(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 879 434 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.01.2008 Bulletin 2008/03

(51) Int Cl.:
H05H 9/00 *(2006.01)* ***H05H 7/00*** *(2006.01)*

(21) Application number: **06425479.0**

(22) Date of filing: **10.07.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(71) Applicant: **Gatto, Pompilio**
00040 Roma RM (IT)

(72) Inventor: **Gatto, Pompilio**
00040 Roma RM (IT)

(54) **Internal-waveguide mobile linac for radiation therapy**

(57) Electromedical apparatus for IORT by means of a linac, including an arm in which a RF generator is assembled. The arm supports a radiating head (2) including an electron linac (20), connected with the RF generator through a waveguide assembly which includes two waveguide lengths connected with each other through a rotary coupling, to allow the roll of the head. A length, that passes between the head and the arm, is flexible (21) to allow the pitch of the head.

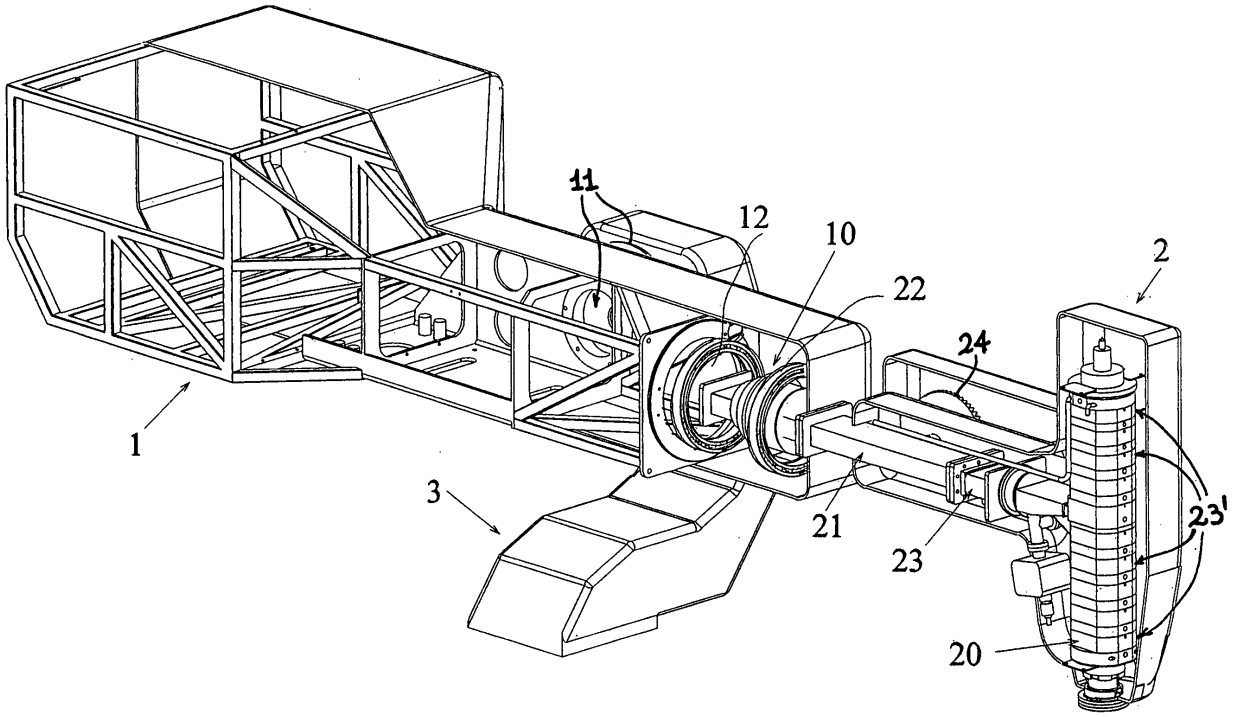

FIG. 1

EP 1 879 434 A1

Description

TECHNICAL FIELD

[0001] This invention relates to a mobile electromedical apparatus for Intraoperative Radiation Therapy (or "IORT") by means of Linear Accelerator (or "linac") of Electrons.

PRIOR ART

[0002] An electron linac is an evacuated waveguide in which a high-frequency travelling electromagnetic wave is excited, the axial electric field of which accelerates electrons. The phase velocity of the wave is made equal to the velocity of electrons by assembling irises in the guide, which delimitate accelerating coupled resonant cavities. The linac is supplied by a radiofrequency (or "RF") oscillator through a waveguide. A feature of a linac is the *collimation* of the beam, i.e. the parallelism of the trajectories of the electrons it emits.

[0003] A mobile "linac for IORT" is a mobile apparatus for applying radiations to produce a destructive effect on a tumour tissue. Electron irradiation has the advantage relative to photon irradiation of penetrating in the tumour tissue in a modulated manner (according to the desired depth), with the exclusion of surrounding healthy tissues. The surgeon after the removal of a tumour fixes the area to be treated with the radiotherapist and selects the energy of the beam with the sanitary physicist to administer the proper dose at a set depth.

[0004] A known-art apparatus includes a mobile radiating head containing an irradiation group including a linac. The beam emitted by this one is collimated by means of an applicator and scattered through the interaction with air existing inside the applicator. The applicator includes an upper applicator, directly connected with the radiating head, and a lower applicator, which is arranged in the surgical breach. With the object in view of the treatment, the upper applicator, in an operating stage of *docking* (i.e. of aligning and coupling) is brought in axis with the lower applicator, at a short distance from it, and connected to it through a ring nut.

[0005] The radiating head is supported by a "stand", including an articulated arm assembled on a motor mobile bedplate by a coupling which allows its yaw and pitch. The radiating head is assembled to the arm by a coupling which allows its roll and pitch.

[0006] The linac is supplied by a RF generator assembly including a cavity magnetron, equipped with a cathode modulation device and connected with the linac through a waveguide.

[0007] In known-art apparatuses the irradiation assembly is assembled in the radiating head, and the RF generator assembly is assembled in the arm of the stand, separately from the radiating head, beyond the coupling of this one. The waveguide that connects the linac to the RF generator assembly is a flexible waveguide that steps over the coupling of the radiating head, passing outside the apparatus, and which in operation bends and twists, correspondingly assuming bending and twisting configurations.

[0008] Problems are connected with such an "external" flexible waveguide, or "external waveguide".

[0009] The flexible waveguide turns out to be the component of the apparatus which wears most. Such a wear is promoted by the mechanical stress which is determined upon it as a consequence of said bending and, still more, twisting per se, and by the fact that in determined positions it goes to scrape against the ceilings, in particular against false ceilings (which are low) of operating theatres. The external guide presents considerable problems in passing through the entry/exit door of operating theatres. The failure rate of the external guide is also increased by the risk that it breaks when one applies a twisting which is accentuated, but required by the type of surgical breach under examination at a given moment.

[0010] The external guide heavily limits the movements of the apparatus in translation on the floor (macromovements) as a consequence of the fact that it goes to interfere with ceilings, it being also possible that the apparatus remains blocked. This is a limiting factor not of little account, because it is critical that the operator has ease in displacing the apparatus, in particular he/she can bring it on a side and on the other of an operating bed, to access an surgical breach and bring the radiating head close to it. The external guide, moreover, limits the movements of the head as for roll and pitch (micromovements), in that it "tethers" the head itself. This "tethering" of the head is too a limiting factor of considerable account, because it is critical that the head has ease of displacement for the purposes of the docking, an essential factor to execute the irradiation.

[0011] A further problem brought by the external guide is that when this one bends or twists, the frequency of the wave guided in it alters, the frequency of oscillation of the magnetron so going out of coincidence with the resonance frequency of the linac.

[0012] A flexible waveguide has an aptitude to bend within determined limits many times, but twisting can cause it to fail, because this one is a strain which puts the cohesion to serious test between the metal portion and the rubber portion which compose the waveguide. A flexible waveguide is not fabricated to support twisting or even bending and twisting at the same time, as is the case of the external waveguide of known-art apparatuses.

DISCLOSURE OF THE INVENTION

[0013] Therefore, in view of the problems of external-waveguide apparatuses, this invention puts itself the object to solve them, by substituting the external guide with an "internal" guide.

[0014] Such an object is reached, according to this invention, by splitting the waveguide in two lengths, and

connecting these ones in a waveguide assembly through a rotary coupling, which will allow the roll of the head, without a twisting of the waveguide assembly, whilst a portion of flexible waveguide that passes between arm and head, will allow the pitch of the head.

[0015] It is an advantage of the inventive apparatus the great mobility of it, it being able to pass through a door even less high than 2.20 m.

[0016] It is an advantage of this invention that by virtue of it so a close approaching is realized of the radiating head to a tumour zone, that a very fine position adjustment is possible of the head itself, whereby the docking turns out to be enormously facilitated.

[0017] Moreover, this invention takes its steps from ascertaining that tumours exist, like skin melanomas, which present themselves in zones having a highly uneven contour, the irradiation of which, if carried out to a poor precision, such as by known-art apparatuses making use of collimating applicators, involves the irradiation of a lot of healthy surrounding tissue, and that, therefore, the exigency is strongly felt of being able to carry out the irradiation of a tumour in an extremely precise manner.

[0018] Therefore, this invention poses itself the further object of satisfying such an exigency by providing an apparatus with which it turns out to be possible to carry out a dot-like (point-to-point) treatment of a tumour zone, bringing the radiating head to scan the zone faithfully within the contour of it.

[0019] Such an object is reached by equipping an inventive apparatus with a self-focusing linac. In fact the restriction of the electron beam emitted by a self-focusing beam, in conjunction with the very fine position adjustment of the radiating head that can be achieved by an inventive apparatus allows a very fine intervention control to be achieved.

[0020] It is an advantage of the apparatus having a self-focusing linac that the applicator is not used with it and therefore the difficulties of the docking are no more present.

[0021] Therefore, it is the subject of this invention an electromedical apparatus according to annexed Claim 1.

[0022] A preferred embodiment is set forth in dependent Claim 2.

BRIEF DESCRIPTION OF THE DRAWING

[0023] This invention will be fully understood based on the following detailed disclosure of an exemplifying, absolutely not restricting embodiment thereof, referring to the annexed drawing, wherein:

- FIGURE 1 is a perspective view of the articulated arm of an inventive apparatus with broken away portions.

BEST WAY OF REALIZING THE INVENTION

[0024] The articulated arm is represented in FIGURE 1 of an electron linac apparatus for radiation therapy, including at an extremity thereof a housing 1 containing a high-voltage generator assembly and a RF generator assembly (not shown) including an oscillator, e.g. a cavity magnetron or a klystron, and supporting at its opposite extremity a radiating head 2 including a housing containing an electron linac 20 and endowed with a diaphragm for the output of the electron beam emitted by such a linac.

[0025] The arm is assembled by means of a coupling 11, which allows the pitch thereof, on a link 3 fabricated to be assembled so as to be free to yaw upon a motor mobile bedplate (not shown). Coupling 11 finds itself in an intermediate position between housing 1 and radiating head 2.

[0026] The electromagnetic waves output by the oscillator are brought to the linac through a waveguide assembly, which, preceptively, includes two waveguide lengths, connected by a pressurized rotary coupling 10, including a fixed portion 12 and a mobile portion 22, which will allow the rotation of a length relative to the other one, and therefore the roll of the head without a twisting of the waveguide assembly.

[0027] A length 21 coming out in the gap between the head and the arm, is flexible, and constitutes a connection which will allow the pitch of the head. The waveguide assembly is inserted in linac 20 trough a rigid waveguide stub 23.

[0028] Radiating head 2 is assembled onto the arm through two side wings (not shown), assembled integral with the arm, cantilevered therefrom. The wings support the head on opposite sides thereof, through a pivoting (not shown). The head performs its pitch on the rotary support of such a pivoting, under the actuation through a gear wheel 24 which meshes with the pivoting.

[0029] It is envisaged that linac 23 is "self-focusing", i.e. that the focusing of the electron beam takes place as a consequence of the constitution of the linac and not by means of external magnets. To such an object accelerating cavities 23' can be of increasing lengths from the first one to the fifth cavity and successively constant. The electrons can be made to pass through the cavities successive to the fifth one after a RF peak, without a further focusing.

[0030] This invention has been described and illustrated referring to a specific embodiment thereof, but it is to be expressly understood that variations, additions and/or omissions can be made, without departing from the relevant scope of protection, which only remains restricted by the annexed claims.

Claims

1. Electromedical apparatus for intraoperative radiation therapy by means of a linear electron accelerator, including an arm including means for generating electromagnetic waves, which arm supports a radi-

ating head (2) including linear electron accelerator means (20), connected with said means for generating electromagnetic waves through waveguide means, **characterized in that** said waveguide means include two waveguide lengths connected with each other through a rotary coupling (10), a waveguide length whereof, that passes between the head and the arm, is a flexible waveguide (21).

2. Apparatus of Claim 1, wherein said linear electron accelerator means (20) are a self-focusing linear electron accelerator.

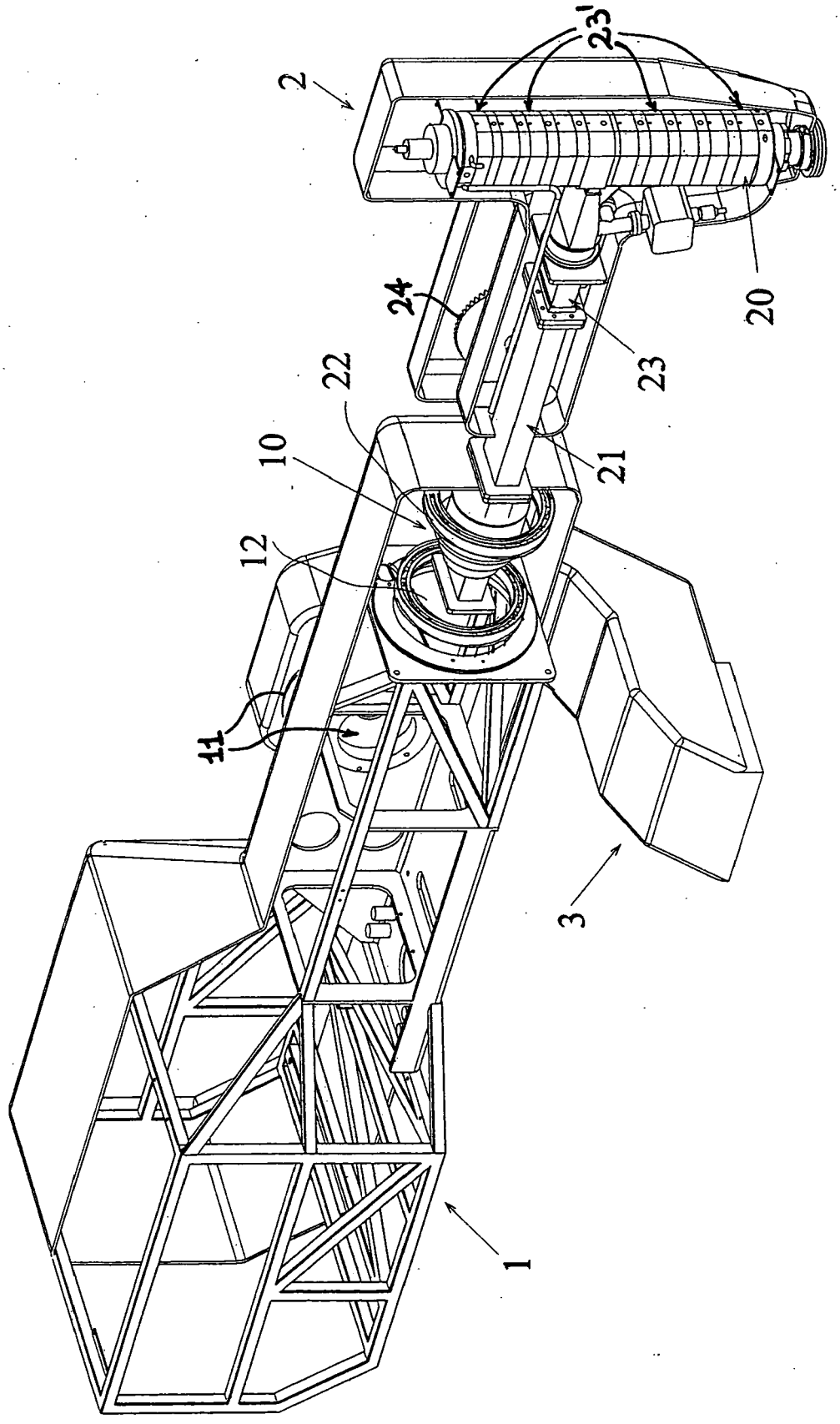

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5479

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 317 944 A1 (HITESYS SPA [IT]) 11 June 2003 (2003-06-11) * column 1, lines 3-6 * * column 5, lines 43-45 * * column 7, lines 22-28 * * column 11, lines 23-46 * * column 12, lines 13-15 * * figures 6,7 * * figure 3 * -----	1,2	INV. H05H9/00 H05H7/00
A	US 5 635 721 A (BARDI GIANLUCA [IT] ET AL) 3 June 1997 (1997-06-03) * claims 1,2,6 * -----	1,2	
A	DE 36 03 015 A1 (SIEMENS AG [DE]) 6 August 1987 (1987-08-06) * abstract * Figure -----	1	
A	DATABASE WPI Week 198442 Derwent Publications Ltd., London, GB; AN 1984-262323 XP002407649 & SU 1 075 335 A (KISELEV YU M) 23 February 1984 (1984-02-23) * abstract * Figure -----	1	TECHNICAL FIELDS SEARCHED (IPC) H05H
A	DATABASE WPI Week 198343 Derwent Publications Ltd., London, GB; AN 1983-800365 XP002407650 & SU 985 858 A (BELENKII M I) 4 January 1983 (1983-01-04) * abstract * Figure ----- -/--	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 November 2006	Crescenti, Massimo

CATEGORY OF CITED DOCUMENTS

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

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5479

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DATABASE WPI Week 197644 Derwent Publications Ltd., London, GB; AN 1976-K6116X XP002407651 & SU 491 175 A (MAIBORODA V G) 17 March 1976 (1976-03-17) * abstract * Figure -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 November 2006	Crescenti, Massimo

CATEGORY OF CITED DOCUMENTS

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

EPO FORM 1503 03.82 (P04C01)

3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 42 5479

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-11-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1317944 A1	11-06-2003	NONE	
US 5635721 A	03-06-1997	DE 69533079 D1	01-07-2004
		DE 69533079 T2	16-09-2004
		EP 0702982 A2	27-03-1996
		ES 2222458 T3	01-02-2005
		IT LT940012 A1	19-03-1996
DE 3603015 A1	06-08-1987	NONE	
SU 1075335 A	23-02-1984	NONE	
SU 985858 A	30-12-1982	NONE	
SU 491175 A	05-11-1975	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82