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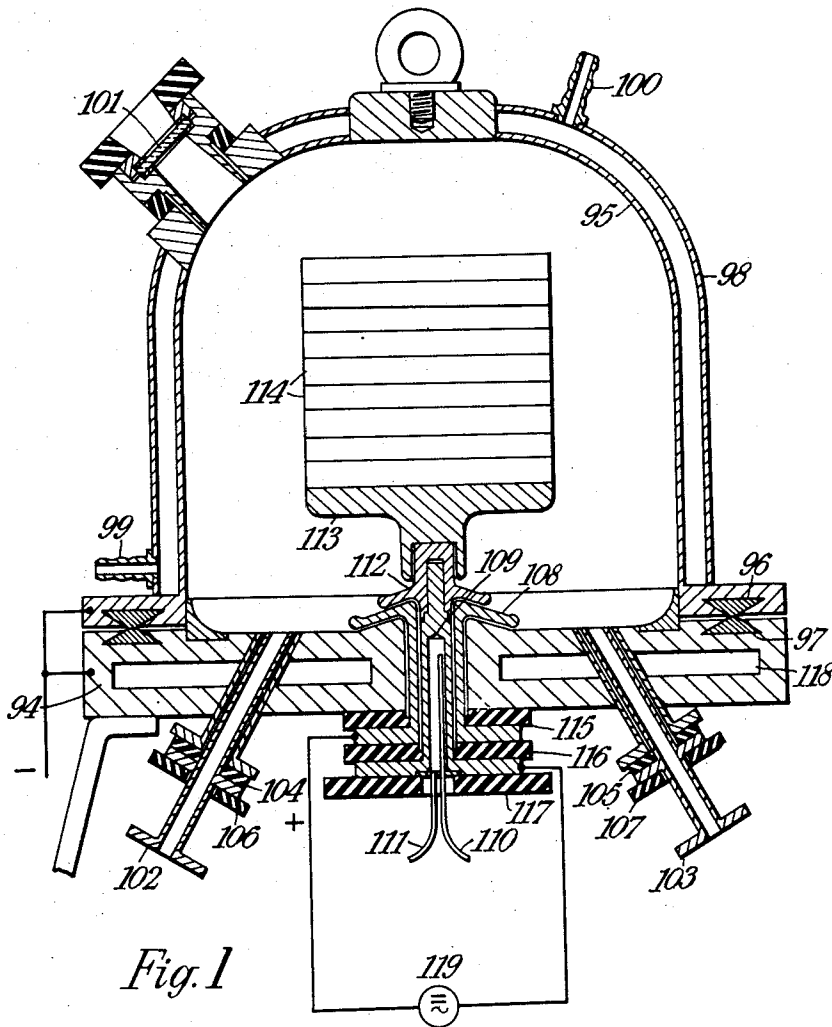
B. BERGHAUS ET AL

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ELECTRICAL DISCHARGE APPARATUS

Filed March 20, 1939

2 Sheets-Sheet 1



Inventors,
B. Berghaus
W. Burkhardt
by *Glascop Downing*
Attys.

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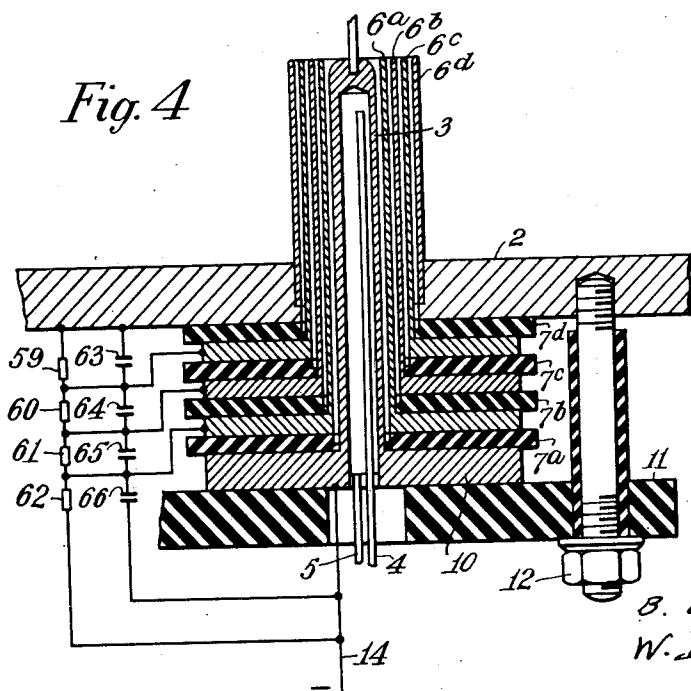
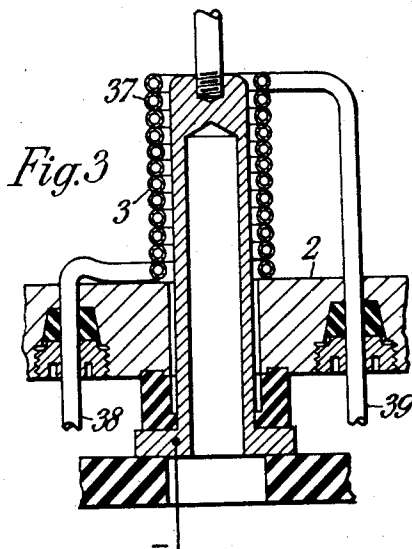
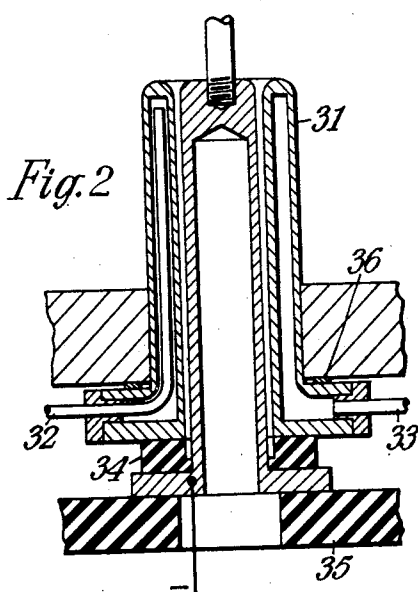
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Inventors,
B. Berghaus
W. Burkhardt

By *Glascow Downing & Lech*
Attys.

UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE APPARATUS

Bernhard Berghaus, Berlin-Lankwitz, and Wilhelm Burkhardt, Berlin-Grünwald, Germany; said Burkhardt assignor to said Berghaus

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In Germany March 24, 1938

4 Claims. (Cl. 250—27.5)

The invention relates to a lead-in conductor for vacuum, annealing and melting furnaces, the characteristic feature of which is that the insulating material is protected by a gap against any attack by the gas discharge. The length of the protective gap is preferably a multiple of its width.

The invention relates to a lead-in conductor for electric vacuum, annealing and melting furnaces, the characteristic feature of which is that the insulated cathode or anode conductor, to which the required voltage is applied for the heating up of the material to be annealed or melted by means of an electric discharge at reduced pressure, is provided with a metal covering at a short distance, preferably projecting into the vacuum chamber of the furnace. The insulating and sealing material of the conductor is so arranged that it is not reached by the charge carriers and metal vapour present in the vacuum chamber. The distance between the conductor and the metal covering is made smaller than the width of the glow fringe which is formed around the conductor and the electrodes, more particularly, the cathode. The distance of the metal covering from the conductor depends upon the nature of the gas, the pressure and temperature of the gas, being about 0.1 to 20 and preferably 0.5 to 5 millimeters, and the metal covering has such a length that the glow and the charge carriers from the ionised atmosphere of the furnace, as well as the metal vapour, do not reach the insulating and the sealing material. The insulated metal covering may lie in the ionised gas space without any direct electric connection and carry a positive potential. Further, it may be in electric contact with the casing of the vacuum, annealing and melting furnace and be even earthed. The metal covering of the lead-in conductor may also be insulated with respect to the casing, in addition to being insulated from the conductor and carry a different voltage than the casing or the conductor. The screen of the conductor is preferably so shaped as to avoid as much as possible the presence of edges and points.

The insulation and sealing of the conductor is preferably provided outside the vacuum, annealing and melting furnace, so that they are easily accessible. The conductor may preferably be constructed as a round hollow member, the inner wall of which is capable of being cooled by a cooling means, such as air, oil or water.

The wall of the furnace may be provided with a cooling device at the point of contact with the packings and insulation. Also the metal cover-

ing of the conductor may be made hollow and capable of being cooled. The cooling has the advantage that any metal vapor formed during the annealing condenses on the cooled screen or lead-in conductor before the insulator is reached thus protecting the insulator against heat.

By thus constructing the lead-in conductor according to the invention it is possible reliably to introduce into the vacuum chamber of the furnace large outputs at high voltage, even in the case of great development of heat on the electrodes.

The lead-in conductor for vacuum, annealing and melting furnaces hereinbefore described can be advantageously employed for all voltages to be introduced into the chamber of a vacuum furnace, irrespective of the fact whether the lead-in conductor is required for a cathode, anode or auxiliary electrodes. Also, in the case of auxiliary circuits, for instance, for electrical devices, such as driving means, it enables the supply of electrical energy to be reliably effected with any desired current intensity and any desired voltage. It retains its advantages when use is made of direct current or alternating current voltages and rectified alternating current voltages. It has been found suitable even when use is made of a high frequency voltage of any desired frequency.

A further characteristic of the invention is that the insulator covers the flange of the conductor completely with respect to the vacuum chamber of the furnace. The insulator is in that case preferably provided with a groove in which the metal screening sleeve is fitted at a short distance from the conductor.

A further feature of the invention resides in the fact that the conductor is surrounded by a plurality of concentric metal coverings, which are arranged in an insulated manner and at a short distance with respect to one another and to the conductor. The metal coverings may carry different voltages with respect to one another and the conductor. In order to regulate the distribution of the voltage on the metal coverings use is preferably made of condensers or resistances.

The invention has the advantage that, owing to the gradation of the voltage between the individual metal coverings, high voltages can be reliably introduced in the vacuum furnace in the case of large powers. The device offers a special advantage when the lead-in conductor is used in metallic furnaces wherein the high voltage is applied between the wall of the furnace

and the conductor. Both the conductor and the wall of the furnace may carry the negative voltage. The same advantages are obtained with the lead-in conductor when the direction of the current is continuously varied, as is, for instance, the case when an alternating current voltage is applied. By using a lead-in conductor such as described it was possible to apply voltages up to 10,000 volts and more, and powers of 100 kilowatt and more, without in any way damaging or destroying the insulating part, even with a long period of operation.

The invention further relates to a lead-in conductor for electric vacuum, heating and melting furnaces, the characteristic feature of which is, that a gap is provided all around between the conductor so narrow that no glow discharge can take place therein with the existing vacuum and the voltage which is applied. The distance of the insulator from the conductor is less than 10, preferably 3 to 0.1 millimeter. Moreover, the gap is preferably made of labyrinth shape, in order to hinder the penetration of charge carriers out of the vacuum space.

The present invention avoids the difficulties hitherto encountered with lead-in conductors owing to the undesirable glow and arc discharges at the point where the lead-in conductors enter into the vessel, which would otherwise lead to the destruction of the sealing and insulating material. The lead-in conductor allows powers of 100 kw. for voltages of a few thousand volts to be reliably supplied to vacuum apparatus of any desired construction in which the wall of the vessel forms permanently or temporarily the cathode. A direct or alternating current voltage may be applied to the lead-in conductor.

The invention is illustrated by way of example and diagrammatically in the accompanying drawings, in which

Fig. 1 is a sectional elevation of electrical heated vacuum annealing and melting furnace.

Fig. 2 is a sectional view of another form of the lead-in assembly.

Fig. 3 is a sectional view of another type of screening sleeve.

Fig. 4 is a sectional view of a lead-in conductor similar to Fig. 2 showing a modified screen assembly including the electrical connections thereof.

In Fig. 1 there is shown an electrically heated annealing or melting furnace for metallic or non-metallic material, in which the wall of the furnace is neutral or is connected as an anode with respect to a cathode introduced therein in an insulated manner, and in which the material to be annealed in the furnace constitutes the cathode and the electrically heated gas between the cathode glow fringe and the anode constitutes the heating element for the material to be heated. The vacuum annealing and melting furnace consists of a lower part 94 and a removable upper part 95, which are connected together in an airtight manner by means of packings 96 and 97 and which form the anode individually or together or are neutral. The upper part 95 which is for instance made in the form of a hood is provided with a jacket 98 to which the cooling medium is supplied through the pipe 99 being discharged through the pipe 100. Further, an opening is provided in the upper part, which opening is closed by an inspection window 101. A vacuum pump, which is not shown, is connected to a pipe connection 102 arranged in an insulated manner in the lower part 94, by means

of which pump a pressure of preferably 10.0 to 0.05 millimeter of mercury is maintained within the housing. The lower part 94 is also provided with a pipe connection 103 which is also insulated with respect to the anode. 104 and 105 are insulating rings, whilst 106 and 107 are insulating and clamping rings. A regulated amount of filling gas may be introduced through the pipe 102 by means of a regulating valve which is not shown. According to the material which is to be annealed the filling gas may be an inert gas, such as argon, krypton, xenon, helium, or a reducing gas such as hydrogen, hydrocarbons or the like. Nitrogen, ammonia or similar gases may also be used when it is intended to produce an effect for instance on the metal to be annealed. Gases or vapours may be supplied which produce a chemical action on the material to be annealed. The anode 108 which is screened by the metal bottom plate is arranged in an insulated and screened manner in the lower part 94. The lead-in conductor 109 is made hollow and to which a cooling medium is supplied by a pipe 110 which cooling medium is discharged through the pipe 111. Between the anode 108 and the lower part 94 of the vessel there is a narrow labyrinth-like gap which is so narrow that no load discharge can take place therein. A similar narrow labyrinth-like gap is provided also between the anode 108 and the cathode lead-in conductor 109. The lead-in conductor 109 carries by means of an electrically conducting screening pin 112, for instance a conducting plate 113, on which the material 114 to be annealed is placed. The lead-in conductor 109 is connected to the negative pole of a source 119 of direct current. Instead of a source of direct current 119 use may be made of a source of alternating current. Instead of the annealing material 114 a crucible may be used which may for instance be of carbon or of ceramic material, such as beryllium-oxide, or of metal to receive the material to be heated or fused. 115 and 116 are insulating rings and 117 is an insulating and clamping ring which is clamped by means of screwing means not shown. 118 is a cooling channel into which the cooling medium is introduced.

The lead-in conductors hereinbefore described are suitable for direct current as well as for alternating current such as multi-phase currents, for instance three phase currents.

The form of construction illustrated in Fig. 2 includes the characteristic that the metallic screening sleeve 31 is constructed as a hollow body capable of being cooled, to which the cooling medium is supplied through the pipe 32 and discharged through the pipe 33. 34 is an insulating member and 35 is the clamping ring of insulating material, while 36 is a packing ring.

The feature of the construction shown in Fig. 3 is that the metallic screening sleeve surrounding the conductor 3 consists of a cooling coil 37 having a supply pipe 38 and a discharge pipe 39, which are introduced in an airtight manner through the bottom 2 of the vessel into the vacuum furnace.

Referring to the form of construction illustrated in Fig. 4, the metallic wall of the vacuum chamber is shown at 2 into which the conductor 3 is introduced through a hole in the wall. The conductor is hollow and cooled by a cooling medium, such as water, oil or air. The cooling medium is introduced through the pipe 4 and is discharged through the pipe 5. The conductor 3 is surrounded by a plurality, for instance four,

cylindrical metal sleeves 6a, 6b, 6c and 6d which are provided at one end with a flange, while at the other end they project into the chamber of the furnace to such an extent that no discharges or metal particles can extend from the space with the furnace through the narrow annular spaces between the conductor 3 and the sleeve 6a, as well as between the other sleeves to the insulation and packings which are arranged outside the vacuum chamber. The insulating rings for the sleeves are shown at 7a, 7b, 7c and 7d. The flange 10 of the conductor 3 is firmly clamped by means of a ring 11 of insulating material and screws 12. Current is supplied to the conductor 3 by the lead 14. Resistors 59, 60, 61 and 62 and condensers are provided for regulating the voltage on the screening sleeves. By means of the lead-in conductor hereinbefore described voltages up to 10,000 volts can be applied without destroying the insulation, even in the case of high temperatures in the vacuum furnace.

What we claim is:

1. In an electric vacuum annealing and melting furnace, a sealed separable metal casing adapted to support a gas discharge therein, said casing having an opening in the wall thereof, a hollow coolable conductor extending into the casing through said opening, a flange carried by the outer end of said conductor, metal screening means surrounding the conductor and spaced therefrom at such a small distance as to prevent the gas discharge from extending outside said casing through said space, an insulating member arranged between said flange and the outer surface of the casing, said insulating member having a groove therein forming a continuation of the space between the conductor and the screening means.

2. In an electric vacuum annealing and melting furnace, a sealed separable metal casing adapted to support a gas discharge therein, said casing having an opening in the wall thereof, a hollow coolable conductor extending into the

casing through said opening, a flange carried by the outer end of said conductor, a metal screening sleeve extending into the casing through said opening and surrounding the conductor and spaced therefrom and spaced from the casing within the opening at such small distances as to prevent the gas discharge from extending outside said casing through said spaces, a flange carried by the outer end of said sleeve, an insulating member arranged between said flanges, and an insulating member arranged between said casing and the flange carried by the sleeve.

3. In an electric vacuum annealing and melting furnace, a sealed separable metal casing adapted to support a gas discharge therein, said casing having an opening in the wall thereof, a hollow coolable conductor extending into the casing through said opening and spaced from the casing within the opening, a hollow metal coil with the convolutions thereof engaging adjacent turns of the coil surrounding the conductor and spaced therefrom to provide a continuation of the space between the conductor and the space within the opening, the ends of said coil extending outside said casing for permitting a cooling medium to be moved through the coil, and means arranged outside the casing for insulating and sealing the conductor with respect to the casing.

4. In an electric vacuum annealing and melting furnace, a sealed separable metal casing adapted to support a gas discharge therein, said casing having an opening in the wall thereof, a hollow coolable conductor extending into the casing through said opening, a flange carried by the outer end of said conductor, metal screening means surrounding the conductor and spaced therefrom at such a small distance as to prevent the gas discharge from extending outside said casing through said space, and an insulating member arranged between said flange and the outer surface of the casing.

BERNHARD BERGHAUS.
WILHELM BURKHARDT.