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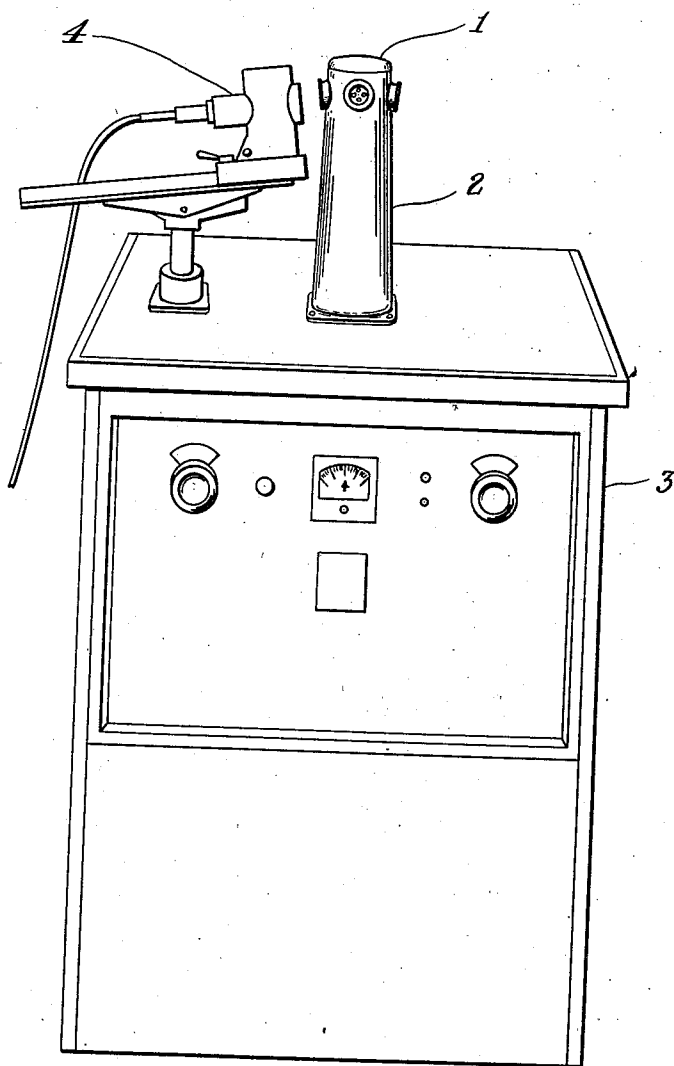
G. KLOOS
X-RAY APPARATUS

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Fig. 1.



INVENTOR
GERARD KLOOS
BY *E. F. Kanderott*
ATTORNEY

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X-RAY APPARATUS

Gerard Kloos, Mount Vernon, N. Y., assignor, by
mesne assignments to Philips Laboratories,
Inc., Irvington-on-Hudson, N. Y., a corporation
of Delaware

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This invention relates to X-ray apparatus, and more particularly to X-ray diffraction apparatus designed for continuous operation.

It is an object of this invention to provide apparatus of this type permitting exchange of the X-ray tube without rendering it necessary to realign cameras and other accessories.

It is another object of this invention to provide X-ray apparatus adapted for a simple and rapid replacement of one X-ray tube by another incorporating a different target.

It is a further object of this invention to provide apparatus of this type wherein on removal and replacement of the X-ray tube the electrical connections are broken and established automatically.

It is a still further object of this invention to provide apparatus of this type having a water-cooled anode and wherein on removal and replacement of the X-ray tube, the water connections are broken and established automatically.

It is still another object of the invention to provide X-ray apparatus wherein a number of cameras may be operated in close proximity to an easily and rapidly exchangeable tube.

It is yet another object of this invention to provide X-ray diffraction apparatus with devices for simply and quickly exchanging filters to match the target of a newly inserted tube, without the need for realigning cameras and other accessories.

It is a still further object of the invention to provide particularly compact yet unusually versatile X-ray diffraction apparatus.

Other objects, and the manner in which the same are attained, will be apparent from the following description.

As is well known to those skilled in the art, X-ray diffraction work necessitates frequent exchanges of the tubes as different investigations require different target materials. A change-over from one target material to another, in turn, requires a corresponding exchange of filters since each target material yields radiation of a certain specific wave length and the filter must always match the target if monochromatic radiation is to be obtained. In the past, these replacements of tubes and filters necessitated, in each instance, a complete realignment of the camera or cameras and other accessories employed in conjunction with the source of monochromatic X-ray radiation, a procedure which not only rendered the work time-consuming and costly but in addition, failed to yield fully re-

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producible or comparable results in view of the differences in adjustment involved.

In view of the drawbacks outlined above inherent in prior art devices of this kind, X-ray diffraction apparatus permitting replacement of tubes and filters without the need for any realignment of cameras and other accessories has long been a desideratum in the X-ray art, but up to the date of the present invention no one seems to have succeeded in suggesting a solution of this problem. Yet, the demands of war production and the consequent growth of X-ray diffraction work into a mass production method, called with steadily increasing emphasis, for X-ray diffraction apparatus adapted for continuous operation and permitting the change-over from one tube or target to another, and the resulting exchange of filters, to take place without disturbing the alignment of cameras and other accessories, so as to result in a critical reduction of time, labor and cost needed for investigations of this type, while at the same time yielding results that would be entirely reproducible or comparable and not subject to deviations due to differences in adjustment of the cooperating parts of the system.

Responding to this demand, the present invention contemplates a tube housing which is fixed in position at all times and thus may be mounted conveniently on a cabinet accommodating the switchboard and other auxiliary apparatus. This housing and the tubes provided to be inserted therein are so arranged that the tubes are guided to assume exactly predetermined positions at all times. Consequently, once a camera or cameras and other accessory devices have been properly aligned with one tube in the housing, removal of this tube and replacement thereof by another does not necessitate any realignment of the cameras or other accessories but due to the new tube being guided, by the housing, into the exact position of the tube which has been removed, the cameras, for example, remain properly aligned with respect to the new tube and thus may be used as soon as the new tube is in place.

Guidance of the tubes into exactly predetermined positions within the housing is accomplished by the cooperation of supporting surfaces on the tubes and the housing which are machined to very close tolerances and which may be assisted by guides located on the tubes and in the housing, respectively. Replacement of the tubes takes place simply by lifting one tube out of the housing and inserting the new tube in its

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place. While the tubes could be supported in the housing solely by their own weight, it is contemplated, in a preferred embodiment of the invention, to secure the tubes to the housing by means of a few screws so that before lifting one tube out and after inserting another, some screws may have to be removed and replaced, a procedure which is as quickly performed as it is simple.

The reduction of the tube exchange operation to the extremely brief and simple procedure indicated above is rendered possible by an arrangement whereby all tube connections, such as electrical and cooling connections, are connected and disconnected automatically in response to the insertion and the removal of a tube, respectively. Thus, a contact device forming part of the cathode supply and connected to the high tension side of the unit may be arranged in the center of the housing to coact with a corresponding contact device provided on the bell-shaped lower part of each tube, whereby upon insertion of a tube into the housing, electrical contact for the cathode supply is established automatically, the anode being grounded, at the same time, by an anode connection with the tube base which, in turn, is arranged to come to rest on top of the grounded tube housing. Similarly, connections with a supply of cooling liquid are brought up from the cabinet through the walls of the housing, for example, to terminate in ports which coact with corresponding ports in the tube base from which connections lead into the anode, to establish and break a continuous path for cooling liquid upon insertion and removal of the tube, respectively.

As noted above, the exchange of tubes necessitates a corresponding replacement of the filters. In order to accomplish this without disturbing the alignment of cameras and similar accessories, rotary filter selectors containing any number of different filters are arranged on the fixed tube housing so that by a simple operation, e. g. a rotation of a rotary disk wherein the filters are inserted circumferentially, a new filter is brought into the path of radiation issuing from a newly inserted tube through a window in the tube housing in front of which the filter selector is located. In this manner, a filter matching the radiation from any particular target is always at hand to be rendered effective by a mere turn of a disk, for example, without in the least affecting the alignment of cameras and other accessories.

According to a preferred embodiment of the invention, a plurality of windows, preferably four, and a corresponding number of filter selectors are provided in and on the housing to permit one tube to be utilized in the simultaneous investigation of a plurality of specimens, thus rendering the novel apparatus particularly compact, versatile and economical.

In the drawing affixed to this specification and forming part thereof, one embodiment of the invention is illustrated diagrammatically by way of example.

In the drawings,

Fig. 1 is a diagrammatic front view, partly in section, of a complete X-ray unit according to the invention;

Fig. 2 is a diagrammatic cross-section taken along line 2—2 in Fig. 3, of the tube housing with a tube inserted therein;

Fig. 3 is a diagrammatic top view of the tube housing with the cover attached, while

Fig. 4 is an enlarged showing of a detail of Fig. 2.

Referring now to the drawing, and first to Fig. 75

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1, this shows the complete assembly of an X-ray unit according to the invention, comprising a tube 1 inserted in a tube housing 2 which is mounted on the table top of the cabinet 3 accommodating the switchboard and other accessory apparatus. A camera 4 is shown as aligned with respect to the tube 2. When the tube 1 is to be exchanged it is lifted out of the housing 2 and replaced by another tube inserted in the tube housing; removal of one tube and replacement by another does not affect the proper alignment of the camera 4 with respect to any tube inserted in the housing 2 since the replacement tube automatically assumes the exact position within the housing for precise alignment with the camera.

Referring now to Fig. 2, this shows the tube housing 2, preferably a casting, having at its bottom a screw flange 5 which is engaged by a screw-threaded portion 6 of a two-sided screw flange 7 mounting an insulating tube 8 which extends in the interior of the tube housing 2 concentrically therewith. The screw flange 7 further serves as a holder for a somewhat narrower and shorter insulating tube 9 extending partly inside and partly outside the tube housing concentrically therewith, tube 9 being secured to screw flange 7 by means of a locking ring 10 engaging the other screw-threaded portion 11 of screw flange 7. The interior of the short insulating tube 9 is screw-threaded at 12 to engage a corresponding screw thread 13 on the outside of a long insulating tube 14 extending inside and outside the tube housing 2 in concentric alignment with the other members of this portion, this tube 14 being closed at the bottom by a screw-threaded, plug-shaped insulating closure 15, and at the top by a likewise screw-threaded, similarly shaped insulating member 16.

The screw flange 5 at the bottom of the tube housing 2 is perforated to permit the passage of two water pipes 17 and 18 connecting a water supply system (not shown) arranged in the cabinet 3 (shown in Fig. 1) with bores 19 and 20, respectively, extending through the wall of tube housing 2, for example, at opposite corners thereof, as shown in Fig. 3.

The plug-shaped insulating members 15 and 16 are perforated to accommodate two cathode supply wires 21 and 22 the lower ends of which are connected to a cathode and high-tension supply (not shown) arranged in the cabinet 3 (shown in Fig. 1), while their upper ends are connected to the two parts of a spring type contact device for the cathode, now to be described.

This contact device includes a cup-shaped insulating member 23 arranged inside a larger similarly shaped insulating member 24 and a screw 25 the head 26 of which is situated inside member 23 while the threaded stem engages a metallic sleeve 28 mounted in the plug-shaped insulating member 16. A helical spring 29 is mounted in the inner cup member 23 on the head 26 of screw 25, and extends upwardly to terminate in a contact member 30, while another helical spring 31 of larger diameter is mounted in the outer cup member 24 and extends upwardly to terminate in another contact member 32. The cathode supply, high-tension wires 21 and 22 are connected through the screw sleeve 28 and screw 25, and through an opening in outer insulating cup member 24, with inner spring 29 and outer spring 31, respectively, so that the cathode and high-tension supply terminates in terminal spring contacts 30 and 32.

The tube housing 2 includes inwardly recessed

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and outwardly flanged portions 33 which have openings 34 and by screws 35, mount rotary filter selectors 36 which have arranged along their periphery a number of holes 37 which are engaged by plungers 37a acted on by springs 38. As seen in Fig. 1, these filter selectors have further arranged along their periphery a number of openings 39 which accommodate different filters 40. A rotary displacement of filter selectors 36 results in placing a new filter 40 in front of opening 34 in the tube housing, the holes 37 cooperating with plungers 37a in registering filters 40 with respect to opening 34. Thus, the exchange of filters takes place without disturbing the alignment of the camera with respect to the tube.

The tube housing cover 42 is provided integral with the X-ray tube, forming the base thereof. A somewhat cup-shaped connecting portion 43 secured to cover or base 42 by screws 44 mounts the tube envelope 45 which comprises a bell-shaped portion 47 which branches out into a portion 48 mounting the cathode shield, and a portion 49 mounting the cathode, as described further below.

The top of the bell-shaped portion 47 is provided with a cathode and high-tension supply contact device arranged to coact with the spring type contact device in the tube housing referred to above. The tube contact comprises a central contact member 50, adapted to be engaged by inner screw terminal 30 of the housing spring contact device, and, suitably insulated from member 50, a peripheral contact member 51 designed to be engaged by outer spring terminal 32 of the housing contact device. The space between envelope portion 49 and the tube contact device is filled with asbestos, indicated at 52, cathode supply wires 53 and 54 leading from members 50 and 51, respectively, through asbestos 52, into envelope portion 49 where they attach to two cathode support rods 55 and 56, respectively, which are fused into portion 49. A cathode filament 57 is supported by these rods in a conventional manner.

The lower envelope portion 48 mounts a cathode shield 58 the bottom of which has an aperture 59 through which rod 55 passes with clearance, while rod 56 passes through the cathode shield in contact therewith to maintain it at the same potential as the cathode 57. The top of the cathode shield is open toward the anode, now to be described.

The anode 60, as shown, is of cup-shape and is mounted in the connecting base portion 43. The anode supports a target 61 which is usually plated on the bottom of the cup. The interior of the anode forms a space 63 for the cooling medium.

As shown in Figs. 2 and 3, the anode cooling system comprises a tubular member 66 extending into the cooling space 63. U-shaped bores 67 and 68 connect the space 63 and the tubular member 66 with ports 69 and 70, respectively, in the tube housing cover 42, these ports being arranged opposite the openings 71 and 72 of bores 19 and 20, respectively. Gaskets 73 and 74 are provided in recessed portions surrounding openings 71 and 72, respectively, while ports 69 and 70 are surrounded by ring-shaped projections 75 and 76, respectively, which engage gaskets 73 and 74 to effectively seal the connection between openings 71 and 72 and ports 69 and 70, respectively. Also a gasket 77 is arranged in a recessed portion of the tube housing cover 42 and has two openings 78 and 79 to accommodate a flanged part 80 surrounding the opening 81 of

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bore 67, and a screw-threaded part 82 of tubular member 66 which is screwed into a recess 83 surrounding the opening 84 of bore 68. A ring-shaped projection 85 on part 43 engages gasket 77 to tightly seal the connections between parts 42 and 43.

The top surface 86 of the tube housing 2, and the bottom surface 87 of the tube base 42, are machined to close tolerances so any tube inserted in the housing will assume a fixed, reproducible position which is the same for all tubes designed to be so inserted.

Guides such as the locating pins 88 projecting from the top surface 86 of the tube housing 2 and adapted to enter matching bores 89 in the tube base 42, may be provided to assist the supporting surfaces 86 and 87 in reproducibly fixing the position of any tube inserted in the housing. Other types of guide members such as, for example, longitudinal guide bars extending from the tubes to enter corresponding recesses in the tube housing, may be provided for this purpose.

A number of screws 90 may be provided in the tube base 42 to firmly secure the same on the tube housing 2, in the precise, reproducible position determined by the surfaces 86 and 87 and the additional guide members, if any.

A lead shield 91 mounted e. g. on the connecting base portion 43 of the tube may be provided to extend down the tube to effectively prevent stray radiation from reaching the inside of the tube housing, apertures 92 being arranged in the lead shield 91 to afford passage to the rays where desired.

The tube envelope 45 as shown, is equipped with four windows 93 made, preferably, of Lindeman glass and arranged on four sides of the envelope. In place of the four windows shown in the drawing, a single window, or a different arrangement of a plurality of windows may be provided if desired.

A ground wire 94 grounds the tube housing 2 including all structure conductivity connected therewith, such as the anode 60.

A solenoid or similar type valve 95 may be provided e. g. in water pipe 18 to automatically control the cooling system in response to changes in electrical conditions.

The invention operates as follows: When a tube is inserted into the housing, it assumes a fixed, precisely predetermined and reproducible position therein so any camera or other accessory apparatus previously aligned with any tube previously inserted will remain aligned with respect to the newly inserted tube. Electrical connections are established automatically by inner and outer spring contact terminals 30 and 32 of the housing engaging tube contact members 50 and 51, respectively, whereby to prepare for heating current and high-tension supply to the cathode 57, while the anode 60 is grounded by contact of tube housing cover 42 with housing 2. At the same time, water connections are established by the alignment of ports 69 and 70 in the cover 42 with openings 71 and 72 in the housing 2 to connect water pipes 17 and 18 and their extensions, bores 19 and 20, with U-shaped bores 67 and 68, and tubular anode cooling members 65 and 66 so cooling water may pass, for example, through pipe 17, bore 19, U-shaped bore 67 and tubular member 65 into the anode cooling space 63, to be discarded through tubular member 66, U-shaped bore 68, bore 20 and pipe 18 controlled by valve 95. After filter selectors 36 have been turned to place the desired filter, e. g.

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filter 40, in front of opening 34 and window 93, the switchboard on cabinet 3 may be operated to start the apparatus.

I wish it to be understood that I do not desire to be limited to the exact details of construction or design shown and described, as various modifications within the scope of the appended claims may suggest themselves to a person skilled in the art.

I claim:

1. An X-ray apparatus comprising a vertically mounted housing open at the top end thereof, a tube, having a vertically disposed anode, insertable into said open end, a base on said tube adapted to rest on top of said housing and bearing the anode in fixed relation thereto, cooling conduits in said housing for carrying a cooling medium, cooling conduits in said base, electrical contact members comprising two spring members positioned in spaced relation within said housing, a tube envelope having a bell-shaped portion adapted to fit over said spring members, two electrical contact members on said bell-shaped tube portion insulated with respect to each other and adapted to engage said spring members upon insertion of said tube into said housing, apparatus for recording X-radiation in fixed position relative to said anode and guide members on said housing adapted to abut recessed portions of said tube base for precisely and reproducibly positioning said anode in said housing with respect to said recording apparatus without altering the relation of the recording apparatus to the housing and to assure positive alignment of said cooling conduits in said tube base and the housing and to assure electrical contact between said contact members on said tube and said spring members.

2. An X-ray apparatus comprising a vertically mounted housing open at the top end thereof, a tube insertable into said open end, a vertically mounted anode and cathode in said tube, a base on said tube adapted to rest on top of said housing and bearing the anode in fixed relation thereto, cooling ducts in said housing for carrying a cooling medium, cooling ducts arranged in said base and extending into said anode, recessed portions surrounding said cooling ducts on top of said housing fitted with gaskets, ring shaped projections surrounding the ducts in said tube base for engaging said gaskets to assure a liquid-tight seal when the base rests on said housing, electrical contact members comprising a pair of resilient contact members disposed in spaced relation within said housing, a tube envelope having a bell-shaped portion adapted to fit over said resilient contact members, a pair of electrical contact members on said bell-shaped tube portion insulated with respect to each other and adapted to engage said resilient contact members upon insertion of said tube into said housing for supplying current and a high potential to said cathode, means for grounding said housing, said tube base and said anode, apparatus for recording X-radiation secured in fixed position relative to said anode, and guide members on said housing adapted to abut recessed portions of said

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tube base for precisely and reproducibly positioning said anode in said housing with respect to said recording apparatus without altering the relation of the recording apparatus to the housing and to assure positive alignment of said cooling ducts in the base with the ducts in the housing and to assure positive electrical contact between said contact members on said tube and said resilient contact members in said housing.

3. An X-ray apparatus comprising a vertically mounted housing open at the top end thereof, a tube insertable into said open end, a vertically mounted anode and cathode in said tube, a base on said tube adapted to rest on top of said housing bearing the anode in fixed relation thereto, cooling ducts in said housing for carrying a cooling medium, cooling ducts arranged in said base and extending into said anode, means for sealing the connections between said base and said housing upon insertion of the tube into the housing, electrical contact members including a pair of resilient contact members disposed in spaced relation in said housing, a tube envelope having a bell-shaped portion adapted to fit over said resilient contact members, a pair of electrical contact members on said bell-shaped tube portion insulated with respect to each other and adapted to engage said resilient contact members upon insertion of the tube into the housing for supplying a current and a high potential to said cathode, means for grounding said housing, said tube base, and said anode, a plurality of windows in said housing, a filter selector arranged in front of each window for rotary displacement about an axis substantially normal to the plane of the window, said filter selector comprising a plurality of circumferentially arranged filters adapted to be placed in front of the window one at a time, apparatus for recording X-radiation secured in a fixed position relative to said anode and arranged to be aligned in a fixed position relative to said anode and said window, and aligning members on said housing adapted to abut recessed portions of said tube in said housing for precisely and reproducibly positioning said anode in said housing with respect to said recording apparatus without altering the relation of the recording apparatus to the housing and to assure positive alignment of said cooling ducts in the base and in the housing, and to assure positive electrical contact between the contact members on said tube and the resilient contact members in said housing.

GERARD KLOOS.

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