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(54) **Digital camera and imaging device**

Digitale Kamera und Bildgebungsgerät

Camera numerique et imageur

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(73) Proprietor: **Planmeca OY**
00810 Helsinki (FI)

(72) Inventor: **Nyholm, Kustaa**
02570, Siuntio KK. (FI)

(74) Representative: **Winter, Brandl, Fürniss, Hübner, Röss, Kaiser, Polte - Partnerschaft**
Bavariaring 10
80336 München (DE)

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Description

[0001] This invention relates to a digital camera according to the preamble of claim 1 and to an imaging device according to the preamble of claim 10.

[0002] In particular, one of the objectives of the invention relates to dental panoramic and other tomographic imaging, and to a digital camera and imaging device used in cephalometric imaging, in which the area covered by means for receiving the image information is essentially smaller than the projection of the object to be imaged on the image-forming surface. In this context, the image-forming surface denotes the virtual plane or surface on which the projection of the object to be imaged is formed.

[0003] Further, there is disclosed a method for digital imaging in which method the object to be imaged is radiated and the radiation is detected by means for receiving the image information, the area covered by which being essentially smaller than the projection of the object to be imaged on the image-forming surface.

[0004] Various tomographic and transillumination imaging methods are used in many kinds of applications. Among others, in the medical and biotechnological imaging applications, it is typical to direct x-ray, gamma, or beta radiation through the object to be imaged and further to the image-forming surface. Digital imaging methods have been developed at the side of the traditional film-based imaging methods, and in these methods semiconductor sensors, such as CDD sensors (Charge-Coupled Device) or CMOS sensors (Complementary Metal-Oxide Semiconductor) are used as image-forming surfaces. Typically, in such semiconductor sensors, x-rays are first converted to radiation the wavelength of which is in the region of visible light but the developing technology is also introducing sensors in which x-rays can be directly converted to electric form.

[0005] Despite the many advantages offered by the digital imaging devices, they have not become as generalised as expected in so many visions. The prices of digital cameras have been one of the essential factors having had influence on this. The semiconductor sensors used in the cameras are typically made of silicon and, along with the growth of the size of the sensor, its manufacturing costs per surface area grow exponentially. This is why, in the applications requiring a wide imaging surface, cameras comprising of one semiconductor sensor will become very expensive.

[0006] The invention presented in this application has been developed in view of the needs of dental x-ray imaging, and thus, it will be illustrated below primarily in the light of the applications of this field. Naturally, the invention is also suitable for use in connection with many other imaging forms.

[0007] The dental x-ray imaging is divided in three main sections, out of which in the so-called intraoral imaging it is typical to image individual, or a few teeth, in the so-called panoramic imaging the dental arch is imaged to a plane as a layer, i.e. as a tomographic image, and in the so-called skull or cephalometric imaging the skull area as a whole is imaged as a transillumination image. Further, many devices used for panoramic imaging are suitable for taking even other cross sectional images of various areas of the dental arch. The present invention is particularly suitable for use in connection with the panoramic and other tomographic imaging forms and with the skull imaging, all of which being typically made by the same imaging device. Particularly in the cephalometric imaging, the need for image information receiving means with large surface area has appeared problematic from the point-of-view of the commercialisation of the digital imaging applications. Taking a skull image with a sensor having a directly matching size with the area to be imaged would require use of tens of times bigger sensors as typically used in panoramic imaging.

[0008] As the dental skull image is a transillumination image it is traditionally taken by using so wide a beam and film that the desired area has been able to be imaged as one single shot. On the other hand, in panoramic imaging a tomographic image is typically produced by using a narrow beam and the area to be imaged is scanned by it, whereby the tomographic effect for imaging the desired anatomic layer is created by continuously changing the entry angle of the beam in relation to the object as the beam travels over the area to be imaged. In this so-called narrow beam tomography method, the movement of the imaging means (the radiation source and the image information receiver) is implemented in a controlled way so that the receiver is moving in relation to the beam with a transversal speed corresponding the vertical scanning speed of the beam in the area to be imaged, multiplied with a magnifying factor, i.e. a coefficient that is the relation between the distance from the image information receiver of the focus of the beam (=radiation source) and the distance from the area to be imaged. In this definition, the detector primarily refers to the radiographic film, whereby, in the digital imaging, the movement of the image information receiver in relation to the anatomic layer to be imaged can be replaced by a suitable electric function, as a charge transfer on the surface of the semiconductor sensor. Mathematically, this imaging equation can be presented in the following form:

$$V_F = (L_{FF} / L_{0F}) \times V_0 \quad ,$$

where V_F = speed of film transfer, or an electric function by the sensor corresponding to it, L_{FF} = distance of film or any respective element from the focus of the radiation source, L_{0F} = distance of the object to be imaged from the focus of the radiation source and V_0 = forward speed, parallel to the image-forming surface, of the beam in the object. Therefore, the precondition to a successful panoramic imaging is that, during the imaging, the respective

positions of the means to receive the image information, of the area to be imaged, and the radiation source in relation to each other, continuously remain, as precisely as possible, in compliance with this theoretical imaging equation.

[0009] In the digital panoramic imaging, the scanning movement of the beam is followed by a narrow sensor from which the image data is read out during the scan. As the panoramic and cephalometric images have typically been taken by the same x-ray imaging device, it has been a natural idea to use the so-called scanning slot imaging technology also for taking the transillumination images of the skull area (e.g. "Direct digital extraoral radiology of the head and neck with a solid-state linear radiographic detector", McDavid, W.D. et al., Oral Surg Med Oral Pathol 1992; 74:811-7). This is how the sensor surface area needed for imaging has been able to get considerably reduced. In some of such applications, however, the scan has been implemented in a way causing at least theoretical errors in the image, i.e. as the beam is positioned to meet the image information receiver perpendicularly and the scanning of the object is carried out by either conveying the object perpendicularly through the beam, or by positioning the object in a fixed position and by moving the radiation source and the image information receiver with a parallel synchronized movement past the object. These kinds of imaging modes do not produce genuine transillumination images but, as a matter of fact, tomographic images where the size of the tomographic effect depends on the width of the beam used. In addition to this, interpreting of the images obtained in this way is not familiar to the doctors, as their projection geometry is different in the horizontal and vertical directions, thus deviating from the traditional geometry of a transillumination x-ray image.

[0010] From the point-of-view of practical applications, use of the same sensor both in the cephalometric and panoramic imagings would be desirable, among others regarding the administration of the camera production and the sensor storage solutions, as the costs of starting the production and, as the manufactured numbers would get larger, the costs per unit, could thus be reduced. In digital panoramic imaging the height of a typically used sensor is, regarding the cephalometric imaging, however, sufficient only in a few special applications, which is why two different sensors have to be manufactured for the market. Therefore, the scanning slot imaging as such does not provide a solution based on which one could manage with only one single sensor.

[0011] A feasible possibility as such would be to use a cephalometric imaging sensor in panoramic imaging in such a way that the sensor height would be utilized only partly, but even this solution is problematic from the commercial point-of-view. The sensor that is sufficiently high for cephalometric imaging is more expensive than two panoramic sensors, i.e., with today's prices, the camera needed for cephalometric imaging might cost even more than the rest of the imaging equipment altogether. As typically only about one third of the panoramic devices are provided with means for cephalometric imaging, regarding this and the points presented above, it is very understandable that the digital cephalometric imaging applications have not become significantly more general.

[0012] Use of the same digital camera for panoramic and cephalometric imagings has been considered e.g. in the U.S. Patent Publication 5,579,366. This publication primarily discusses one dimensional digital cameras, to the evident idea of using a sensor that is high enough even for cephalometric imaging applications, i.e. a camera that is expensive and overdimensioned from the point-of-view of the needs of mere panoramic imaging. In the scanning cephalometric imaging, a longer sensor than in the panoramic imaging is needed, in any case, whether the imaging scan is made horizontally or vertically.

[0013] The actual invention according to the said U.S. Patent Publication concerns the camera interface arrangements that seem to be easy to use as such but that also include potential sources for problems. Use of the same camera in different imaging positions requires its repeated transfer between the panoramic and the cephalometric imaging stations and these measures will always imply a risk of damaging the expensive camera, e.g. as a consequence of dropping it. Often repeated removals and attachments set requirements of their own also to the mechanical, and particularly to the electric interface solutions of the camera. In practice, the problem of the interface solution according to the the publication might prove to be the precise and steady positioning of the camera in the imaging device, which is critical, in particular, in scanning slot imaging.

[0014] Also in connection with other imaging applications, different solutions have been developed to solve the surface area/price problem of the semiconductor sensors. Typically in these solutions, sensors covering only a part of the image-forming surface are used, which are then moved or transferred during the exposure, or between individual exposures. E.g. in the mammographic devices different mosaic or chessboard pattern built sensors have been used, which are then moved between two or several different exposures. Typically, the different modular realisations are expensive and to make them function in practice, too, the combination of the modules has to be carried out with extreme precision - especially when the intention by combining them is to construct a uniform sensor surface based on modules.

[0015] The Patent Publication WO 95/12133 presents a modular sensor arrangement, based on the formation of a kind of zig-zag pattern, to be used in different radiographic and tomographic imaging applications. This as such technically excellent solution has not, however, been shown to become a commercial success, at least not in connection with medical imaging - probably at least partly due to the fact that, e.g. a uniform panoramic image cannot be achieved by this kind of a sensor. In the sensor arrangement according to the Publication, the sensor

modules are all the time moving, in the direction of the scanning movement, in different stages, i.e. in relation to the rotational centre they are in each moment of time in different positions and are continuously imaging the object from different projections, i.e. they form images based on different imaging geometries. Therefore, such a sensor arrangement creates an image formed of stripes of the different projections, parallel with the scanning movement, where on the borders of them there may be points of incontinuency. In particular, in the (dental) medical radiographic imaging, these kinds of faults in images are not acceptable.

[0016] Furthermore, the US 5 579 366 discloses a digital camera, to be used in tomographic imaging, or in both tomographic and transillumintaion imaging, for use specifically in the dental so-called panoramic and other tomographic imaging, or in both panoramic and cephalometric imaging, whereby the area to be imaged is scanned by a beam, during which imaging scan the means of the camera for reception of the image information are positioned, or are moving, on a desired image-forming surface. The area covered by the image information receiving means is essentially smaller than the projection of the object to be imaged on the image-forming surface. Further, the means for reception of image information comprises a sensor module arrangement intended for reception of the image information produced in tomographic imaging. Finally, the camera known from the US'366 includes a connection arrangement to enable its connection to and its detachment of an imaging device. This connection arrangement comprises mechanical and electric connection means being separated to the connection structures of their own.

[0017] The objective of this invention is to develop digital imaging technology to reduce the problems presented above. In particular, one objective is to develop a camera that is relatively inexpensive to manufacture and to acquire, suitable for scanning slot imaging and an imaging device for the use of this kind of camera. In this way, the investments to digital technology become more justifiable and the threshold for its introduction lower. The digital technology, among other, will make the doctor's work easier as it enables getting images of better quality, and thus more precise diagnoses, but even saving the pictures and administration of them in electric form - together with the rest of the documentation concerning the patients and the adminstration of the reception.

[0018] This objective is solved by a digital camera according to the patent claim 1.

[0019] One of the objectives of the invention is to provide such a camera that it can be used in more than one form of imaging, particularly in both tomographic and transillumination imagings, especially in the same imaging device, and possibly in its different imaging positions. Further, the objective of the invention also is to provide such a method for digital imaging according to which the same camera can be used to take both tomographic images and transillumination images - even of objects of different sizes.

[0020] Further, one of the objectives of the invention is to provide a camera the sensor surface of which could simply and with moderate cost be modified, implying that one of the objectives of the invention is to provide this kind of a camera using a modular sensor arrangement. One of the additional objectives of the invention is to provide a modular sensor arrangement for the camera in such a way that the characteristics of the camera can be easily changed, without the need to change its basic structure, when one further additional objective of the invention is to provide the modular sensor arrangement for the camera so that it will be easy to add modules to the camera in order to increase the sensor surface of the camera, or so that the way it is used can be altered so that different imaging modes and imaging of objects of different sizes will be possible with the same camera.

[0021] A particular objective of the invention is to provide such a camera suitable for dental panoramic and other tomographic imaging, that can be used, or that can be relatively easily and economically be modified so that it will also be suitable for dental cephalometric imaging.

[0022] Further, one of the objectives of the invention is to provide a modular sensor arrangement for the camera so that the camera can be used utilizing only a part of it, especially in tomographic imaging utilizing only one module, that of the sensor arrangement.

[0023] One of the additional objectives of the invention also is to implement the sensor arrangement so that the possibly broken individual sensor module could easily be replaceable by a new one, possibly by a module that is identical with the other modules.

[0024] A further additional objective of the invention is to provide such a modular sensor system for the camera that the sensor surfaces of the modules and/or the circuit boards belonging to the modules can be positioned also on different levels.

[0025] One of the special objectives of the invention is to provide an imaging device in which the same camera according to invention can be used for both tomographic and transillumination imaging, in particular, for both dental panoramic and cephalometric imaging.

[0026] Further, one of the additional objectives of the invention is to provide such an imaging device whereby a camera according to the invention can easily and safely be moved from one imaging station to another and positioned precisely in its correct imaging position.

[0027] This objective is solved by an imaging device according to patent claim 10.

[0028] Further, one of the additional objectives of the invention is to implement the camera connection arrangement so that it will consist of at least two structurally different connectors, to connect the camera correctly to its imaging stations for at least two different imaging purposes.

[0029] Further, one of the additional objectives of the invention is to provide such an imaging device in the imaging positions of which, designed for at least two differ-

ent imaging purposes, there are structurally different connecting arrangements for connecting the camera to the imaging device.

[0030] Further, one of the additional objectives of the invention is to utilize the connection arrangements of the camera to direct the image information received from certain modules of the camera out from the camera via signal paths exclusively assigned to these modules - in particular, to direct the image information from one module for tomographic imaging out from the camera via a connection arrangement exclusively suitable for a tomographic imaging station.

[0031] One of the additional objectives of the invention is to realize the usability of the camera in more than one point of use so that the removal and connection of it would include as few risks as possible for damaging the camera itself, as well as its connecting structures.

[0032] Further, one of the additional objectives of the invention is to realize the connecting arrangement of the camera so that its electric connecting parts would be as little vulnerable as possible to mechanical stress that might, in time, damage them and lead to intermittent power contact failures, or even to a permanent failure.

[0033] Further, one of the additional objectives of the invention is to realize the connection arrangement of the camera so that it can be positioned to its imaging station relatively simply but in the same time as precisely and for being as non-movable as possible.

[0034] Further, one of the additional objectives of the invention is to realize the connection arrangement of the camera so that it will ensure a stable and safe mounting of it in the imaging device, in order to minimize the electrical safety risks that could be caused by e.g. unusually strong external forces upon the camera. These forces can be caused by e.g. stumbling on the camera so that the connection structures would bend and cause shortcuts and thus potential damages to the imaging device and the camera, or even personal injuries as a consequence of an electric shock.

[0035] Further, one of the additional objectives of the invention is to provide such an imaging device where the connection arrangements intended for the camera have been realized by using separate mechanical and electric connection structures.

[0036] Further, one of the additional objectives of the invention is to realize the connection arrangement so that its mechanical and electric connection structures have been separated from each other, e.g. placed physically on different surfaces of the camera housing.

[0037] Further, one of the additional objectives of the invention is to realize the connection arrangement so that fixing of the camera will take place in a compulsory sequence of - positioning - locking of the mechanical connection - electric coupling.

[0038] The essential characteristics of the invention have been presented in detail in the attached claims. One of the main characteristics of these is a modular sensor arrangement of a digital camera that consists of, in view of sensor surfaces or their projections on a certain plane, in particular, the point projections in relation to the focus of the radiation source, an overlapping assembly formed by at least two sensor modules - or of a structure including at least the first module, and with means arranged for connecting at least another module functionally to the structure to provide this kind of an assembly; whereby the first module has been arranged to be used for scanning tomographic imaging, and whereby this said module has been arranged to be available for scanning transillumination imaging together with at least another sensor module. In the same way, in the method according to these characteristics, particularly one module unit of the modular sensor assembly is used for tomographic imaging, whereby this same module, together with at least another module belonging to this sensor assembly, is also used for transillumination imaging, whereby imaging of even larger areas than the areas that can be imaged by this first module will become possible.

[0039] In particular, the overlapping module assembly according to this invention means a sensor arrangement whereby the sensor modules have been positioned, in relation to each other, in an overlapping position so that considering the sensor surfaces of the sensor modules, or their projections on the plane formed by the axles y, z of a right-angled set of coordinates x, y, z,
whereby a projection here indicates, in particular, the point projection which is imaged to said plane via the focus of the radiation source used in the imaging and the said sensor surface,
each of them covers a different area on this plane, and that,
when proceeding in the direction of the axle y,
the projection, or the said point projection of the sensor surface, of each subsequent sensor surface placed on the plane formed by the axles x, z, will cover a different area from the previous projection,
and that the projection, or the said point projection of the sensor surface, of each subsequent sensor surface placed on the plane formed by the axles x, y, will meet that of the previous projection - possibly by at least partially covering the same area.

[0040] The modular structure according to this definition can therefore be implemented so that, when proceeding in the direction of the axle y, each subsequent projection, on the plane formed by the axles x, z, covers a different area from the previous projection so that the borders of these areas meet.

[0041] When the camera with the sensor arrangement according to the invention is positioned in the imaging device using scanning slot technology according to this invention, the direction of the scanning movement of the beam is the direction of the axle z of the definition above.

[0042] Thus, the sensor assembly can consist of only the first sensor module used for tomographic imaging and, in addition to this, the means, such as the space required and the means attached to it for connecting at least one another sensor module functionally to this ar-

rangement, in order to form an overlapping modular structure.

[0043] In the following, the invention will be described in more detail, using its preferred embodiments and referring to the attached figures, out of which

Fig. 1 shows a typical traditional panoramic and cephalometric imaging device,

Fig. 2 shows a structure of a camera housings according to the invention,

Figs. 3A-3E show some sensor module arrangements according to the invention,

Fig. 4 shows a collimator system according to one preferred embodiment of the invention used to limit the beam of an imaging device,

Figs. 5A and 5B show one way according to one preferred embodiment according to this invention to connect the camera to the panoramic and cephalometric imaging device, and

Fig. 6 shows a camera holder-connector structure in an imaging device according to one preferred embodiment according to this invention.

[0044] Fig. 1 shows one typical, traditional film-based panoramic and cephalometric imaging device comprising a body part 1, another body part 2 movably attached to it, with further a suspension arm 3 movably attached to the second body part 2, at the essentially opposite ends of which the radiation source 4 and the image information receiver 5 used in panoramic imaging are located. In the device according to Fig. 1, this image information receiver is a film cassette, but it could also, respectively, be a digital camera attached to the suspension arm 3. In addition, positioning means for the object to be imaged are also typically used in panoramic imaging; their position in Fig. 1 is referred to by reference number 6. To control the functions of the device, it also typically comprises a user interface 7.

[0045] To the device according to Fig. 1 are attached means for taking cephalometric images, when it also comprises another suspension arm 8 with positioning means 9 for the object to be imaged in cephalometric imaging attached to it, as well as means 10 for positioning and attaching the image information receiver, which in the device according to Fig. 1 is a film cassette.

[0046] In addition, considering the digital application of this kind of device, a panoramic 11 and respectively a cephalometric 12 imaging station of the camera 5 have been indicated by reference numbers 11 and 12 in Fig. 1. These imaging stations will be later referred to in connection with the embodiments of the invention according to Figs. 5 and 6.

[0047] When using the imaging device shown in Fig. 1, the object to be imaged is positioned either in a desired tomographic imaging position, in the area indicated by reference number 6, between the radiation source 4 and the image information receiver 5, or in a desired cephalometric imaging position, by the positioning means 9 used in the cephalometric imaging. In tomographic imaging, a layer of the desired anatomy is imaged by moving the radiation source 4 and the image information receiver 5 in a controlled way on the essentially opposite sides of the object to be imaged so that at the same time the area to be imaged is scanned by a narrow beam. On the other hand, for cephalometric imaging, the radiation source 4 is positioned to direct the beam towards the positioning means 9 used in cephalometric imaging, and further towards the image information receiver not shown in Fig. 1. The traditional film-based devices have typically had to be constructed so that the structures that remain between the radiation source 4 and the cephalometric imaging station 12, as the holder structures of the panoramic film cassette 5, or the like, have had to be moved aside when the device has been changed from panoramic imaging mode to cephalometric imaging mode. In particular, in applications using the same digital camera 5 this problem can simply be solved by producing such a panoramic imaging station 11 of the camera 5 that removal of the camera 5 is sufficient to leave a free path for the beam towards the camera 5 moved to its cephalometric imaging station 12.

[0048] Fig. 2 shows a structure of a camera housings 51 of a digital camera 5 according to the invention. In this embodiment of the invention, respective apertures 53, 53' matching the form of one of the sensor module arrangements according to the invention have been arranged to the actual housing part of the camera 5, which is covered by an upholstery surface which is permeable to the radiation used for imaging. In addition, camera 5 comprises means 60 for positioning and mechanical fixing of the camera 5, to be later shown in more detail in connection with Fig. 6, and means 70 for electric connection of the camera, which means can be implemented so that there are separate connecting means in the camera, on one hand for different imaging modes, and on the other for electrical and mechanical connections of the camera to the imaging device.

[0049] Figs. 3A-3E show some of the sensor module arrangements according to the invention. In this context, by sensor module is meant any structure forming an essentially uniform sensor surface. The sensor module 2 0 may e.g. have the structure shown in Fig. 3A, of the sensor structure 21 formed by four CCD microchips, optical fibre 22, scintillating material 23, housing 24 of the sensor structure 21, cover 25 and a printed circuit board (PCB) 27, or the like, coupled to this structure by electric interface surfaces 26, but it may also consist of, e.g., a single monolithic CCD chip.

[0050] The sensor module arrangement according to the invention may be implemented in innumerable different ways out of which some have been shown in Figs.

3B-3E. These figures show the structure of camera 5 seen from the direction of the focus of the radiation source, when the radiation containing image information is directed via the apertures 53, 53' of the camera housing 52, essentially corresponding to the form of the sensor module arrangement of camera 5, to the sensor modules 20, 20',20", 20"' that have been placed on the opposite inner wall in relation to the apertures 53, 53' of the camera housing. A right-angled set of coordinates x, y, z according to the definition used above has been added to the Figs. 3B-3E, where the direction of the axle z is the same as the direction of the movement of the camera, i.e. the scanning direction of the beam, when the camera is used for scanning slot imaging.

[0051] Fig. 3B shows the simplest embodiment, consisting of two modules 20, 20', of the sensor module arrangement according to the invention. With a camera 5 consisting of this kind of a structure one is able to take a tomographic image using one module 20, and a larger transillumination image by using also the other sensor module 20' positioned in overlapping relation to the first module 20. The stripe-forming effect encountered in tomographic imaging, where at any moment of time during the imaging scan the sensors are at different stages, can be controlled without problems in transillumination imaging. When the focus of the radiation source and the object to be imaged are held stationary and the scanning movement of the beam is implemented by collimators limiting the beam, the modules moving synchronized with the scanning movement form a true transillumination image, each of them at a certain stage of the scanning movement, i.e. e.g. when using the sensor arrangement according to Fig. 3B, when the modules pass the object from left to right, the upper part of the transillumination image will be completed later than the lower one. Even a long distance between the modules 20, 20' in the direction of scanning movement is not problematic from the point-of-view of the formation of the final integrated image but, naturally, e.g. due to the possibly uneven radiation output of the radiation source 4, or regarding the physical dimensions of the camera, this distance should, however, be left as short as will be reasonable, regarding the other solutions of the camera arrangement. And, as in all slot imaging applications of this type, it would also be preferred, in view of the object not to move, to be able to have as short imaging time as possible, i.e. to keep the distance in between the modules scanning direction as short as possible for this reason, too.

[0052] If the projections of modules 20, 20', on the plane formed by axles x, y at least partly cover the same area this will not cause any problems in the formation of a transillumination image, as the overlapping parts can be integrated by the image processing methods evident to those professed in the art, to appear as if they had been taken by one sensor. The partial images can be combined e.g. so that the image information corresponding to the part of the object that has possibly been imaged more than once, due to the overlapping of the sensor surfaces, is either removed from the information produced by all the modules except one, or, in particular, so that all of the information received is used in forming the image and the part having been imaged more than once is scaled to correspond the image information that would have been received from only one sensor module. On the other hand, overlapping is also useful regarding the fact that then there will certainly not be left any gaps between the partial images formed by the separate modules. In some special imaging modes it may even be appropriate to arrange two ore more modules to image, even totally, the same area, i.e. to arrange the modules so that, according to the definition used above, the projections of the sensors cover the same areas on the plane formed by the axles x, y.

[0053] According to the invention, the camera 5 may also include three, four, or even more sensor modules to form e.g. an overlapping line according to Fig. 3C, a structure formed by sensor modules of different sizes according to Fig. 3D, or a structure formed by two columns according to Fig. 3E. Then, Figs. 3D and 3E illustrate the possibility that, according to the definition used above, when proceeding in the direction of the axle y, the border of the area covered by each successive projection on the plane formed by the axles x, z can be at a distance in different directions from the border of the area covered by the previous projection, compared with the previous projection and the one before it, and that these projections may cover, partly or even totally, the same area. This kind of covering the same area cannot, however, be present when proceeding in the direction of the axle y for any two successive projections.

[0054] Figs. 3B to 3E only show some simple basic structures that can be combined and extended in many different ways within the basic idea of the invention. Further, according to the invention, the sensor module arrangement can also be realized e.g. by arranging the modules 20, 20', 20", 20"', and, in particular, their surfaces 23 receiving the image information, on different planes, i.e. at different distances from the focus of the radiation source. This can be realized e.g. by using connecting surfaces 26 of different lengths. On the other hand, using connecting surfaces of different lengths, it is possible to create a structure where the sensor surfaces are at the same level but where the printed circuit boards 27, or the like, are at different levels. These types of arrangements allow more latitude for the implemention of the electronics arrangements of the camera. The marginal magnification error caused by the position of the sensor surfaces at different distances from the objects to be imaged can, if desired, be corrected e.g. by the image processing methods known as such.

[0055] In order to achieve as effective sensor surface as possible in transillumination imaging using the sensor module arrangement according to the invention, it would be preferred to leave the possible overlapping portion of the sensor surfaces, naturally even for cost reasons, as short as possible. In principle, the sensor module ar-

rangement could be realized so that, according to the definition used above, the projections of the sensor surfaces on the plane formed by the axles x, y, would not overlap at all, i.e. that the distance between them would be zero. A so precise physical positioning of the modules is, however, technically more difficult to achieve than e.g. an arrangement where the modules are positioned at least a little overlapping and the possible extra overlapping will be taken into account in the imaging process, e.g. by using a suitable collimation of the beam. Furthermore, an overlapping of the size of at least one row of sensor pixels is preferred also because the combination of images is then more easily feasible, using means offered by many as such known electronic and/or image processing software solutions. Especially if the effective height of the sensor arrangement does not belong to the critical development criteria, the use of overlapping and its optimal magnitude can be considered in the light of any particular characteristics of the respective application.

[0056] Regarding the needs of dental imaging, it is preferred to arrange the module used for tomographic imaging as the lowest module of the sensor module arrangement, as in all other cases especially the imaging of the lower jaw onto the panoramic image is difficult to arrange. In these type of applications, it is also preferred to implement the sensor module arrangement according to the invention so that two identical modules, possibly in overlapping positions, are used, and the physical and electronic arrangements of the camera are implemented so that the modules can be easily removed and/or connected to the camera. Expressed more precisely, this means that it will be possible, in the first stage, to arrange in the camera housing only the module needed for tomographic imaging, and the physical space needed for the transilllumination imaging module plus the necessary means for its positioning and functional connection to the camera. In this way, a panoramic camera is provided with a relatively inexpensive acquisition price, and to which, however, another module needed for cephalometric imaging can later be connected in a simple way. In addition to this, thus a damaged module can easily be replaced by a new one and if the damaged module happened to be one used only for cephalometric imaging, the camera can still be used for panoramic imaging purposes even during the time the acquisition of a new module takes. The price of this type of a panoramic camera can be made to match the price of a conventional panoramic camera, i.e. the camera will be significantly cheaper - due to its smaller sensor surface - than a panoramic camera consisting of one sensor module that could as such also be used for cephalometric imaging. In addition, even price of a camera according to this invention, extended suitable also for cephalometric imaging, consisting of two relatively small sensor modules will, however, remain clearly lower than that of a one module camera of comparable size. Even in a more general consideration, a sensor arrangement according to the invention can thus be realized so that, for whatever single module or several modules used only for transillumination imaging, only the physical space and the necessary means for connecting the module functionally to the camera are arranged to the camera housing, in which case the sensor arrangement can by simple connection measures be arranged to form a larger overlapping modular structure.

[0057] According to the invention, there are numerous ways to remove or discard the signal produced by other modules than that used for tomographic imaging from the image information used for creating the tomographic image. E.g. the electronics arrangements of the camera can be implemented so that the signal path to the transillumination imaging modules can be cut, or so that the image is formed, or the image data is transmitted from the camera to separate image processing means only from the signal received from the tomographic imaging sensor. The non-desired information can be sorted out and removed by using electronics arrangements, known as such, e.g. in the logic circuit of the camera, or later by image processing methods, known as such. In addition or besides to these arrangements, it is also possible to proceed so that the collimation arrangement limiting the beam of the imaging device is implemented so that, when the imaging device is used for tomographic imaging, the access of radiation to other sensor modules is blocked.

[0058] Further, taking into consideration certain preferred embodiments to be presented later, one possible solution is to arrange two sets of separate electric connection means for the camera, in which case the signal paths can be arranged so that one connecting element will be in connection only to the tomographic imaging sensor module and the other both to the tomographic imaging sensor module and at least to one transilluminaton imaging sensor module - or then at least to one of the connection means arranged for this type of module. Thus, when the first mentioned electric connector is used for attaching the camera to the tomographic imaging position, automatically, only the image information produced by the tomographic image sensor module is obtained via this connector, as desired.

[0059] The final formation of the image may be done in ways known as such, e.g. by connecting the imaging device to a computer, whereby the memory and the processing means of the computer can be utilized. The processing means can also be realized by e.g. a dedicated ASIC circuit (Application Specific Integrated Circuit), connected to memory means, e.g. RAM memory. Naturally, and as already partially described above, many measures of the image information processing can already be carried out in the camera, e.g. specifically in the ASIC circuit arranged to the camera. The formation of the final image information as such is well-known technology to those professed in the art, and a more detailed description of it is not necessary for the implementation of the invention. In principle, the camera may be made by arranging all means required for the image formation in the camera itself when it could be connected directly

to the display device.

[0060] In the implementation of the invention, it is possible to utilize the CCD sensor technology known as such, having shown to be very useful in e.g. panoramic imaging. On the other hand, one interesting alternative also is the use of a newer technology based on CMOS sensors and direct detection of radiation, as with them certain advantages can be obtained as compared to the traditional semiconductor sensors. The CMOS sensor technology as such enables, due to its so-called parallel bus type data transfer system, a faster transfer of image information, and with sensors based on direct detection an even better resolution is achieved than with the traditional semiconductor sensors, when there are no scintillating and optical fibre structures reflecting light also to non-desired directions. The sensitivity of the sensors based on direct detection is better, too. The CMOS technology is the most commonly applied semiconductor technology and, because of this, the availability of CMOS circuits is good and their manufacturing costs are being reduced by the technical development.

[0061] One of the sensor technologies based on direct detection of radiation has been described in more detail e.g. in the Patent Application Publications WO 95/33332 and WO 97/20342. It is not possible to perform a charge transfer function (Time Delay Integration = TDI) with this type of a sensor, nor is there any simple way to construct such a function to it. However, this type of a sensor can be used in these imaging modes by forming the image so that an image of the object is produced every time the object to be imaged, or the sensor, has moved about one pixel forward, and by adding these images to each other so that they are, at the same time, overlapping a corresponding distance in relation with each other.

[0062] Fig. 4 shows one preferred embodiment of the invention for a collimator arrangement for limiting the beam, which in the situation shown in the figure has been arranged to be ready for use in cephalometric imaging. In cephalometric imaging the beam received from the radiation source 4 is first limited by a primary collimator 31 (collimator opening 31A) placed in the vicinity of the radiation source 4, and before the object to be imaged 33 by another collimator 32 placed to a sufficient distance from the focus, which will limit the beam to essentially match the form of the areas 53, 53' the camera housing, which are permeable to radiation. The scanning movement of the beam is realized by the movement of the collimators and the camera is moved synchronized with this movement. If the sizes of the active surfaces 23, 23' of the sensor modules 21 and of the areas 53, 53' permeable to radiation, especially their overlapping, are arranged to be larger than the effective sensor surface 23, 23' required in the respective imaging, with a suitable limitation of the beam it will be possible to prevent the unnecessary direction of radiation through the object to be imaged 33 twice, to the area of the sensor surface not to be utilized in image formation, and the image information of the area left outside the beam can be removed before the partial images are combined.

[0063] Panoramic imaging can be realized in a manner known as such by the structure according to Fig. 4 by positioning the aperture 31 B, intended for panoramic imaging, of the primary collimator 31 in the essential vicinity of the radiation source 4 to limit the beam to match the conventional beam used in panoramic imaging, i. e. to essentially match the aperture 53 of the camera housing.

[0064] The Figs. 5A and 5B show one of the preferred ways to attach the camera 5 according to the invention to the imaging device.

[0065] In the solution according the figures, the camera 5 can be considered as positioned e. g. to its cephalometric imaging station 12 in Fig. 5A and to its panoramic imaging station 11 in Fig. 5B. In Figs. 5A and 5B arrow 41 indicates the entry direction of the x-rays to the camera 5, i. e. the camera 5 and the connection arrangements 42A, 42B of the imaging device have been arranged to be of different structure, so that the camera 5 can, on one hand, only be mounted from one direction to the cephalometric imaging station 12, and from the other direction to the panoramic imaging station 11 (compare with Fig. 1). When the said directions have been arranged horizontally according to Figs. 5A and 5B, moving the camera 5 between the imaging stations 40A, 40B is easy and fast, and at the same time, the danger of dropping the camera 5 unintentionally has been minimized. When positioning oneself to the area between the panoramic imaging station 11 and the cephalometric imaging station 11, 12, the camera is easily removable from one imaging station and attachable to the other imaging station by using a simple horizontal movement. In this way, that critical time for the risk of damaging the camera 5 when it is not safely mounted and secured to the imaging device, is reduced.

[0066] Technically, the imaging device according to the invention is, naturally, also possible to realize so that the scanning move ment of the beam is made in some other direction than horizontally. Especially, the panoramic and cephalometric imaging devices according to the invention can be made so that the scanning movement of the cephalometric imaging is arranged to be done in vertical direction, whereby the sensor module arrangement can be implemented in a somewhat shorter form.

[0067] Fig. 6 shows a connection arrangement 60', 70'enabling one preferred embodiment of the invention shown in Fig. 5 to fix the camera 5 according to Fig. 2 to the imaging device. The structure shown in Fig. 6 may be considered to correspond the panoramic imaging station 11 according to Fig. 5B, when e. g. the respective connecting arrangement (60, 70) forming a structural mirror image may be arranged to the cephalometric imaging station 12. The connection arrangement 42B according to Fig. 6 consists means 60' for positioning and mechanical mounting of the camera 5 and means associated with the electrical coupling 70' of the camera. The camera 5 is brought to the imaging station 11 in the direction of the

guiding rails 61, 62 that ensure the correct positioning, from the opposite side of their end plate 63. When the guiding rails 61, 62 have penetrated fully into the matching guiding grooves in the camera 5, the fixing of the camera 5 can be secured by turning the locking means 64 to its locking position over the camera housing 51. Additionally, the connection arrangement according to Fig. 6 can also be made so that the electric connecting means 71, 72 are moved to contact the matching elements in the camera not until the camera has been mechanically locked, e. g. with a perpendicular movement in relation to the direction of the positioning movement of the camera, which is realized by a pressing element appearing from below of the locking means 64.

[0068] Thus, the sensitive electric means can be protected from mechanical stresses by this kind of compulsory operating sequence of positioning-securing the mechanical connectionelectric coupling. In particular, this kind of an arrangement enables the realisation of the electric coupling and its switching off without any gliding movements of the connecting means.

[0069] The connecting arrangement 42B according to Fig. 6 does not cause mechanical stresses to the means 70 involved with the electric coupling of the camera 5 and the imaging device even when the camera is connected to its operational station. The mechanical stresses on the electric connectors are problematic, especially if the duration of them is long, as the connection elements may bend with time, or otherwise be damaged to the extent that the electric contact starts to fail, or even becomes cut off permanently.

[0070] As already partly described above, in the solution according to Fig. 6 specifically horizontal rails have been used to reduce the possibility that the expensive camera would slip to the floor unintentionally during its removal and/or mounting. On the other hand, intention in using more than one guide rail, as well as in separating the positioning and the actual locking means to elements of their own, is to ensure the correct positioning of the camera, regarding which in slot imaging, in particular in the direction of the width of the narrow beam, one must especially precise. The solution (as claimed) according to Fig. 6 of separating the actual mechanical connection from the electric coupling also reduces e. g. the imminent danger of shortcuts by unintentional crashes to the camera that could lead to a consequence of damaging the camera, or the imaging device as a whole, or even to fatal danger in the form of an electric shock.

[0071] The connecting arrangements 42A, 42B of the separate imaging stations 11,12 can be realized as structurally different so that the camera 5 can be attached to one imaging station 11 only by using a connection arrangement 60,70 only compatible with it, and to another imaging station 12 by using another connection arrangement. Thus it can be ensured that the camera 5 will always be connected correctly to each imaging station 11,12. At the same time, the operational life time of the electric connectors will be increased when the number of times of coupling per connector structure is reduced to half, and even if, despite of the above, one connection arrangement would be damaged, the camera could still be used at least in one of the imaging stations during the time the acquisition of a new camera, or in practice, most likely new connecting means, will last.

[0072] As a summary, it can be said that, according to the embodiment of the invention shown in Figs. 2,5, and 6 (as claimed), there are structurally different connection arrangements for the tomographic and for the transillumination imaging stations, whereby, respectively, there are two structurally different connection arrangements in the camera, and these connection arrangements consist of separate mechanical connection structures and electric connector elements arranged as independently functioning elements, one for connection for tomographic imaging on one hand and the other for transilluminaton imaging connection on the other. The electric coupling means arranged to the imaging devices are connected to means for moving them in order to move them into contact with the coupling means located in the camera, and when the mechanical connection means are arranged to consist of separate positioning and locking means for the mechanical connection, the camera according to this embodiment of the invention can be attached to the imaging device by one connection arrangement consisting of two separate connection structures only to a certain kind of connection arrangement of the imaging station, and only using a compulsory operating sequence of positioning-securing the mechanical connectionelectric coupling.

[0073] Although the invention has been described above mainly by using panoramic and cephalometric imaging applications as examples, it can naturally also be used in connection with any other corresponding imaging applications. For example, according to the invention, any radiation that can be detected by semiconductor sensors can be used.

[0074] The invention is especially useful in the imaging applications of medical technology where x-ray or gamma ray radiation is typically used, or in biotechnological applications where beta radiation is typically used.

[0075] Further, the invention can be applied to industrial testing and quality control methods utilizing transillumination.

[0076] For those professed in the art, it is evident that, especially with developing technology, the basic idea of the invention is realizable in many ways, and the embodiments will not be limited by the above examples, but they can vary within the scope of protection defined in the attached claims.

Claims

1. A digital camera (5), to be used in tomographic imaging, or in both tomographic and transillumination imaging, for use specifically in the dental so-called

panoramic and other tomographic imaging, or in both panoramic and cephalometric imaging, the camera (5) comprising means for reception of the image information whereby the area to be imaged is scanned by a beam, during which imaging scan the means of the camera (5) for reception of the image information are positionable, or are movable, on a desired image-forming surface, the area to be covered by the means for reception of the image information being essentially smaller than the projection of the object to be imaged on the image-forming surface, and which means for reception of image information comprise a sensor module arrangement (20) intended for reception of the image information produced in tomographic imaging, the camera (5) including a connection arrangement (60, 70) to enable its connection to and, detachment of, an imaging device, wherein

said connection arrangement (60, 70) comprises mechanical (60) and electric connection means (70) being separated to connection structures of their own, **characterized in that** said electric connection means (70) has been implemented so that the mechanical connecting of the camera (5) to the imaging device does not directly bring about an electric coupling with an electric connection means (70') of the imaging device.

2. A camera according to claim 1, **characterized in that** said camera (5) includes a tomographic imaging module and a transillumination imaging module and said connection arrangement (60, 70) includes an electric connector adapted to transmit the main power, the image data and/or any corresponding variables along one signal path from and to the tomographic imaging module, and another electric connector adapted to transmit corresponding variables via another, branching signal path from and to the tomographic imaging module, and from and to the transillumination imaging module.

3. A camera according to claim 2, **characterized in that** said branching signal path includes means, as e. g. an electronic logic circuit, for combining partial images produced by two or several individual sensor modules to one uniform transillumination image.

4. A camera according to any of the claims 1 to 3, **characterized in that** a housing (51, is arranged for said sensor module arrangement (20) and that said electric connection means (70) is placed on the housing (51), especially on a different side of the camera housing (51), surrounding the sensor module arrangement (20), than the mechanical connection means (60).

5. A camera according to any of the claims 1 to 4, **characterized in that** the mechanical connection means (20) comprises positioning means for positioning the camera (5) to its correct position before locking of its mechanical fixing.

6. A camera according to claim 5, **characterized in that** the positioning means are formed as matching guiding grooves provided in the camera (5) and being penetrated by guiding rails (61), wherein the mechanical fixing is formed as a locking means (64) which is turnably supported between a release position and a locking position.

7. A camera according to any of the claims 1 to 6, **characterized in that** the connection arrangement (60, 70) includes two sets of structurally different connecting means for connecting the camera (5) mechanically for tomographic imaging on one hand, and for transillumination imaging on the other.

8. A camera according to claim 7, **characterized in that** said different mechanical connection means are located on different physical surfaces of the camera housing (51), or the like, surrounding the sensor module arrangement (20), specifically on the opposite sides of the camera (5).

9. A camera according to any of the claims 1 to 8, **characterized in that** the connection arrangement (60, 70) has been implemented as a compulsory-phased system so that the camera (5) can be fixed to the imaging device only by following the sequence positioning of the camera(5), locking of the mechanical connection means, electric coupling.

10. An imaging device to be used for tomographic imaging, or both for tomographic and transillumination imaging, especially for use in the dental panoramic and other x-ray imaging, which device comprises a radiation source (4), a collimator structure for limiting the beam received from the radiation source (4), a connection arrangement (60', 70') mounting a camera (5) according to one of claims 1 to 9 and means for positioning the object to be imaged located at a tomographic imaging station, and on the other hand at the possible transillumination imaging station, as well as means for the controlled movements of the radiation source (4), the collimation structure, the camera (5) and/or the object to be imaged during the imaging scan, when the said camera has been positioned, or when it can be positioned using said connection arrangement, so that the means of the camera (5) for receiving image information are situated, or they can be moved along a desired image-forming surface, whereas the area covered by the means for receiving image information is essentially smaller than the projection of the object to be imaged on the desired imageforming surface, and where the means for receiving the image information from the said

camera (5) comprises a sensor module arrangement (20) intended for reception of the image information produced in tomographic imaging, whereinthe connection arrangement (60', 70') of the imaging device comprises separate electric (70') and mechanical connection means (60'), which have been implemented so that the mechanical connecting of the camera (5) to the imaging device does not directly bring about an electric coupling with an electric connection mans (70') of the imaging device.

11. An imaging device according to claim 10, **characterized in that** at least two structurally different connection arrangements have been arranged in connection with the various imaging stations of the imaging device, for connecting the camera (5) in a removable way to its respective imaging stations.

12. An imaging device according to claim 10 or 11, **characterized in that** at least in one of the connection means of the imaging device the electric coupling has been arranged so that that the contacting means of the electric coupling can be moved to a physical contact with their matching elements in the camera (5) only after the locking of the mechanical connection has been completed.

13. An imaging device according to any of the claims 10 to 12, **characterized in that** the mechanical connection means of the connection arrangement comprises separate positioning means and means for locking the mechanical connection means.

14. An imaging device according to any of the claims 10 to 13, **characterized in that** the connection arrangement of the imaging device, together with its corresponding elements in the camera (5), have been arranged so that the mounting of the camera (5) will be finished by fixing, wherein the fixing of the camera (5) will take place in a compulsory sequence of positioning of the camera (5), locking of the mechanical connection means electric coupling.

15. An imaging device according to any of the claims 10 to 13, **characterized in that** the connection arrangements of the imaging device, together with their corresponding elements in the camera (5), have been arranged so that the camera (5) can be positioned from opposite sides, especially from one side to one, and from the other side to the other of the imaging stations.

Patentansprüche

1. Digitalkamera (5), die in einer tomographischen Bildgebung oder in sowohl einer tomographischen Bildgebung als auch in einer Durchleuchtungsbildgebung, insbesondere zur Nutzung in der sogenannten Dentalpanoramabildgebung und in anderen tomographischen Bildgebungen, oder in sowohl der Panoramabildgebung als auch in einer kephalometrischen Bildgebung, zu verwenden ist, wobei die Kamera (5) Bildinformationsempfangseinrichtungen aufweist, über die der abzubildende Bereich durch einen Strahl gescannt wird, wobei während dem Bildgebungsscan die Bildinformationsempfangseinrichtungen der Kamera (5) an einer gewünschten Bilderzeugungsfläche positionierbar oder bewegbar sind, wobei die Fläche, die über die Bildinformationsempfangseinrichtungen abgedeckt ist, wesentlich kleiner als die Projektion des Objekts ist, das auf der Bilderzeugungsfläche abzubilden ist, und wobei die Bildinformationsempfangseinrichtungen eine Sensormodulanordnung (20) aufweisen, die zum Empfang der in der tomographischen Bildgebung produzierten Bildinformation vorgesehen ist, wobei die Kamera (5) eine Verbindungsanordnung (60, 70) aufweist, um ihre Verbindung mit und ihre Trennung von einer Bildgebungsvorrichtung zu ermöglichen, wobei
die Verbindungsanordnung (60, 70) eine mechanische (60) und eine elektrische Verbindungseinrichtung (70) aufweist, die in eigenständige Verbindungsstrukturen aufgeteilt sind, **dadurch gekennzeichnet, dass** die elektrische Verbindungseinrichtung (70) so realisiert ist, dass das mechanische Verbinden der Kamera (5) mit der Bildgebungsvorrichtung nicht direkt eine elektrische Kopplung mit einer elektrischen Verbindungseinrichtung (70') der Bildgebungsvorrichtung herbeiführt.

2. Kamera nach Patentanspruch 1, **dadurch gekennzeichnet, dass** die Kamera (5) ein tomographisches Bildgebungsmodul und ein Durchleuchtungsbildgebungsmodul aufweist, wobei die Verbindungsanordnung (60, 70) einen elektrischen Verbinder, der angepasst ist, die Versorgungsenergie, die Bilddaten und / oder entsprechende Größen entlang eines Signalwegs von und zu dem tomographischen Bildgebungsmodul zu übertragen, und einen weiteren elektrischen Verbinder, der angepasst ist, entsprechende Größen über einen weiteren abzweigenden Signalweg von und zu dem tomographischen Bildgebungsmodul und von und zu dem Durchleuchtungsbildgebungsmodul zu übertragen, aufweist.

3. Kamera nach Patentanspruch 2, **dadurch gekennzeichnet, dass** der abzweigende Signalweg eine Einrichtung, wie beispielsweise einen elektronischen Logikkreis, zum Kombinieren von Teilbildern, die durch zwei oder mehrere individuelle Sensormodule erzeugt werden, zu einem einheitlichen Durchleuchtungsbild aufweist.

4. Kamera nach einem der Patentansprüche 1 bis 3,

dadurch gekennzeichnet, dass ein Gehäuse (51) für die Sensormodulanordnung (20) vorgesehen ist, und dass an dem Gehäuse (51) die elektrische Verbindungseinrichtung (70) angeordnet ist, wobei diese insbesondere an einer anderen Seite des die Sensormodulanordnung (20) umgebenden Kameragehäuses (51) angeordnet ist, als die mechanische Verbindungseinrichtung (60).

5. Kamera nach einem der Patentansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die mechanische Verbindungseinrichtung (20) Einrichtungen aufweist zum Positionieren der Kamera (5) in ihrer korrekten Position vor einer Verriegelung ihrer mechanischen Fixierung.

6. Kamera nach Patentanspruch 5, **dadurch gekennzeichnet, dass** die Einrichtungen zum Positionieren als ein Paar von in der Kamera (5) vorgesehenen Führungsnuten ausgebildet sind, die von Führungsschienen (61) penetriert sind, wobei die mechanische Fixierung als eine Verriegelungseinrichtung (64) ausgebildet ist, die zwischen einer Entriegelungsposition und einer Verriegelungsposition drehbar gelagert ist.

7. Kamera nach einem der Patentansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Verbindungsanordnung (60, 70) zwei Sätze von strukturell unterschiedlichen Verbindungseinrichtungen zum mechanischen Verbinden der Kamera (5) für eine tomographische Bildgebung einerseits und für eine Durchleuchtungsbildgebung andererseits aufweist.

8. Kamera nach Patentanspruch 7, **dadurch gekennzeichnet, dass** die unterschiedlichen mechanischen Verbindungseinrichtungen an verschiedenen physikalischen Flächen des Kameragehäuses (51), das die Sensormodulanordnung (20) umgibt, oder ähnlichem angeordnet sind, im Speziellen an den entgegengesetzten Seiten der Kamera (5).

9. Kamera nach einem der Patentansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die Verbindungsanordnung (60, 70) als ein zwangsabgestimmtes System ausgeführt ist, so dass die Kamera (5) mit der Bildgebungsvorrichtung nur durch Befolgen der Reihenfolge Positionieren der Kamera (5), Verriegeln der mechanischen Verbindungseinrichtung, elektrisches Koppeln verbunden werden kann.

10. Bildgebungsvorrichtung, die für eine tomographische Bildgebung oder für sowohl eine tomographische Bildgebung als auch für eine Durchleuchtungsbildgebung zu verwenden ist, insbesondere zur Verwendung in der Dentalpanoramabildgebung und in einer anderen Röntgenbildgebung, wobei die Vorrichtung aufweist: eine Strahlungsquelle (4), einen Kollimatoraufbau zum Begrenzen des von der Strahlungsquelle (4) empfangenen Strahls, eine Verbindungsanordnung (60', 70'), an der eine Kamera (5) nach einem der Patentansprüche 1 bis 9 montiert ist und eine Einrichtung zum Positionieren des abzubildenden Objekts, die an einer tomographischen Bildgebungsstation und andererseits an der möglichen Durchleuchtungsbildgebungsstation angeordnet ist, eine Einrichtung für die gesteuerten Bewegungen der Strahlungsquelle (4), des Kollimatoraufbaus, der Kamera (5) und / oder des abzubildenden Objekts während des Bildgebungsscans, wenn die Kamera positioniert ist, oder wenn sie unter Nutzung der Verbindungseinrichtung positioniert werden kann, so dass die Bildinformationsempfangseinrichtungen der Kamera (5) entlang einer gewünschten Bilderzeugungsfläche angeordnet sind oder bewegt werden können, wobei der Bereich, der durch die Bildinformationsempfangseinrichtungen abgedeckt ist, wesentlich kleiner als die Projektion des Objekts ist, das an der gewünschten Bilderzeugungsfläche abzubilden ist, und wobei die Bildinformationsempfangseinrichtung der Kamera (5) eine Sensormodulanordnung (20) aufweist, die zum Empfang der in der tomographischen Bildgebung produzierten Bildinformation vorgesehen ist, wobei die Verbindungsanordnung (60', 70') der Bildgebungsvorrichtung eine separate elektrische (70') und mechanische Verbindungseinrichtung (60') aufweist, die so realisiert sind, dass das mechanische Verbinden der Kamera (5) mit der Bildgebungsvorrichtung nicht direkt eine elektrische Kopplung mit einer elektrischen Verbindungseinrichtung (70') der Bildgebungsvorrichtung herbeiführt.

11. Bildgebungsvorrichtung nach Patentanspruch 10, **dadurch gekennzeichnet, dass** zumindest zwei strukturell verschiedene Verbindungsanordnungen in Verbindung mit den Bildgebungsstationen der Bildgebungsvorrichtung zur Verbindung der Kamera (5) in einer entfernbaren Weise an ihren jeweiligen Bildgebungsstationen angeordnet sind.

12. Bildgebungsvorrichtung nach Patentanspruch 10 oder 11, **dadurch gekennzeichnet, dass** zumindest in einer der Verbindungseinrichtungen der Bildgebungsvorrichtung die elektrische Kopplung so angeordnet ist, dass die Verbindungseinrichtung der elektrischen Kopplung nur in einen physikalischen Kontakt mit ihren zusammenpassenden Elementen in der Kamera (5) bewegt werden kann, nachdem die Verriegelung der mechanischen Vebindung beendet worden ist.

13. Bildgebungsvorrichtung nach einem der Patentansprüche 10 bis 12, **dadurch gekennzeichnet, dass** die mechanische Verbindungseinrichtung der Verbindungsanordnung eine separate Positionierungs-

einrichtung und eine Einrichtung zur Verriegeln der mechanischen Verbindungseinrichtung aufweist.

14. Bildgebungsvorrichtung nach einem der Patentansprüche 10 bis 13, **dadurch gekennzeichnet, dass** die Verbindungsanordnung der Bildgebungsvorrichtung zusammen mit ihren entsprechenden Elementen in der Kamera (5) so angeordnet sind, dass das Montieren der Kamera (5) durch Fixieren beendet wird, wobei das Fixieren der Kamera (5) in einer Zwangsreihenfolge von Positionieren der Kamera (5), Verriegeln der mechanischen Verbindungseinrichtung, elektrischer Kopplung stattfindet.

15. Bildgebungsvorrichtung nach einem der Patentansprüche 10 bis 13, **dadurch gekennzeichnet, dass** die Verbindungsanordnungen der Bildgebungsvorrichtung und ihre zugehörigen Elemente in der Kamera (5) so angeordnet sind, dass die Kamera (5) von entgegengesetzten Seiten positioniert werden kann, insbesondere von einer Seite zur einen und von der anderen Seite zur anderen der Bildgebungsstationen.

Revendications

1. Caméra numérique (5) à utiliser en imagerie tomographique, ou à la fois en imagerie tomographique et diaphanoscopique, destinée à une utilisation spécifique en imagerie dentaire dite panoramique et autre imagerie tomographique, ou à la fois en imagerie panoramique et céphalométrique, la caméra (5) comprenant des moyens de réception des informations d'image grâce auxquels la zone à imager est balayée par un faisceau, balayage d'imagerie pendant lequel les moyens de la caméra (5) de réception des informations d'image sont positionnables, ou sont mobiles, sur une surface de formation d'image souhaitée, la zone à couvrir par les moyens de réception des informations d'image étant essentiellement plus petite que la projection de l'objet à imager sur la surface de formation d'image, et lesquels moyens de réception d'informations d'image comprennent un agencement de module de capteur (20) destiné à la réception des informations d'image produites dans l'imagerie tomographique, la caméra (5) comprenant un agencement de connexion (60, 70) pour permettre sa connexion à un dispositif d'imagerie et son détachement de celui-ci, dans laquelle
ledit agencement de connexion (60, 70) comprend des moyens de connexion mécanique (60) et électrique (70) séparés de leurs propres structures de connexion, **caractérisée en ce que** ledit moyen de connexion électrique (70) a été mis en oeuvre de sorte que la connexion mécanique de la caméra (5) au dispositif d'imagerie n'entraîne pas directement un couplage électrique avec un moyen de connexion électrique (70') du dispositif d'imagerie.

2. Caméra selon la revendication 1, **caractérisée en ce que** ladite caméra (5) comprend un module d'imagerie tomographique et un module d'imagerie diaphanoscopique et ledit agencement de connexion (60, 70) comprend un connecteur électrique adapté pour transmettre l'alimentation principale, les données d'image et/ou toute variable correspondante le long d'un chemin de signal à partir du module d'imagerie tomographique et vers celui-ci, et un autre connecteur électrique adapté pour transmettre des variables correspondantes via un autre chemin de signal de branchement à partir du module d'imagerie tomographique et vers celui-ci, et à partir du module d'imagerie diaphanoscopique et vers celui-ci.

3. Caméra selon la revendication 2, **caractérisée en ce que** ledit chemin de signal de branchement comprend des moyens, tels que par exemple un circuit de logique électronique, permettant de combiner les images partielles produites par deux modules de capteur individuels ou plus en une seule image diaphanoscopique uniforme.

4. Caméra selon l'une quelconque des revendications 1 à 3, **caractérisée en ce qu'**un logement (51) est agencé pour ledit agencement de module de capteur (20) et **en ce que** ledit moyen de connexion électrique (70) est placé sur le logement (51), notamment sur un côté du logement de caméra (51), entourant l'agencement de module de capteur (20), différent du moyen de connexion mécanique (60).

5. Caméra selon l'une quelconque des revendications 1 à 4, **caractérisée en ce que** le moyen de connexion mécanique (20) comprend des moyens de positionnement permettant de positionner la caméra (5) sur sa position correcte avant le verrouillage de sa fixation mécanique.

6. Caméra selon la revendication 5, **caractérisée en ce que** les moyens de positionnement sont formés en tant que rainures de guidage assorties fournies dans la caméra (5) et pénétrées par des rails de guidage (61), dans laquelle la fixation mécanique est formée comme un moyen de verrouillage (64) qui est supporté de façon à pouvoir tourner entre une position de libération et une position de verrouillage.

7. Caméra selon l'une quelconque des revendications 1 à 6, **caractérisée en ce que** l'agencement de connexion (60, 70) comprend deux jeux de moyens de connexion structurellement différents permettant de connecter la caméra (5) mécaniquement pour l'imagerie tomographique d'une part, et pour l'imagerie

diaphanoscopique d'autre part.

8. Caméra selon la revendication 7, **caractérisée en ce que** lesdits moyens de connexion mécanique différents sont situés sur des surfaces physiques différentes du logement de caméra (51), ou similaire, entourant l'agencement de module de capteur (20), spécifiquement sur les côtés opposés de la caméra (5).

9. Caméra selon l'une quelconque des revendications 1 à 8, **caractérisée en ce que** l'agencement de connexion (60, 70) a été mis en oeuvre en tant que système à phase obligatoire de sorte que la caméra (5) peut être fixée au dispositif d'imagerie uniquement en suivant la séquence suivante : positionnement de la caméra (5), verrouillage du moyen de connexion mécanique et couplage électrique.

10. Dispositif d'imagerie à utiliser en imagerie tomographique, ou à la fois en imagerie tomographique et diaphanoscopique, notamment destinée à une utilisation en imagerie dentaire panoramique et autre imagerie aux rayons X, lequel dispositif comprend une source de rayonnement (4), une structure de collimateur permettant de limiter le faisceau reçu à partir de la source de rayonnement (4), un agencement de connexion (60', 70') permettant de monter une caméra (5) selon l'une des revendications 1 à 9 et des moyens de positionnement de l'objet à imager situés au niveau d'une station d'imagerie tomographique, et d'autre part au niveau d'une station d'imagerie diaphanoscopique éventuelle, ainsi que des moyens pour les mouvements commandés de la source de rayonnement (4), la structure de collimation, la caméra (5) et/ou l'objet à imager pendant le balayage d'imagerie, lorsque ladite caméra a été positionnée, ou lorsqu'elle peut être positionnée à l'aide dudit agencement de connexion, de sorte que les moyens de la caméra (5) de réception d'informations d'image sont situés, ou peuvent être déplacés le long d'une surface de formation d'image souhaitée, tandis que la zone couverte par les moyens de réception d'informations d'image est essentiellement plus petite que la projection de l'objet à imager sur la surface de formation d'image souhaitée, et où les moyens de réception d'informations d'image à partir de ladite caméra (5) comprennent un agencement de module de capteur (20) destiné à la réception des informations d'image produites dans l'imagerie tomographique, dans lequel l'agencement de connexion (60', 70') du dispositif d'imagerie comprend des moyens de connexion électrique (70') et mécanique (60') séparés, qui ont été mis en oeuvre de sorte que la connexion mécanique de la caméra (5) au dispositif d'imagerie n'entraîne pas directement un couplage électrique avec un moyen de connexion électrique (70') du dispositif d'imagerie.

11. Dispositif d'imagerie selon la revendication 10, **caractérisé en ce qu'**au moins deux agencements de connexion structurellement différents ont été agencés en connexion avec les diverses stations d'imagerie du dispositif d'imagerie, pour connecter la caméra (5) de façon amovible à ses stations d'imagerie respectives.

12. Dispositif d'imagerie selon la revendication 10 ou 11, **caractérisé en ce qu'**au moins dans l'un des moyens des connexions de dispositif d'imagerie, le couplage électrique a été agencé de sorte que les moyens de contact du couplage électrique peuvent être déplacés vers un contact physique avec leurs éléments assortis dans la caméra (5) uniquement après que le verrouillage de la connexion mécanique a été effectué.

13. Dispositif d'imagerie selon l'une quelconque des revendications 10 à 12, **caractérisé en ce que** le moyen de connexion mécanique de l'agencement de connexion comprend les moyens de positionnement séparés et les moyens permettant de verrouiller le moyen de connexion mécanique.

14. Dispositif d'imagerie selon l'une quelconque des revendications 10 à 13, **caractérisé en ce que** l'agencement de connexion du dispositif d'imagerie, conjointement avec ses éléments correspondants dans la caméra (5), a été agencé de sorte que le montage de la caméra (5) se terminera par la fixation, où la fixation de la caméra (5) aura lieu dans une séquence obligatoire suivante : positionnement de la caméra (5), verrouillage du moyen de connexion mécanique et couplage électrique.

15. Dispositif d'imagerie selon l'une quelconque des revendications 10 à 13, **caractérisé en ce que** les agencements de connexion du dispositif d'imagerie, conjointement avec leurs éléments correspondants dans la caméra (5), ont été agencés de sorte que la caméra (5) peut être positionnée à partir des côtés opposés, notamment d'un côté à l'autre, et à partir de l'autre côté à l'autre station des stations d'imagerie.

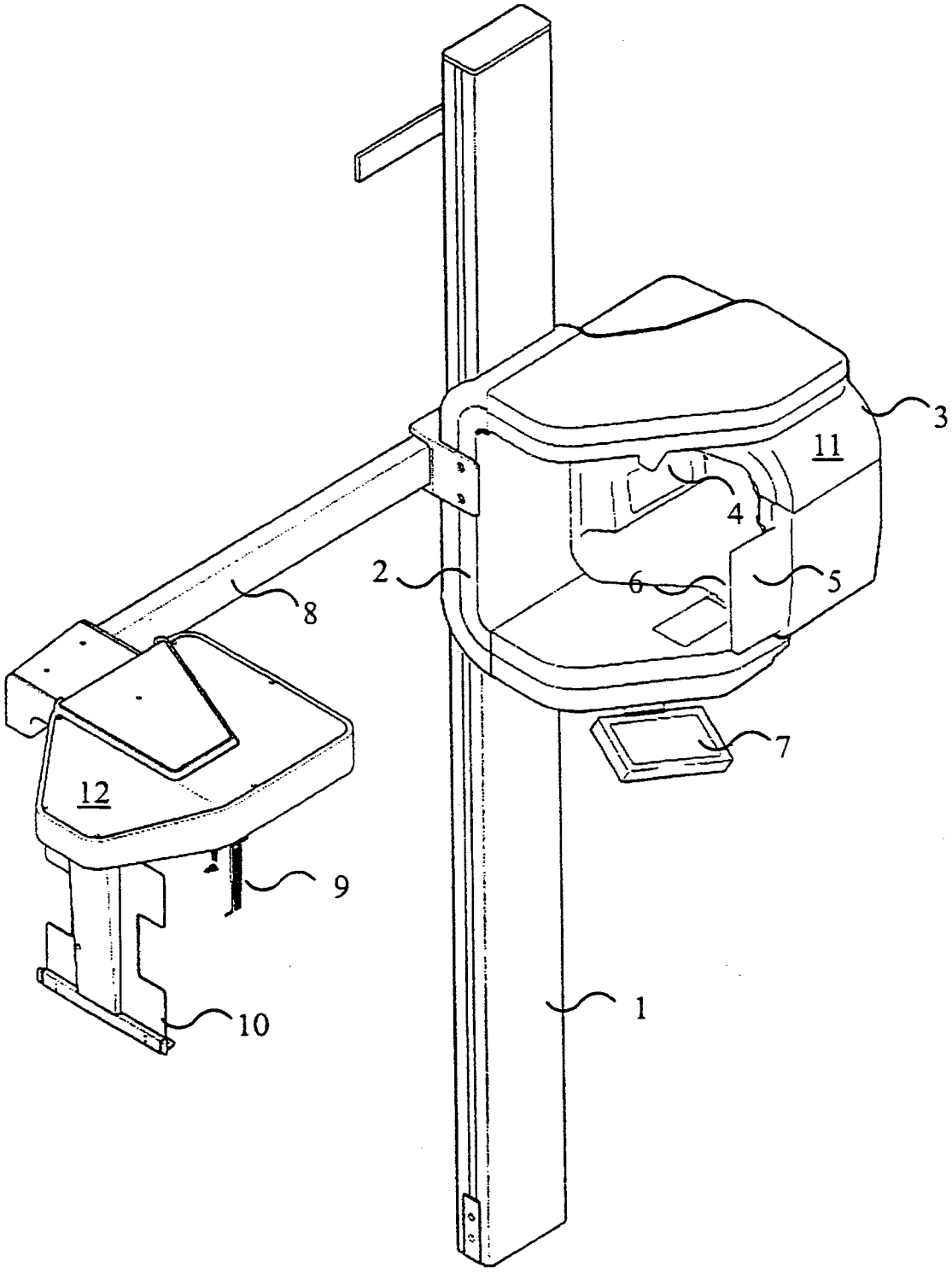


FIG. 1

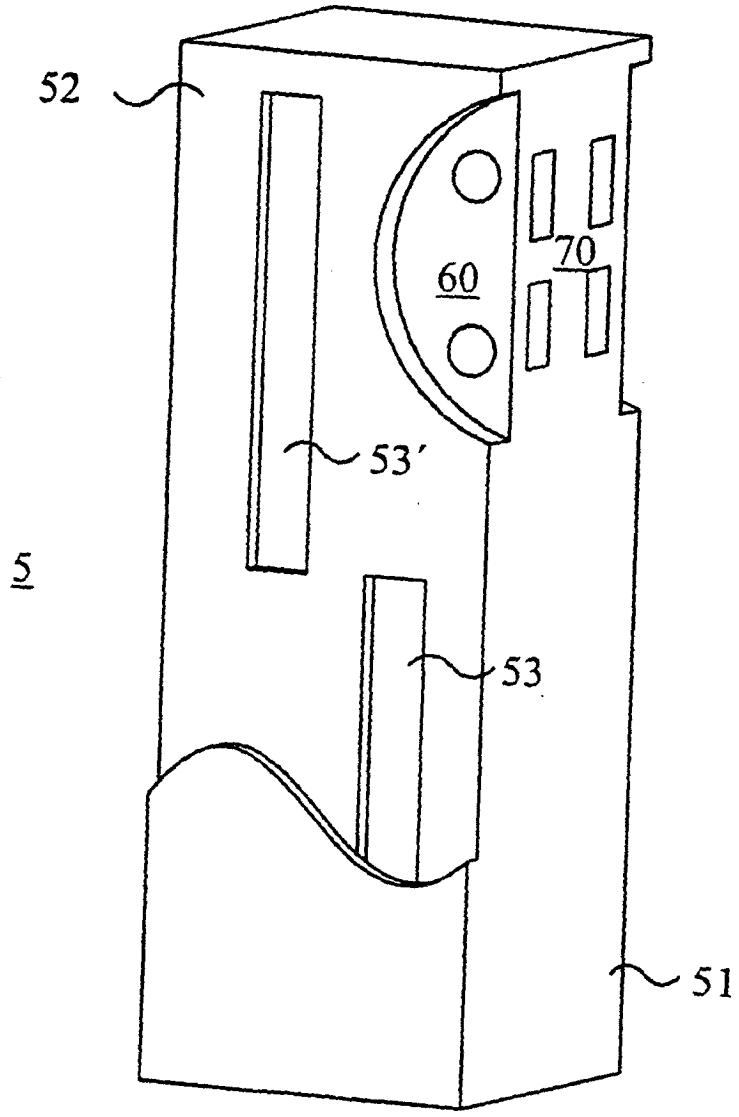


FIG. 2

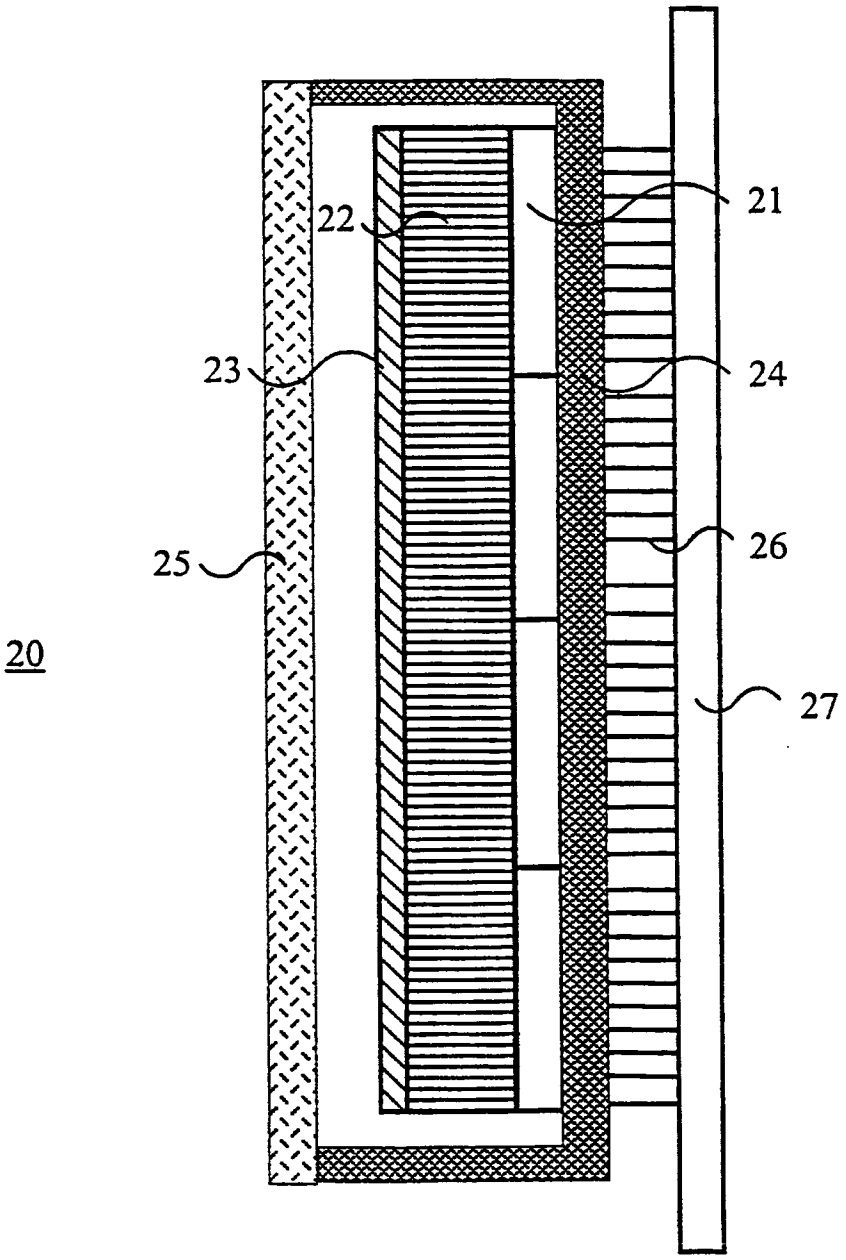


FIG. 3A

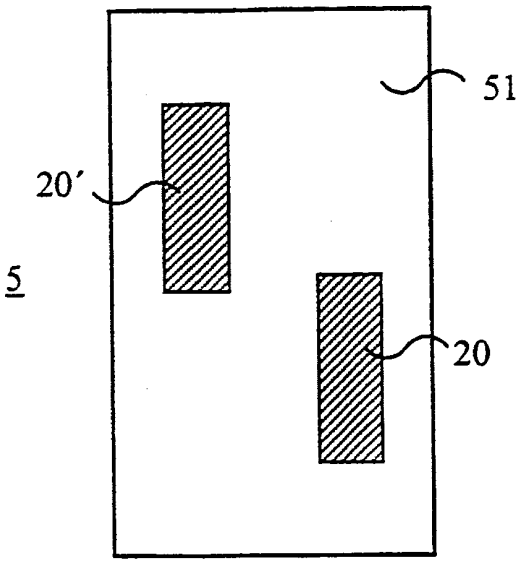


FIG. 3B

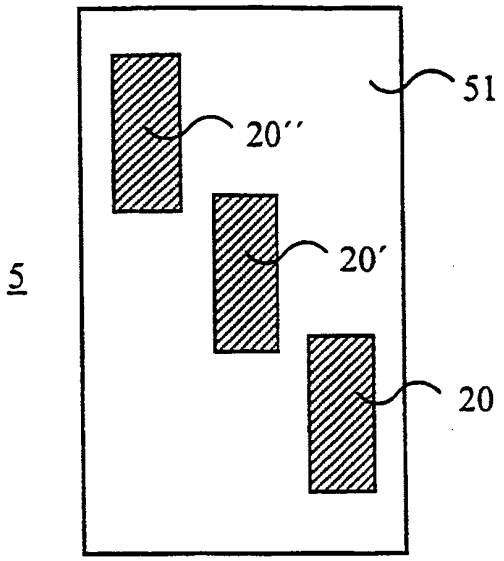
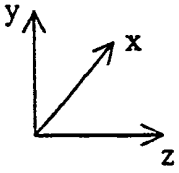


FIG. 3C



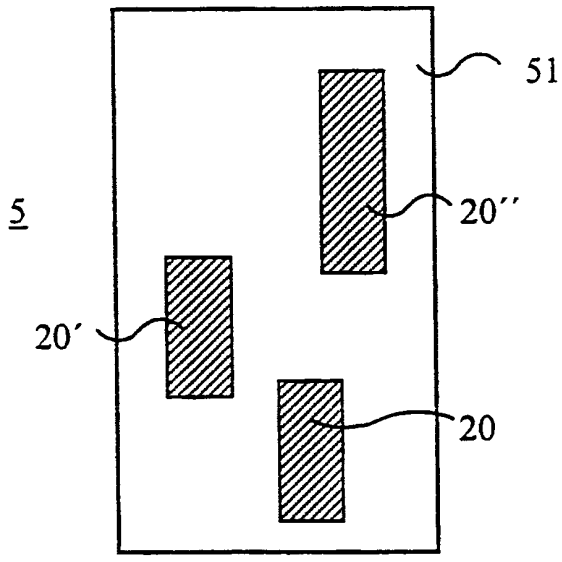


FIG. 3D

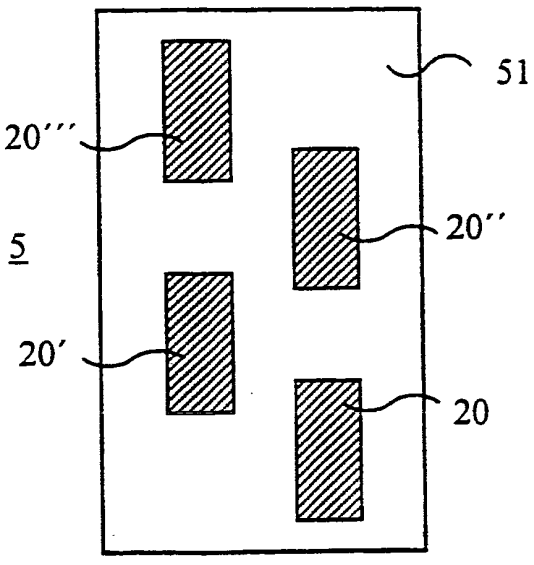


FIG. 3E

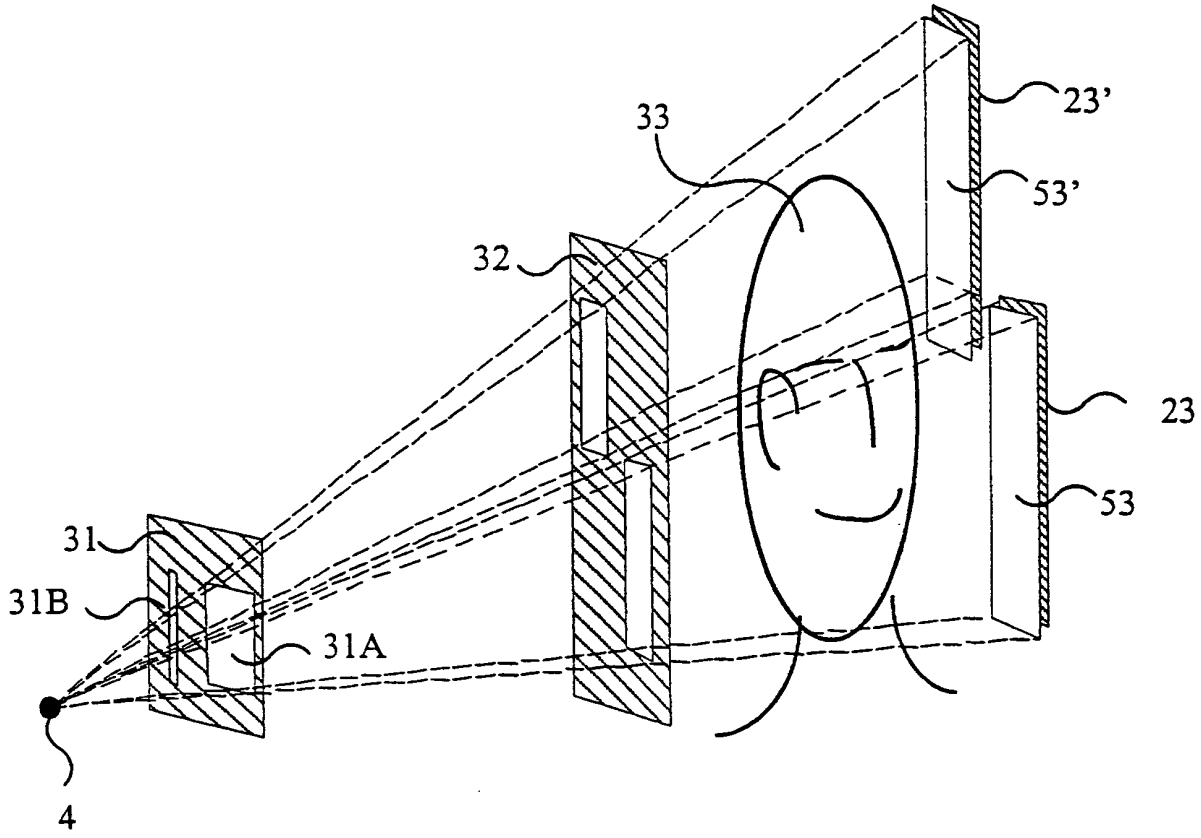


FIG. 4

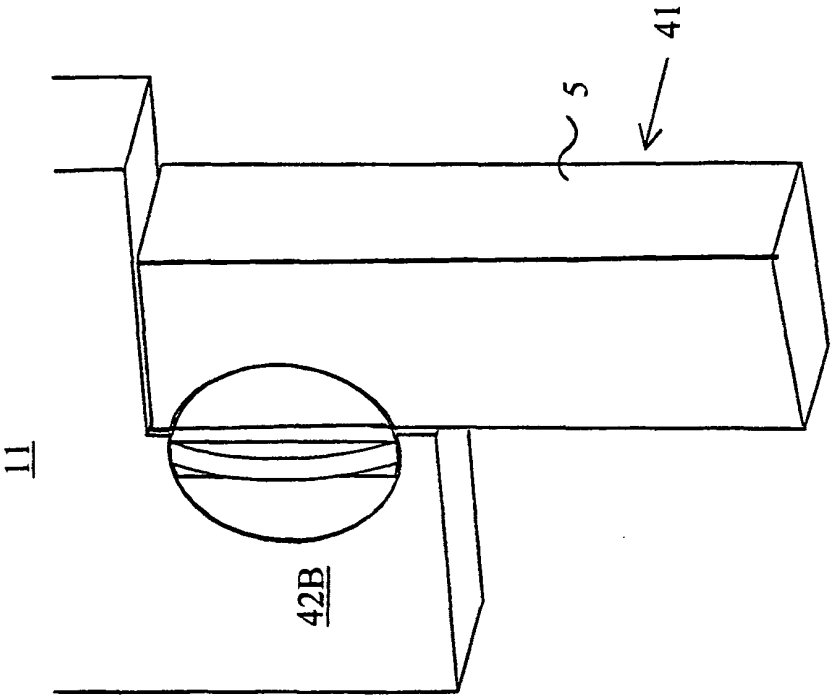


FIG. 5B

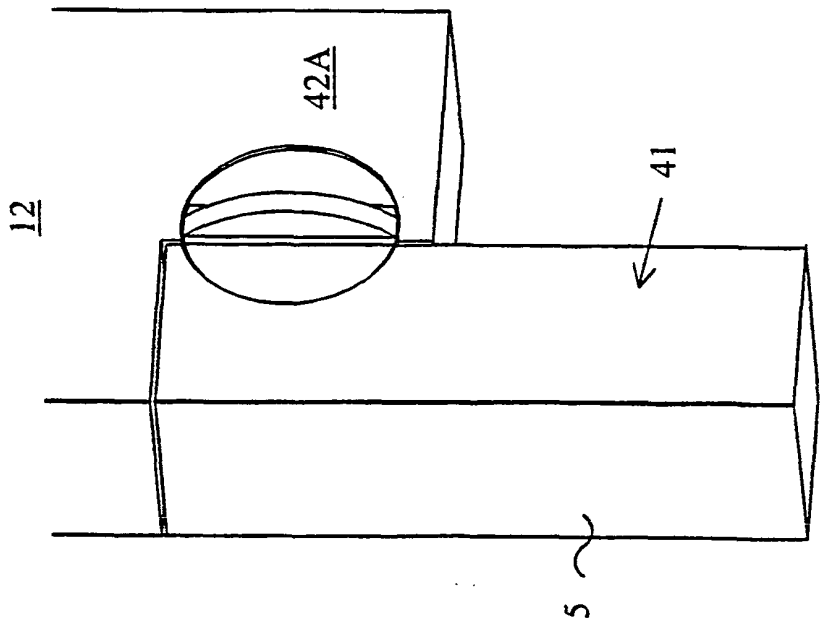


FIG. 5A

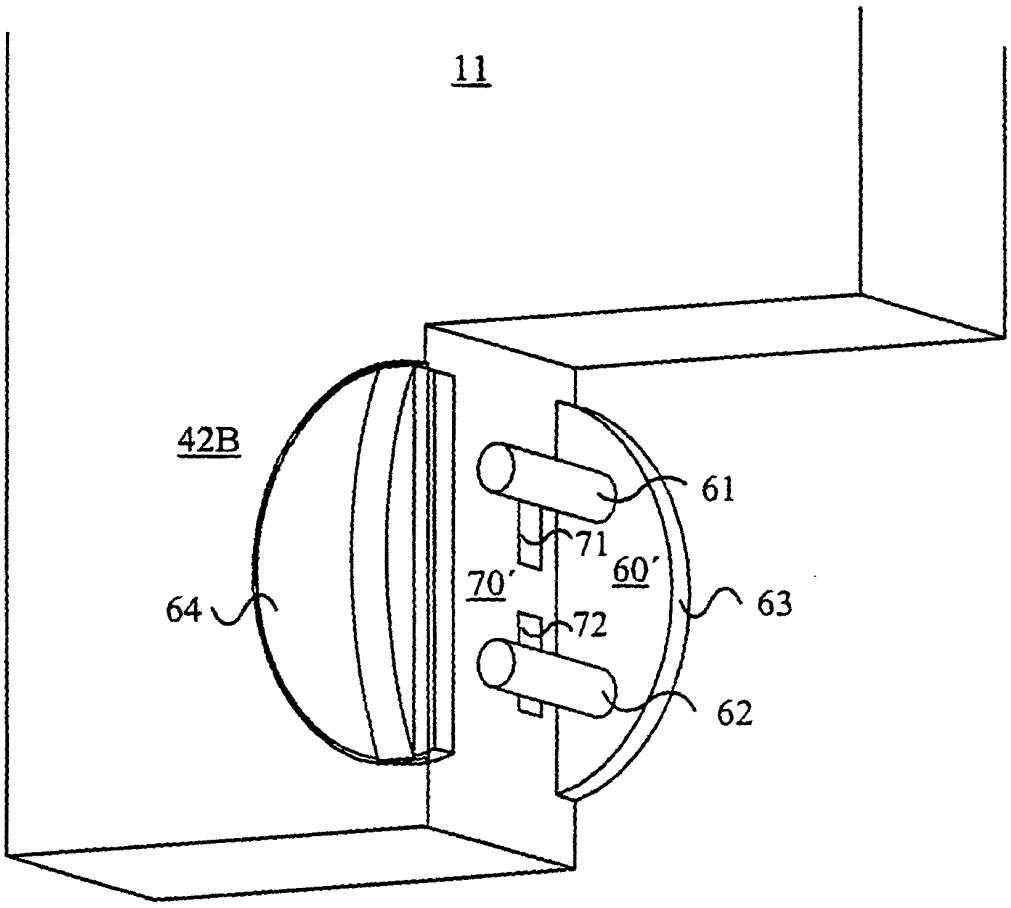


FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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- **McDavid, W.D. et al.** Direct digital extraoral radiology of the head and neck with a solid-state linear radiographic detector. *Oral Surg Med Oral Pathol,* 1992, vol. 74, 811-7 **[0009]**

专利名称(译)	数码相机和成像设备		
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申请(专利权)人(译)	普兰梅卡OY		
当前申请(专利权)人(译)	普兰梅卡OY		
[标]发明人	NYHOLM KUSTAA		
发明人	NYHOLM, KUSTAA		
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摘要(译)

本发明涉及数字照相机，成像装置和牙科数字成像方法。一个传感器用于断层摄影成像，并且至少一个传感器用于透射成像。传感器布置成彼此重叠。与使用一个大面积传感器的相比，这种布置提供了多次使用和相对便宜的相机。另外，可以为不同的成像模式布置至少两个单独的电连接结构。此外，其连接布置可以以这样的方式布置，使得相机的机械连接结构与电连接结构分离。