

MOBILE X-RAY DEVICE WITH TELESCOPIC COLUMN

DESCRIPTION

5 OBJECT OF THE INVENTION

The object of the present invention, as the heading of the invention establishes, is an x-ray device with telescopic column, used to make x-rays that can reach any point in space, in any angle and/or direction, also having a design capable
10 of adopting a configuration that facilitates moving the equipment.

The mobile x-ray device comprises a chassis that supports the entire assembly, a telescopic column that comprises a fixed portion jointed to the chassis, the fixed portion having at least one telescopic portion, the device also comprising a
15 telescopic arm that moves along at least one telescopic portion and that supports an x-ray emitter at its end.

The present invention is characterised by the special configuration and design of each and every one of the elements forming part of the equipment, and
20 particularly by the fact that both the column and the arm that supports the x-ray emitter are extendable telescopically, allowing any point in space to be reached, in addition to adopting a compact configuration that facilitates movement and having a balancing mechanism of all movements, of the telescopic arm along the mobile portion and of the telescopic column's extension and retraction.

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Therefore, the present invention relates to the field of mobile devices for making x-rays.

BACKGROUND OF THE INVENTION

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The state of the art is familiar with mobile devices for making x-rays, such as the one disclosed in patent document US 20110249807, having a chassis on

which a telescopic column is disposed and associated to a telescopic arm that has an x-ray emitter at its end.

5 The device has means for mechanically balancing the vertical movements that take place, the movement of extension and retraction of the mobile portion of the column and the movement of the telescopic arm along the mobile portion of the column.

10 The means used in balancing the two movements are counterweights and/or motorised brake systems, which are costly and complex means, depend on having a power supply, and require continuous maintenance.

15 Consequently, the object of the present invention is to develop a mobile x-ray device that has a telescopic column and a telescopic arm that has an x-ray emitter assembled on its end, wherein the balancing means of the vertical movements are simplified, thereby developing a mobile x-ray device such as the one described herein whose essence is reflected in claim one.

DESCRIPTION OF THE INVENTION

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The object of the present invention is a mobile x-ray device with a telescopic column on which there is a telescopic arm assembled that has an x-ray emitter assembled at its end, the mobile device having on the telescopic column means for balancing the vertical movement of the assembly.

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The mobile x-ray device is made up of the following parts:

- An arm-head assembly made up of a telescopic arm and an x-ray emitter at its end.
- 30 - A telescopic column with a fixed lower portion and a mobile upper portion that allows positioning of the height of the arm-head assembly. This

column can, in turn, rotate around a vertical axis allowing the arm-head assembly to rotate around the column on the horizontal plane.

- A telescopic arm that moves along the vertical column and that supports an X-ray emitter at its end. This arm when extending or retracting allows the x-ray emitter to be moved further away or brought closer horizontally.
- A chassis that supports the entire telescopic column and in which the manual or motorised system for moving the equipment is included, including the wheels that allow the mobile x-ray equipment to be moved.
- A head or head assembly which includes an x-ray emitter.
- A user console.

Thanks to the combination of the extendable characteristics of the telescopic column and the telescopic arm, the achievement is on the one hand to reach any part in space where an x-ray is to be made, while on the other hand, adopting a compact configuration, in such a way that during movement, the telescopic column itself does not represent an obstacle in the field of vision ahead of the mobile device.

Both the chassis and the telescopic arm incorporate a parking lock so that the emitter is locked during transport for increased safety.

This configuration for transport provides a field of vision free of obstacles for the operator driving the equipment.

The arm-head assembly can be moved from the lower position of the mobile column in its retracted position (minimum height position) to the upper position of the mobile column in its extended position (maximum height position).

In addition, all the movements of the column are manual and are mechanically balanced, making it possible to position the arm-head assembly at any height between the maximum and minimum height positions.

The movements of the elements assembled on the chassis of the mobile x-ray device include:

- Rotation of the telescopic column on the vertical axis over the horizontal plane.
- 5 - Vertical movement: extension and retraction of the telescopic column.
- Movement of the arm-head assembly over the mobile portion of the telescopic column.
- Extension and retraction of the telescopic arm
- Rotations of the head assembly.

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Of all these movements there are two that are made in a vertical direction and that need to be balanced: that of the arm-head assembly over the mobile portion of the column and that of extension and retraction of the telescopic column.

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In the state of the art this problem is usually resolved by means of counterweights and/or motorised brake systems. In the present invention, thanks to all the movements described above being manual and mechanically balanced correct and continuous functioning of the balancing system is

20 ensured, in contrast to balancing systems based on electrical means, which require maintenance and have a higher risk of failure.

The mechanical balancing mechanism provided to the invention is divided into two parts:

- 25 - a first mechanism that balances the weight of the assembly of the two bodies with vertical movement. These two bodies are the mobile part of the column and the arm-head assembly. This mechanism consists of the fixed column, the block and tackle, the spring, and the variable-radius pulley).
- 30 - a second mechanism that balances the weight of the arm-head assembly. This second mechanism consists of the mobile column, the recovery pulley and the two-radii pulley.

The second balancing mechanism can be modified to admit further vertical telescopic portions by merely adding one new variable radius pulley and one new recovery pulley for each new portion of telescopic column.

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The compact telescopic arm comprises various portions, a base portion joined to the column and at least one other portion which slides horizontally with respect to the base portion.

10 **EXPLANATION OF THE DRAWINGS**

To complement the description being made and with a view to contributing towards a better understanding of the characteristics of the invention, according to a preferred example of a practical embodiment thereof, a set of drawings is attached as an integral part of said description, which by way of illustration and not limitation, represent the following.

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In figure 1, it is possible to observe a general representation of the mobile x-ray device comprising the object of the invention.

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Figure 2 shows a representation of the device in the compact and retracted position.

Figures 3 and 4 show the extreme positions that the arm-head assembly can adopt in terms of height. Figure 3 shows the minimum height position. Figure 4 shows the maximum height position.

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Figure 5 shows the mechanical balancing means of the telescopic column in a simplified manner.

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Figure 6 shows an exploded view of the telescopic column and the mechanical balancing means housed inside.

Figure 7 shows a top view representation of the telescopic column.

Figures 8 and 9 show two sections made of the telescopic column on the planes
 5 VIII-VIII and IX-IX respectively. These section planes are indicated in figure 7.

Figure 10 shows a representation of the device in the compact and retracted position showing the different possibilities of rotation of the user console.

10 **PREFERRED EMBODIMENT OF THE INVENTION.**

In the light of the drawings what follows is a description of a preferred mode of embodiment of the proposed invention.

15 In figure 1 it is possible to observe that the mobile device that is the object of the invention comprises:

- A chassis (1) that supports the telescopic column and having a system with wheels for manual or motorised movement which allow the equipment to be transported.
- 20 - A telescopic column (2) comprising a lower portion fixed in height (5) which rotates with respect to the vertical axis, and at least one portion mobile in height (6).
- A telescopic arm (3) which moves vertically along the telescopic column and which supports at its end a head assembly (4) where the x-ray
 25 emitter is located. This arm when extending or retracting allows the x-ray emitter to be moved further away or brought closer horizontally.
- The head assembly (4) includes the x-ray emitter.

The telescopic arm (3) comprises a base portion (7) and at least one other
 30 horizontally mobile portion. In a possible mode of embodiment, said telescopic arm comprises:

- A base portion (7) fixed to the telescopic column (2) by means of a joint that is moveable along the last portion (the highest) of the telescopic column.
- Two portions (8) and (9) which slide horizontally with respect to the base portion (7).

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In figure 2, it is possible to observe the retracted (parking) position of both, the telescopic column (2) and the telescopic arm (3), a convenient position for transport of the mobile device, and how a user (28) has an unrestricted field of vision (29).

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Figures 1, 2 and 10 show the presence of a user console (27). In figure 1, the user console (27) is unfolded, whereas in figure 2, the user console (27) is folded.

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In figure 10, the user console (27) can rotate between 0° and 90° on the horizontal axis and additionally shows how the user console (27) could rotate between -180° and $+180^\circ$ on the vertical axis.

Figures 3 and 4 show the extreme positions in height that the assembly consisting of the telescopic arm (3) and the head assembly (4) can adopt, which range from the lowest position of the mobile portion (6) of the telescopic column (2) in the retracted position (figure 3), to the highest position of the mobile portion (6) of the telescopic column (2) in the extended position (figure 4).

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Figure 5 shows schematically in detail the mechanical balancing mechanism which comprises:

- A first mechanism which balances the weight of the suspended bodies that move vertically (the mobile portion (6) of the telescopic column (2) on the one hand, and the telescopic arm (3) with the head assembly (4) on the other hand). This first mechanism is housed in the fixed lower portion (5) of the telescopic column (2).

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- A second mechanism which balances the weight of the assembly consisting of the telescopic arm (3) and the head assembly (4) and which is housed in each of the mobile portions (6) that the telescopic column (2) comprises.

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The first balancing mechanism comprises:

- A tension spring (11) using any type of traction technology, which is the device in charge of storing the potential gravitational energy of the mobile suspended bodies in the form of potential elastic energy when these move downwards and which would return it when these bodies move upwards.
- A block and tackle (12) in charge of dividing the force of the spring (11) and multiplying the run of the cable at the output. The degree of multiplication and division depends on the number of pulleys of the block and tackle (12). In the represented case, the multiplication factor is 6. The block and tackle (12) consists of one group of lower pulleys (12.1) and one group of upper pulleys (12.2).
- A variable radius pulley (13). The cable that comes from the block and tackle that is joined to the spring (11) coils in the grooves of a pulley wherein the radii vary throughout the run of the cable, achieving the cable at the output of said variable radius pulley having a constant tension. This force will be the sum of the weights to be balanced (that of the mobile portion (6) of the telescopic column (2) and that of the telescopic arm (3) and head assembly (4).

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The fixed column houses the elements mentioned above: the spring (11), the block and tackle (12) and the variable radius pulley (13).

The fixed portion (5) of the telescopic column (2) is fixed to the frame of the chassis and can rotate on it. The rotation mechanism incorporates an orifice concentric with the column that allows passage of the system's electrical cables

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that run from the chassis (1) to the telescopic column (2) and whose final destination is any device between said orifice and up to the head assembly (4).

5 In a possible mode of embodiment of the block and tackle (12), it is possible to achieve with only two axes the coaxial alignment of the upper pulleys (12.2) and the variable radius pulley (13) on the one hand with the lower pulleys (12.1) on the other, although this does not exclude other possible block and tackle configurations that can perform the same function.

10 The system represented in figure 5 has two degrees of freedom in a vertical direction wherein the movement is manual and balanced. Therefore, if the head assembly (4) is moved manually in a vertical direction there is uncertainty in respect of which of the two vertical guides will start to move. Due to different friction of the vertical guides (16) and (17) only one of the two will move until it
15 reaches a stopper, and as of that moment the other one will start to move.

The second balancing mechanism comprises:

- 20 - A two-radii pulley (14) that takes charge of balancing the weight of the telescopic arm (3) and of the head assembly (4) with the traction at the input of this pulley (sum of the mobile portion (6) of the telescopic column (2) plus the telescopic arm (3) and head (4) assembly). This is achieved by making the ratio between the input and output radii equal to the weight of the arm-head assembly divided by the weight of the mobile portion (6)
25 plus the telescopic arm (3) and head assembly (4), in other words, the ratio between input radius and output radius is equal to the quotient between weight $[(3)+(4)]$ divided by weight $[(6)+(3)+(4)]$. This two-radii pulley (14) is fixed to the upper part of the mobile portion (6) of the telescopic column (2).
- 30 - A recovery pulley (15) that allows the cable that comes from the variable radius pulley (13) to pull upwards from the lower part of the mobile portion (6) of the telescopic column (2).

This second balancing mechanism is housed in the mobile portion (6), therefore housing the recovery pulley (15), and the two-radii pulley (14). Furthermore, it has the linear guides (16) between the mobile portion (6) and the fixed portion (5), and the linear guides (17) between the mobile portion (6) and the telescopic arm (3).

The second balancing mechanism can be modified to admit further portions, as many as the mobile portions of the telescopic column (2), by merely adding a new two-radii pulley and a recovery pulley for each new portion of mobile column.

In this figure 5, the telescopic arm (3) has also been represented, which at its end has the head assembly (4) consisting of the x-ray emitter (4.1) and the x-ray collimator (4.2).

In figure 6, it is possible to observe the elements previously described, with the rotary joint between the lower fixed portion (5) and the chassis (1) being particularly noteworthy, which is achieved by means of a ball bearing (5.1), said joint having a concentric orifice through which the system's electrical cables are made to pass which run from the chassis (1) to the fixed portion (5) and whose final destination can be any device between said orifice and the head assembly (4) including its components.

On the fixed portion (5) of the telescopic column (2) front bearings (18) and lateral bearings (19) are disposed on either side, which allow the movement of the mobile portion (6) with respect to the fixed portion (5), without heaving or pitching.

A base plate (20) can also be observed for the movement of the telescopic arm (3) wherein the base portion (7) is shown. Said base plate (20) has at both its upper end and its lower end and on both sides front bearings (21) and other

lateral bearings (22) which allow perfect guiding without heaving or pitching of the telescopic arm (3) in its vertical movement along the mobile portion (6) to which it is associated.

5 In figure 7, the guides (16) between the fixed portion (5) and the mobile portion (6) and the guides (17) between the telescopic arm (3) and the mobile portion (6) can be observed. Guides (16) house the front bearings (18) and lateral bearings (19). Guides (17) house the front bearings (21) and lateral bearings (22).

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Figures 8 and 9 show sections of the telescopic column, wherein the support (11.1) of the spring (11) at its lower end can be observed.

Also the mechanical balancing mechanism has safety means, which in a possible mode of embodiment comprise:

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- An electromagnetic brake (24) mounted on the variable radius pulley (13)
- A first parachute mechanism (25) which prevents the assembly consisting of the telescopic arm (3) and the head assembly (4) from falling in the event of the cable breaking

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- A second parachute mechanism (26) which prevents the mobile portion (6) from falling in the event of the cable breaking.

Having sufficiently described the nature of the present invention, in addition to a way of putting it into practice, it is stated that, within its essence, it may be put into practice in other modes of embodiment which differ in detail to the one portrayed by way of an example, and to which the protection sought hereby will likewise extend, on condition that its fundamental principle is not altered, changed or modified.

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CLAIMS

1. - Mobile x-ray device with telescopic column comprising:

- A chassis (1) which supports the telescopic column (2),
- 5 - A telescopic column (2) comprising a lower fixed portion (5) which rotates with respect to a vertical axis, and at least one upper mobile portion (6).
- A telescopic arm (3) which moves vertically along the telescopic column (2) and which supports at its end a head assembly (4) which contains the x-ray emitter. This arm on extending or retracting allows the x-ray emitter
- 10 to be moved further away or brought closer horizontally.

Characterised in that:

- The arm-head assembly can move from the lower position of the telescopic column in its retracted position to the upper position of the mobile column in its extended position.
- 15 - Also all movements of the column are manual and have a mechanical balancing mechanism.

2.- Mobile x-ray device with telescopic column according to claim 1, characterised in that the chassis (1) has a system of wheels with manual or

20 motorised movement, which allows the equipment to be moved.

3. - Mobile x-ray device with telescopic column according to claim 1, characterised in that the telescopic arm (3), comprises

- A base portion (7) fixed to the mobile portion (6) of the telescopic column
- 25 (2) by means of a joint moveable along the mobile portion (6).
- Two portions (8) and (9) which slide horizontally with respect to the base portion (7) and each one of them also with respect to the immediately preceding portion.

30 4. - Mobile x-ray device with telescopic column according to claim 1, characterised in that the mechanical balancing mechanism comprises:

- A first mechanism that balances the weight of the two suspended bodies with vertical movement (the mobile portion (6) on the one hand, and the telescopic arm (3) with the head assembly (4) on the other hand). This first mechanism is housed in the fixed portion (5).

- 5 - A second mechanism that balances the weight of the assembly consisting of the telescopic arm (3) and the head assembly (4) and which is housed in each of the mobile portions (6) that the telescopic column (2) comprises.

10 5. - Mobile x-ray device with telescopic column according to claim 4, characterised in that the first balancing mechanism comprises:

- A tension spring (11) which can use any type of traction technology, and which is fixed to a support (11.1) at its lower end
- A block and tackle (12) consisting of one group of lower pulleys (12.1) and one group of upper pulleys (12.2). The lower pulleys (12.1) of the
15 block and tackle (12) are joined to the tension spring (11).
- A variable radius pulley (13) wherein the cable that comes from the block and tackle (12) and is coiled in the grooves of the pulley whose radii vary throughout the run of the cable, thereby achieving that the cable at the
20 output of the pulley (13) has a constant tension. This force will be the sum of the two weights to be balanced (that of the mobile portion (6) and that of the telescopic arm (3) with the head assembly (4)).

25 6. - Mobile x-ray device with telescopic column according to claim 4, characterised in that the second balancing mechanism, housed in each of the mobile portions (6) of the telescopic column (2), comprises:

- A two-radii pulley (14) which takes charge of balancing the weight of the telescopic arm (3) and of the head assembly (4) with the traction at the input of this pulley (sum of the mobile portion (6) plus the assembly of the
30 telescopic arm (3) and head assembly (4)).

- A recovery pulley (15) that allows the cable that comes from the variable radius pulley (13) to pull upwards from the lower part of the mobile portion (6).

5 7.- Mobile x-ray device with telescopic column according to claim 6, characterised in that the two-radii pulley (14) achieves a balancing of forces by making the ratio between the input radius divided by the output radius equal to the sum of the weights of the telescopic arm (3) assembly and the weight of the head assembly (4) divided by the sum of the weights of the mobile portion
10 (6), of the telescopic arm assembly (3) and of the head assembly (4), in other words the ratio between the input radius and the output radius is equal to the quotient between weight [(3)+(4)] divided by weight [(6)+ (3)+(4)], leaving the two-radii pulley (14) fixed to the upper part of the mobile portion (6).

15 8. - Mobile x-ray device with telescopic column according to claim 4, characterised in that the mobile portion (6) has linear guides (16) between the mobile portion (6) and the fixed portion (5), and linear guides (17) between the mobile portion (6) and the telescopic arm (3).

20 9. - Mobile x-ray device with telescopic column according to claim 1, characterised in that the rotary joint between the lower fixed portion (5) and the chassis (1), which is embodied by means of a bearing (5.1), has an orifice (6.1) through which the system's electrical cables are made to pass from the chassis (1) to the inside of the fixed portion (5).

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10. - Mobile x-ray device with telescopic column according to claim 1, characterised in that

- on the fixed portion (5) of the telescopic column (2) disposed on both sides there are front bearings (18) and lateral bearings (19), which allow
30 movement of the mobile portion (6) with respect to the fixed portion (5), without heaving or pitching.

- on a base plate (20), for movement of the telescopic arm (3), both at its upper end and its lower end and on both sides front bearings (21) are disposed and other side bearings (22) to allow guiding of the telescopic arm (3) in its vertical movement over the mobile portion (6) to which it is associated.

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11. - Mobile x-ray device with telescopic column according to claim 5, characterised in that the mechanical balancing mechanism has safety means in the event of the cable breaking. These safety means are a first parachute mechanism (25) between the telescopic arm (3) and the mobile portion (6), and

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a second parachute (26) between the mobile portion (6) and the fixed portion (5). These two parachute mechanisms prevent the possible fall of the telescopic arm (3), of the head assembly (4) and of the mobile portion (6) in the event of the cable breaking.

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12. - Mobile x-ray device with telescopic column according to claim 5, characterised in that the lower fixed portion (5) rotates with respect to the chassis (1) by means of a rotation bearing (5.1), having also in the rotary joint an orifice concentric with respect to the rotation bearing which allows passage

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of the system's electrical cables from the chassis (1) to the telescopic column (2).

13. - Mobile x-ray device with telescopic column according to any of the preceding claims, characterised in that the assembly comprises a user console

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14. - Mobile x-ray device with telescopic column according to claim 13, characterised in that the user console (27) rotates between 0° and 90° about the horizontal axis.

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15. - Mobile x-ray device with telescopic column according to claim 14, characterised in that the user console (27) rotates between -180° and $+180^{\circ}$ about the vertical axis.