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HIGH TENSION APPARATUS

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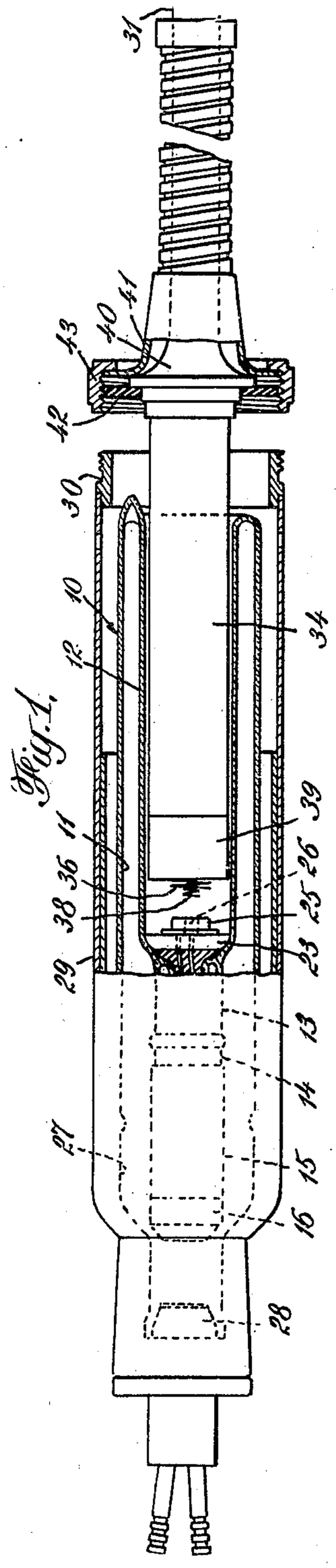

Fig. 1.

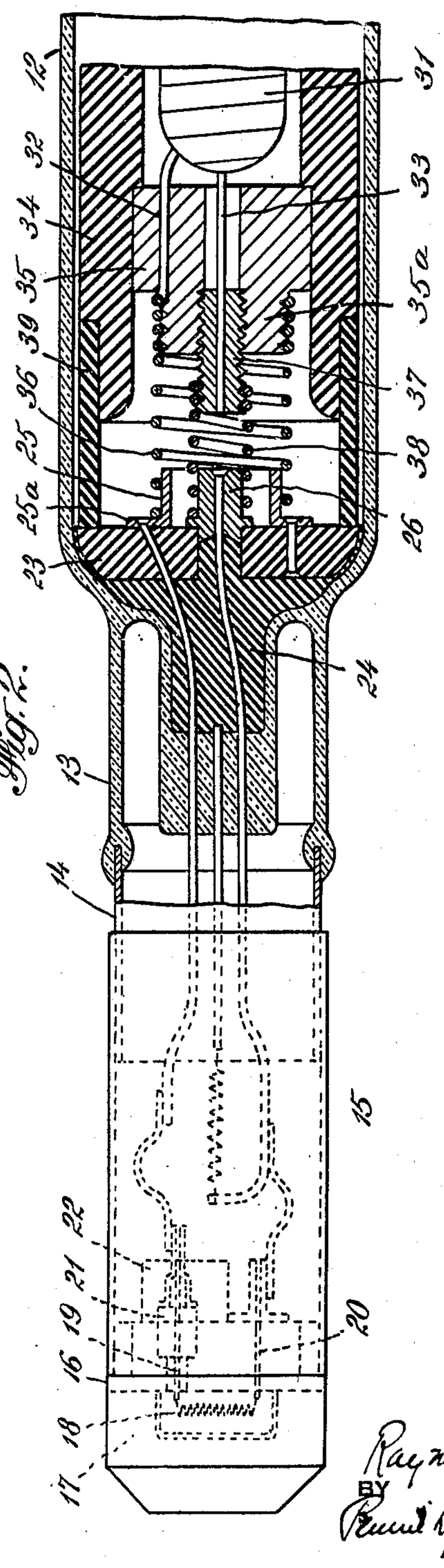

Fig. 2.

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HIGH TENSION APPARATUS

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8 Claims. (Cl. 250—104)

This invention relates to high tension apparatus and is concerned more particularly with novel connecting means through which high tension energy may be supplied to an element within the envelope of such apparatus. The new connection is superior to those previously employed for the purpose in that it occupies little space and is of such construction that current leakage and difficulties arising from corona are avoided. At the same time, the parts may be readily put together and taken apart to establish or break the connection. As the new connection affords special advantages when used with X-ray tubes, an embodiment of the invention for use with such tubes will be illustrated and described in detail for purposes of explanation.

The X-ray tube with which the new connection is employed has an envelope with a re-entrant end through which extend one or more leads from one of the electrodes within the envelope. A plate of insulation carrying terminals on its outer face lies within the re-entrant end and the leads are connected to the terminals. An insulator, of a size receivable in the re-entrant end, is mounted on the cable and it is provided with exposed terminals connected to the conductors in the cable and engageable with those on the plate when the insulator is introduced into the re-entrant end. The end of the insulator is constructed to cooperate with the wall of the envelope to enclose the terminals and means are provided for holding the insulator in place with the two sets of terminals in engagement. With this arrangement, the cable may be connected to the element within the tube by inserting the insulator into the cavity in the envelope and securing it in place by the holding means, and disconnection is effected with equal facility.

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

Fig. 1 is a view, partly in elevation and partly in longitudinal section, of an X-ray unit and the new connection by which high tension energy may be supplied to the tube thereof; and

Fig. 2 is a similar view on an enlarged scale of a portion of the tube at the end to which current is supplied through the new connection.

The X-ray unit shown in the drawing is particularly useful for diffraction analysis of crystals and it is described and claimed in my copending application Serial No. 428,196, filed January 26, 1942, of which this application is a continuation-in-part. The unit includes a tube generally designated 10 which comprises a glass envelope 11 having a re-entrant end portion 12 at one end. Projecting inwardly from this end is an extension 13 of the envelope wall in the end of which is sealed a metal tube 14 carrying the cathode structure.

The cathode includes a tube 15 telescoped over tube 14 and spot welded thereto. A metal focusing block 16 is mounted in the free end of tube 15 and the block has a transverse channel 17 in its free end. An incandescent filament 18 of helical form lies within the channel and is connected to leads 19 and 20 which extend through the block, lead 19 being insulated from the block by being mounted in blocks 21 and 22 of ceramic material. The leads 19 and 20 extend through and are sealed in the wall of the envelope at the bottom of the re-entrant cavity. A plate 23 of insulating material is seated near the bottom of the cavity and the leads pass through it to the outer surface. The space between the bottom of the cavity and the plate 23 is filled with insulating compound 24 through which portions of the leads pass.

Mounted on the outer face of plate 23 is a terminal 25 of cylindrical form and having a flange 25*a* lying against and secured to the outer face of plate 23. Lead 19 passes through an opening in the plate and is electrically connected to the flange 25*a*. A terminal 26 is mounted in a central opening through plate 23 and lead 20 passes through the opening and into the interior of the terminal, to which it is electrically connected.

The tube envelope is completed by a metallic section 27 in the end of which is mounted an anode 28. The tube is enclosed within a housing 29 having an end portion secured in place on the shank of the anode in any suitable way. The opposite end of the housing lies slightly beyond the end of the glass portion of the tube envelope and includes a ring 30 which is threaded externally.

The cable 31 by which current is to be supplied to the cathode includes the usual conductors enclosed in insulation and the insulation is stripped back from the end of the cable and the conductors are provided with leads 32, 33. A sleeve 34 of insulating material is fitted over the end of the cable and the sleeve is closed at its free end by a block 35 of insulating material lying inward from the end of the insulator and having openings through which leads 32 and 33 pass. The block is provided with an extension 35*a* on which is mounted a helical spring termi-

nal 36 connected to lead 32, the spring being of such diameter as to fit over the cylindrical portion of terminal 25 and bear against the flange 25*a* thereof. Threaded into a central bore through block 35 is a sleeve 37 which projects beyond the end of extension 35*a* and carries a smaller helical spring terminal 38 which is connected to lead 33 and is of such diameter as to receive the terminal 26.

When the insulator is received in the re-entrant portion of the envelope and the contacts are engaged, the path through the space between the insulator and the envelope wall from the terminals to the nearest grounded portion of the apparatus is blocked off and the terminals are shut off from contact with the atmosphere. For this purpose, the outer surface of insulator 34 is circumferentially channeled at its free end and a cylindrical sleeve of yielding insulating material and preferably synthetic rubber of the type known as "neoprene" is mounted in the channel. The sleeve 39 is of such length that when the insulator is inserted in the re-entrant portion of the envelope sufficiently to cause terminals 36 and 38 to engage terminals 25 and 26, respectively, the free end of the sleeve presses against the outer face of plate 23, so that the terminals are completely enclosed. By shutting off the space surrounding the contacts from the atmosphere, corona is reduced and to inhibit corrosion resulting from corona, the terminals may be silver plated and the space within the insulator and sleeve 39 may be filled with insulating material, such as "Vaseline."

At the outer end of the insulator is a metal flare 40 connected to the metallic sheathing on the cable and thereby grounded. Beyond the flare is a clamping collar 41 serving as part of a means for holding the end of the cable with the insulator in the re-entrant portion of the tube and the terminals in contact. For this purpose, the flare is seated against a washer 42 which bears against the sleeve 30 on the housing. A clamping nut 43 mounted on the clamping ring and internally threaded may be screwed on section 30 of the tube housing to force the clamping ring, flare, and insulator inwardly and hold them securely in position.

By making terminals 25, 26, 36, and 38 of silver, corrosion arising from corona may be cut down to such an extent that sleeve 39 may be made of spun metal instead of synthetic rubber. The contact between the spun metal sleeve and plate 23 may permit some leakage of air, but with the terminals protected against corrosion, such air leakage is not important, provided the path from the terminals to ground between the insulator and the wall of the envelope is sufficiently long. The spun metallic member radiates heat to the tube housing and it is preferred in some cases for that reason.

With the construction described, the re-entrant portion of the tube serves as an insulating socket for receiving the insulator enclosing the end of the cable, and since the terminals are at the bottom of the cavity, the distance between the terminals and any grounded portion of the structure may be made long without substantially increasing the overall length of the apparatus. If the insulator 34 were received in a socket mounted in the end of the housing and separate from the tube, the overall length of the housing would have to be greatly increased to make the socket long enough to provide a path of the desired length from the terminals to ground.

In connecting the unit to a source of energy, the insulator on the end of the cable is merely inserted through the end of housing 29 and into the cavity at the re-entrant end of the tube until the terminals are brought into contact. Thereafter, the clamping ring 43 is screwed tightly on the end of the housing and the parts are held in operative position. When the cable is to be disconnected, the clamping ring is unscrewed and insulator 34 pulled out of the end of the tube.

I claim:

1. In X-ray apparatus, the combination of a tube including an envelope having a re-entrant portion at one end, an anode within the tube at the other end having a portion extending through the envelope wall, a cathode within the envelope, a terminal within the re-entrant end portion, a conductor sealed through the envelope wall and connected to said terminal and to the cathode filament, a housing enclosing the tube, a cable extending into the housing and having its end within the re-entrant end portion of the envelope, the cable containing at least one conductor, a terminal at the end of the cable connected to the conductor and in engagement with the first terminal, cooperating means on the insulator and envelope at the inner end of the re-entrant portion of the envelope for shutting off the engaged terminals from the atmosphere, a grounded flare encircling and connected to the cable outside the re-entrant end portion of the envelope, and means mounted on the housing and engaging the envelope, and a member mounted on the housing and clamping the flare to the housing to hold the end portion of the cable in the re-entrant end portion of the envelope with the terminals in engagement.

2. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a terminal mounted within said re-entrant portion and connected through the envelope wall to said element, an insulated cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and cooperating means on the insulator and envelope at the inner end of the re-entrant portion of the envelope for shutting off the engaged terminals from the atmosphere.

3. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a terminal mounted within said re-entrant portion and connected through the envelope wall to said element, an insulated cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and cooperating means on the insulator and envelope shutting off the terminals from the atmosphere when they are in engagement, said means including a tubular element projecting beyond the free end of the insulator and encircling the terminal thereon.

4. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a terminal mounted within said re-entrant portion and connected through the envelope wall to said element, an insulated cable containing a con-

ductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and cooperating means on the insulator and envelope shutting off the terminals from the atmosphere when they are in engagement, said means including a tubular element of flexible elastic insulating material projecting beyond the free end of the insulator and encircling the terminal thereon.

5. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a plate of insulating material within the re-entrant portion, a terminal mounted on the outer side of the plate and connected through the envelope wall to said element, an insulated cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and means on the insulator engageable with the plate, when the terminals are in contact, to shut off the terminals from the atmosphere.

6. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a plate of insulating material at the inner end of the re-entrant portion, a terminal mounted on the outer side of the plate and connected through the envelope wall to said element, an insulated cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and a tubular element on the insulator engageable with the plate, when the terminals are in contact, to shut off the terminals from the atmosphere.

7. In high tension vacuum apparatus, the combination of an exhausted envelope having a re-entrant portion, an element within the envelope, a plate of insulating material within the re-entrant portion, a terminal mounted on the outer side of the plate and connected through the envelope wall to said element, an insulated cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the end of the insulator connected to the conductor, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, and a tubular element mounted on the insulator at its free end and projecting beyond said end, said element being engageable with the plate, when the terminals are in contact, to shut off the terminals from the atmosphere.

8. In X-ray apparatus, the combination of a tube including an envelope having a re-entrant portion at one end, an anode and a cathode within the envelope, a terminal within the re-entrant end portion, a conductor sealed through the envelope wall and connected to said terminal and to the filament of the cathode, a housing enclosing the tube, an insulating cable containing a conductor, an insulator enclosing the end of the cable, a terminal at the free end of the insulator connected to the conductor within the cable, the insulator being insertable into the re-entrant portion of the envelope to effect engagement of the terminals, cooperating means on the insulator and envelope at the inner end of the re-entrant portion of the envelope for shutting off the engaged terminals from the atmosphere, a grounded metallic flare encircling and connected to the cable at the other end of the insulator, and a clamping member on the housing operable on the flare for holding the insulator in the re-entrant end portion of the envelope with the terminals in engagement.

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