

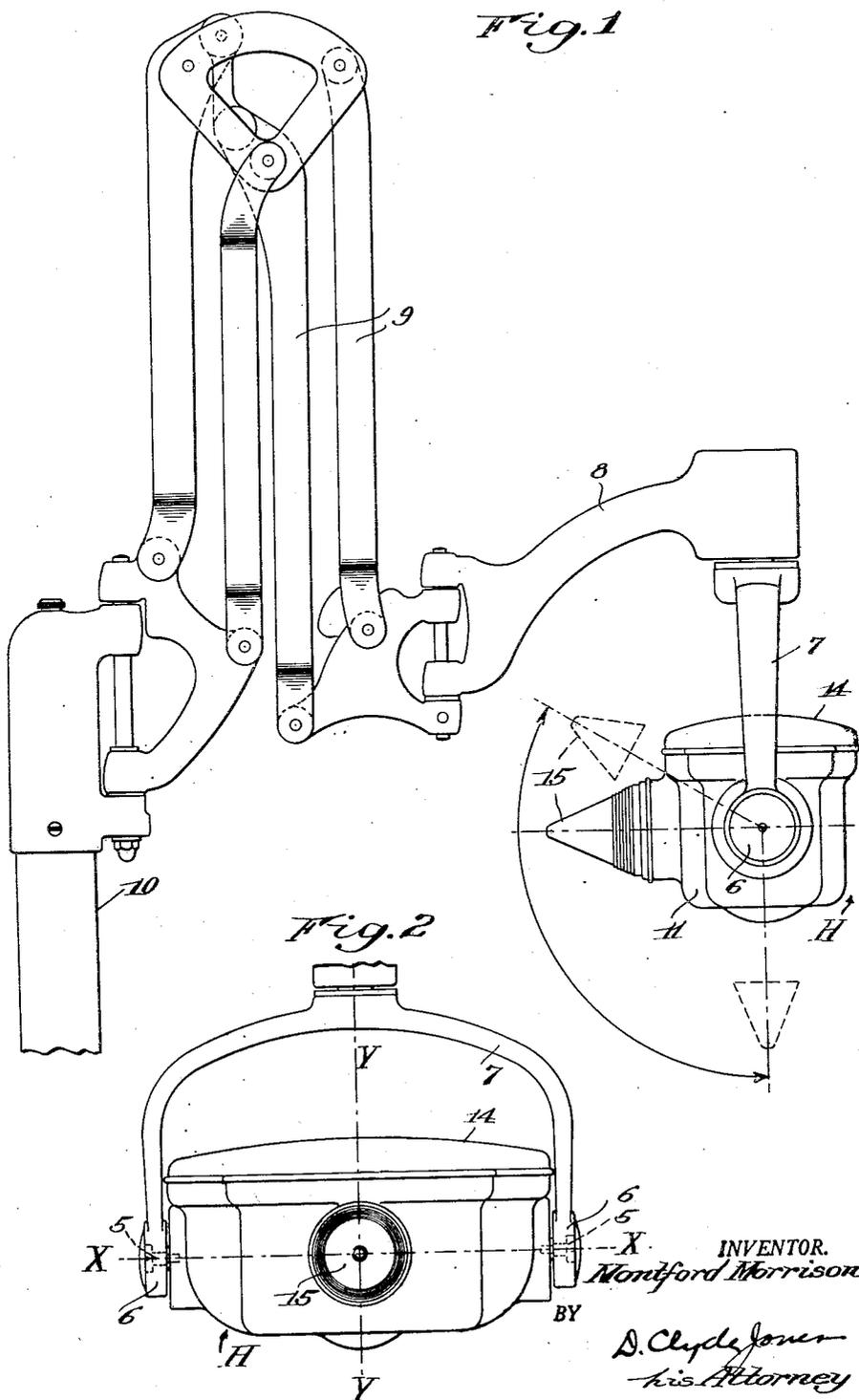
April 10, 1951

M. MORRISON
X-RAY APPARATUS

2,548,489

Filed Dec. 20, 1946

5 Sheets-Sheet 1



INVENTOR.

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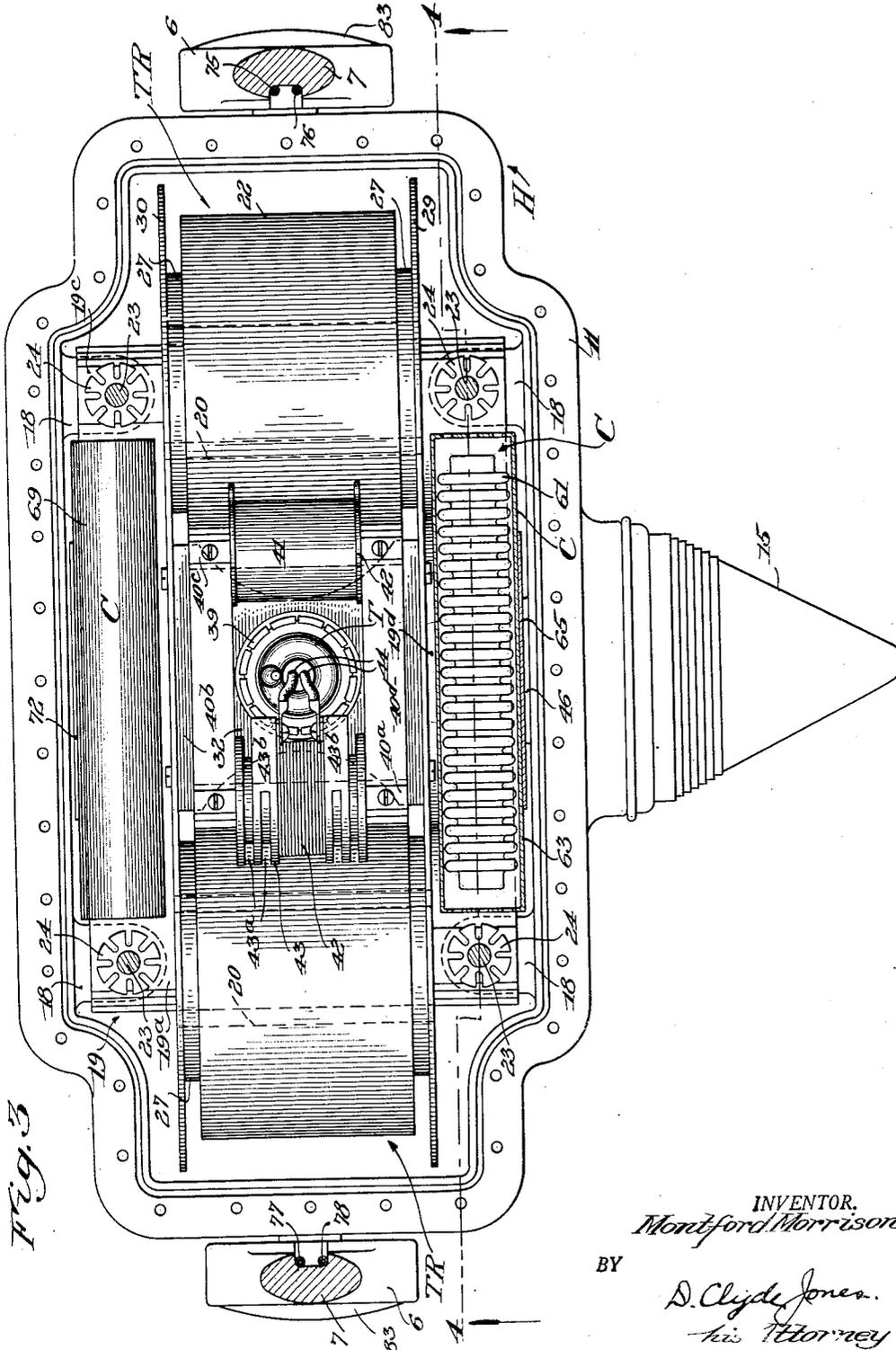
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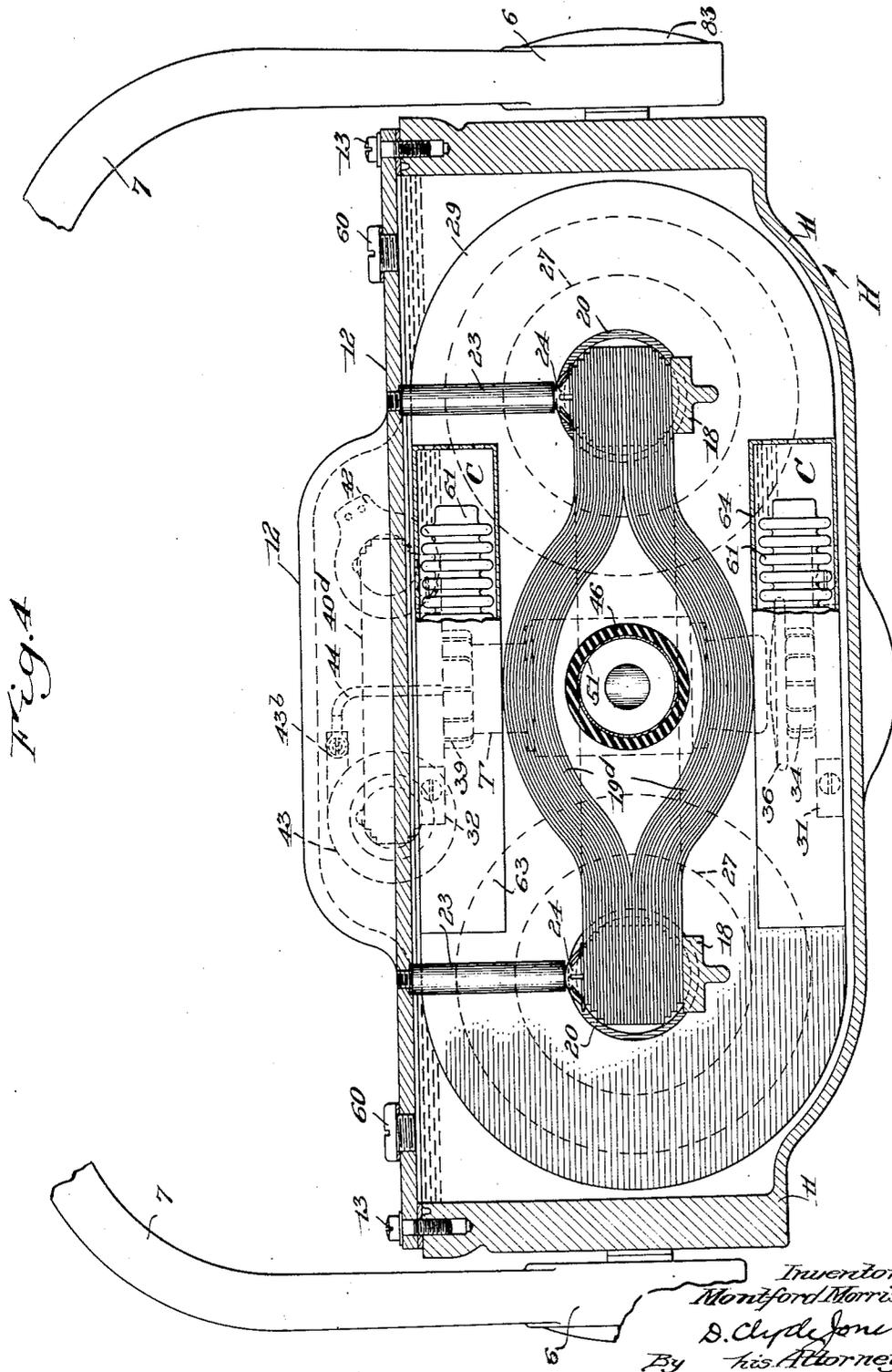
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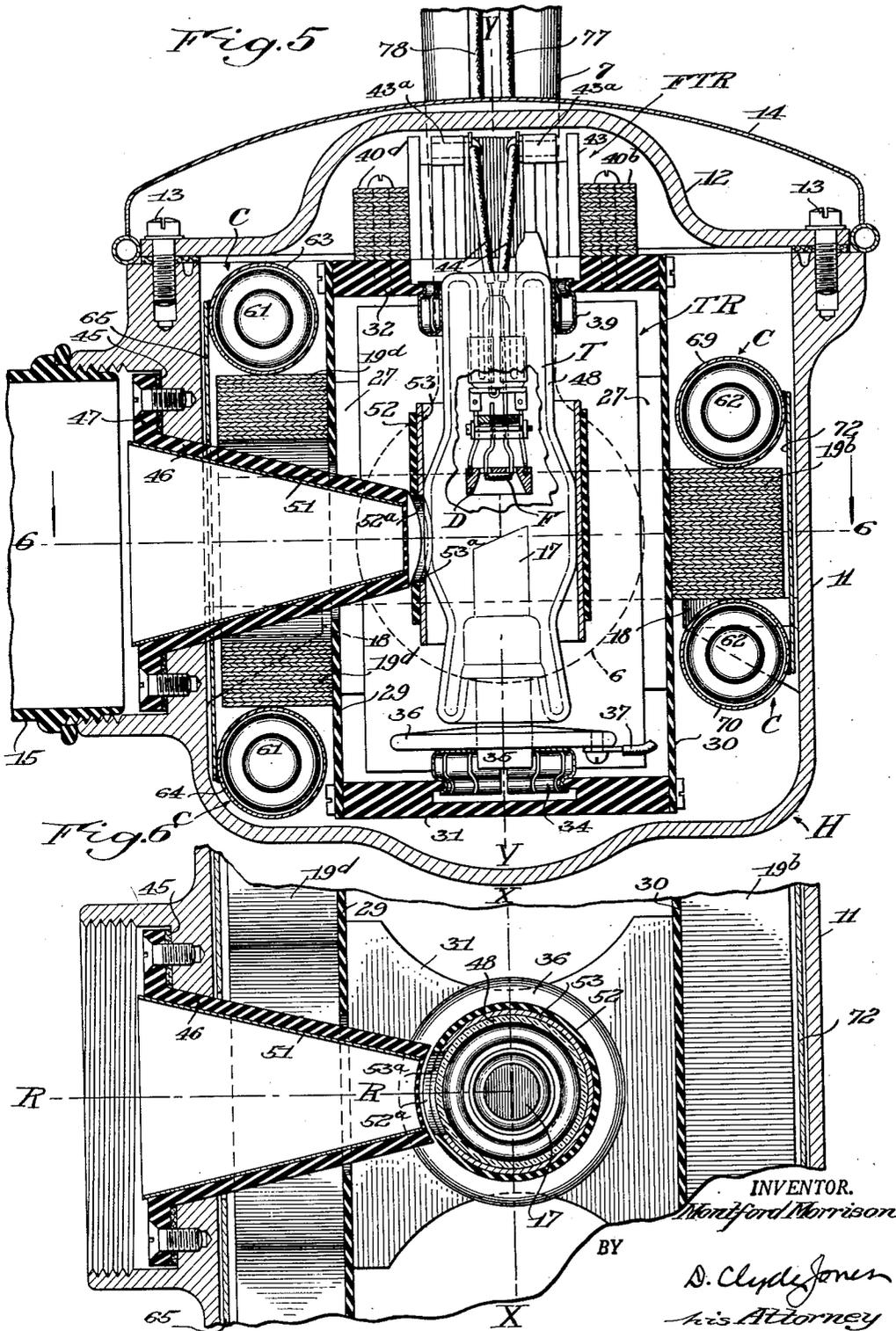
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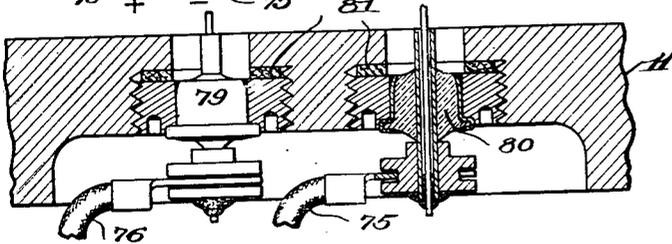
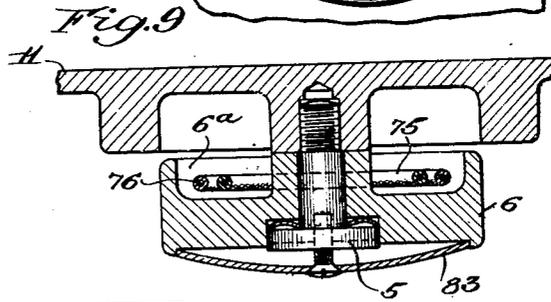
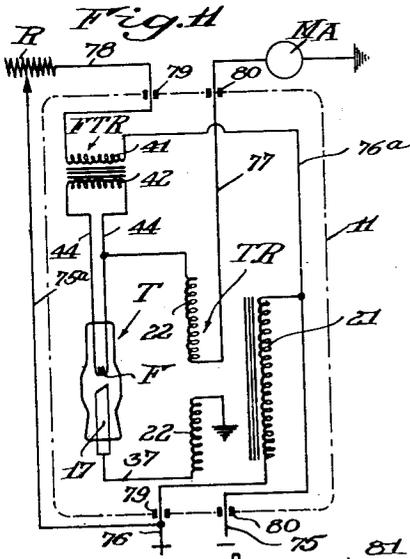
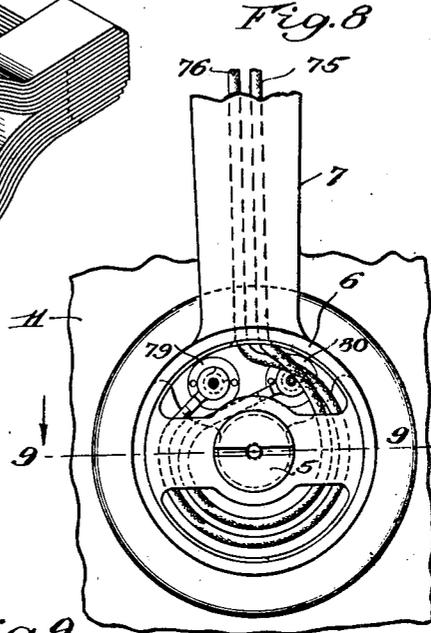
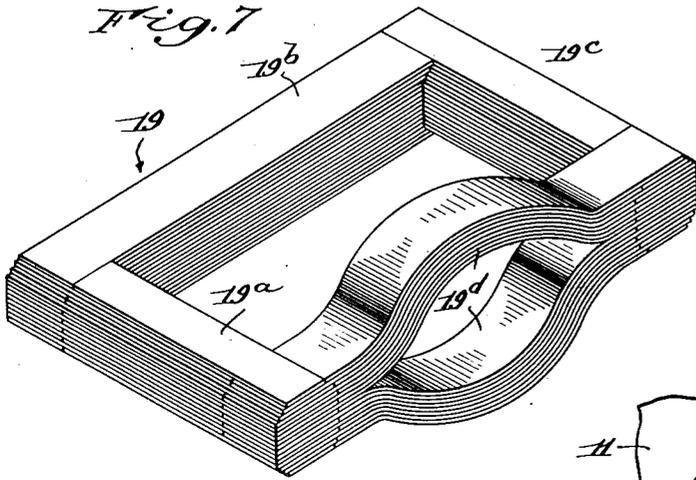


Fig. 10

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UNITED STATES PATENT OFFICE

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X-RAY APPARATUS

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5 Claims. (Cl. 250—87)

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This invention relates to X-ray apparatus and more particularly to an X-ray head comprising a sealed casing in which an X-ray tube and its related transformers are immersed in insulating oil.

Since such X-ray heads have a large field of use in connection with dental work, it is essential that the several parts of the head be compactly arranged, whereby the casing of the head presents a streamlined appearance and whereby the component parts thereof are so nicely balanced that the head can be quickly and easily adjusted to a position in proper relation to the patient, in which position it will remain.

Inasmuch as the component parts within the head are preferably immersed in oil, a short path for the X-rays through the oil should exist and provision must be made to maintain a uniform volume of oil within the casing irrespective of ambient temperatures.

In accordance with an important feature of the present invention, there is provided an X-ray head mounted for movement about a horizontal axis as well as about a vertical axis and having an X-ray tube supported in the casing with the principal axis of the tube at right angles to the horizontal axis and with the anode of the X-ray tube so disposed that a plane providing uniform definition by the emanating beam of X-rays lies in a plane substantially parallel to said horizontal axis.

In accordance with a further feature of the invention there is provided an X-ray head which is adjustable about an axis of rotation and which is so constructed that its center of gravity is located at a point on this axis of rotation.

Another feature of the invention relates to an X-ray head having its component parts symmetrically arranged with respect to the axis of rotation of the head and also with respect to one or more axes at right angles thereto, the several axes intersecting each other at the focal point of the X-ray tube.

An additional feature of the invention relates to a rotatable X-ray head in which the center of gravity thereof is located at approximately the focal point of the X-ray tube as well as at the axes of rotation of the head.

A further feature of the invention relates to a rotatable X-ray head in which the component parts thereof including the X-ray tube are immersed in oil with the center of gravity of the head located on the axis of rotation at the focal point of the X-ray tube, and in which there is provided a short path through the oil for the issuing X-rays.

For a clearer understanding of the invention, reference is made to the detailed description and drawings in which:

Fig. 1 is an end view of the X-ray head to-

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gether with the mounting column as well as the folding bracket, the horizontally swinging arm and the yoke on which the head is supported;

5 Fig. 2 is a front view of the head and the yoke on which it is mounted;

10 Fig. 3 is a top view of the head with the closure and decorative cover for its casing as well as the insulating oil omitted, and with all but the bearing portions of the yoke arms broken away;

15 Fig. 4 is a vertical section taken approximately on the line 4—4 of Fig. 3;

20 Fig. 5 is a vertical section taken medially of the ends of the head;

25 Fig. 6 is a fragmentary section taken substantially on the line 6—6 of Fig. 5;

30 Fig. 7 is a perspective view of the core of the high tension transformer, particularly showing how the intermediate portions of the laminae of the front leg of the core are spread apart to provide a passage through which the pencil of X-rays can pass;

35 Fig. 8 is a fragmentary end view of the casing and its mounting in one of the arms of the yoke showing how the commercial current leads are brought to the head;

40 Fig. 9 is a section on the line 9—9 of Fig. 8;

45 Fig. 10 is a section through the casing of the head illustrating how the commercial current conductors are extended through the wall of the casing without the danger of the insulating oil seeping along these conductors to the outside; and

50 Fig. 11 is a diagrammatic showing of the electrical circuits of the present head.

As illustrated in Figs. 1 and 2, the unitary X-ray head H of the present invention is provided at its ends with trunnions 5 rotatable in the bearings 6 on the yoke 7. The upper end of the yoke is mounted to rotate in the horizontally swinging arm 8 which in turn is mounted on one end of the folding or extensible bracket 9. The other end of the extensible bracket is supported for rotary movement on the column 10. This supporting mechanism which is well-known, enables the head to be easily positioned in any desired relation with respect to the patient.

The head H comprises an approximately oblong tank or casing 11, open at its top, in which the X-ray tube, generally designated T, the main or high voltage, core type transformer TR, the filament transformer FTR and certain volume compensating units, generally designated C, are mounted and immersed in oil. The top of the casing is sealed by a gasketed closure 12 which is secured in position by screws 13 threaded into tapped openings in the upper edge of the casing. A decorative cover 14 conceals

the closure 12 and the securing screws 13. The front of the casing has a window opening, which is covered by the focusing cone 15 through which the X-rays emerge, the cone being screwed into the internal threaded boss 16 integral with the casing and encircling the opening. The window opening is also sealed closed against the leakage of oil, in a manner hereinafter set forth.

It is an important feature of this invention that the casing as well as all of the component parts thereof, be so designed and so symmetrically mounted that the center of gravity thereof is at the axis of rotation X—X (Fig. 2) of the head, on its trunnions 5. Preferably, the center of gravity is not only at this axis of rotation but it is also at the focal point of the X-ray tube target or anode 17 (Fig. 6). To the end of obtaining this ideal location of the center of gravity, substantially all of the parts of the apparatus within the casing are symmetrically positioned with respect to the mentioned axis of rotation as well as with respect to an axis Y—Y (Fig. 5) at right angles thereto which intersects the axis of rotation at the mentioned focal point on the anode.

In arriving at this symmetry, the inner front and back surfaces of the casing are respectively provided with a pair of integral lugs 18, together defining a support (Figs. 3, 4 and 5), parallel to the top of the casing, on which support the rectangular laminated core generally designated 19 (Fig. 7) of the high tension transformer TR, is held. These lugs are so positioned that they respectively support the four corners of this core in such relation within the head that the mentioned axis of rotation X—X will lie in the medial plane through the four legs 19a, 19b, 19c and 19d of the transformer core, the plane being parallel to the flat surfaces of the core laminae. Certain of the laminae of the end legs 19a and 19c of the core are of progressively reduced width outward from the center laminae, to afford a stepped effect at what would otherwise be the side corners of these end legs. By this construction, the cross section of these end legs of the core, roughly conforms to the size and shape of the cylindrical spools 20 which fit over the mentioned legs and on which the two-part superimposed primary windings 21 and secondary windings 22 of the high tension transformer, are respectively wound. The transformer is securely held in position on the lugs 18 by four posts 23 (Fig. 4) which have their upper ends threaded into the closure 12 and which, at their lower ends, carry feet 24 to engage resiliently the mentioned corners of the transformer core.

The end legs of the core with the mentioned transformer windings thereon, together with the rear leg 19b and the front leg 19d of the core, afford a space in which the X-ray tube T can be mounted with its principal axis Y—Y (Fig. 5) extending at right angles to and intersecting the mentioned axis of rotation of the head. Specifically, the X-ray tube is mounted so that these axes intersect at the focal point on the tube anode 17. It will be noted that the intermediate portion of one half of the laminae of the front leg 19d of the core are curved upward (Figs. 4, 5 and 7) and the intermediate portion of the other half of the laminae of this leg are curved downward to provide a passage through which the X-rays can emerge from the tube anode and pass out through the related sealing and protective structure to be referred

to. These rays continue through the window opening in the front of the casing and thence through the focusing cone 15 at this window.

The mounting of the X-ray tube T and the several associated parts may conveniently include washer-like spacers 27 (Fig. 3) of laminated phenolic material, such as Formica, through which the respective ends of the spools 20 pass into openings in the front supporting plate 29 and in the rear supporting plate 30. These plates, which are made of insulating material such as sheet Formica, with the ends of the spools received in the mentioned openings therein, are snugly held by the spacers 27 against the inner surfaces of the core legs 19b and 19d respectively. It will be noted that the front plate 29 (Figs. 5 and 6) has an opening therein in line with the passage through the front leg 19d of the core and also in line with the pencil of X-rays which emerge from the X-ray tube along the axis R—R (Fig. 6). At the respective ends of the plates 29 and 30, a lower mounting strip 31 and an upper mounting strip 32, are secured at right angles by suitable screws, thereby defining an oblong space enclosed by the high tension transformer core in which space the X-ray tube T can be supported. The lower mounting strip is recessed to receive the resilient fingers of a spring mounting ring 34, the opening in which snugly receives the slightly tapered end portion of the anode stem 35 of the X-ray tube. Also this mounting ring supports the annular radiator 36 which is anchored to the anode stem by a set screw (not shown). The annular radiator is supplied with anode potential through conductor 37, connected to a high tension terminal of the high tension transformer TR. The upper mounting strip 33 is centrally apertured to be gripped by the resilient fingers of the upper spring mounting ring 39. This ring which is generally U-shaped in cross section, snugly fits over the neck of the X-ray tube. The mounting arrangement just described, is such that the X-ray tube T, is held with its principal axis Y—Y at right angles to the axis of rotation X—X of the head.

The filament supply transformer FTR is secured to the top of the upper mounting strip 32. This transformer includes a rectangular laminated core comprising legs 40a, 40b, 40c and 40d which are fastened by screws to the upper surface of the mounting strip in symmetrical position around the principal axis Y—Y, of the X-ray tube. The primary winding 41 of the transformer which is connected to a commercial source of current, is wound on a spool 42 of molded insulating material, such as Lucite. This spool fits on the core leg 40c which is assembled from laminae of different widths as in the case of the core legs 19a and 19c of the transformer TR. The secondary winding 42 of the filament transformer is wound on a spool 43 of Lucite, grooved as at 43a to afford a long electrical leakage path. This spool with the secondary winding wound thereon is assembled on the core leg 40a which has a stepped contour like the core leg 40c. The spool 43 is also provided with integral strips 43a which respectively carry terminals of the secondary winding 42. These terminals are connected to the filament conductors 44 which supply heating current to the cathode or filament and proper voltage to the focusing device D of the tube.

It has been mentioned that there is a path provided through the apparatus within the head

and through the front window opening in the casing, for the emergence of a pencil of rays from the X-ray tube and that the window opening is sealed against oil leakage. For this reason, the front wall of the casing is formed within the margin of the mentioned window opening. A Formica member 46 in the form of a truncated cone is provided at its large open end with a flange 47 to be sealed by a suitable gasket and screws, to the shoulder 45 so that the conical member projects into the casing where its small closed end is curved (Fig. 6) into close relation with the envelope 48 of the X-ray tube at the part thereof which faces the inclined end surface of the anode 17. This construction reduces the length of the path of the X-rays through the oil bath. It will be noted that the principal axis R—R of the conical member extends at right angles to the mentioned axis of rotation X—X and to the principal axis Y—Y of the X-ray tube, the three axes intersecting each other at the focal point on the anode 17 (Figs. 5 and 6). The tapered inner surface of the conical member has secured thereto a lead liner 51 which limits the dispersion of the pencil of X-rays. In order to prevent the escape of scattered X-rays, the envelope 48 of the X-ray tube is encircled in the region of its anode, by a cylindrical Formica sleeve 52 and by a lead liner 53 for the sleeve both provided with registering window openings 52a and 53a (Fig. 5) so located that the pencil of X-rays from the target or anode can pass through these window openings and through the small end of the conical member, to emerge through the window opening in the casing and thence through the focusing cone 15. It will be understood that in this construction the inclined face of the anode 17 is so disposed that a plane providing uniform definition by the emanating beam of X-rays lies in a plane substantially parallel to the horizontal axis of the casing. This is especially desirable in making radiographs of the horizontal rows of teeth in a patient's mouth.

It has been mentioned that the apparatus within the casing is immersed in insulating oil such as mineral oil. Preferably, the casing is filled with this oil, the oil being introduced through openings in the closure 12 which are sealed by the screws 60 (Fig. 4). Inasmuch as the casing is exposed, during use, to changing temperature conditions, provision must be made to compensate for the changing volume of the oil due to such changes. To this end, there are provided four volume compensating units C, each including a Syphon bellows. The first pair of Syphon bellows 61, 61 extend parallel to the front of the casing and also parallel to the principal plane of the main transformer core. Likewise, a second pair of Syphon bellows 62, 62 are similarly arranged at the rear wall of the casing. These bellows will contract when the volume of the oil in the casing increases and will expand when the volume of oil decreases. The bellows 61, 61 (Fig. 5) are respectively enclosed in the cylindrical containers 63 and 64 which are perforated at their ends (Fig. 4) to admit the oil bath so that it will encounter the outer surfaces of the bellows therein. The containers 63 and 64 are respectively held in contact with the curved intermediate portion of the core leg 19d, being held in this position by the strip 65 to which they are soldered. This strip is held against outward displacement since

it extends between the inner front surface of the casing and the adjacent surface of the core leg 19d. The strip 65 is provided with an opening through which the conical member 44 passes. The bellows 62, 62 are similarly enclosed in containers 69 and 70 which are likewise perforated at their ends. These containers snugly engage the top and bottom surfaces of the core leg 19b by reason of the fact that they are soldered to the ends of the strip 72. This strip is positioned in the space between the inner rear wall of the casing and the adjacent surface of the core leg 19b. By the provision of the compensating units C, C with their several Syphon bellows, the casing will always be maintained full of oil without the danger of oil being forced past the gaskets when its volume would otherwise become excessive due to the head being exposed to temperatures above normal room values. Here also the two pairs of bellows and their respective containers are symmetrically positioned with respect to the mentioned axis of rotation and also with respect to the principal axis of the X-ray tube.

While the electrical conductors including the commercial power leads can be connected through the walls of the casing to the electrical apparatus therein in various ways, it is preferred to utilize the construction best illustrated in Figs. 8, 9 and 10. In each arm of yoke 7, there is concealed a pair of conductors which are respectively designated 75, 76 and 77, 78 (Fig. 11). Each pair of conductors is concealed within the annular recess 6a in the bearing portion of each arm of the yoke, being wound therein into a single turn to connect electrically with the hermetically sealed connector plugs 79, 80 (Fig. 10). These connector plugs with interposed gaskets 81 are screwed into taped openings at that part of the casing which is concealed by the bearing portion 6 of the yoke. Each trunnion 5, as shown in Fig. 9, is conveniently in the form of a stud threaded into the end wall of the casing and having its head received in a recess in the bearing portion 6. A decorative disc 83 screwed to the head of the stud, conceals the stud.

Although the invention is not limited to any specific circuit arrangement, a wiring diagram for the head is shown in Fig. 11. The conductors 75 and 76, previously mentioned as concealed in one of the arms of yoke, are connected outside of the head, to a commercial source of current such as 60 cycle, 110 volt current. Within the casing the conductors 75 and 76 are respectively connected to terminals of the two-part primary winding 21, of the high tension transformer TR. One section 22 of the secondary winding of this transformer is connected in a circuit extending between the anode 17, conductor 37, and ground, to supply the necessary operating voltage for the anode. The other section 22 of the secondary winding of this transformer, is connected from one conductor 44 of the filament circuit through conductor 77 and through a milliammeter A, outside of the casing, to ground for providing the operating voltage for the focusing device D (shown in Fig. 5 but not in Fig. 11). The primary winding 41 of the filament transformer FTR is connected to the source of current through a series circuit including conductors 75 and 75a, adjustable resistor R, winding 41 and conductors 76a and 76, for supplying heating current to the filament.

What I claim is:

1. An X-ray device comprising a casing having a window in the side thereof and mounted for rotation about a vertical axis and about a horizontal axis, an X-ray tube having an anode and a cathode, said X-ray tube being mounted in said casing with its principal axis in line with said vertical axis, and a transformer including a core for energizing said X-ray tube, said transformer being mounted at said horizontal axis with the core thereof surrounding the focal spot of said X-ray tube and having an opening to permit the emergence of X-rays therethrough, said anode being disposed so that a plane providing uniform definition by the emanating X-ray beam lies in a plane substantially parallel to said horizontal axis and so that a substantial part of said X-ray beam can pass through said opening and said window.

2. In an X-ray tube head, a casing mounted for rotation about a horizontal axis and about a vertical axis, said casing having a window opening in the front thereof, an X-ray tube having an anode and a cathode, a transformer comprising a laminated core with primary and secondary windings thereon enclosed in said casing for energizing said X-ray tube, said X-ray tube being encircled by said core and being mounted within the casing with its longitudinal axis at right angles to said horizontal axis, said anode being disposed so that a plane providing uniform definition by the emanating beam lies in a plane substantially parallel to the horizontal axis of the casing and its focal spot lies on the horizontal axis of said casing opposite said window whereby the X-rays from said X-ray tube can pass through said window.

3. In an X-ray tube head, a casing mounted for rotation about a horizontal axis and about a vertical axis, said casing having a window opening in the front thereof, an X-ray tube having an anode and a cathode, a transformer comprising a windowed core with primary and secondary windings thereon enclosed in said casing for energizing said X-ray tube, said X-ray tube being encircled by said core and being mounted within the casing with its longitudinal axis at right angles to said horizontal axis, said anode being disposed so that a plane providing uniform definition by the emanating beam lies in a plane substantially parallel to the horizontal axis of the casing and its focal spot lies substantially at the intersection of the vertical and horizontal axes of said casing opposite said window as well as the opening in said core where-

by the X-rays from said X-ray tube can pass through said window.

4. In an X-ray tube head, a casing mounted for rotation about a horizontal axis and about a vertical axis, said casing having a window opening in the front thereof, an X-ray tube having an anode and a cathode, a transformer comprising a laminated core with primary and secondary windings thereon enclosed in said casing for energizing said X-ray tube, the principal planes of the laminations being parallel to said horizontal axis, said X-ray tube being mounted within the casing and encircled by said core, said tube having its longitudinal axis at right angles to the horizontal axis of the casing, said anode being disposed so that the plane providing uniform definition by the emanating beam lies in a plane substantially parallel to the horizontal axis of the casing and its focal spot lies on the horizontal axis of said casing, the laminations of that portion of the core which is opposite the focal point of the X-ray tube being separated to provide a path through which the X-rays from said X-ray tube can pass to said window.

5. An X-ray device comprising a casing mounted for rotation about a vertical axis and about a horizontal axis, said casing containing an X-ray tube electrically connected to an alternating current transformer, said X-ray tube being mounted longitudinally in line with said vertical axis, said transformer being mounted longitudinally in line with said horizontal axis, the core of said transformer surrounding the focal spot of said X-ray tube, and said core being windowed permitting the emergence of X-rays therethrough.

MONTFORD MORRISON.

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