Feb. 16, 1960 J. SEIDEL 2,925,499

X-RAY APPARATUS

Filed Feb. 4, 1958 3 Sheets-Sheet 1

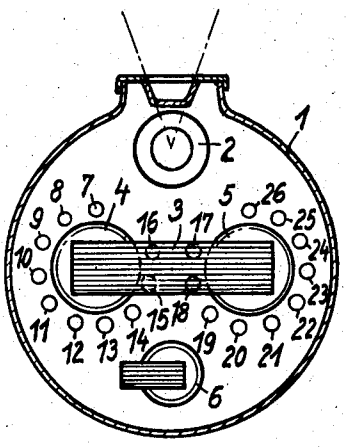

Fig.1

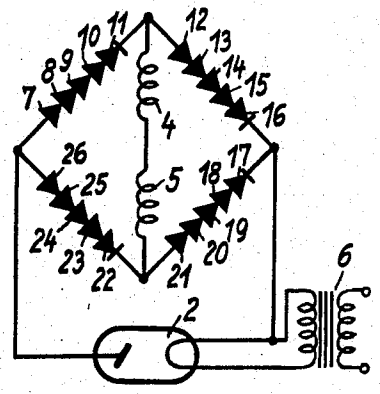

Fig.2

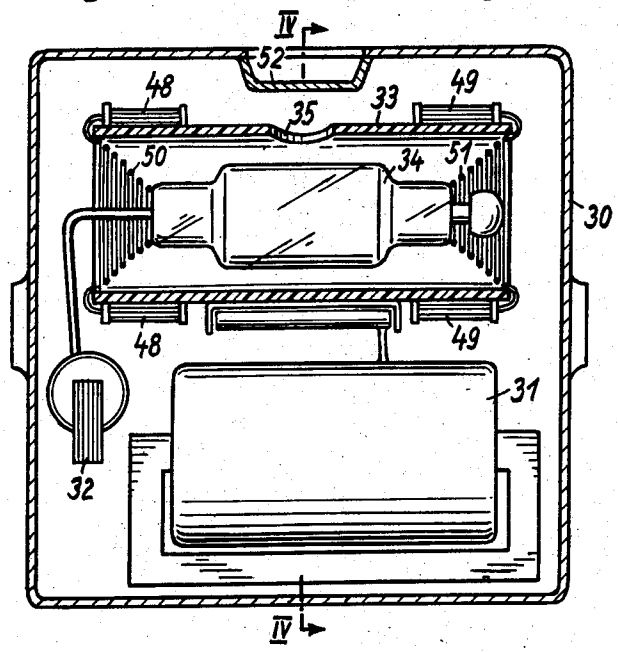

Fig.3

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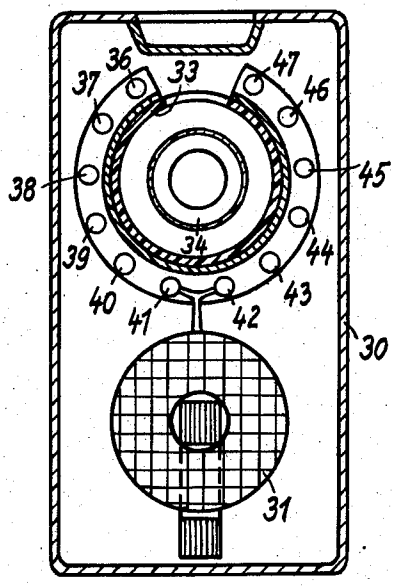

Fig. 4

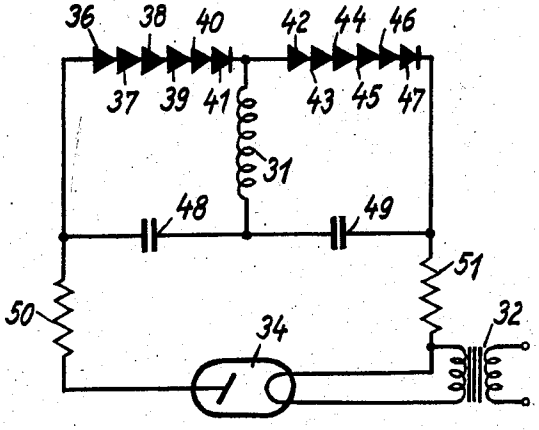

Fig. 5

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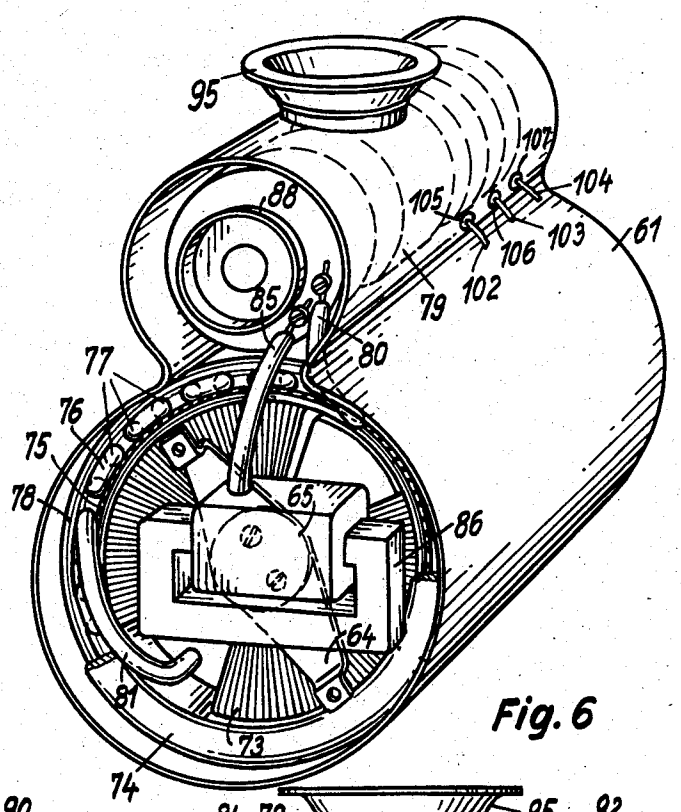

Fig. 6

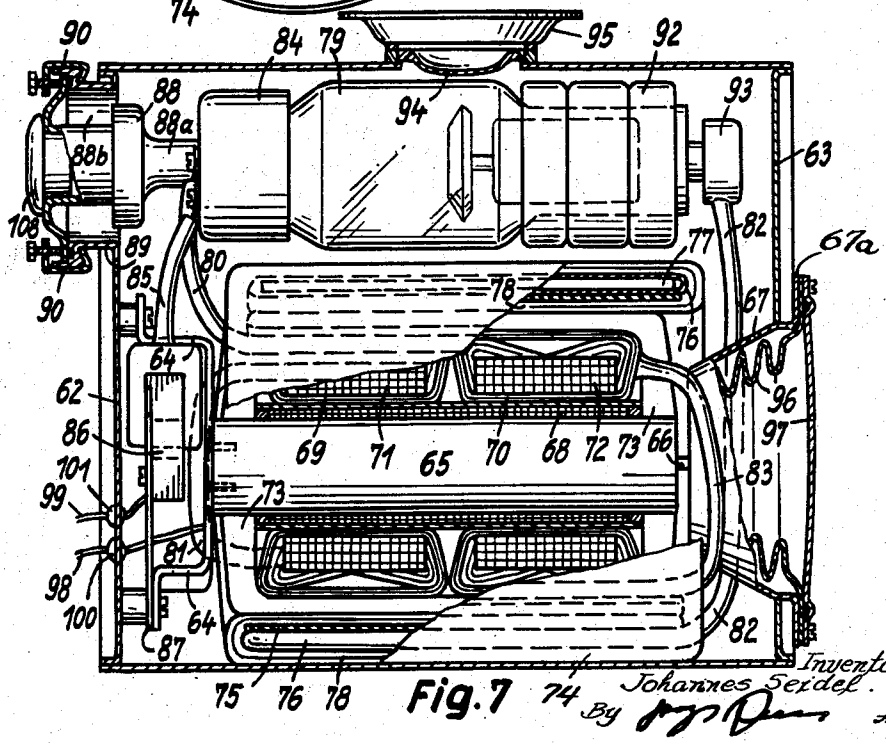

Fig. 7

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X-RAY APPARATUS

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Claims priority, application Germany February 7, 1957

8 Claims. (Cl. 250—90)

This invention relates to X-ray apparatus, and more specifically to an X-ray apparatus having a high voltage generator and an X-ray tube, which are accommodated in a common housing (single tank X-ray apparatus) and which are, if necessary, separated from each other by a partition wall. Being of a unitary structure, the whole apparatus must be moved in order to focus the X-ray tube to an object. For this reason, single tank X-ray apparatus have previously only been built on the so-called half-wave rectification principle, in which the X-ray tubes themselves effect the rectification of the high-voltage alternating current; rectifier tubes and associated heating-current transformers can accordingly be dispensed with, thus effecting a saving in space and weight.

The reduction in weight obtainable by the use of high-voltage dry rectifiers instead of hot cathode valves likewise brings construction of X-ray single tank apparatus with rectifier sets within the range of practical possibility.

It is, therefore, the object of the present invention to provide a single tank X-ray apparatus which is of compact construction and has the necessary dielectric strength.

An X-ray apparatus according to the invention comprises a high-voltage generator, an X-ray tube, a common protective housing accommodating said high-voltage generator and said X-ray tube, the high-voltage generator incorporating rod-shaped containers, rectifier tablets built up in said rod-shaped containers, a plurality of said containers electrically serially connected forming respectively container groups which functionally takes the place of hot valves, and a structural element (high-voltage transformer coil, X-ray tube) of circular cross section, the rod-shaped containers of said container groups being distributed circumferentially of said structural element with their longitudinal axes extending parallel to the longitudinal axis of said structural element and being electrically connected therewith.

In the arrangement according to the invention, all elements accommodated in the protective housing are spatially so disposed that only slight differences in potential occur in operation between neighboring points thereof and very short connecting wires are necessary for the points to be connected.

Two examples of embodiments of the invention will now be described with reference to the accompanying drawings in which

Fig. 1 is a cross sectional view of a single tank X-ray apparatus;

Fig. 2 shows a circuit diagram of the apparatus;

Fig. 3 illustrates a single tank X-ray apparatus of modified construction in a longitudinal section;

Fig. 4 is a transverse cross section along line IV—IV of Fig. 3;

Fig. 5 shows a circuit diagram for the apparatus made in accordance with Figs. 3 and 4;

Fig. 6 is a perspective view of a single tank X-ray apparatus incorporating the features of the invention and showing particularly the favorable spatial arrangement of parts thereof; and

Fig. 7 is a side view of Fig. 6, with the tank partly broken away to show the interior disposition of parts.

The structure illustrated in Figs. 1 and 2 comprises a housing 1 in which are accommodated an X-ray tube 2, a high-voltage transformer comprising an iron core 3 and two coils 4 and 5, and a heating-current transformer 6 for the X-ray tube 2. According to the invention, groups of rod-shaped rectifier elements 7 to 16 and 17 to 26 are respectively disposed circumferentially of the coils 4 and 5 and interconnected with the other switching elements to form a Graetz rectifier arrangement.

In the example illustrated in Figs. 3, 4 and 5, a high-voltage transformer 31 and a heating-current transformer 32 for an X-ray tube 34, fitted in an insulating tube 33, are arranged in the lower portion of a protective housing 30. The insulating tube 33 is provided with an aperture 35 formed therein and the protective housing 30 is provided with a window 52 to allow the passage of the rays. As shown in Fig. 4, containers 36 to 47 containing rectifiers in the form of tablets, are arranged peripherally of the middle portion of the insulating tube 33. Tubular capacitors 48 and 49 are disposed at the outer ends of the insulating tube 33. Damping resistors in the form of wire spirals 50 and 51 serve for limiting the X-ray current in the event of impact ionization occurring in the X-ray tube.

The arrangement of the rectifiers permits to dispose points of the installation which carry in operation the same potential, in close proximity so that leads of parts to be connected can be kept as short as possible. These leads accordingly need not pass points carrying a potential differing considerably from the potential of the leads, which would necessitate a very bulky construction owing to the insulating spacings that would have to be maintained.

Figs. 6 and 7 show a housing made of steel tubing 61 cross-sectionally substantially in the form of the numeral 8 and closed at both ends by covers 62 and 63 welded thereinto. The core 65 of a high-voltage transformer is mounted with one of its ends on the inside of the cover 62 by means of a supporting strap 64 and is provided at its opposite end with a pin 66 engaging in a central bore formed in the wall of a pot 67 fitted in the cover 63. An insulated primary coil 68 is slipped onto the core 65 and upon the coil 68 are arranged side by side two secondary coils 71 and 72 enclosed in insulating wrappings 69 and 70. U-shaped short-circuit plates 73 are then fitted in ray-shape on the central core 65 over the coils 71 and 72. The cylindrical transformer aggregate thus built up carries a tubular rectifier aggregate 74 which is slipped thereon and which is constructed in the following manner.

A paper tube 76 fixed uniformly distributed peripherally of a thin insulating tube 75, contains rectifier rods 77 connected in series and is bent in meander fashion at the points where the rectifier rods 77 join. This assembly is thereupon wrapped with paper strips 78 and thus forms the self-contained tubular rectifier aggregate 74 which is assembled with the high-voltage transformer to form a compact high-voltage unit. The rectifier chain is in the manner illustrated in Fig. 2 electrically connected with the secondary coils 71 and 72 and with an X-ray tube 79 disposed above the high-voltage unit. The thickly wrapped connecting wires are designated in Figs. 6 and 7 by numerals 80, 81, 82, 83. The X-ray tube 79 is cemented at the cathode end in a socket 84 to which are connected the connecting wire 80 for the high-voltage and also wrapped output wires 85 of a heating current transformer 86, the transformer being held on the cover

62 by a retainer plate 87. The socket 84 is bolted to an extension 89 of the cover 63 by means of an extension 88, an oil-tight joint being obtained by means of clips 90. The anode end of the tube 79 fits loosely in an annular stator 92 of a rotary anode motor and is resiliently pressed against a socket 93 engaged by the connecting wire 82.

The housing has a ray outlet aperture which is closed by a cap 94 of synthetic material positioned close to the X-ray tube 79 and thus leaving only a small volume of oil between it and the wall of the tube. A funnel-shaped extension 95 on the ray outlet aperture serves for fitting a ray diaphragm or the like. The heat expansion of the insulating oil is assured by a bellows 96, disposed in the previously mentioned pot 67 provided with several bores, to be pressed oil-tight against a flange 67*a* of the pot 67 which is closed by a protective cover 97. Current lead wires 98 and 99 for the primary coils of the high-tension transformer and the heating current transformer extend through glass beads 100 and 101 fused in the cover 62. Current lead wires 102—104 (Fig. 6) for the stator 92 extend similarly through glass beads 105—107 fused in the housing 61.

To exchange the tube 79, the connections at 89 and 90 are loosened, after the apparatus has been placed in standing position with the cover 63 at the bottom, another connection between two parts 88*a* and 88*b* of the holding element 88 becoming accessible after the removal of a plug 108 and such connection can then also be loosened. The wires 80 and 85 can thereupon be disconnected and the tube 79 removed from the socket 93 and the stator 92. Should it be necessary, after assembling the apparatus, to again open the housing, the welded seam on the edges of the steel tube 61 and the covers 62 and 63 can be ground off. The flanges of the covers 62 and 63 are made sufficiently long so that they can again be welded in position.

Changes and modifications may be made within the scope and spirit of the appended claims which define what is believed to be new and desired to have protected by Letters Patent.

I claim:

1. X-ray apparatus comprising a high-voltage generator having a high voltage transformer structure, an X-ray tube structure, a common protective housing accommodating said high-voltage generator and said X-ray tube structure, said high-voltage generator incorporating rod-shaped containers, rectifier tablets built up in said rod-shaped containers, a plurality of said containers being electrically connected in series and forming container groups functionally effective in the manner of hot valves, and an insulating structural element of tubular cross section in which at least a portion of one of said structures is disposed, said rod-shaped containers of each container group being distributed about said structural element circumferentially thereof and closely spaced therefrom and with their longitudinal axes extending parallel to the longitudinal axis of such structural element.

2. X-ray apparatus is set forth in claim 1, wherein said rod-shaped containers are arranged on an insulating tube constituting said stuctural element and surrounding the X-ray tube structure.

3. X-ray apparatus as set forth in claim 1, wherein said rod-shaped containers are disposed on an insulating tube constituting said structural element and surrounding the X-ray tube structure, and tubular high-voltage capacitors also disposed on said insulating tube.

4. X-ray apparatus as set forth in claim 1, wherein said rod-shaped containers which are electrically connected in series are surrounded by an insulating tube folded in meander fashion at the electric connection points between the containers.

5. X-ray apparatus comprising a common housing which encloses an X-ray tube and also a high-voltage transformer including a primary coil and two secondary coils disposed side by side on said primary coil in generally circular configuration relative thereto, four groups of rod-shaped containers distributed peripherally of said secondary coils with their longitudinal axes extending parallel to the longitudinal axis of said secondary coils, each container having rectifier tablets enclosed therein, and means for electrically interconnecting said groups of containers with said secondary coils in accordance with the Graetz system.

6. X-ray apparatus according to claim 5, comprising an insulating tube surrounding said secondary coils for supporting said rod-shaped containers.

7. X-ray apparatus according to claim 5, comprising an insulating tube surrounding said containers, said insulating tube being folded in meander fashion at the electrical connection points between said containers.

8. X-ray apparatus comprising a high-voltage generator, an X-ray tube, a common protective housing accommodating said high voltage generator and said X-ray tube, said high voltage generator incorporating a cylindrical transformer and rod-shaped containers, rectifier tablets built up in said rod-shaped containers, a plurality of said containers being electrically connected in series and forming container groups functionally effective in the manner of hot valves, and a structural element of circular cross section comprising an insulating tube, said rod-shaped containers of each container group being distributed about said structural element circumferentially thereof and closely spaced therefrom and with their longitudinal axes extending parallel to the longitudinal axis of said structural element, the latter being slipped onto said transformer and forming a high voltage unit therewith.

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