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ELECTRON IRRADIATION MACHINE

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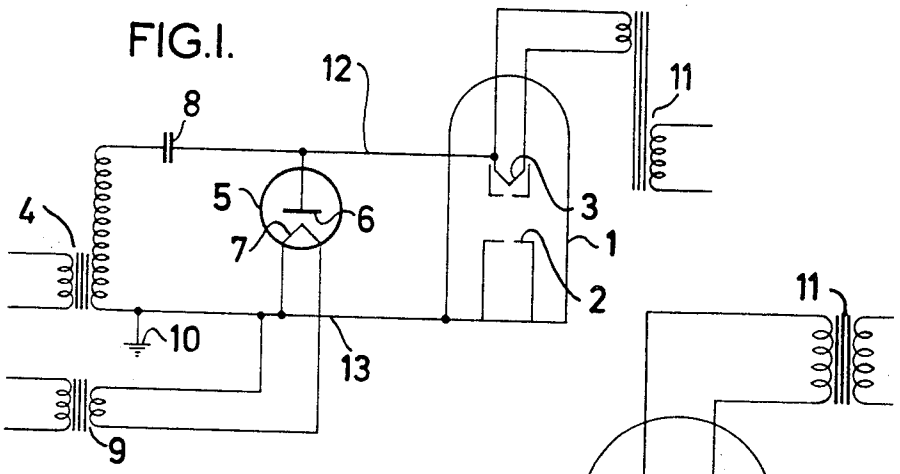
FIG.1.



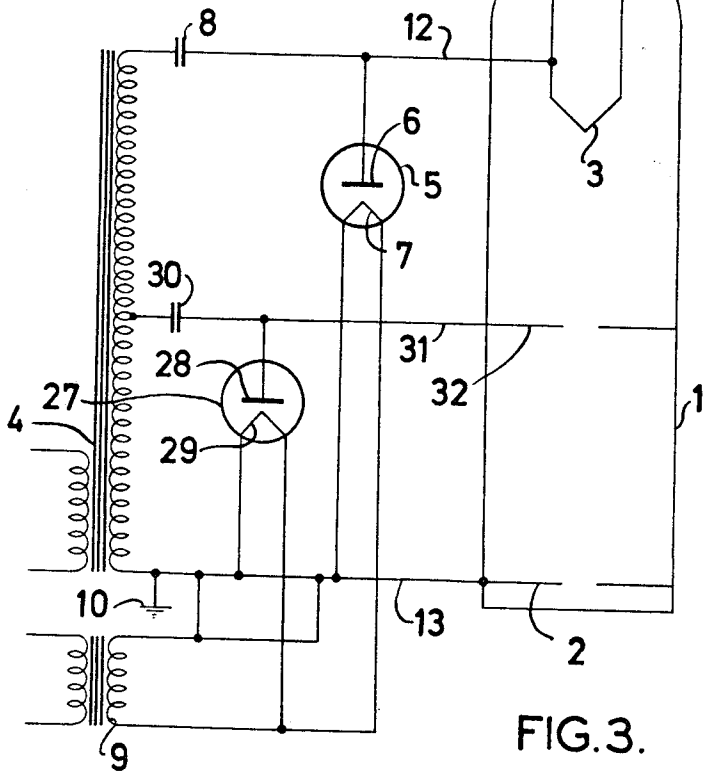


FIG.3.

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FIG.2.

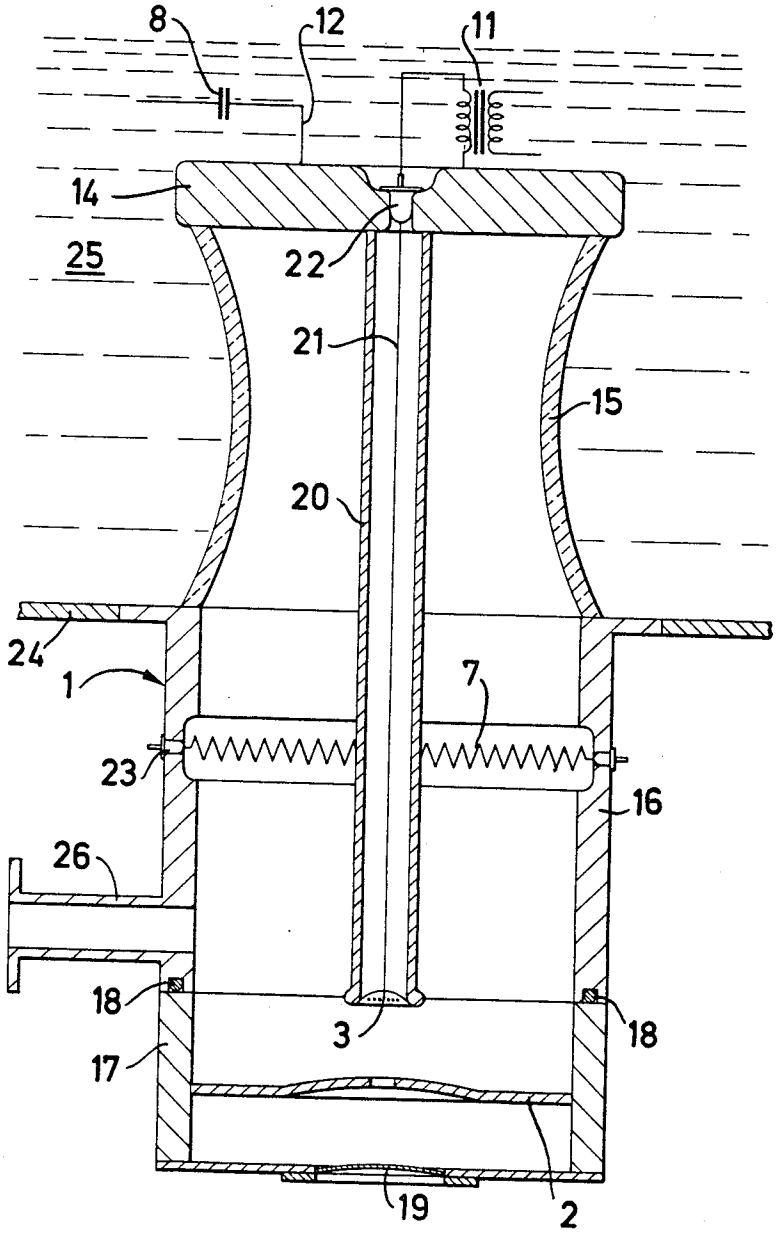

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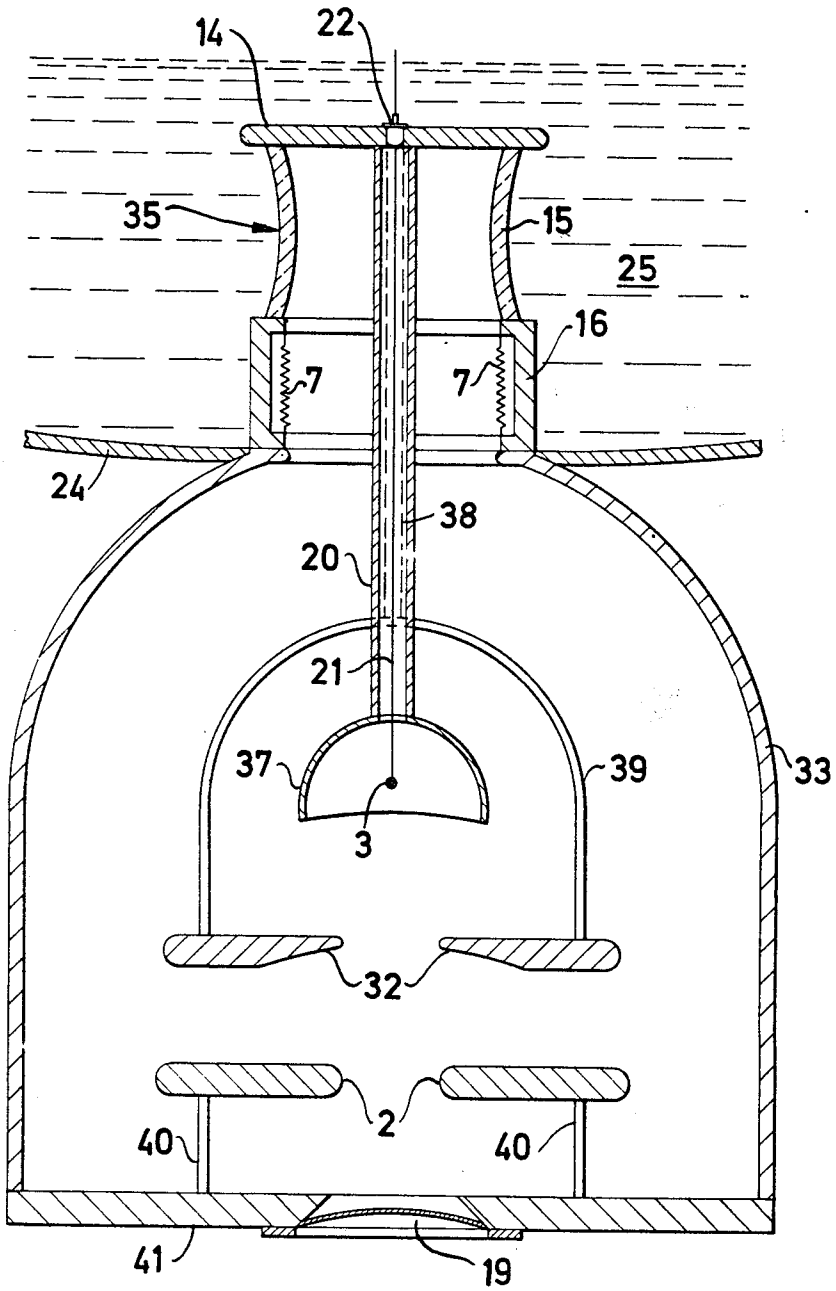
FIG. 4.



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ELECTRON IRRADIATION MACHINE

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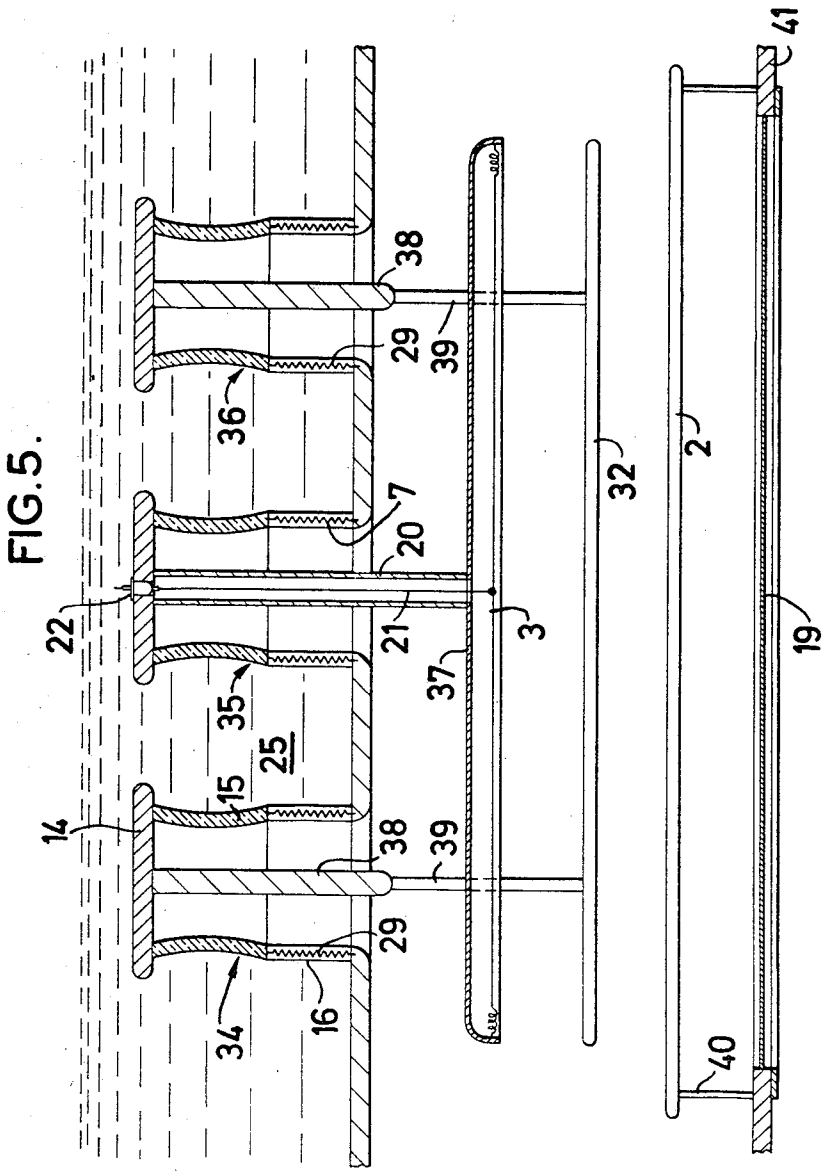
FIG. 5.



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ELECTRON IRRADIATION MACHINE

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2 Claims. (Cl. 315—14)

ABSTRACT OF THE DISCLOSURE

An electron irradiation machine comprising an evacuated envelope having a diode, which regulates an A.C. voltage source, for controlling the electron flow from an emitter cathode to a remote apertured anode. The emitter cathode is mounted on a hollow conducting stem and the diode has an anode, which is the stem, and a cathode surrounding the stem.

The present invention relates to electron irradiation machines.

Electron irradiation machines are usually supplied with a high voltage, for example 150 kv., from a transformer and it will be appreciated that the output from the transformer will be an alternating output. Since it is undesirable to apply an alternating potential between the emitter cathode and the anode of the electron irradiation machine, a rectifier diode is included in the transformer circuit. A capacitor is connected between the anode of the diode and one end of the transformer, while the cathode of the diode and the other end of the transformer are connected to earth. This arrangement prevents the anode from becoming more than a few volts positive relative to earth. During the negative half cycle of the transformer however the diode anode attains a negative potential which is only slightly less than the value of the peak to peak potential of the transformer.

It is therefore necessary that the diode should withstand a voltage difference between its anode and cathode equal to the peak to peak amplitude developed by the transformer. The diode should also give a high emission and possess low impedance characteristics during the positive half cycles. Suitable diodes are readily available for voltage differences of up to 150 kv., but for voltages above this suitable diodes are not readily available and are expensive.

In commercial irradiation machines a potential of 250–500 kv., is required and such a machine should be cheap to operate and maintain and should therefore contain a minimum of separate high voltage components.

It is an object of the present invention to provide a new or improved rectifying arrangement for an electron irradiation machine.

According to the present invention there is provided an electron irradiation machine comprising a vacuum enclosure having an electrically conducting stem therein, an electron emitting cathode connected to said stem, an apertured anode spaced from the emitter cathode, and an electrode which forms the cathode of a rectifying diode arranged around the stem, the stem forming an anode for the rectifying diode in addition to acting as a connection to the said electron emitting cathode.

It will be appreciated that the apparatus of the present invention provides an electron irradiation machine in which the rectifying diode is an integral part of the machine and is included in the same vacuum enclosure.

In some irradiation machines, a two, or more, stage acceleration may be applied by using several anodes, these being maintained at increasingly positive potentials

in passing from the emitting cathode, said anodes being connected to different tappings on a transformer and the cathode for each of said several anodes being the electrode arranged around said stem.

It should be appreciated that the irradiation machine may be used for the irradiation of objects by the electron beam within the vacuum enclosure, and also to irradiate objects located in a region of higher pressure external of the vacuum enclosure, into which region the beam of electrons passes out of the vacuum enclosure through a window located in the said enclosure. The term "irradiation target" will be applied hereafter to those objects which are to be irradiated by the electron beam within the vacuum enclosure.

The vacuum enclosure may be provided with a removable cover thereby allowing access to the interior of the enclosure in order to change targets and also to replace worn components.

In order that the present invention may be more readily understood, several embodiments thereof will now be described by way of example, reference being made to the accompanying drawings wherein:

FIGURE 1 is a circuit diagram showing a previous arrangement;

FIGURE 2 is a diagrammatic cross-section of an electron irradiation machine with a single integral diode;

FIGURE 3 is a circuit diagram of an arrangement employing two rectifier diodes;

FIGURE 4 is a diagrammatic sectional end elevation of an electron irradiation machine with two integral diodes; and

FIGURE 5 is a diagrammatic sectional front elevation of the electron irradiation machine of FIGURE 4.

Referring to FIGURE 1, an electron irradiation machine **1**, having an anode **2** and an emitter cathode **3** is connected to a transformer **4** which provides an alternating high voltage. A rectifier diode **5**, having an anode **6** and cathode **7** is connected across the transformer **4**, with a 180 kv. capacitor **8** connected in series with the anode **6**. A cathode transformer **9** is connected to the cathode **7** of the diode **5** to supply the heating current thereto. The end of transformer **4** remote from the capacitor **8** is connected to earth as indicated at **10**. The rectified supply from the transformer **4** provides the accelerating potential for the machine **1**. An emitter transformer **11** is connected to the emitter cathode **3** to supply the heating current thereto. A lead **12** connects the anode **6** of diode **5** and the capacitor **8** to the emitter cathode **3** and a further lead **13** connects the anode **2** to earth potential at **10**.

In operation the lead **13**, and thus anode **2**, are maintained at earth potential, while capacitor **8** and diode **5** produce a varying voltage in the lead **12**, this voltage varying from about zero to a negative value equivalent to about the peak to peak output voltage of the transformer **4**. Thus, if transformer **4** gives an output voltage having an R.M.S. value of 120 kv., the maximum potential developed across the diode **5**, and thus the maximum accelerating potential in the machine **1**, is of the order of —340 kv. It will be appreciated that the diode **5** will have to withstand a potential drop of 340 kv. between the cathode and anode without breakdown occurring and that such diodes are costly to replace.

In the arrangement shown in FIGURE 2, corresponding parts are indicated by the same reference numerals as in FIGURE 1. The electron irradiation machine **1** comprises a top flange **14** of brass or stainless steel, a ceramic, preferably glass, insulator segment **15** secured to the flange **14** and a tubular stainless steel section **16**. A removable cover **17** is secured to the tubular section **16**, an O-ring **18** providing a vacuum seal between section **16** and cover **17**. The cover **17** is provided with a thin exit window

19 of aluminium/magnesium alloy. The anode 2, which has a central aperture, is fitted within the cover 17. A tubular stem 20 of stainless steel is secured to the flange 14. A conducting lead 21 of copper passes centrally through the stem 20 and at the bottom thereof is connected to the emitter cathode 3, the latter being also connected to the stem 20. The lead 21 is connected at its upper end to an insulated connector 22 in a central aperture in the flange 14. The connector 22 and the flange 14 are connected across the emitter transformer 11.

The diode cathode 7 is mounted around the perimeter of the section 16 on suitable insulated supports, through one of which, 23, connections may be made to an earth connection which is also common to the high voltage transformer, and to a cathode transformer, in a manner similar to that described with reference to the FIGURE 1 arrangement. The flange 14 is connected to the opposite end of the high voltage transformer through the lead 12 and capacitor 8.

The upper section of the electron irradiation machine 1 is located at the bottom of a containing vessel 24 so that the insulator segment 15 and flange 14 are covered by a quantity of oil 25 which provides electrical insulation. Section 16 is provided with a side conduit 26 by means of which during operation the interior of the machine 1 is connected to a suitable vacuum pump (not shown).

In operation, the stem 20 functions as an anode relative to the cathode 7, and is at the same potential as the cathode 3. The anode 2 is connected by a lead (not shown) to the same earth connection as is the diode cathode 7. The assembly operates in the same manner as described with reference to FIGURE 1, cathode 7 and stem 20 being equivalent in function to the diode 5. In this arrangement, all the high voltage components are in the same vacuum enclosure and replacements are readily effected, when required, by removing the cover 17.

FIGURE 3 shows a conventional arrangement, using two rectifying diodes and two anodes in the electron irradiation machine. The arrangement is similar to that shown in FIGURE 1 except that a further diode 27 is connected between the earthed lead 13 and a tapping from the mid-point of the transformer 4. The anode 28 of the diode 27 is connected to the tapping on the transformer 4 through a 90 kv. capacitor 30. A lead 31 connects the anode 28 to an anode 32 of the accelerator 1. The cathode 29 of diode 27 is connected to cathode transformer 9 in common with the cathode 7 of diode 5.

The output voltage of the transformer 4 has an R.M.S. value of 120 kv. and thus at the mid-point of the transformer the voltage has an R.M.S. value of 60 kv. In operation the emitter cathode 3 will reach a potential of about —340 kv., anode 32 a potential of about —170 kv. and the anode 2 will be at earth potential. Thus, electrons emitted by cathode 3 will experience a two stage acceleration from cathode 3 to anode 32 and from anode 32 to anode 2.

FIGURES 4 and 5 show an apparatus in accordance with the present invention and possessing two accelerating anodes. The main section of the irradiation machine comprises an elongated vacuum chamber 33. Three separate cathode units 34, 35 and 36 are mounted on the top of the chamber 33 and immersed in the oil bath 25

in containing vessel 24. Each of the cathode units comprises a flange 14, insulator segment 15 and section 16. The section 16 of each of units 34 and 36 contains a cathode 29, and section 16 of unit 35 contains a cathode 7.

From the flange 14 of the unit 35, the stem 20 supports an elongate cathode support 37. The emitter cathode 3 is an elongate cathode and is connected at its ends to the support 37. The lead 21 passes through the stem 20 and is connected at its lower end to the midpoint of the cathode 3. The lead 21 is also connected to the insulated connector 22 and from there to a high voltage transformer and an emitter transformer (not shown).

From the flanges 14 of units 34 and 36, support members 38 are suspended, and to the lower end of each member 38 are fixed two support arms 39 to each of which is secured a part of the anode 32. Each part of the anode 2 is supported on two support legs 40 which are fixed to the base 41 of the vacuum chamber 33 at either end of the elongate window 19.

The anode 32 is electrically connected through arms 39 and support members 38 to the flanges 14 of units 34 and 36, and from these flanges 14 to a capacitor connected to the mid-point of the same high voltage transformer as the lead 21. The support members 38 act as anode to the cathodes 29 which are connected to a suitable earth connection, as are also the cathode 7 and the anode 2. The cathodes 7 and 29 are also connected to a suitable cathode transformer.

It will be appreciated that the external connections to the apparatus shown in FIGURES 4 and 5 will correspond to the circuit of FIGURE 3 and that the operation of the apparatus will correspond to the operation of the FIGURE 3 circuit.

Various modifications may be effected on the apparatus described herein without departing from the scope of the invention.

I claim:

1. An electron irradiation machine comprising a vacuum enclosure having an electrically conducting stem therein, an electron emitting cathode connected to said stem, an apertured anode spaced from the emitter cathode, and an electrode which forms the cathode of a rectifying diode arranged around the stem, the stem forming an anode for the rectifying diode in addition to acting as a connection to the said electron emitting cathode.

2. An electron irradiation machine according to claim 1 wherein two or more acceleration stages are applied to said electrons using several anodes characterised in that said anodes are maintained at increasingly positive potentials in passing from the emitting cathode said anodes being connected to different tappings on a transformer and the cathode for each of said several anodes being the electrode arranged around said stem.

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M. F. HUBLER, *Assistant Examiner.*