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BY A. P. C.

B. BERGHAUS ET AL

PROCESS FOR HEATING SOLID, LIQUID OR GASEOUS BODIES

Filed Sept. 28, 1938

Serial No. 232,236

2 Sheets-Sheet 1

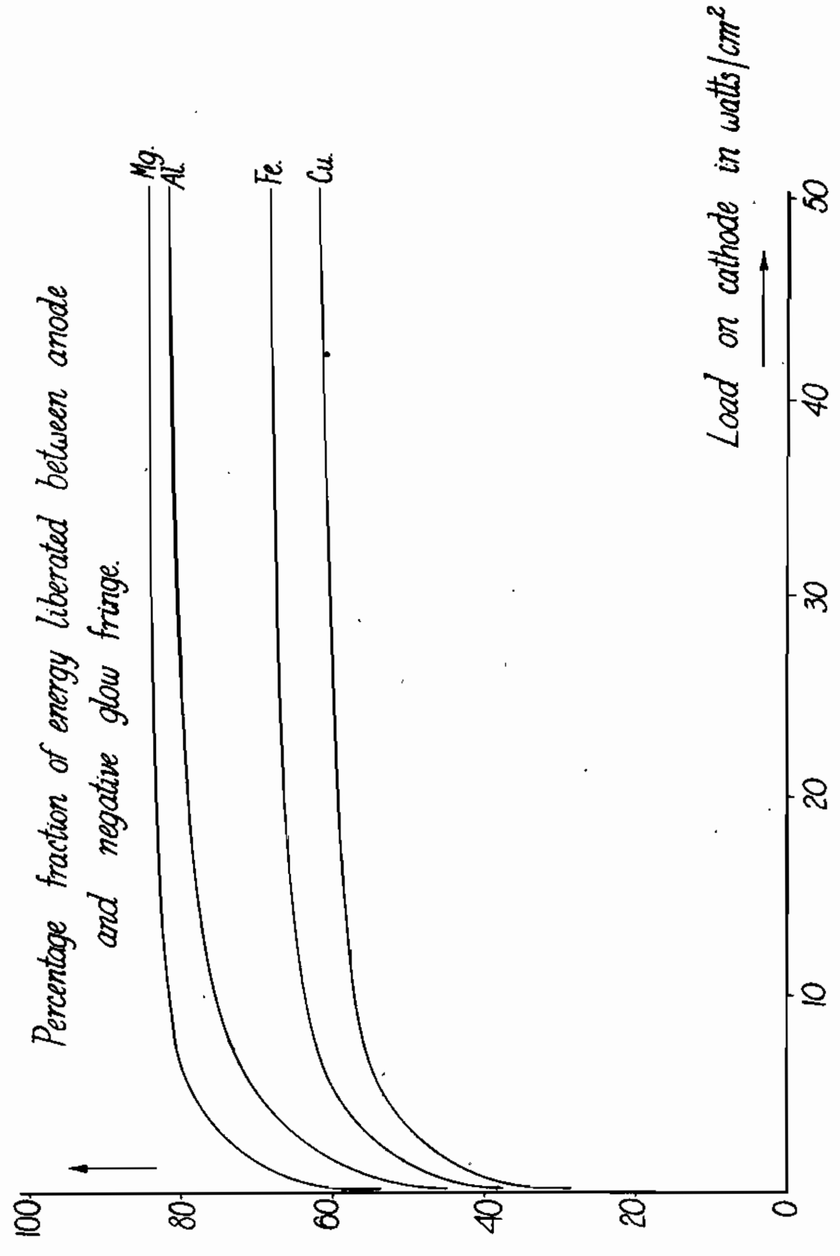

Fig. 1

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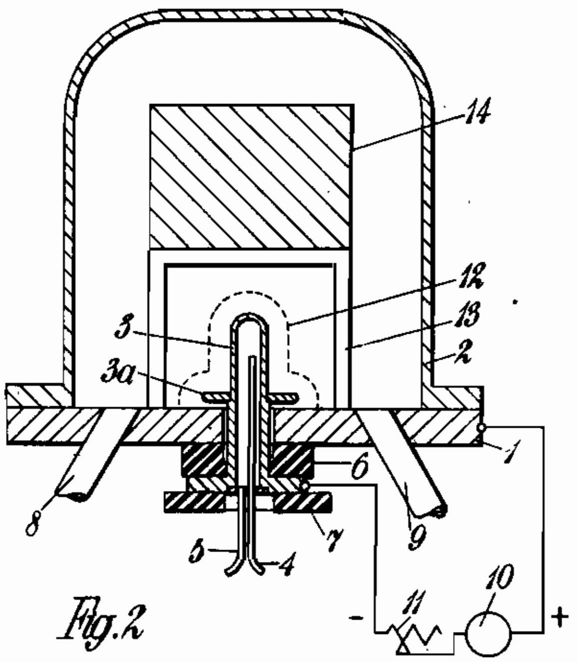

Fig.2

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ALIEN PROPERTY CUSTODIAN

PROCESS FOR HEATING SOLID, LIQUID OR GASEOUS BODIES

Bernhard Berghaus, Berlin-Lankwitz, and Wilhelm Burkhardt, Berlin-Grunewald, Germany; vested in the Alien Property Custodian

Application filed September 28, 1938

Electric energy is used for heating purposes in various ways. It is for example known in vacuum ovens to convert into heat electric energy in the form of ion bombardment on articles which for the most part are metallic. In this case the articles must be in electrically or thermally conducting connection with the cathode of the gas discharge. The portion of the current which is formed by the ions is available for the heating up and the converted energy on the cathode is a function of the voltage of the cathode drop and the ion stream. It has been found that the energy conversion takes place completely at the cathode if the "heating voltage" (termed in the German language "Brennspannung") of the gas discharge is equal to the cathode drop. If higher voltages than the cathode drop are applied as "heating voltage" to the discharge path then already a part of the energy, and in fact that derived from the total current and the voltage difference between cathode drop and "heating voltage", is converted into heat in the gas space, which heat is lost for the heating of the cathode. The efficiency of the cathodic heating consequently becomes worse with increasing output of the gas discharge and for certain cathode materials, as experiments have shown, becomes even very unfavourable.

The present invention relates to a process for heating solid, liquid or gaseous bodies which is characterised by the feature that the solid, liquid or gaseous bodies are heated in the space between the glow fringe and the anode of a glow discharge in which the energy supplied exceeds the product of normal cathode drop and normal current strength. The pressure of the gas is preferably adjusted to between 0.05 to 10 mm. of mercury. The "heating voltage" on the discharge path is chosen higher than the cathode drop. In practical operation voltages exceeding 7000 volts have been found not to be necessary. The current load of the cathode material is chosen higher than that which corresponds to the normal cathode drop. As cathode material preferably copper, iron, aluminium, elektron, or a light metal alloy is used. The electrode is introduced into the vacuum vessel insulated, cooled and screened. The cooling is necessary, for on the one hand the insulation material is to be protected from heat, and on the other hand because higher powers can be applied than those which would result in the fusion of the cathode material without cooling. The screening off of the cathode is effected according to use in such a way that between the two electrodes a gap is left which is smaller than the glow fringe forming about the cathode. For example, according to the pressure adjusted and the nature of the filling gas as well as of the applied voltage, distances of 5 to 0.1 mm. have proved to be suitable. It has been found to be particularly advantageous to make the space ring shaped. The length of the space is so chosen that charge carriers or particles disintegrated off the cathode can no longer reach the insulation material arranged as continuation of the gap. This requirement has been fulfilled particularly by means of a gap of labyrinth form, which prevents the direct path of the charge carriers or particles disintegrated off to the insulating material. The insulator is preferably arranged outside the vacuum vessel and the introduced electrode, which may be anode, if the vessel is cathode, and vice versa. If the vessel is connected to no voltage pole then it charges itself up almost to anode potential, as a result of which the same screening off is obtained with respect to the introduced electrode. The length of the necessary screening gap can be produced by placing metallic or non-metallic sleeves on. The screened-off lead-through element however may also be constructed as holder and current lead in for a cathode or anode of any shape or form. Also several screening-off sleeves with differently applied potential may insulatingly surround the electrode or current lead in. In this way either higher voltages or higher pressures may be adjusted in the discharge chamber with operative certainty. In order to raise the tension strength the current lead in may also be surrounded in addition by an insulator, e. g. glass, quartz, porcelain, and so forth, which is surrounded at the described distance by the metallic screening. As cathode for the heating of the vacuum chamber the insulated introduced electrode may be used with a metallic vacuum vessel as anode or with a separate anode. A metallic vacuum vessel may also be used as cathode and the insulated introduced electrode as anode. The applied voltages may be direct voltages or alternating voltages of various frequencies. If the electrode surfaces are favourably chosen (small anode in opposition to a large cathode) a rectifying effect can be produced at the same time when using alternating voltage.

Experiments have shown that the distribution of output between the energy liberated at the cathode and that of the gas space becomes greater and greater the higher the total energy of the discharge path is chosen. In order to make this output rise on the cathode possible it is necessary to protect the insulating material from ion bombardment and metal which is disintegrated off, as well as from heat, since otherwise it will no longer stand up to the high specific outputs. For the introduced cathodes protected thus, which permit of an energy increase up to 100 watts per square centimetre and more with operative certainty, it was found, as is apparent from Figure 1 of the accompanying drawings, that with increasing load per square centimetre a very great portion of the output was in the gas space; that is to say the higher the gas discharge output is chosen, the more energy from the total output is liberated in the gas space. Moreover, as is apparent from the curves, there is also a considerable difference in the division of this energy for different materials. Thus it is apparent for example that for magnesium or a light metal alloy such as elektron, as cathode material the fraction for the gas space is particularly favourable. From this it can be inferred that the output division for the gas space is always better the more powerfully the cathode material is able to emit electrons. This was confirmed when oxidised light metals were used as cathode. Since light metals are particularly sensitive towards oxygen the output division in the case of some oxygen gas addition to the filling gas was substantially improved in favour of the gas space by the resulting oxidising effect. The heat liberated in the vacuum oven may be used for chemical, physical, and metallurgical purposes, thus for example for heating gases, vapours and liquids for chemical reactions or for heating articles in vacuum for the purpose of drying or degassing, or for annealing and melting metals or other substances.

In the accompanying drawing the invention is shown schematically in some detail with reference to one constructional example, Figure 2 showing a section through an apparatus for carrying out the process described.

The apparatus consists of a lower part 1 and a hood-shaped upper part 2. In the lower part the cathode 3 is insulated and is arranged screened by a narrow labyrinth-like gap. The cathode, carrying a screen 3*a*, is constructed as a hollow body and through the lead 4 a cooling medium may be supplied and led off through the connection 5. The part 6 is an insulating ring and the part 7 is an insulating and pressing-on ring. The vessel may be evacuated through the pipe connection 8 by means of a vacuum pump (which is not shown) to the desired pressure lying about between 10 mm. to 0.1 mm. of mercury. Through the pipe connection 9 a filling gas may be supplied by way of a regulating valve. The current source 10 of preferably 500 to 7000 volt tension has its negative pole connected with the cathode 3 by way of a regulating resistance 11, the positive pole being connected with the wall of the vessel. The dash line represents the limit of the negative glow, whilst for example the body 14 to be treated rests on an insulating frame 13.

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