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GB 2560966 A **GB 2036421 A**
GB 1284047 A **EP 1199739 A2**
EP 1063670 A2 **EP 1018137 A2**
JP 2006221983 A **US 4055780 A**
US 20170148605 A1

(58) Field of Search:
INT CL **B23K, H01J**
Other: **WPI, EPODOC, Patent Fulltext, XPESP, XPIOP, XPAIP, XPI3E, XPIEE, XPMISC, OAC, SPRINGER, IP.COM, INSPEC, Internet**

(54) Title of the Invention: **Electron beam emitting assembly**
Abstract Title: **Electron beam emitting assembly where the filament directly contacts the cathode**

(57) An electron beam emitting assembly, and associated method of generating an electron beam, comprising a filament element 40 and a cathode element 42, wherein the filament element 40 is in direct physical contact with the cathode 42. The filament element may be resistively or inductively heatable and may be made of Tungsten or Graphite. The cathode element 42 may be made from Lanthanum Hexaboride (LaB_6). The filament element 40 may be heatable to a temperature around or slightly greater than an electron emission temperature of the cathode element 42. The cathode 42 may be in the form of a disc, which is mounted on a hollow frustoconical support 44 comprising a Tantalum cone 46 and a ceramic mounting ring 48. The electron beam emitting assembly may be used in an electron beam gun used in electron beam welding.

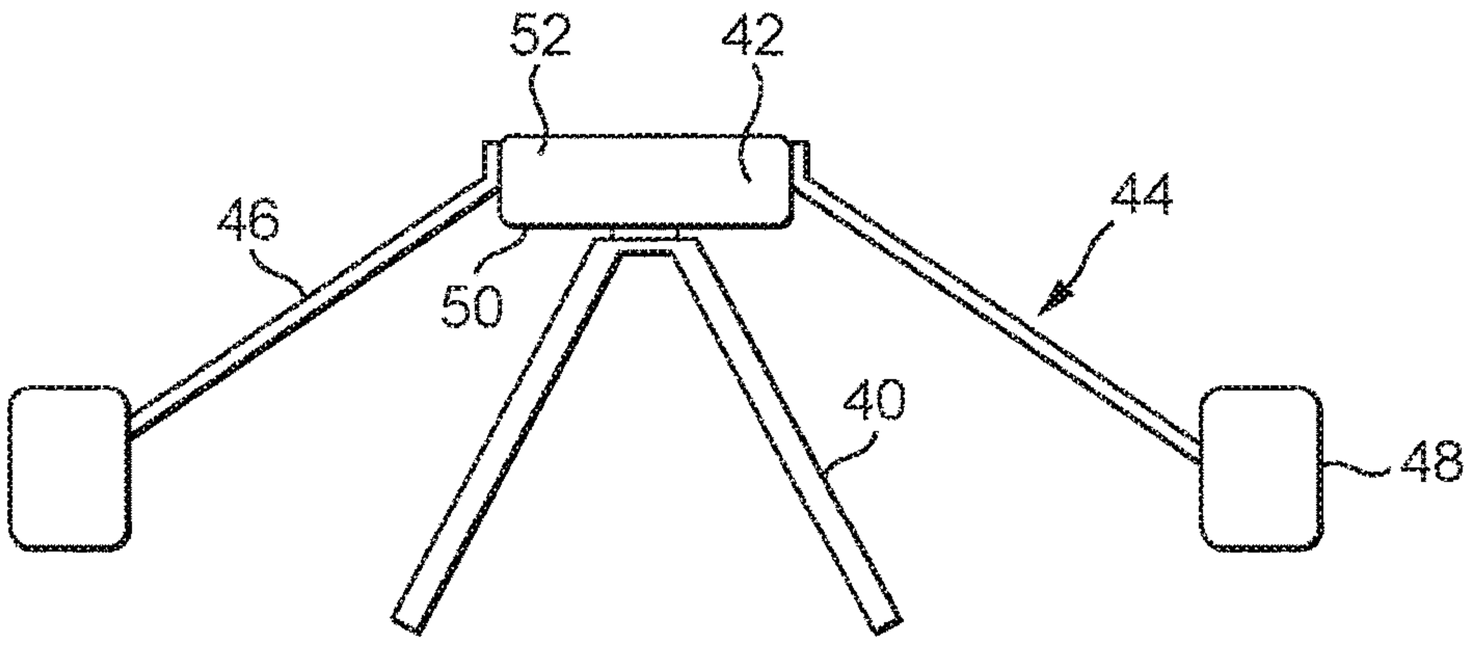

FIG. 2

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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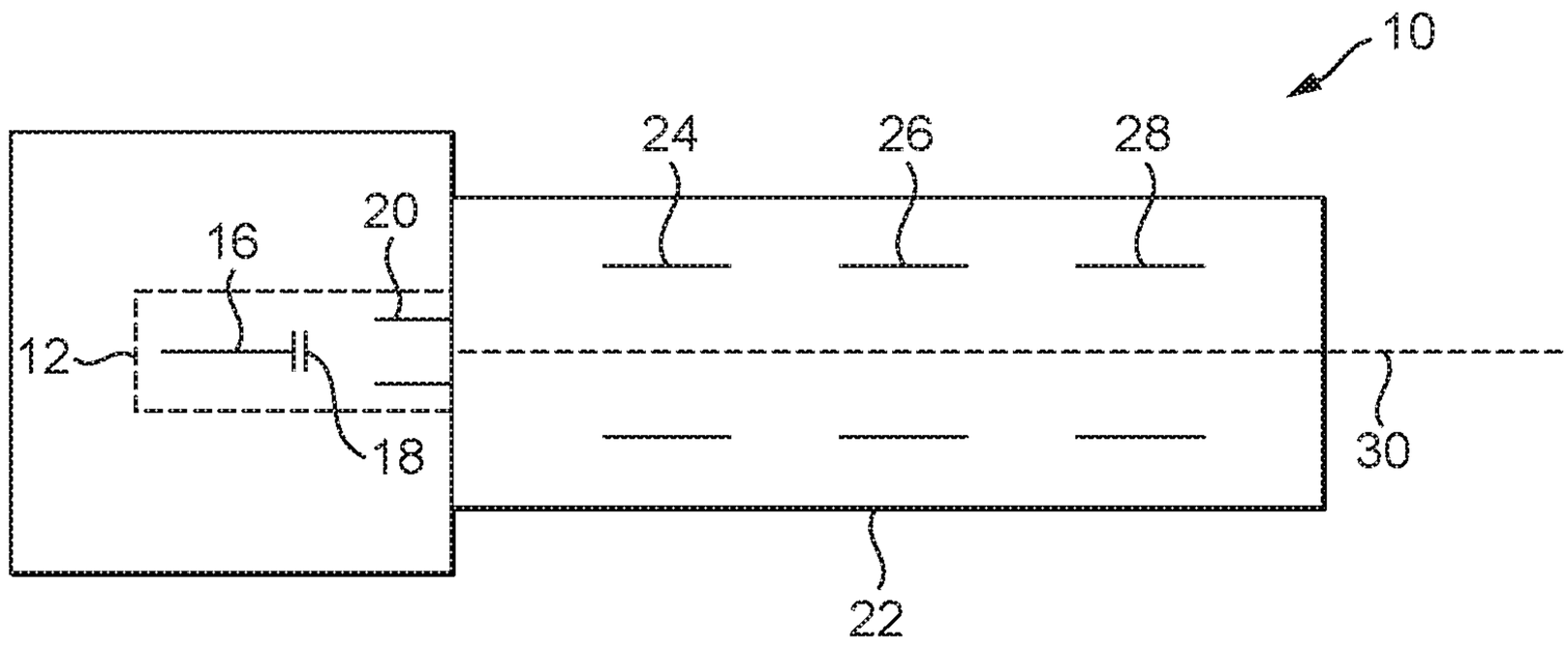

FIG. 1

20
24 04

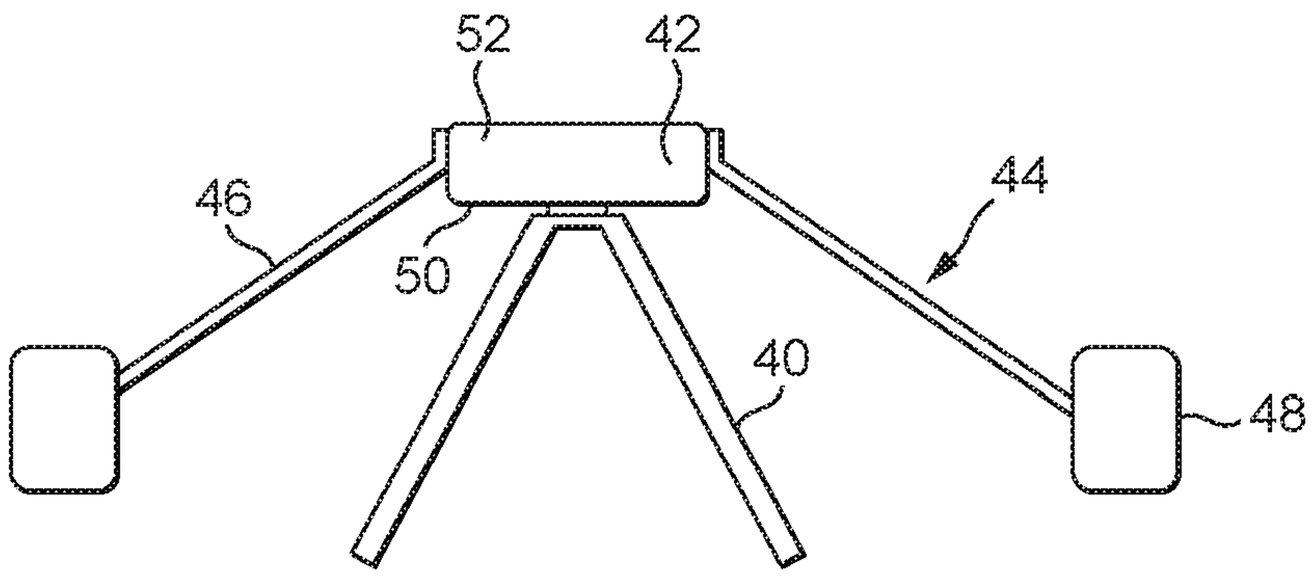

FIG. 2

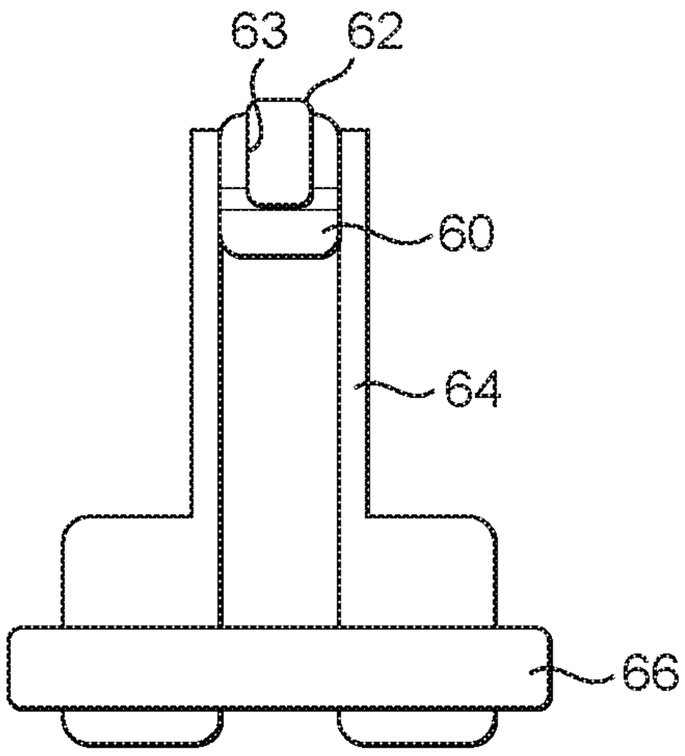

FIG. 3

24 04 20

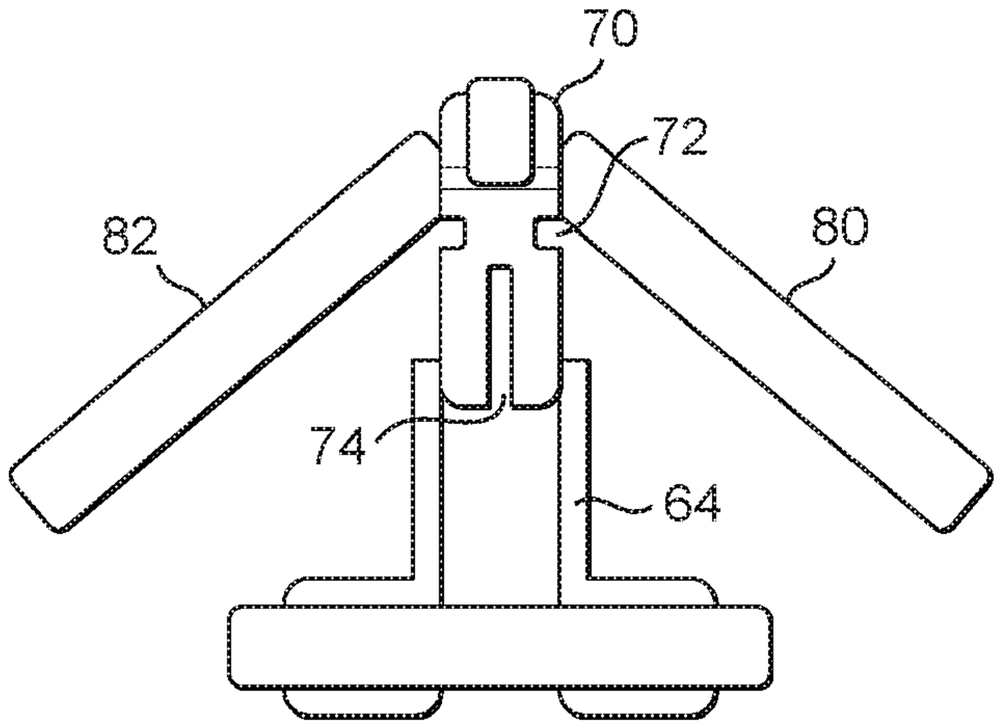

FIG. 4

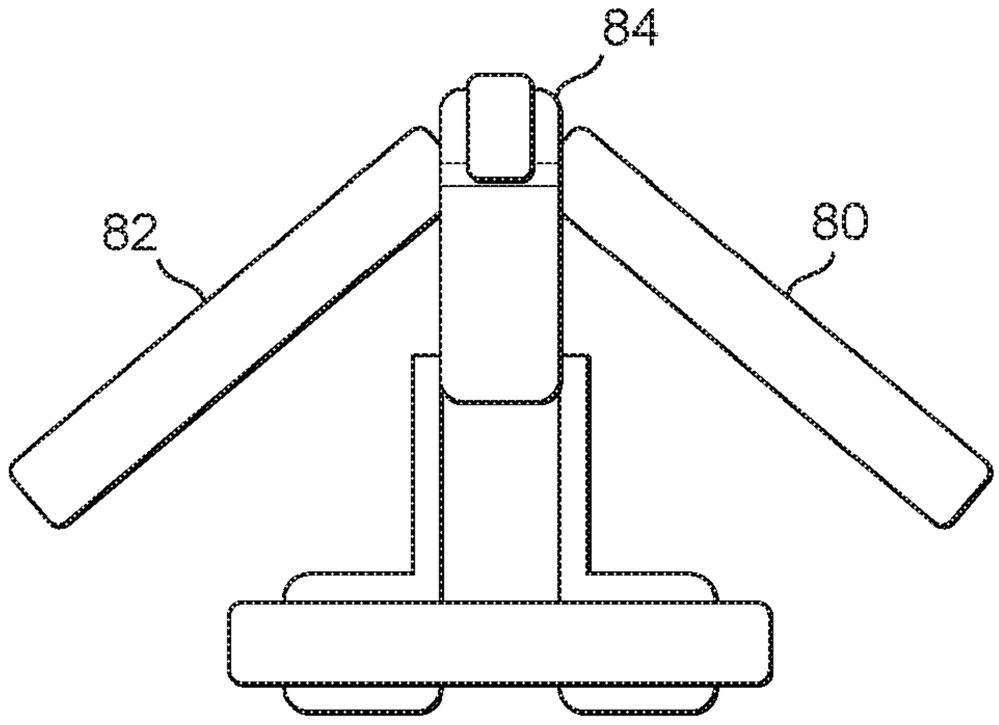

FIG. 5

Title: Electron Beam Emitting Assembly

Field of the invention

This invention relates to an electron beam emitting assembly, such as used in an electron beam gun used in electron beam welding.

Background to the invention

Electron beam emitting assemblies are used within electron beam guns to position an emitter, cathode and anode relative to one another. The filament and cathode need replacing on a regular basis which is a complicated procedure requiring skilled personnel to modify the position and orientation of the emitter, cathode and anode relative to each other. Set-up procedures to ensure correct beam characteristics after replacing a filament take many hours.

Summary of the invention

In accordance with one aspect of the present invention, there is provided an electron beam emitting assembly comprising a filament element and a cathode element, wherein the filament element is in direct physical contact with the cathode element. This allows the filament element to be used to directly heat the cathode element.

Preferably the filament element is heatable to a temperature around an electron emission temperature of the cathode element. Typically the filament element will be heated to just above the electron emission temperature of the cathode element, so as to ensure that the cathode element reaches its electron emission temperature. Typically the filament element will be heated to a temperature around 200 to 300°C greater than the electron emission temperature of the cathode element.

The filament element may be resistively heatable or inductively heatable by connection to an electric supply.

The cathode element is preferably Lanthanum Hexaboride as this is particularly suitable for electron beam emission for welding purposes.

The filament element may be formed with a recess and the cathode element positioned to sit within the filament element, with at least one surface of the cathode element uncovered and free to emit electrons when the cathode element is at its electron emission temperature.

The assembly may further comprise a clamp, such as a Molybdenum clamp, to grip the filament element, particularly where the filament element needs to be inductively heatable. For such embodiments, a ceramic support may be used to hold the filament element in position within the clamp.

In accordance with another aspect of the invention there is provided a method of generating an electron beam comprising positioning a filament element and a cathode element in direct physical contact, and heating the filament element to a temperature around an electron emission temperature of the cathode element so as to cause the cathode element to emit electrons.

Typically the temperature to which the filament element is heated will be slightly above the electron emission temperature of the cathode element. The filament element will not be heated to its own electron emission temperature but will be substantially below its own electron emission temperature.

The method may further comprise resistively heating the filament element. Alternatively the method may comprise inductively heating the filament element.

The cathode element may be Lanthanum Hexaboride.

The method may further comprise disposing at least part of the filament element within a clamp, such as a Molybdenum clamp.

The method may further comprise disposing the cathode element within a recess formed in the filament element, at least one surface of the cathode element being uncovered and free to emit electrons.

The invention will now be described, by way of example, and with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of an electron beam gun incorporating an electron beam emitting assembly;

Figure 2 is an end view of a first embodiment of a cathode and filament arrangement used in such an assembly;

Figure 3 is an end view of a second embodiment of a cathode and filament arrangement used in such an assembly;

Figure 4 is an end view of a third embodiment of a cathode and filament arrangement used in such an assembly; and

Figure 5 is an end view of a fourth embodiment of a cathode and filament arrangement used in such an assembly;

Description

A schematic diagram of an electron beam gun 10 is shown in Figure 1 for explanatory purposes. Electron beam assembly 12 from which electrons are generated is located in evacuatable housing 14, with assembly 12 comprising filament 16, cathode 18 and anode 20. Cathode 18 generates an electron beam which is accelerated through anode 20 to pass into a second evacuatable housing or chamber 22 in which are disposed focussing coils 24, alignment coils 26 and beam deflection coils 28 so as to produce a high energy focussed electron beam 30 for electron beam welding.

In prior art arrangements, filament 16 is spaced from cathode 18 and filament 16 is heated to its electron emission temperature to generate electrons which are accelerated towards cathode 18 to cause cathode 18 to generate an electron beam. The temperature to which filament 16 needs to be heated to emit electrons depends on the material from which the filament is made, with Tungsten filaments needing to be heated to 2600°C, Graphite filaments to 4000°C and Tantalum/Molybdenum filaments to around 2400°C. Heating to such high temperatures causes the filaments to degrade and they need replacing often which involves time consuming realignment of the cathode, filament and other components in the electron beam gun.

In embodiments of invention and as shown in Figures 2 to 5, the filament is placed in direct contact with the cathode so as to directly heat the cathode to generate electrons. The filament does not need to be heated to its electron emission temperature but rather only to a temperature sufficient to ensure the cathode reaches its electron emission temperature. Thus for a Lanthanum Hexaboride cathode with an emission temperature of 1300°C, a Tungsten filament only needs to be heated to around 1500 to 1600°C which is much lower than the temperature needed for electron emission from the filament.

By arranging direct contact between the cathode and the filament, the cathode can be stimulated to emit electrons without the filament needing to be heated to emission temperature.

By heating the filament to a lower temperature, the filament does not burn out so quickly. This ensures that the combination of filament and cathode lasts much longer than prior art arrangements, typically at least 10 times as long which is advantageous as it saves on delays in setting up with replacement filaments.

In the arrangement shown in Figure 2, a Tungsten filament 40 directly contacts a Lanthanum Hexaboride LaB_6 cathode 42 in the form of a disc of around 4mm in diameter. Cathode 42 is mounted on a hollow frustoconical support 44 comprising a Tantalum cone 46 and a ceramic mounting ring 48. Filament 40 is connected to an electrical supply (not shown) and resistively heated to a temperature just above the emission temperature of cathode 42 and directly physically contacts a lower surface 50 of cathode 42 such that an electron beam is emitted from upper surface 52 of cathode 42.

In the arrangement shown in Figure 3, $La B_6$ cathode 62 being a 1mm diameter block is positioned within a recess 63 of a filament being a graphite cylinder 60, with a Molybdenum clamp 64 attaching to graphite cylinder 60. Electrical current is sent through Molybdenum clamp 64 to inductively heat graphite cylinder 60, with graphite cylinder 60 in direct physical contact with cathode 62 to heat cathode 62 to its

electron emission temperature. Typically Molybdenum clamp 60 is secured within a ceramic holder 66.

In the arrangement shown in Figure 3, a magnetic field is generated parallel to the extended arms of clamp 64. Figures 4 and 5 show alternative embodiments of the inductively heated filaments which have opposing current flow and ensure there is no magnetic field induced at the cathode. In Figure 4, graphite filament 70 protrudes beyond clamp 64 and is formed with grooves 72, 74 so as to modify the magnetic field. Additional ceramic clamps 80, 82 are used to secure the top end of filament 70 which is distal from clamp 64. Figure 5 shows a similar arrangement with ceramic clamps 82 but with filament 84 omitting any grooves.

If desired, the electron beam assembly can be supplied as a single item so that the filament and cathode are already positioned in direct physical contact with one another and do not need adjusting within the electron beam gun.

Claims

1. An electron beam emitting assembly comprising a filament element and a cathode element, wherein the filament element is in direct physical contact with the cathode element.

2. An electron beam emitting assembly according to claim 1, wherein the filament element is heatable to a temperature around an electron emission temperature of the cathode element.

3. An electron beam emitting assembly according to claim 1 or claim 2, wherein the filament element is resistively heatable.

4. An electron beam emitting assembly according to claim 1 or claim 2, wherein the filament element is inductively heatable.

5. An electron beam emitting assembly according to any of the preceding claims, wherein the cathode element is Lanthanum Hexaboride.

6. An electron beam emitting assembly according to any of the preceding claims, wherein the filament is formed with a recess and the cathode element is positioned to sit within the filament element.

7. An electron beam assembly according to any of claims 1, 2, 4, 5 or 6, further comprising a clamp to grip the filament element.

8. A method of generating an electron beam comprising positioning a filament element and a cathode element in direct physical contact, and heating the filament element to a temperature around an electron emission temperature of the cathode element so as to cause the cathode element to emit electrons.

9. A method according to claim 8, wherein the temperature to which the filament element is heated is slightly greater than the electron emission temperature of the cathode element.

10. A method according to claim 8 or claim 9, further comprising resistively heating the filament element.

11. A method according to claim 8 or claim 9, further comprising inductively heating the filament element.

12. A method according to any of claims 8 to 11, wherein the cathode element is Lanthanum Hexaboride.

13. A method according to any of claims 8, 9, 11, or 12, further comprising disposing at least part of the filament element within a clamp.

14. A method according to any of claims 8, 9, 11, 12 or 13, further comprising disposing the cathode element within a recess formed in the filament element.

Intellectual Property Office

Application No:	GB1905758.7	**Examiner:**	Dr Thomas Martin
Claims searched:	1-3, 5, 8-10, 12 and 13	**Date of search:**	30 September 2019

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-3, 5, 8-10, 12 and 13	US 2017/148605 A1 (TESCH AND MAGERA) see whole document, especially [0032], [0043] and figure 10.
X	1-3, 5, 8-10, 12 and 13	GB2036421 A (KERNFORSCHUNGSANLAGE JUELICH) see whole document, especially page 2 lines 27-28 and figure 1.
X	1-3, 5, 8-10, 12 and 13	US4055780 A (KAWAI et al) see whole document, especially column 3 lines 61-63, column 5 lines 50-54, figures 1 and 2.
X	1-3, 5, 8-10, 12 and 13	EP1063670 A2 (LUCENT TECHNOLOGIES INC) see whole document, especially [0013] and figure 3.
X	1-3, 5, 8-10, 12 and 13	EP1199739 A2 (ELITH LLC) see whole document, especially [0024] and figure 7b.
X	1-3, 5, 8-10, 12 and 13	GB1284047 A (PHILIPS ELECTRONIC ASSOCIATED) see whole document, especially figures.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B23K; H01J

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

Intellectual Property Office

International Classification:

Subclass	Subgroup	Valid From
H01J	0001/15	01/01/2006
B23K	0015/00	01/01/2006
H01J	0001/20	01/01/2006
H01J	0037/06	01/01/2006

Intellectual Property Office

Application No:	GB1905758.7	**Examiner:**	Dr Thomas Martin
Claims searched:	1, 2, 5-9, 12-14 (in part) and 4, 11	**Date of search:**	22 November 2019

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 2, 4, 5, 7-9, 11-13	EP1018137 A2 (WELDING INST) see whole document, especially figures 24-26 and [0069-0075].
X	1, 2, 4, 5, 7-9, 11-13	GB2560966 A (AQUASIUM TECH LIMITED) see whole document, especially figure 2 and page 3.
X	1, 2, 4-9, 11-14	JP2006221983 A (NUFLARE TECHNOLOGY INC) see whole document, especially [0040].

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B23K; H01J

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WPI, EPODOC, Patent Fulltext, XPESP, XPIOP, XPAIP, XPI3E, XPIEE, XPMISC, OAC, SPRINGER, IP.COM, INSPEC, Internet

International Classification:

Subclass	Subgroup	Valid From
H01J	0001/15	01/01/2006
B23K	0015/00	01/01/2006
H01J	0001/20	01/01/2006
H01J	0037/06	01/01/2006