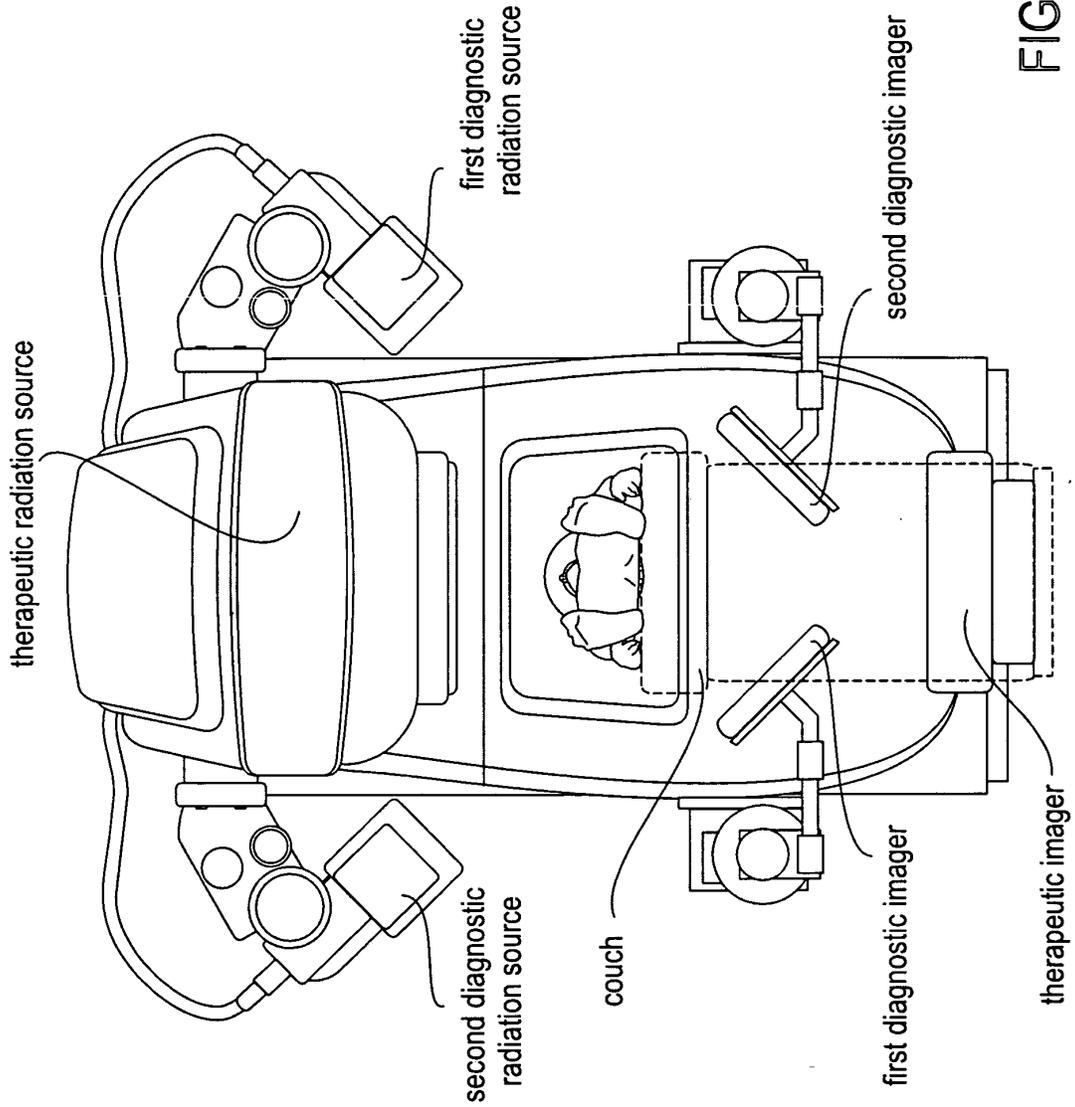


FIG. 1B  
(Prior Art)

APPROVED	O.G. FIG.
BY	CLASS. SUBC.
DRAFTSMAN	

200

FOOT WEAR

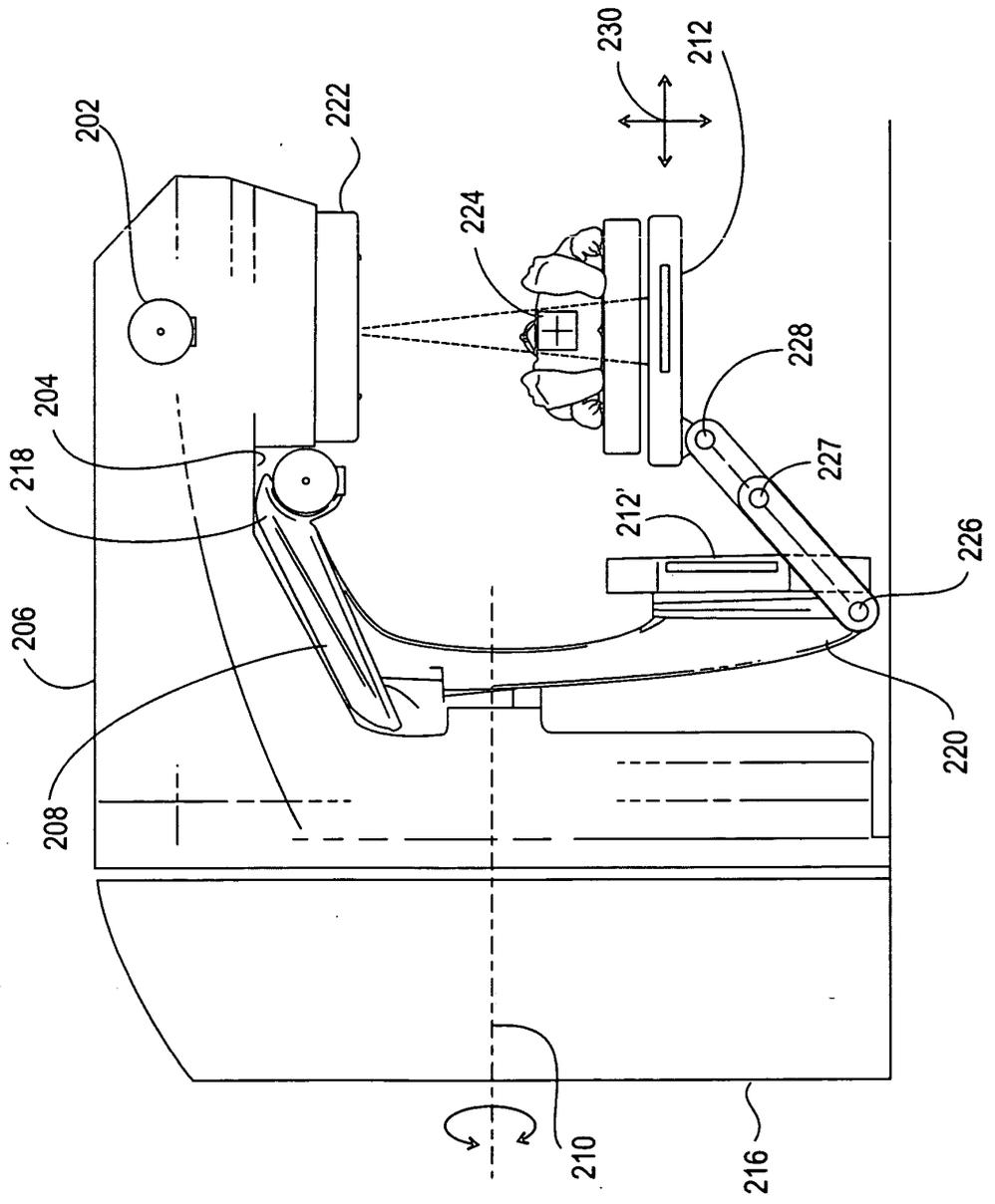


FIG. 2A

DESIGNED BY	DATE	FIG.
CRAFTSMAN	CLASS	SUBC

FOOT-22E001

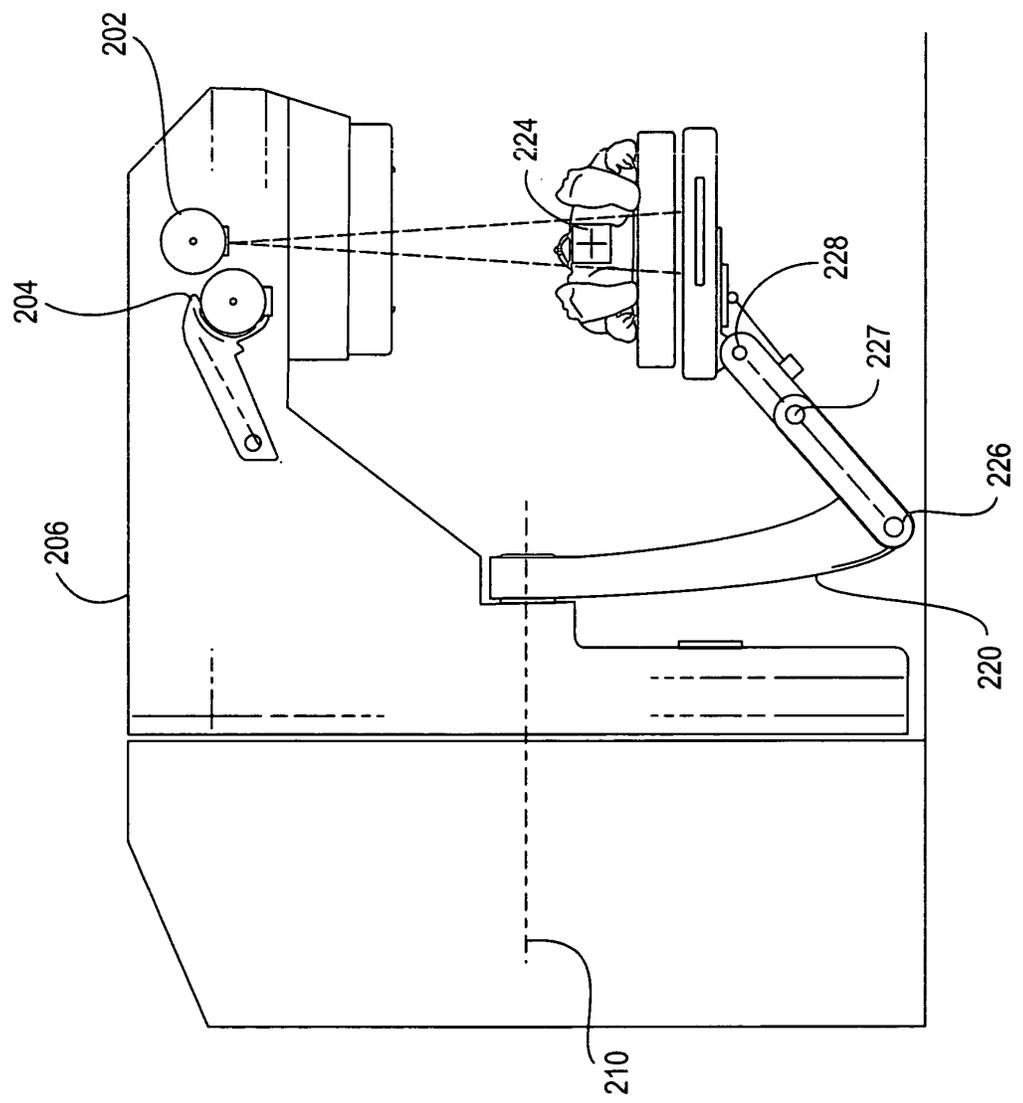


FIG. 2B

APPROVED	O.G. FIG.
BY	CLASS/SUBCL.
DRAFTSMAN	

FOOT FEED

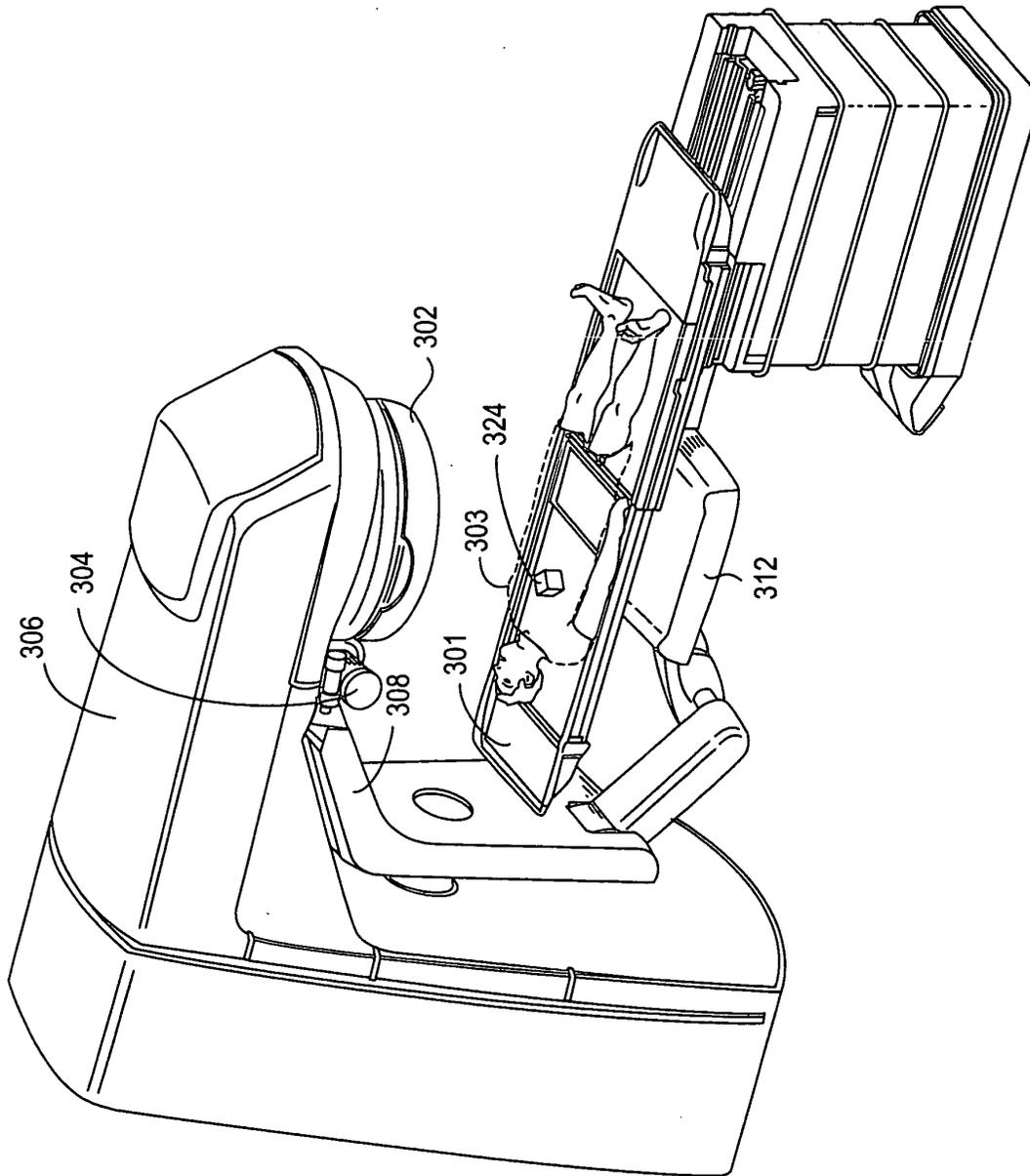


FIG. 3A

REVISED O.G. FIG.  
BY CLASS. SUBC.  
DRAFTSMAN

FOOT ZEEDOT

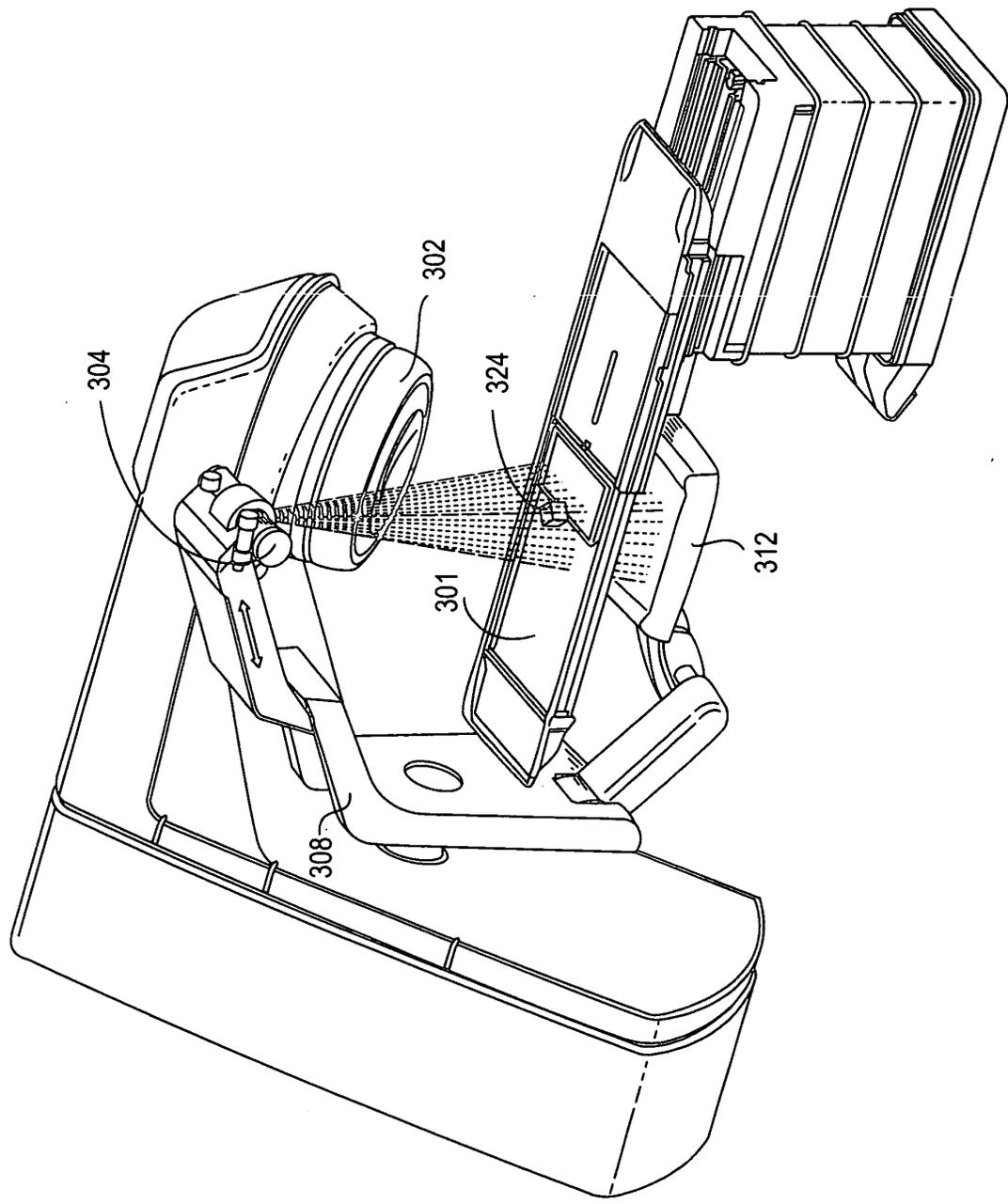


FIG. 3B

DESIGNED	O.G. FIG.
BY	CLASS: SUBC
DRAFTSMAN	

FOOT ZEEDOT

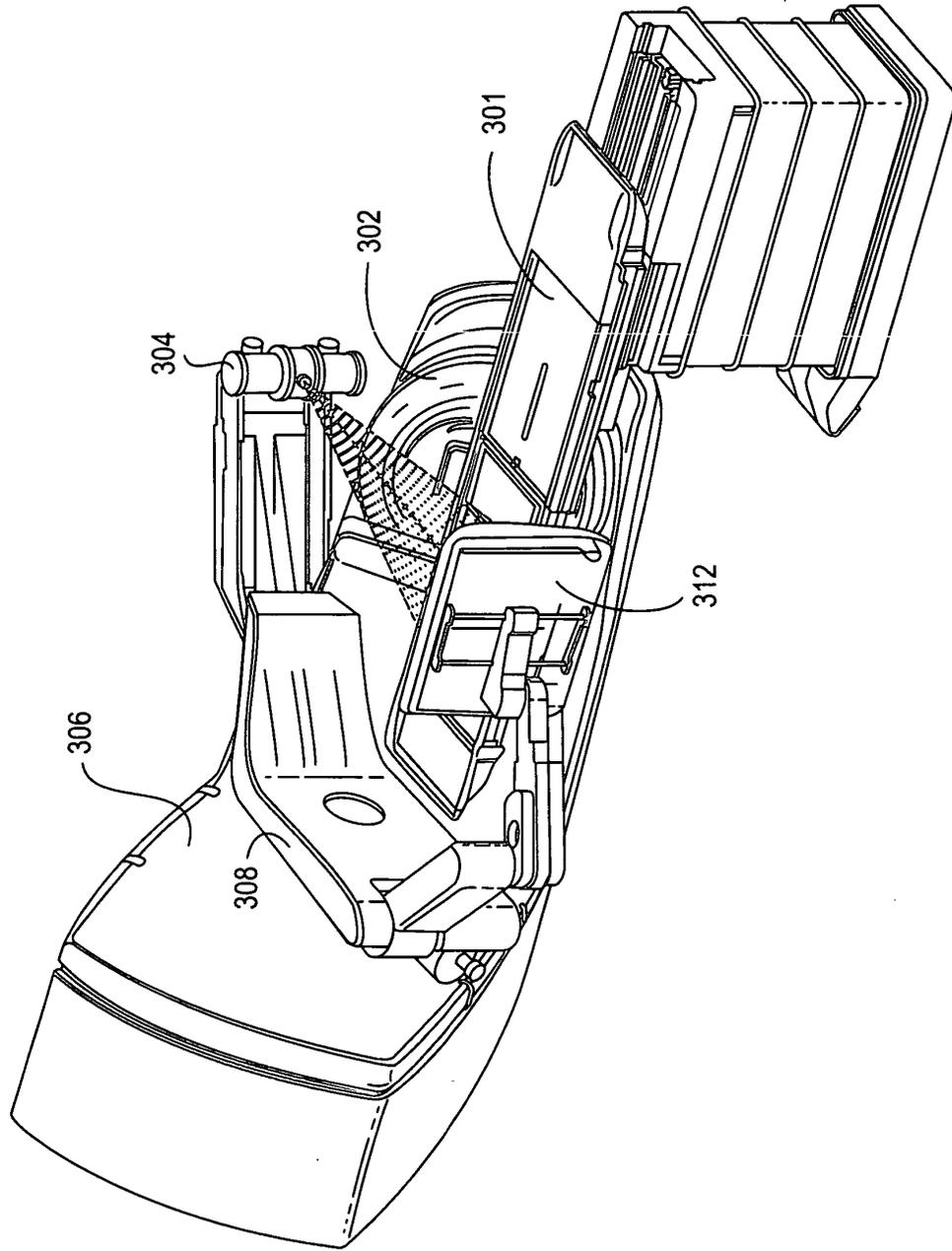


FIG. 3C

APPROVED	O.G. FIG.
BY	CLASS/SUBC.
DRAFTSMAN	

FOOT FEED

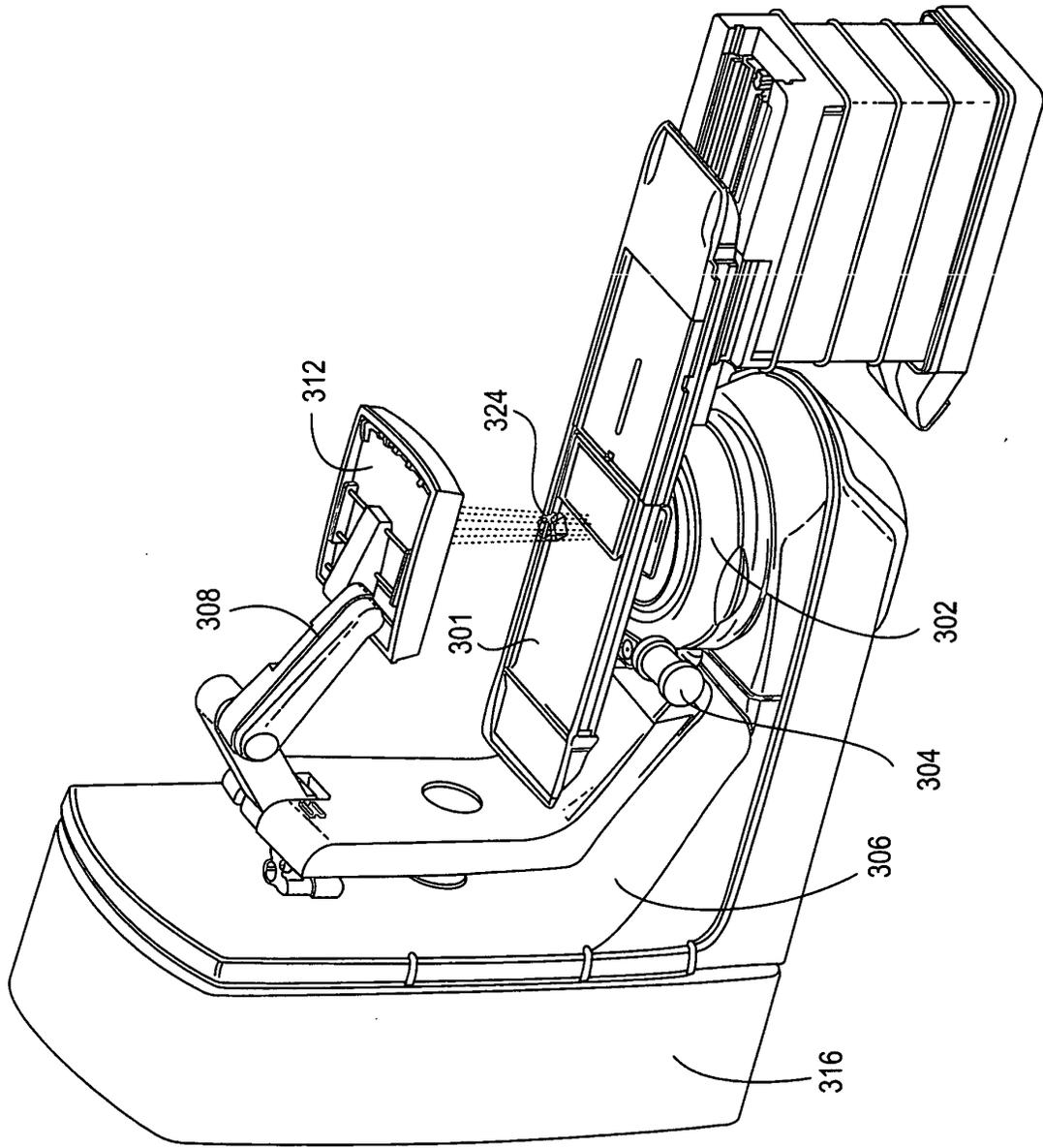


FIG. 3D

APPROVED	O.G. FIG.
BY	CLASS. SUBJECT
CRAFTSMAN	

FOOT SHEET

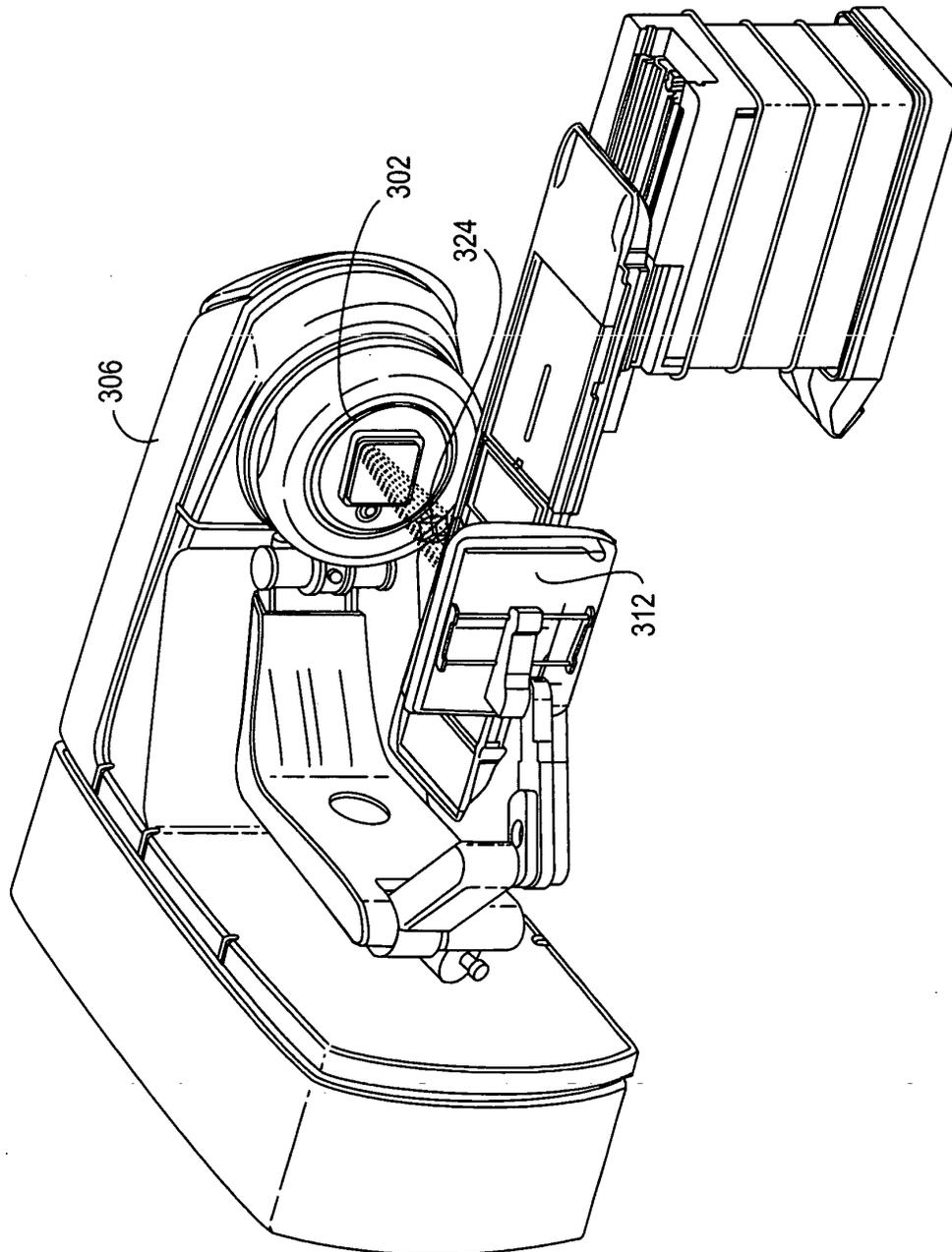


FIG. 3E

APPROVED	O.G. FIG.
BY	CLASS/SUBCL.
DRAFTSMAN	

FOOT REEBOOT

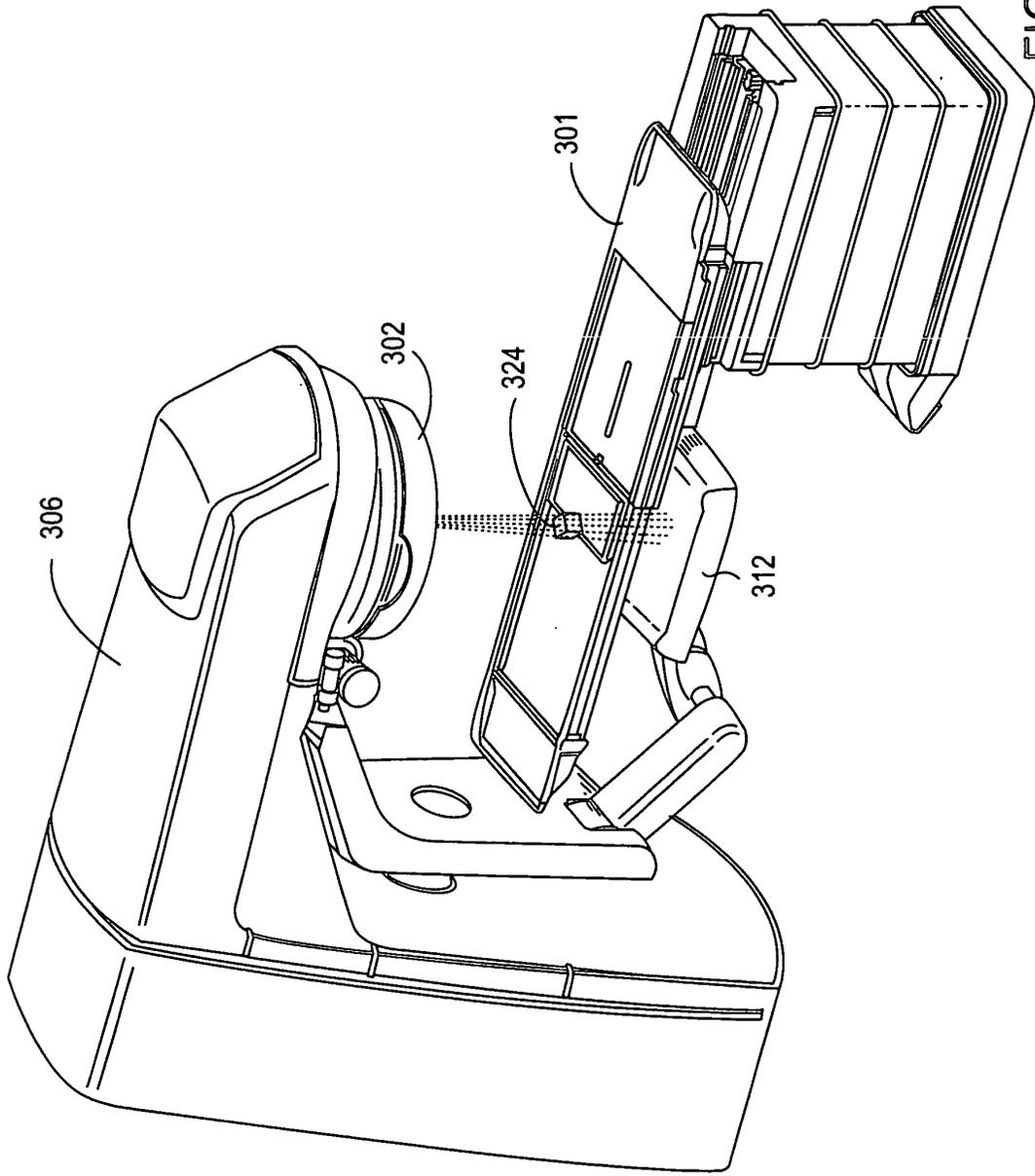


FIG. 3F

UNITED STATES PATENT APPLICATION

FOR

RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

INVENTOR:

ULRICH MARTIN GRAF

PREPARED BY:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP  
12400 WILSHIRE BOULEVARD  
SEVENTH FLOOR  
LOS ANGELES, CA 90025-1026

(408) 720-8300

BSTZ DOCKET NO.: 005513.P003

EXPRESS MAIL CERTIFICATE OF MAILING

"Express Mail" mailing label number: EL 672 750 138 US  
Date of Deposit: November 2, 2001

I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to Box Patent Application, Commissioner for Patents, Washington, D. C. 20231

Dianne Neathery  
(Typed or printed name of person mailing paper or fee)

Dianne Neathery 11-2-01  
(Signature of person mailing paper or fee)

Application  
Express Mail Label EL 672 750 138 US

Docket: 005513.P003

FOOT # 222222

## **RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR POSITIONING AN IMAGING UNIT**

### **FIELD OF THE INVENTION**

**[0001]** The present invention pertains in general to oncology radiation therapy. In particular, the invention involves an X-ray and electron radiotherapy machine used in radiation treatment applications.

### **BACKGROUND OF THE INVENTION**

**[0002]** The use of linear accelerators for the generation of either electron radiation or X-ray radiation is well known. After generating a stream of electrons, components in the radiotherapy machine can convert the electrons to X-rays, a flattening filter can broaden the X-ray beam, the beam can be shaped with a multileaf collimator, and a dose chamber can be arranged at the exit of an accelerator. A detector is mounted and is mechanically or electronically scanned synchronously with the mechanically or electronically scanned paraxial X-ray beam, providing continuous monitoring of alignment of the patient's anatomy. These systems typically provide either static fixed field radiation therapy or fully dynamic intensity modulated radiation therapy (IMRT) used by the medical community in the treatment of cancer.

**[0003]** One of the challenges inherent in radiotherapy treatment is the accurate positioning of the tumor in the radiation field. The main sources of the problem result from the fact that there is a natural motion of organs inside the body, which can range, for example, from approximately a millimeter in the case of the brain inside the skull, to several centimeters for the organs in the trunk above the diaphragm. Another factor relates to changes which occur in the tumor over time because of successful treatment. Over the course of treatment and as the tumor shrinks in volume, normal tissue which had been displaced returns to its original position within the treatment volume.

**[0004]** To accurately verify tumor positioning, detectors such as X-ray films or electronic X-ray imaging systems are commonly used in the radiation treatment

FOOTNOTES

FOOTNOTES

diagnostic process. In the case of electronic imaging, the megavolt therapeutic X-rays emerging from the patient can be used to generate images. However, these methods at target location deliver images of low contrast and insufficient quality. As a result, imaging with megavoltage radiation is used primarily for verification, that is to confirm that the target volume has been radiated. These problems associated with utilizing high energy X-rays produced by a megavolt electron beam are the result of interacting with matter mostly due to Compton scattering, in which the probability of interactions is proportional to the electron density. Low energy X-rays typically have energies of about 125 peak kilovolts (kVp) or below, where a significant portion of the interactions with matter is photoelectric and the interactions are proportional to the cube of electron density. Low energy X-rays are more useful to provide accurate targeting or diagnostic information because tissue in the human body is typically of low density and as a result, the contrast achieved in low energy X-rays is far superior to that obtained with megavoltage X-rays. Therefore, distinctions of landmark features and the imaging of other features not perceptible with high energy X-rays are possible using kV energy. As a result, two separate imagers, each sensitive to an energy range, i.e. either the megavolt source or the kV source are used in treatment.

**[0005]** One method taught is to incorporate a low energy X-ray source inside the treatment head of the accelerator capable of positioning itself to be coincident with the high energy X-ray source. With this approach, a high energy X-ray target is modified to include a compact 125 kV electron gun to be mounted to a moveable flange at the base of the high energy source with the cathode of the gun operably coupled to the upstream end of a drift tube. By engaging an actuator, the electron gun can be provide target information for diagnostic imaging. An imager can be used that is sensitive to kV range radiation energies and positioned opposite the kV electron gun with the target volume in between. Therapeutic treatment can then be started or resumed by positioning the high-energy or megavolt electron beam trajectory to be in line with the target volume. A second imager is positioned opposing the megavolt source that is more sensitive to the radiation energy used in the therapeutic and verification procedure.

**[0006]** **FIGS. 1A & 1B** are illustrations of a radiotherapy clinical treatment machines to provide therapeutic and diagnostic radiation, each directed to a different imager.

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**FIG.1A** is an illustration of the radiotherapy machine having a single diagnostic X-ray source directed to a single imager. The radiotherapy machine has a therapeutic radiation source directed to a therapeutic imager along a first axis and the diagnostic X-rays are directed to the second imager along an axis that is 90° from the first axis. This apparatus places the therapeutic radiation source capable of propagating radiation in the megavoltage (MV) energy range and the kilovoltage (kV) diagnostic radiation source on different support structures. Each radiation source has an imager opposing that is in line to the respective radiation source along an axis.

**[0007] FIG. 1B** is an illustration of the radiotherapy machine having dual diagnostic X-ray sources, each directed to a separate diagnostic imager. The radiotherapy machine has a therapeutic radiation source capable of propagating a therapeutic radiation beam along an axis to a therapeutic imager. Attached to support structures are two diagnostic radiation sources that can propagate diagnostic X-rays at off-angles from the therapeutic radiation axis. Each radiation source as an imager in line to receive the radiation. The entire structure of radiation sources and imagers can be pivoted together by a common base.

**[0008]** Cancer patients usually need to lie on their backs for radiation treatment and the patient's anatomy can shift markedly from supine to prone positions. In order to irradiate the target volume from different directions without turning the patient over, 360° rotation of the support structure holding the radiation source is needed. For convenience in setting up the patient, the isocenter around which the equipment rotates should not be too high above the floor. Adequate space must be provided between the isocenter and the radiation head for radiation technologist access to the patient and for rotation clearance around the patient. This leaves a quite limited amount of space for the various components such as the radiation shielding in the radiation head, and particularly for the magnet system. To a significant extent, the design challenge over the years has been to stay within this space, to reduce cost where possible, and while making major advances in the clinical utility of machines.

## SUMMARY OF THE INVENTION

[0009] A radiotherapy clinical treatment machine can have a therapeutic radiation source on a first pivotable gantry. A second pivotable gantry can have a single imager mounted on an articulable end of the second gantry and a diagnostic radiation energy source can be mounted on a retractable opposing end of the second gantry. The first gantry and the second gantry may pivot on a common centerline. The imager can be a multiple-energy imaging unit which can be naturally in line with the diagnostic radiation source or the second gantry can pivot to place the multiple-energy imaging unit in line with the therapeutic radiation source. Pivoting the second gantry may require the diagnostic radiation source first be retracted to provide clearance where it rotates past the therapeutic radiation energy source.

[0010] This arrangement for positioning the multiple-energy imaging unit to be in line with either one of the radiation sources can provide improved imaging useful in directing the treatment beams used in radiation therapy. A first energy level in the kV range can radiate a target volume to provide diagnostic quality image information from the multiple-energy imaging unit. The diagnostic information can be used to better direct radiation at a second energy level in the MV range for therapeutic radiation of the target volume and from which verification information from the multiple-energy imaging unit can then be acquired. The second gantry can pivot, extend/retract, and/or articulate to receive diagnostic radiation or therapeutic radiation. The application of therapeutic radiation and diagnostic radiation can alternate in any combination to provide diagnostic imaging and verification imaging as a result of the degrees of freedom available to position the single multiple-energy imaging unit.

FOOTNOTES

## BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

[0012] FIG. 1A is an illustration of the radiotherapy machine having a single diagnostic X-ray source directed to a single imager.

[0013] FIG. 1B is an illustration of the radiotherapy machine having dual diagnostic X-ray sources, each directed to a separate diagnostic imager.

[0014] FIG. 2A is an illustration of a radiotherapy clinical treatment machine in one embodiment using a multiple-energy imaging unit.

[0015] FIG. 2B is an illustration of an alternate embodiment of the radiotherapy clinical treatment machine using the multiple-energy imaging unit.

[0016] FIG. 3A is an illustration in one embodiment of the starting position for the radiotherapy clinical treatment machine.

[0017] FIG. 3B is an illustration in one embodiment of a diagnostic radiation source in use.

[0018] FIG. 3C is an illustration in one embodiment of the diagnostic radiation source providing multiple-slices of a target volume.

[0019] FIG. 3D is an illustration in one embodiment of a therapeutic radiation source providing radiation to the target volume.

[0020] FIG. 3E is an illustration in one embodiment of the therapeutic radiation source rotated to a new position to provide radiation to the target volume.

[0021] FIG. 3F is an illustration in one embodiment of another rotation of the first gantry and dose of therapeutic radiation applied to the target volume from another position.

FOOTNOTES

## DETAILED DESCRIPTION

**[0022]** A method and apparatus for a radiotherapy clinical treatment machine for positioning an imager to oppose one or more radiation sources is disclosed. For purposes of discussing the invention, it is to be understood that various terms are used by those knowledgeable in the art to describe apparatus, techniques, and approaches.

**[0023]** In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one skilled in the art that the present invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in gross form rather than in detail in order to avoid obscuring the present invention. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, mechanical, electrical, and other changes may be made without departing from the scope of the present invention.

**[0024]** In one embodiment, a method and apparatus is disclosed for an X-ray and electron radiotherapy clinical treatment machine. The apparatus and method can position and re-position a single imager to receive radiation from more than one radiation source. Imagers can generally provide high quality imaging from one radiation energy range and less quality imaging from other radiation energy ranges and such an imager can be incorporated into this invention. However, in this embodiment, the imager can be capable of receiving and displaying high quality imaging information from multiple energies (multiple-energy imaging unit). One of the energies can be a source of therapeutic energy and another a source of diagnostic X-rays, both of which can alternately activate the multiple-energy imaging unit for high quality verification imaging and high quality diagnostic imaging respectively. The radiotherapy machine can generate an electron beam, generally in the 4 to 25 megavolt (MV) range, to provide electrons or X-rays to a volume within a patient undergoing treatment, i.e. a target volume. The multiple-energy imaging unit can display radiographic information from the

FOOTNOTES

megavolt radiation sufficient to provide verification that the target volume is being radiated.

**[0025]** This single multiple-energy imager can also be optimized to work with energy in the kilovolt (kV) range. The multiple-energy imaging unit can receive X-rays in the kV range to provide more accurate diagnostic information on the size, shape, and location of the target volume. Repeated X-ray shots with kV energy that alternate with therapeutic radiation can reduce target error such as by directing a continuous adjustment of the beam shaping by a dynamic multileaf collimator and by providing targeting information to the therapeutic radiation source.

**[0026]** The diagnostic radiation source can be rotated about the target volume for CT single or multiple CT images using a fan x-ray beam, or by using a cone x-ray beam where volumetric information can be constructed. Also, if a partial data set is acquired from a limited number of images taken at specific angles around the target volume, enough information can be obtained with the help of previously acquired volumetric information to provide the 3D reconstruction of the anatomy of interest. As a result, imaging from the diagnostic X-rays can provide targeting information to accurately direct the therapeutic X-rays to the target volume from any angle while effectively excluding healthy tissue from injury. Furthermore, the diagnostic source can be operated either in a continuous or pulsed manner to provide a real time or quasi-real time fluoroscopic image of moving internal anatomy. This fluoroscopic image can be used to provide information to track the motion of anatomy being treated. Normal respiration or unwanted voluntary or involuntary patient movement may cause such motion. This motion tracking information can in turn be used to adjust treatment parameters or gate the treatment beam off and on such that the anatomy intended to be treated is always in the intended position within the treatment beam.

**[0027]** **FIG. 2A** is an illustration of one embodiment of an imager positioning gantry on a radiotherapy clinical treatment machine where the imager can be a multiple-energy imaging unit. As shown in **FIG. 2A**, the radiotherapy clinical treatment machine 200 can have an imager positioning gantry to position the multiple-energy single imager to oppose one or more radiation sources. A therapeutic radiation source 202 and a diagnostic radiation source 204 can be positioned on separate arms (gantries), 206 and

208, where one arm (second gantry) 208 is nestled within the other (first gantry) 206, and with both arms 206 and 208 on a common pivot axis 210. The two arms 206 and 208 can pivot 210 independently and in addition, the inner arm (second gantry) 208 can extend and retract the diagnostic radiation source 204 for positioning and clearance. The therapeutic radiation source 202 can be positioned on the first arm (first gantry) 206 which can be pivotally attached to a vertical stand or base 216 to allow an effective 360° rotation of the therapeutic radiation source 202 about the target volume 224.

**[0028]** The imager can be a multiple-energy imaging unit and can be attached to the inner arm (second gantry) 208 at the end opposite from the diagnostic radiation source 204. The inner arm end 220 attached to the multiple-energy imaging unit 212 can articulate the multiple-energy imaging unit 212 into alignment with either radiation source 202 or 204. Attached to the second gantry 208, the multiple-energy imaging unit 212 is in natural alignment to receive radiation from an extended diagnostic radiation source 204. Fine adjustments to place the multiple-energy imaging unit into alignment with and at the proper distance from the radiation source 202 or 204 are also accomplished with the articulating portion of the second gantry 220. Alternately, the diagnostic radiation source 204 can be retracted for clearance so that the inner arm 208 can rotate and the multiple-energy imaging unit 212 articulate until the multiple-energy imaging unit 212 is in alignment to receive radiation from the other radiation source 202 or 204.

**[0029]** The first gantry 206 and the second gantry 208 can have a “C” shape (C-Arm) and the second gantry 208 can have a smaller radius of curvature and be nestled within the first gantry 206. The diagnostic X-ray source 204 can be mounted on one end 218 of the second gantry 208 and the multiple-energy imaging unit 212 to oppose on the other end 220. The radiation source end 218 of the second gantry 208 can extend or retract the diagnostic X-ray source 204 to provide clearance around the therapeutic radiation geometry (head) 222 on the first gantry 206. The diagnostic X-ray source 204 can also be extended and retracted, along with second gantry 208 rotation, to place the diagnostic X-ray source 204 in positions about the target volume 224. The articulating end 220 can be attached to an opposite end 220 of the second gantry C-arm 208 to hold and position the multiple-energy imaging unit 212. In one embodiment, the

FOOTNOTES

articulating end 220 can pivot at three points 226, 227, and 228 the multiple-energy imaging unit 212 along two independent axes 230 in a plane. The articulating end 220 can contain any number of pivot points from single plane pivots to ball joints having 360 degrees of rotation for positioning the multiple-energy imaging unit. The translatable 230 portion of the articulating joint can be a set of sliding mechanisms that include gears and motors which are well known to one skilled in the art. The result of such articulation can be to place the multiple-energy imaging unit in alignment with, and at a distance from, either of the radiation sources 202 and 204 with the target volume 224 positioned in between. Further, the articulating end 220 can retract to position the multiple-energy imaging unit 212 ' into a stowed position.

**[0030]** FIG. 2B is an illustration of an alternate embodiment of the radiotherapy clinical treatment machine using the multiple-energy imaging unit. As shown in FIG. 2B, the therapeutic radiation source 202 and the diagnostic radiation source 204 can be positioned adjacent to each other and attached at the same end of the first gantry 206. The first gantry 206 can rotate about pivot axis 210 to position either the therapeutic radiation source 202 or the diagnostic radiation source 204 into alignment about the target volume 224. The second gantry, an inner arm 209, can be attached to the pivot axis 210 with an opposite end 227 attached to the articulating multiple-energy imaging unit 212. The multiple-energy imaging unit 212 can be rotated and articulated until alignment with either radiation source 202 or 204 is achieved, maintaining the target volume 224 in between.

**[0031]** FIGS. 3A – 3E illustrate the operation of one embodiment of the radiographic clinical treatment machine. FIGS. 3B –3E retain the target volume 324 but have the patient outline 303 removed for clarity. FIG. 3A is an illustration of a starting position for the radiotherapy clinical treatment machine. A couch 301 can place a patient 303 in a starting position. The patient 303 can contain a volume within the body that constitutes the targeted volume 324. The first gantry 306 can be in an upright position, and the second gantry 308 can be upright with the diagnostic radiation source 304 in a retracted position. The multiple-energy imaging unit 312 can be unstowed and positioned beneath the couch 301.

**[0032] FIG. 3B** is an illustration of the diagnostic radiation source in use. The second gantry 308 can first rotate to provide clearance for the diagnostic radiation source 304 from the therapeutic radiation source 302. Once the diagnostic radiation source 304 is clear, the second gantry 308 can further rotate and extend the diagnostic radiation source 304 to be in alignment with the target volume 324 and maintain clearance between interfering geometries, i.e. 302 and 304. The multiple-energy imaging unit 312 can be further articulated and the couch 301 translated and raised or lowered until a proper alignment and distance is set relative to the target volume 324. When in position, the diagnostic radiation source 304 can direct an X-ray beam to the target volume 324 and then to the multiple-energy imaging unit 312.

**[0033] FIG. 3C** is an illustration of the diagnostic radiation source providing another X-ray view of the target volume (not shown) at a new position. The diagnostic radiation source 304 and the multiple-energy imaging unit 312 can be rotated together by rotating any combination of either the first gantry 306 or the second gantry 308 to provide multiple X-ray views at different angles that can be assembled to generate 3-dimensional images of the target volume.

**[0034] FIG. 3D** is an illustration of the therapeutic radiation source providing radiation to the target volume. After target volume definition has been provided by the diagnostic radiation step, the diagnostic radiation source 304 can be retracted for clearance and the second gantry 308 rotated until the multiple-energy imaging unit 312 opposes the therapeutic radiation source 302. The therapeutic radiation source 302 can be positioned to radiate the target volume 324 based on information gained from the diagnostic radiation step. At this point, the target volume 324 can receive a therapeutic dose of radiation and the multiple-energy imaging unit 312 can generate verification data from this same radiation.

**[0035] FIG. 3E** is an illustration of the therapeutic radiation source rotated to a new position to provide radiation to the target area 324. The first gantry 306 can be rotated, along with the multiple-energy imaging unit 312, to reposition the therapeutic radiation source 302 to radiate the target volume 324 from the new angle.

**[0036] FIG. 3F** is an illustration of another rotation of the first gantry 306, and the multiple-energy imaging unit 312, to generate another dose of therapeutic radiation to

FOOTNOTES

the target volume 324 from yet another position. With each new position of the therapeutic radiation source 302, the multiple-energy imaging unit 312 and the couch 301 can be repositioned, new diagnostic imaging performed and another dose of therapeutic radiation initiated.

**[0037]** It is to be appreciated that, with this apparatus to position a single imager, it is possible to alternate therapeutic radiation with diagnostic radiation in several ways. In one method, the diagnostic radiation can provide imaging of a 2-dimensional nature. For therapeutic targeting, the therapeutic radiation source may be required to position itself at the same axis used by the diagnostic radiation source. In other methods, when multiple slices are taken or when using imaging data from a cone beam, a 3-dimensional construction is possible of the target area and therapeutic radiation can be targeted from any axis angle as a result.

**[0038]** In one embodiment, radiation at a first energy level can radiate a target volume along a first axis to provide diagnostic information to a multiple-energy imaging unit. Diagnostic information from the multiple-energy imaging unit can direct radiation at a second energy level along a second axis to provide therapeutic radiation to the target volume and verification information to the multiple-energy imaging unit. The first energy level can be in the kV energy range and the second energy level can be in the MV energy range. At any time during treatment, the first axis of radiation and the second axis of radiation can be the same or different. Diagnostic radiation and therapeutic radiation can alternate in any combination to provide diagnostic imaging and verification imaging by a single multiple-energy imaging unit for the overall radiation therapy of one or more target volumes.

**[0039]** The accuracy of diagnostic information can be improved by placing internal seeds to act as markers for the target volume. Placement of these markers can be accomplished by performing a needle biopsy. This is a commonly performed procedure normally required to gain tumor grading information needed to plan the therapy. These markers can provide higher contrast for the multiple-energy imaging unit for some tissues that might otherwise be difficult or impossible to discern. This can determine a more accurate location of the target volume and/or edges of the target volume. Marker

data can be stored and recalled later to provide anatomical landmark definition to enhance position information on target volume during radiotherapy.

**[0040]** The multiple-energy imaging unit is a common portal imager capable of receiving radiation from the two radiation sources, each having a different energy level or range. One radiation source can provide energy in the megavolt range for treatment (therapeutic) and coarse target or verification information while the other radiation source can provide energy in the kilovolt range for determining a more precise location of target volumes (diagnostic) for periodically directing the megavolt energy source. The multiple-energy imaging unit can be a flat-panel amorphous silicon (a-Si) portal imaging device. A-Si flat-panel imagers can consist of a two-dimensional array of imaging pixels which are configured as photodiodes.

**[0041]** A multiple-energy imaging unit can display results from radiation from either a higher energy source, such as, for example, as used in therapeutic treatment or from radiation by a lower energy source such as, for example, as used in diagnostic purposes. A-Si imagers convert the optical signal from the overlaying phosphor, which acts together with a thin metal plate as an x-ray detector, to charge and store that charge on the pixel capacitance. To form an image, the charge on the pixels is read out line by line. Multiple-energy a-Si imagers may use a conversion screen design within the imager for multiple energy data unit collection from the two radiation sources. This specialized design can result in different spectral efficiency detection. One design is to use two or more conversion screen/a-Si detector layers, one on top of the other with a combined filter/grid design. Each screen layer will produce an image data unit for a particular radiation energy. One embodiment of a multiple-energy imaging unit, as discussed in US patent application titled "X-Ray Image Acquisition Apparatus", filed November 2, 2001, and assigned with this application to a common owner at the date of filing, hereby incorporated by reference, may be used. Alternatively other imaging units may be used.

**[0042]** With this invention, the multiple-energy imaging unit can receive kV radiation that passes through the target volume. The multiple-energy imaging unit can then provide detailed location information for targeting by the therapeutic radiation source. During the application of therapeutic radiation, the multiple-energy imaging unit can be

repositioned to receive megavoltage energy to provide verification information. A single imager can reduce the amount of space taken up in the treatment area by elements of a radiotherapy machine. In addition, a single imager can reduce cost and complexity for an overall IMRT system.

**[0043]** Thus a method and apparatus for a radiotherapy clinical treatment machine having a single imager attached to a pivotable and articulable gantry have been described. Although the present invention has been described with reference to specific exemplary embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the invention as set forth in the claims. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

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## CLAIMS

What is claimed is:

1. An apparatus comprising:  
a first radiation source attached to a first gantry;  
at least one second radiation source;  
a second gantry that is rotatable; and  
an imager attached to an articulable end of the second gantry.
2. The apparatus of claim 1, wherein at least one second radiation source is attached to the first gantry.
3. The apparatus of claim 1, wherein at least one second radiation source is attached to the second gantry.
4. The apparatus of claim 1, wherein the first radiation source is capable of propagating therapeutic energy.
5. The apparatus of claim 1, wherein at least one second radiation source is capable of propagating diagnostic energy.
6. The apparatus of claim 1, wherein the first gantry is rotatable.
7. The apparatus of claim 6, wherein the first gantry and the second gantry are rotatable about a common pivot axis.
8. The apparatus of claim 1, wherein the imager is a multiple-energy imaging unit.
9. The apparatus of claim 1, wherein the articulable end includes at least one pivot point between the second gantry and the imager.

FOOTER

FOOTNOTES

- 10. The apparatus of claim 1, wherein the articulable end includes a sliding mechanism capable of translating the imager in a plane.
  
- 11. The apparatus of claim 1, wherein one of the at least one second radiation source is attached to a sliding mechanism capable of extending and retracting the second radiation source from the second gantry.
  
- 12. The apparatus of claim 1, wherein the articulable end is capable of folding the imager against the second gantry.
  
- 13. The apparatus of claim 7, wherein the second gantry is nestled within the first gantry.
  
- 14. A method for applying radiation, comprising:
  - positioning a diagnostic radiation source to be in alignment with a target volume;
  - positioning an imager to receive radiation from the diagnostic radiation source;
  - positioning a therapeutic radiation source to be in alignment with the target volume; and
  - re-positioning the imager to receive radiation from the therapeutic radiation source.
  
- 15. The method of claim 14, further comprising:
  - propagating the diagnostic radiation toward the target volume;
  - receiving the diagnostic radiation by the imager after passing through the target volume;
  - positioning the therapeutic radiation source is based on results of the diagnostic radiation to the imager;
  - propagating the therapeutic radiation into the target volume;
  - receiving the therapeutic radiation by the imager after passing through the target volume; and
  - generating verification data by the imager from the therapeutic radiation.

16. The method of claim 14, wherein the imager is a multiple-energy imaging unit.
17. The method of claim 14, further comprising; placing an internal seed to act as a marker for the target volume.
18. The method of claim 15, further comprising generating multiple diagnostic radiation slices using a fan X-ray beam to provide a 3-dimensional reconstruction of the target volume.
19. The method of claim 15, further comprising generating a cone X-ray beam where volumetric information can be constructed.
20. The method of claim 15, wherein the diagnostic radiation can be operated continuously to provide real time a fluoroscopic image of moving internal anatomy.
21. The method of claim 15, wherein the diagnostic radiation can be operated in a pulsed manner to provide a quasi-real time fluoroscopic image of moving internal anatomy.
22. A method for imaging radiation, comprising:  
    positioning a multiple-energy imaging unit normal to a first axis to receive radiation at a first energy level;  
    propagating radiation by a first radiation source at the first energy level along the first axis;  
    retracting the first radiation source and positioning a second radiation source along the first axis.  
    maintaining the multiple-energy imaging unit normal to the first axis to receive radiation by the second radiation source; and  
    propagating radiation by the second radiation source.

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23. The method of claim 22, further comprising:  
rotating the first radiation source until clear of the second radiation source;  
extending the first radiation source to be in line with the multiple-energy imaging unit;  
propagating radiation at a first energy level toward the multiple-energy imaging unit.

24. The method of claim 22, further comprising pivoting two arms independently, the first arm attached to the first radiation source for propagating at the first energy level, and the second arm attached to the second radiation source for propagating at the second energy level.

25. The method of claim 24, wherein the multiple-energy imaging unit is attached to the second arm.

26. An apparatus, comprising:  
a therapeutic energy source attached to a first gantry;  
a diagnostic energy source attached to a translatable end of a second gantry;  
a multiple-energy imaging unit attached to an opposite articulable end of the second gantry;  
the first gantry and the second gantry independently pivotable and attached at a common axis;  
a patient couch capable of translation, wherein the result of such pivoting and translation is to place a target volume of a patient between the multiple-energy imaging unit aligned with the diagnostic energy source or the therapeutic energy source.

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ABSTRACT OF THE DISCLOSURE

An apparatus including a first radiation source attached to a first gantry, at least one second radiation source, a second gantry that is rotatable; and an imager attached to an articulable end of the second gantry.

FOR OFFICIAL USE ONLY

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

RADIOTHERAPY APPARATUS EQUIPPED WITH AN ARTICULABLE GANTRY FOR  
POSITIONING AN IMAGING UNIT

the specification of which

X  is attached hereto.  
    was filed on (MM/DD/YYYY) \_\_\_\_\_ as  
United States Application Number \_\_\_\_\_  
or PCT International Application Number \_\_\_\_\_  
and was amended on (MM/DD/YYYY) \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application. I do not know and do not believe that the claimed invention was in public use or on sale in the United States of America more than one year prior to this application, nor do I know or believe that the invention has been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior Foreign Application(s)

Priority Claimed

(Number)	(Country)	(Foreign Filing Date - MM/DD/YYYY)	Yes	No
(Number)	(Country)	(Foreign Filing Date - MM/DD/YYYY)	Yes	No
(Number)	(Country)	(Foreign Filing Date - MM/DD/YYYY)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

(Application Number)	(Filing Date – MM/DD/YYYY)
(Application Number)	(Filing Date – MM/DD/YYYY)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	(Filing Date – MM/DD/YYYY)	(Status -- patented, pending, abandoned)
(Application Number)	(Filing Date – MM/DD/YYYY)	(Status -- patented, pending, abandoned)

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

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(Name of Attorney or Agent)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made in information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and those like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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APPENDIX A

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TORRETT & ASSOCIATES

## APPENDIX B

### Title 37, Code of Federal Regulations, Section 1.56 Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

PATENT APPLICATION SERIAL NO. \_\_\_\_\_

U.S. DEPARTMENT OF COMMERCE  
PATENT AND TRADEMARK OFFICE  
FEE RECORD SHEET

01/04/2002 MBIZUNES 00000065 10033327

01 FC:101	740.00	DP
02 FC:103	109.00	DP
03 FC:102	84.00	DP

PTO-1556  
(5/87)

\*U.S. GPO: 2000-468-987/39595

**PATENT APPLICATION FEE DETERMINATION RECORD**  
Effective October 1, 2001

Application or Docket Number

*005513. P003*

**CLAIMS AS FILED - PART I**

	(Column 1)	(Column 2)
TOTAL CLAIMS	<i>26</i>	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	<i>26</i> minus 20 = *	<i>6</i>
INDEPENDENT CLAIMS	<i>4</i> minus 3 = *	<i>1</i>
MULTIPLE DEPENDENT CLAIM PRESENT <input type="checkbox"/>		

SMALL ENTITY TYPE

OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X\$ 9=		OR	X\$18=	<i>108</i>
X42=		OR	X84=	<i>84</i>
+140=		OR	+280=	—
TOTAL		OR	TOTAL	<i>932</i>

\* If the difference in column 1 is less than zero, enter "0" in column 2

**CLAIMS AS AMENDED - PART II**

	(Column 1)		(Column 2)		(Column 3)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA
	Total	*	Minus	**	=
	Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>					

SMALL ENTITY

OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)		(Column 2)		(Column 3)
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA
	Total	*	Minus	**	=
	Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>					

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)		(Column 2)		(Column 3)
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA
	Total	*	Minus	**	=
	Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>					

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."

\*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

# CLAIMS ONLY

SERIAL NO. 103333 27 FILING DATE  
 APPLICANT(S)

## CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT		*	*		*	
	IND.	DEP.	IND.	DEP.	IND.	DEP.		IND.	DEP.	IND.	DEP.
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TOTAL IND.	4										
TOTAL DEP.	22										
TOTAL CLAIMS	26										
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99											
100											
TOTAL IND.											
TOTAL DEP.											
TOTAL CLAIMS											

\* MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS

Attorney's Docket No. 005513.P003

**PATENT**

#4  
LJUSON  
01-28-02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

JC979 U.S. PTO  
10/033327  
11/02/01

In Re Patent Application of: )  
Ulrich Martin Graf )  
Application No.: Not yet assigned )  
Filed: Herewith (11/2/2001) )  
For: RADIOTHERAPY APPARATUS )  
EQUIPPED WITH ARTICULABLE )  
GANTRY FOR POSITIONING AN )  
IMAGING UNIT )

Examiner: Not yet assigned

Art Unit: Not yet assigned

Box Patent Application  
Commissioner for Patents  
Washington, D.C. 20231

**INFORMATION DISCLOSURE STATEMENT**

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 together with copies of the documents cited on that form. It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

I hereby certify that I am causing this correspondence to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service (Label # EL 672 750 138 US) on the date indicated below and that this correspondence has been addressed to: Box Patent Application, Commissioner for Patents, Washington, D. C. 20231 on November 2, 2001

(Date of Deposit)

Dianne Neathery  
(Typed or printed name of person mailing correspondence)

Dianne Neathery 11-2-01  
(Signature and date of person mailing correspondence)

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of the appropriate paragraph):

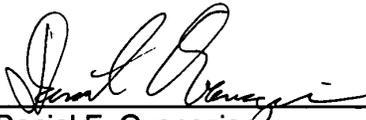
- 37 C.F.R. §1.97(b).
- 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:
- A statement pursuant to 37 C.F.R. §1.97(e) or
- A check for \$180.00 for the fee under 37 C.F.R. § 1.17(p).
- 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:
- (1) A statement pursuant to 37 C.F.R. §1.97(e); and
  - (2) A check for \$180.00 for the fee under 37 C.F.R. §1.17(p) for submission of the Information Disclosure Statement.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: November 2, 2001



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