Nov. 23, 1948. T. H. ROGERS ET AL 2,454,525

X-RAY APPARATUS

Filed Oct. 9, 1946 2 Sheets-Sheet 1

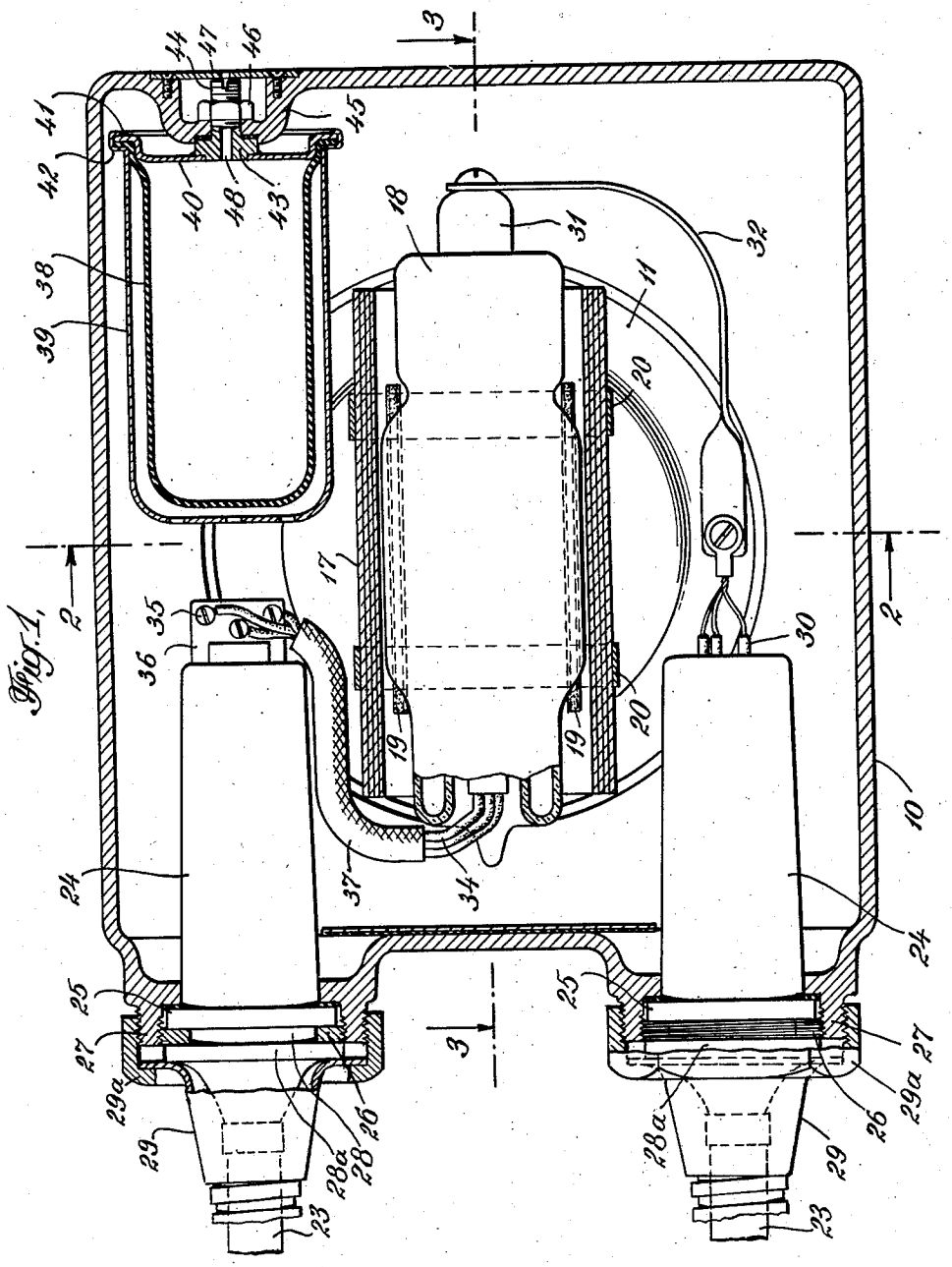

Fig. 1.

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Filed Oct. 9, 1946 2 Sheets-Sheet 2

Fig. 2,

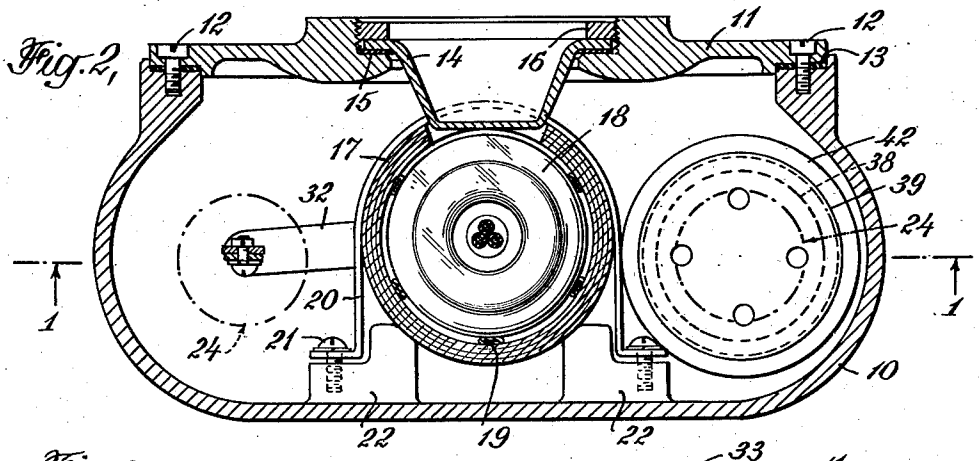


Fig. 3,

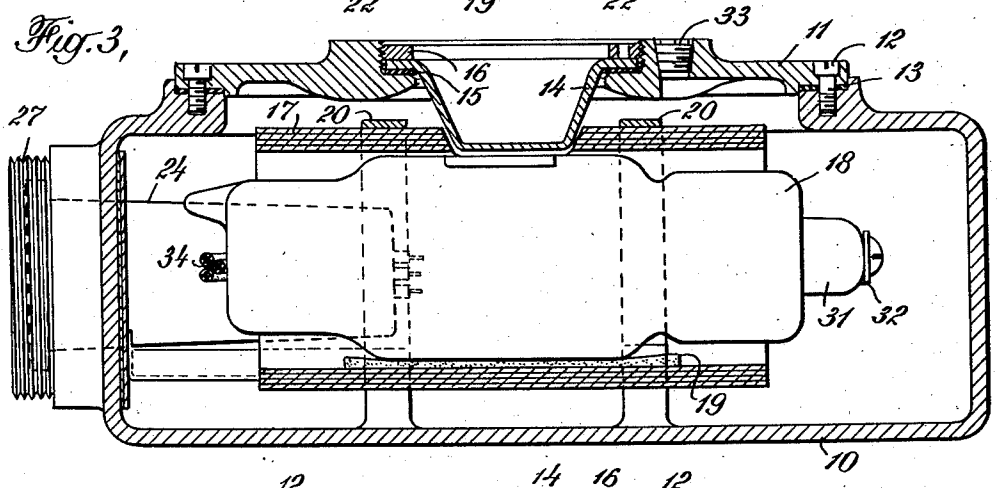
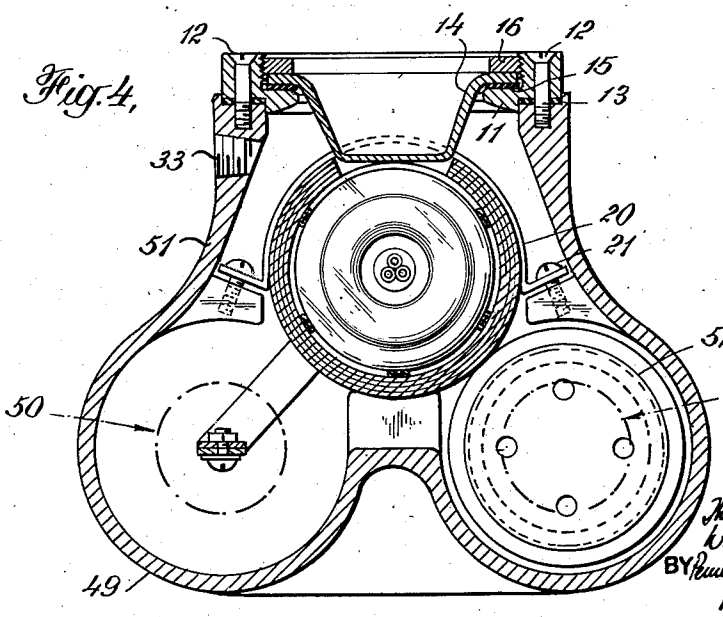


Fig. 4,



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Patented Nov. 23, 1948 2,454,525

UNITED STATES PATENT OFFICE

2,454,525

X-RAY APPARATUS

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Application October 9, 1946, Serial No. 702,138

5 Claims. (Cl. 250—89)

1

This invention relates to X-ray apparatus of the type that includes a table upon which the patient reclines while undergoing examination, and is concerned more particularly with a novel shockproof X-ray tube unit especially adapted for installation beneath the table of such apparatus. The new unit may be readily mounted for movement lengthwise and transversely of the table, and it is so constructed as to permit it to be moved to the extent necessary to permit the beam issuing from the unit to reach any part of the table.

In X-ray apparatus of the kind above referred to, an X-ray tube employed for radiographic examination of the patient is mounted above the table in a tube stand, and many tables have been provided with a second tube beneath the table, which is used for producing a fluoroscopic image of the patient on a screen above the table, where it can be readily seen by the operator. The tube carried by the tube stand is commonly shockproofed, that is, the tube is mounted within a grounded metallic housing containing insulating fluid in which the tube is immersed, but shockproof tubes have not ordinarily been employed beneath the table and, instead, reliance has been placed on the metal enclosure of the lower part of the table to take care of the shock hazard. One reason for the failure to employ a shockproof tube beneath the table is that a tube housing of the kind heretofore available is provided with extensions at right angles to the longitudinal axis of the tube for receiving the ends of the cables supplying energy to the tube and, when the unit is mounted beneath the table with its long axis parallel to that of the table, as is desirable, the housing extensions or the cables interfere with the structural parts of the table and prevent the desired movement of the unit.

Recently, it has become increasingly desirable to utilize shockproof tubes beneath tables in X-ray apparatus in order, for example, to simplify the construction of the table, which must otherwise provide protection against shock. Another important advantage of shockproof tubes is that they are of greater reliability and capacity under busy operating conditions than those that are not shockproof. A shockproof unit for use beneath the table of such apparatus should be so constructed for radiological reasons that the long axis of the tube is parallel to the long axis of the table and, for similar reasons, it is desirable to have the dimension of the unit in a direction perpendicular to the table top as short as possible. Moreover, the long dimension of the unit should be as short as possible in order to permit maximum longitudinal travel, and adequate lateral travel places a practical limitation on the transverse dimension of the unit.

2

The present invention is directed to the provision of a shockproof X-ray unit, which is so constructed that, when employed beneath the table in an X-ray apparatus, it fulfills the conditions above pointed out and can be moved both lengthwise and across the table to the full extent required. The new unit includes a housing containing insulating fluid, such as oil, in which the tubing is immersed, and the housing is mounted with the long axis of the tube parallel to the long axis of the table. The cable terminal members are mounted within the housing at one end thereof and on either side of the long axis of the tube, and the usual collapsible chamber, which permits expansion of the oil, is also mounted within the housing and preferably at its other end at one side of the long axis of the tube and in alignment with one of the cable terminal members. The high tension connection to the terminal of the tube remote from the cable members extends from the other cable terminal member through the oil along the tube at the other side of the long axis thereof, and adequate insulation for this connection is thereby provided. With this arrangement, the housing is symmetrical about its longitudinal axis, the lengthwise dimension of the housing can be kept to the desired minimum, and adequate lateral movement of the unit is permitted, because there are no housing extensions or portions of the cables which would restrict such movement.

For a better understanding of the invention reference may be had to the accompanying drawings, in which

Fig. 1 is a plan view of one form of the new unit with parts shown in section and broken away;

Figs. 2 and 3 are sectional views on the lines 2—2 and 3—3 of Fig. 1; and

Fig. 4 is a transverse sectional view through a modified form of the unit.

The unit illustrated in Fig. 1 comprises a housing 10 ordinarily made of a suitable metal such as aluminum. The housing is generally rectangular in horizontal section and it is formed with a circular opening in its bottom wall, which is closed by a plate 11 held in place by screws 12, a gasket 13 being interposed between the plate and the wall of the housing adjacent the opening. The plate 11 has a central opening, which is closed by a re-entrant window 14 formed with a flange, which is clamped against a gasket 15 by an an-

nular nut 16 threaded into the wall of the opening closed by the window. At its inner end, the window extends into an opening in a tubular rayproof shield 17 and terminates close to the wall of an X-ray tube 18 lying within the shield and held in place by spacers 19 interposed between the wall of the tube and the shield. The shield is held in place by a pair of stirrups 20, the ends of the stirrups being secured by screws 21 to bosses 22 formed on the inner wall of the housing opposite the opening closed by plate 11. The longitudinal axis of the tube lies in the longitudinal axis of the housing.

At one end, the housing 10 is formed with a pair of openings through which pass the terminal members on the cables 23, through which energy is supplied to the tube. In the construction illustrated, the cables are detachably connected to the unit and a socket member 24 of insulating material is mounted in each opening. Each socket member is provided with a flange 25 encircling its outer end and the flange rests against the outer wall of the housing around the opening and is engaged by an annular nut 26 threaded into a flange 27 on the housing encircling the opening. Each cable is provided with a terminal sleeve 28 receivable in one of the socket members and the outer end of the sleeve enters a bell-shaped collar 28a. Collar 28a lies within a bell-shaped clamping collar 29 which is engaged by an annular nut 29a threaded on the outside of flange 27. Each socket member is provided with terminals 30 at its inner end, which are engageable with corresponding terminals projecting from the terminal sleeve 28 on the cable and connected to the conductors in the cable. As illustrated, the socket members 24 lie parallel and in symmetrical arrangement on either side of the longitudinal axis of the tube, at least in part on opposite sides of the tube, and the longitudinal axes of the socket members lie in a plane through the longitudinal axis of the tube.

The tube illustrated is so disposed within the housing that its anode lies at the end of the tube remote from the socket members 24 and the anode shank 31 projecting out of the tube is connected by a metal strap 32 to the terminals 30 exposed beyond the inner end of one of the socket members 24. The strap extends from the anode shank parallel to the end wall of the housing and then through the space along one side of the tube. The strap is at a considerable distance from the housing at all points so that it is adequately insulated by the insulating fluid with which the completed unit is filled through the opening in plate 11 closed by plug 33. The connections 34 from the cathode of the tube pass around the end of the tube and the shield 17 to be connected to terminals 35 on a plate 36 mounted in the end of the other socket member 24. Connections 34 are enclosed within an insulating sleeve 37, where they extend around the end of the tube and shield and to the end of the socket member.

During the operation of the unit, its oil contents become heated and expand, and it is, therefore, necessary to provide collapsible means defining a part of the space occupied by the oil and acting upon collapse to increase the volume of that space. In the construction shown, such means take the form of a chamber 38 of cup shape and made preferably of a suitable synthetic rubber compound. The chamber lies within a perforated metal enclosure 39 and the chamber and enclosure lie within the housing

and are supported by a disc 40 having a peripheral flange 41. The rim of the chamber is seated against flange 41 and held in place by a flange 42 on the enclosure 39, which is spun over the rim of the chamber and flange 41 on the disc. The disc is secured to the head of a fitting 43 having a threaded shank 44 which extends through an opening in a re-entrant portion 45 of housing 10. A nut 46 is threaded on the shank and serves to secure the fitting in place against the inner face of portion 45 of the housing. The projecting end of the shank and the nut are concealed by a plate 47 attached to the housing and the fitting has a passage 48 through it and plate 47 is perforated, so that air can be expelled from within the chamber 38 as the latter is collapsed.

It will be noted that the chamber 38 and its enclosure 39 lie in axial alignment with the socket member 24 to which the cathode connections lead, such chamber and enclosure lying in part transversely opposite the tube and in a space, which, in a symmetrical housing, would otherwise be unoccupied. It is to be understood that, if desired, the position of the tube in the housing could be reversed and the tube could be placed with its anode end adjacent the socket members. In that case, the chamber 38 and its enclosure would lie on the side of the tube opposite to that in which it is now shown.

With the construction described, the housing is approximately square and its vertical dimension is a minimum. The cables extend in parallel from one end of the housing and there are no necks on the housing extending at right angles to the longitudinal axis of the tube as in prior constructions. The housing has the minimum horizontal dimension consistent with proper insulation for the connection 32, and by mounting the collapsible chamber wholly within the housing and in alignment with the socket member to which connections 34 lead, a saving in the overall dimensions of the unit is effected.

Some X-ray tables may require a reduction in the transverse dimensions of the unit while permitting an increase in its vertical dimension, and for such an installation, the unit illustrated in Fig. 4 may be employed. In this construction, the housing 49 is so formed that the socket members 50 lie with their longitudinal axes parallel to one another and to the longitudinal axis of the tube 51 but the axes of the socket members lie in a plane offset from the horizontal plane through the longitudinal axis of the tube. The collapsible chamber and its housing 52 lie with their longitudinal axes in alignment with that of one of the socket members. The distance between the axes of the socket members 50 is substantially smaller than the distance between the axes of the socket members 24 in the construction shown in Fig. 1, and the overall transverse dimension of the housing is, accordingly, substantially less than that of the Fig. 1 housing. In the construction shown in Fig. 4, planes passing through the axes of the respective socket members and the longitudinal axis of the tube lie at right angles to one another, but the enclosed angle between the planes may be varied within the limits permitted by the requirements of the installation.

The new shockproof unit may be advantageously employed for serialographic X-ray work because of the possibility of moving the unit lengthwise and across the table to the extent necessary to permit all parts of the table to be reached by the beam issuing from the unit. For

such use the unit is provided with a double focus tube, one focal spot being employed for producing the fluoroscopic image, and the other for radiography.

We claim:

1. A shockproof X-ray unit which comprises a housing containing insulating fluid, an X-ray tube mounted within the housing with its longitudinal axis generally parallel to the side walls of the housing, the tube having terminals at its opposite ends, a pair of cable terminal members mounted within the housing at one end and extending generally parallel to the longitudinal axis of the tube and on opposite sides of said axis and at least in part on opposite sides of said tube, a collapsible chamber mounted within the housing at the other end thereof and aligned with one of the cable terminal members, the chamber lying in part transversely opposite the tube, a connection extending through the space at the opposite side of the tube between the other cable terminal member and the tube terminal at the remote end of the tube, and a connection between the other cable terminal member and the tube terminal at the adjacent end of the tube.

2. A shockproof X-ray unit which comprises a housing containing insulating fluid, an X-ray tube mounted within the housing with its longitudinal axis generally parallel to the side walls of the housing, the tube having an anode terminal at one end and a cathode terminal at the other, a pair of cable terminal members mounted within the housing at the end, to which the cathode terminal of the tube is adjacent, and extending generally parallel to the longitudinal axis of the tube and on opposite sides of said axis and at least in part on opposite sides of the tube, a collapsible chamber mounted within the housing at the other end thereof and aligned with one of the cable terminal members, the chamber lying in part transversely opposite the tube, a connection extending through the space at the opposite side of the tube between the other cable terminal and the anode terminal of the tube, and a connection between the first cable terminal and the cathode terminal of the tube.

3. A shockproof X-ray unit which comprises a housing containing insulating fluid, an X-ray tube mounted within the housing with its longitudinal axis generally parallel to the side walls of the housing, the tube having terminals at its opposite ends, a pair of cable terminal members mounted within the housing at one end and extending generally parallel to the longitudinal axis of the tube and on opposite sides of said axis and at least in part on opposite sides of the tube, the longitudinal axes of the tube and cable terminal members lying in substantially the same plane, a collapsible chamber mounted within the housing at the other end thereof and aligned with one of the cable terminal members, the chamber lying in part transversely opposite the tube, a connection extending through the space at the opposite side of the tube between the other cable terminal member and the tube terminal at the remote end of the tube, and a connection between the other cable terminal member and the tube terminal at the adjacent end of the tube.

4. A shockproof X-ray unit which comprises a housing containing insulating fluid, an X-ray tube mounted within the housing with its longitudinal axis generally parallel to the side walls of the housing, the tube having terminals at its opposite ends, a pair of cable terminal members mounted within the housing at one end and extending generally parallel to the longitudinal axis of the tube and on opposite sides of said axis and at least in part on opposite sides of the tube, the longitudinal axes of the cable terminal members lying substantially in a horizontal plane offset from that of the longitudinal axis of the tube, a collapsible chamber mounted within the housing at the other end thereof and aligned with one of the cable terminal members, the chamber lying in part transversely opposite the tube, a connection extending through the space at the opposite side of the tube between the other cable terminal member and the tube terminal at the remote end of the tube, and a connection between the other cable terminal member and the tube terminal at the adjacent end of the tube.

5. A shockproof X-ray unit which comprises a housing containing insulating fluid, an X-ray tube mounted within the housing with its longitudinal axis generally parallel to the side walls of the housing, the tube having terminals at its opposite ends, a pair of cable terminal members mounted within the housing at one end and extending generally parallel to the longitudinal axis of the tube on opposite sides of said axis and at least in part on opposite sides of the tube, the longitudinal axes of the cable terminal members lying in a horizontal plane offset from a horizontal plane through the longitudinal axis of the tube.

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