

May 29, 1973

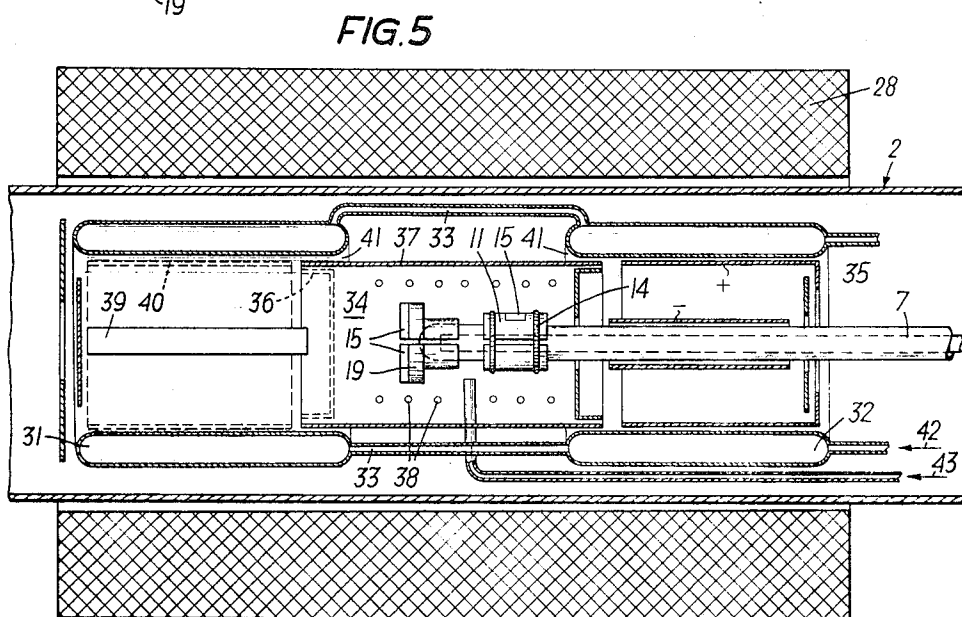
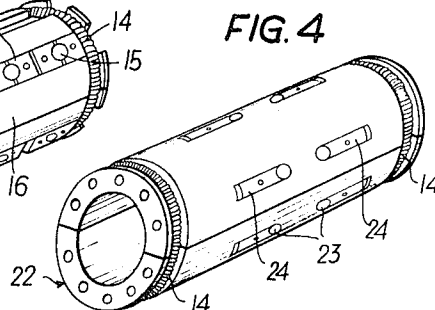
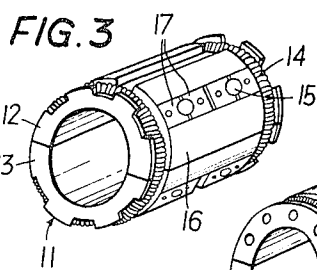
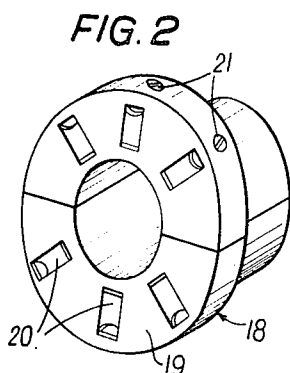
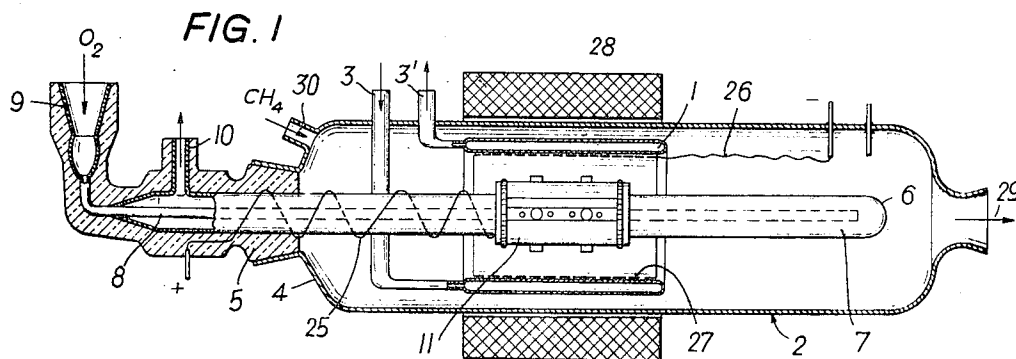
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3,736,246

APPARATUS FOR THE PREPARATION AND TREATMENT OF THIN LAYERS

Filed Nov. 4, 1971

2 Sheets-Sheet 1



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FIG. 6

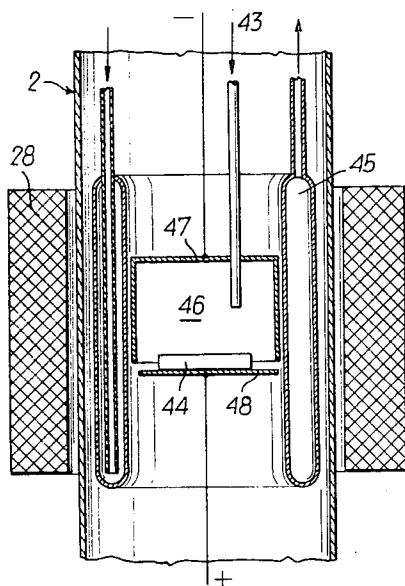


FIG. 7

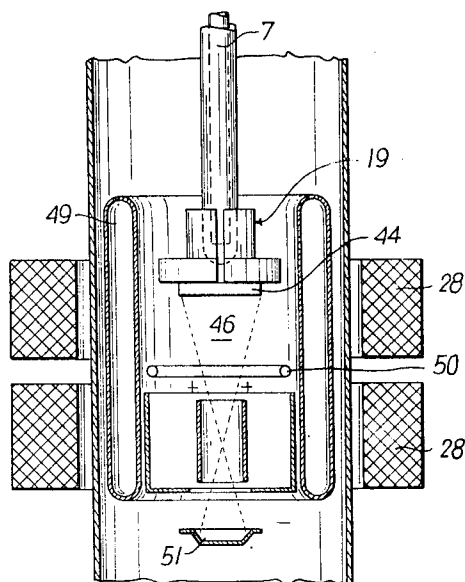
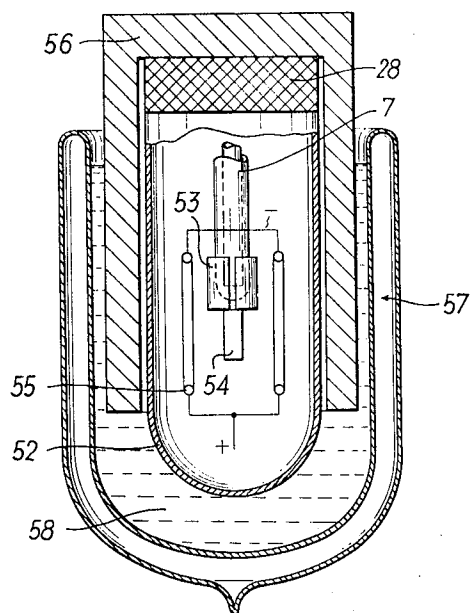


FIG. 8



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3,736,246

APPARATUS FOR THE PREPARATION AND TREATMENT OF THIN LAYERS

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Continuation-in-part of application Ser. No. 778,908, Oct. 25, 1968, which is a continuation-in-part of application Ser. No. 481,556, Aug. 23, 1965, both now abandoned. This application Nov. 4, 1971, Ser. No. 195,792

Claims priority, application Austria, Aug. 25, 1964, 7,362/64

Int. Cl. C23c 15/00; B01k 1/00

U.S. Cl. 204—298

7 Claims

ABSTRACT OF THE DISCLOSURE

A device for the production and treatment of thin layers on objects by means of electric gas discharges within an evacuable container comprising a coolable or heatable coaxial carrier tube mounted within a cooled double-walled hollow cylinder, an object carrier arranged slidable and fixable on said carrier tube, means for maintaining an electric gas discharge, means for the production of a magnetic field within the container and means to induce treatment and cooling media into the container.

This application is a continuation in part of application Ser. No. 778,908, filed Oct. 25, 1968, and now abandoned, which in turn is a continuation in part of application Ser. No. 481,556, filed Aug. 23, 1965, now abandoned.

The invention relates to a device for the production and treatment of thin layers on articles by means of electric gas discharges at low pressures. It is the purpose of this device to permit not only the application of coatings to a supporting element but also the reduction of the thickness of existing layers to the required level.

The provision of thin layers is of paramount and ever increasing importance in many scientific and engineering fields, particularly for the treatment of microscopic and ultramicroscopic preparations. For example, thin layers are required for the coating of optical systems, for the manufacture of high-ohmic resistors, interference filters and micro circuits. Another example is the metallization of nonconductors for the purpose of obtaining electrically conductive surfaces. It is frequently also necessary to apply thin layers of a specific thickness and particular properties to wires.

With known devices of this kind, thin layers or coatings can be produced by vaporization in a high vacuum. Other conventional apparatuses are used for the production of layers by means of resistance heating, cathode sputtering or by electrolytic deposition of the layer-forming material on the supporting element to be coated. In connection with other devices, electron impact vaporization is resorted to for the production of thin layers.

The properties of layers produced in conventional devices depend to a large extent upon the process used on the one hand, and upon generally complex operating conditions which are difficult to control. Consequently, the production of high-grade layers of great purity, uniform quality and thickness by means of conventional apparatus is beset with considerable difficulties and the cost of the necessary equipment is generally well above the economically bearable level.

Deposition of layer-forming materials from the gas phase under the action of electric discharges is resorted to in exceptional cases only, although in recent years use has been made of the possibility of carrying out gas discharges at low pressures. Ordinary electric discharges (glow-discharges) up to a pressure range of approximately 10^{-3} torr seldom produce layers of the same high

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quality as is obtainable by vaporization in high vacuum at pressures varying from 10^{-4} to 10^{-6} torr.

In general, pure or defined layers are desired. These can be attained more readily where contamination from the residual gas atmosphere is reduced by an appropriate improvement of the vacuum. For high-vacuum deposition, equipment for working pressures varying from 10^{-5} to 10^{-7} torr is available nowadays at reasonable cost. For still lower pressures, the expense involved increases considerably so as to be warrantable in exceptional instances only.

Where depositions are made from the gas phase by means of electron radiation or by resorting to Penning-type discharges (where electrons produced between the cathode and the anode are subject to the action of a magnetic field for the purpose of extending the path of the electrons and increasing the impact rate) operated practically at any low pressure as required, it is not sufficient for pressure to be reduced in conventional vacuum plants, since residual gases (including objectionable, complex and varying emissions of gas by the container, attachments, sealing means, as well as back diffusion from pumps) are obviously also ionized and thus co-operate increasingly at the formation of layers.

If, however, any of the conventional apparatus is used for this purpose, which have been designed to meet the requirements of modern ultrahigh vacuum techniques (including the use of special materials and sealing means as well as the heatability of the high-vacuum sector), the advantages to be derived from discharge depositions are lost and the cost increases as compared with high-vacuum vaporization.

Another drawback of the Penning discharge as used in conjunction with conventional equipment is the fact that the articles are subject to high loads when, as generally required, deposition is to be made on the anode, with the cooling of the article leading to increased deposition of impurities from the gas phase.

It is the purpose of the invention to provide an improved device for the production and treatment of thin layers on articles by means of electric gas discharges at low pressure in such a manner as to avoid the shortcomings of conventional apparatuses, as hereabove described.

According to another feature of the invention the device permits the cost-saving production of thin layers of exactly specified properties by the deposition of one or several components (pure elements, compounds, mixed and alternating layers) from the gas phase.

Finally, the device according to the invention serves to produce layers of particular purity and of a homogeneous quality, with layer formation to be made possible also on sensitive carriers. A further object of the invention is the provision of a device of the type hereabove described, of simple design, easy operation and featuring ready interchangeability of the articles to be treated.

According to the invention, such a device comprises an evacuable container with inlets and outlets for the various agents enclosing a double-walled hollow cylinder containing a cooling medium, a treatment chamber defined by the inner walls of the said hollow cylinder, a carrier tube arranged in coaxial relation to the hollow cylinder with inlets and outlets for the cooling and/or heating media, at least one object carrier operated as an anode, slidably mounted on the carrier tube and attached thereto by means of an elastic clamping means, a cathode located in the treatment chamber and a magnet coil surrounding the said container for the production of a D.C. or A.C. magnetic field. With such a device the treatment chamber inside which the layer-forming material is deposited from the gas phase or wherein the discharge burns, is subject to particular conditions permitting the application of a variety of layers also on temperature-sensitive carriers and

carriers with a high vapor pressure. By means of the design of the device according to the invention it is possible to eliminate all residual gases from the discharge chamber which are liable to ionization during the discharge and likely to produce undefined conditions during the application and/or removal of layers.

The attachments installed in the container for cooling purposes can be used for reducing the temperatures of such articles as are sensitive to heat or subject to high vapor pressures to a very low level without the deposition of objectionable precipitates from the residual gases of the vacuum chamber. On the other hand, it is possible, according to the invention, to have the article heated occasionally if and when required, and/or to increase the temperature in the chamber surrounding the object when and as required if the object to which the thin layer is to be applied, is heat-resisting.

For example, pure carbon layers can be obtained from hydrocarbons by means of the device according to the invention, as well as from silicon or silicon dioxide layers, depending on whether oxygen is eliminated or not. With conventional equipment it had not been possible to obtain silicon layers by discharges. Furthermore, it is possible to produce from gas mixtures or appropriate compounds solid deposits of mixed layers and compounds.

With the device according to the invention it is also possible to produce pure layers consisting of elements, of compounds, or of mixtures of elements or mixtures of compounds, as well as mixtures of elements and compounds, by anode sputtering depending on the type of cathode and the gas used for sputtering. In addition to these possibilities of producing thin layers by deposition from gases by cathode sputtering it is also possible to obtain thin layers by the process of additionally thinning thin laminae or deep-frozen preparations (of a biological nature, for example) both by chemical removal by means of activated gases and by cathode sputtering.

The shortcomings of cathode sputtering in conjunction with normal glow discharges result from the high gas pressure and the large proportion of objectionable admixtures in the residual gas. In addition to the heating of the cathode, heavy granulation also occurs, leading to a reduction of the sputtering rate and producing a preparation full of fissures, if cathode sputtering is to be resorted to for the purpose of reducing the thickness of a layer. However, cooling of the preparation makes sense only where, as with the device according to the invention, the environment is deep-frozen. If the Penning discharge process is employed, it is possible, to operate at low pressures while avoiding the production of impurities. The arrangement according to the invention finally permits uniform removal of the cathode if in addition to a convenient electrode arrangement, an alternating magnetic field is used. The magnetic field, the cooling chamber and the electrodes all have double functions. On the one hand, they permit discharges at low pressures, thereby ensuring uniform layer deposition and removal. For layer deposition, the object carrier in the center is operated as a cathode. For microscopic structure tests where the first etching and impression are preferably carried out without interrupting the vacuum, the object carrier is alternately operated as a cathode or as an anode.

According to a preferred embodiment of the invention, the hollow cylinder is divided into two sections in coaxial relation to each other and interconnected by means of lead wires, the treatment chamber proper extending in the area between the two sections of the hollow cylinder. As a result, precipitation of the gases introduced directly from the gas phase into the working chamber for the purpose of depositing the layer, is avoided, since this would lead to increased gas consumption.

According to an embodiment of the invention, the hollow cylinder can be provided with a coolant feed pipe and a coolant return pipe, but according to yet another

embodiment of the invention it is also possible to design the hollow cylinder as a Dewar vessel.

According to another feature of the invention, baffle sheets are provided in transverse relation to the axis of the hollow cylinder for the purpose of directing diffusing gases to the cooling surfaces.

For particularly convenient operation of the device according to the invention, the object carrier is a hollow cylindrical body comprising two segments symmetrical in relation to a longitudinal central plane of the hollow cylindrical body, with holders for the objects to be treated mounted on its outer surface, closed helical springs encompassing the hollow cylindrical body along its periphery. This design greatly facilitates the insertion and removal of objects and provides an extremely simple attachment of the object carrier to the coolable and/or heatable carrier tube, by simply sliding the object carrier on to the carrier tube and pressing the two segments of the object carrier upon the carrier tube by means of the helical springs, thereby facilitating heat exchange between the carrier tube and the object carrier. As a result, both the object carrier and the preparations attached thereto will readily assume the treatment temperature desired.

However, it is also possible to design the object carrier as a stepped-down hollow-cylindrical body comprising two segments symmetrical in relation to a longitudinal central plane of the body and provided at one extremity with an annular flange on the outer front face of which holders for the objects to be treated are mounted. All of these object carriers are preferably made from heatable materials of high thermal conductivity.

Further details of the device according to the invention will become apparent from the following description of several embodiments of the invention with reference to the accompanying drawings, wherein

FIG. 1 shows one variant of the device according to the invention,

FIGS. 2, 3 and 4 each represent an object carrier for the device according to the invention, and

FIGS. 5 through 8 each show a variant of the device, for the production and treatment of thin layers according to the invention.

The device illustrated in FIG. 1 comprises an evacuable tubular container 2, made of glass, for example, inside which a double-walled hollow cylinder 1 is arranged in coaxial relation to the longitudinal axis of the container. The said hollow cylinder can be supplied with a coolant, such as liquid nitrogen, through a pipe 3 extending through the shell of the container. The cooling medium is recirculated from the hollow cylinder 1 through a pipe 3' also extending through the shell of the container 2. It is possible to replace the hollow cylinder 1 by a tubular spiral additionally provided with close-fitting thin sheets made of material of high thermal conductivity.

The container 2 is closed at one end 4 by means of a plug 5 of insulating material, into which a tube 7 closed at its free extremity 6 is inserted in such a manner as to protrude axially into the container 2 and extending over almost its entire length. Into the tube 7 an insert pipe 8 protrudes, through which a cooling medium can be admitted to the interior of tube 7. In special instances it is also possible to use the insert pipe 8 for the heating of tube 7.

For that purpose, the plug 5 is provided with pipe connections 9 and/or 10 communicating with the interior of the pipe 8 or tube 7, respectively. Other potential heating means are a resistance heating system, an incorporated heating coil or an air heater. If made of glass, the cooling cylinder 1 and/or the tube 7 can be provided with a heating winding which for deep-freezing may be left in the cooling medium. The temperature range from minus 200° centigrade up to a few hundred degrees centigrade, generally applicable for tests by means of an electron microscope, is easily controllable. The centralized

arrangement permits cooling of the preparation to be treated down to the temperature of the surrounding cooled cylinder 1 without contamination.

A longitudinally slidable object carrier 11 is provided on the tube 7. As shown in FIG. 3, this object carrier comprises two semi-annular segments 12 and 13. Two closed annular volute springs 14 encompass the object carrier 11 close to its extremities and press the insides of its two segments 12 and 13 against the outer surface of tube 7. Thus the object carrier 11 is attached to the tube 7 on the one hand, and positive thermal contact between the tube 7 and the object carrier 11 made of some material of high thermal conductivity is assured on the other hand.

Experience has shown cooling of the tube 7, if it covers the entire length of the cylinder, alone to suffice for keeping the center of the container 2, that is, the working space of the device, free from hydrocarbons and water vapors. In order to obtain appropriate temperatures depending on the kind of work or test to be performed, independently for the preparation 15 mounted on the object carrier 11, and to avoid contamination during the insertion, it is advisable to have the hollow cylinder 1 deep-frozen.

The preparations 15 can be either clamped to the outer surface 16 of the object carrier 11 by means of holders 17 as illustrated in particular, in FIG. 3, or, as appears from FIG. 2, they can be attached to the front end of a stepped-down hollow-cylindrical object carrier 18, also comprising two segments and having at one extremity a flange 19 with radial recesses 20. In these excesses 20, holders for the various objects are provided, which can be attached to the object holder by means of countersunk radial clamping screws 21.

FIG. 4 shows another variant of the object carrier, designated by reference number 22, where the preparation 23, attached to the outer surface of the object carrier 22 are fixed by means of clamping jaws 24.

Both the preparations 15 and/or 23 proper and their means of attachment should not be freely exposed anywhere on their surface. For that reason, the clamping screws 21 are of the countersunk type. Likewise, preparations used in electron microscopy should be mounted on the object carrier in a countersunk manner.

Where a layer is to be formed from the gas phase, as illustrated in FIG. 1, the object carrier 11 is operated as an anode via a connecting line 25 emerging from the container 2, and surrounded by a grid 27 operated as a cathode via a connecting line 26. If a layer is to be formed by means of the cathode sputtering method, the operation is inverted. The grid cathode 27 directly adjoins the inner surface of the cooling cylinder 1. Even where as different from this variant, a grid cathode of a smaller diameter is used, it is advisable to provide an interchangeable sheet adjoining the cooling cylinder 1, so as to keep the walls of the cooling cylinder always clean.

The container 2 is surrounded by a coil 28 for the production of a magnetic D.C. or A.C. field in the area of the object carrier 11 and its environment.

On the side opposite the plug 5, the container 2 has an aperture 29 for the connection of a vacuum pump (not shown), by means of which, the container 2 can be subjected to such low pressures as is required for the treatment. The gas used for deposition from the gas phase is admitted to the container 2 through a pipe connection 30 provided at the front end 4 of the said container.

For the production of a thin layer on the preparations 15, these are mounted on the object carrier 11 which is then slid on the tube 7 and connected to the connecting line 25. The tube 7 together with the object carrier 11 is inserted in the container 2, with the plug 5 tightly closing the aperture provided at the front end 4. After the gas feed pipe (not shown) has been connected to the pipe connection 30, and the coolant pipes 3, 3' to a cooling system, the container 2 is evacuated by means of a vacuum

pump connected to the aperture 29 until such time, when the required underpressure prevails.

Depending on the type of preparation to be treated, a cooling or heating medium is introduced through the pipe connections 9 and 10 into the interior of tube 7. By the connection of the coil 28 a magnetic D.C. or A.C. field is produced in the working space of the container 2 and an electric discharge is induced between the anode formed by the object carrier 11 and the grid cathode 27. On the anode, the layer material deposited from the gas phase is precipitated in such a manner that a pure, homogeneous layer is formed on the surface of the preparations 15.

The process is terminated as soon as the layer on the preparations 15 presents the required thickness. If the preparations are to be coated with a plurality of layers of different compositions, the process hereabove described is repeated with the appropriate feed stock.

In order to ensure the production of faultless layers, the ratio between the length and the diameter of the container 2 should be chosen in such a manner that the gas molecules are made to impinge repeatedly prior to reaching the center of the working space. The larger the diameter, the greater should be the length of the chamber. In order to avoid the need for an excessive length of the cylinder 1, it is possible to insert baffle sheets directing the gas particles towards the cooled surfaces of the device.

In this way it is possible for the majority of water vapors and hydrocarbons contained in all vacuum apparatuses to be eliminated from the reaction chamber proper. Gases of difficult condensation, such as oxygen, nitrogen or methane, can be eliminated in a very simple manner, except where helium is used as a cooling medium, provided the discharge itself is made to produce a barrier. The middle portion of the cylinder is closed against carrier losses as a working chamber of approximately one third of the entire length by means of grid-shaped electrodes perpendicular to the cylinder axis. These electrodes are negatively charged. The adjoining cylinder spaces are either operated collectively or separately as a Penning discharge. Such an arrangement is illustrated in FIG. 5. The container 2 comprises two double-walled cooling cylinder sections 31 and 32 interconnected by means of pipes 33. In between the working chamber 34 proper is located. The magnet coil either extends over the entire length of the cooling cylinders 31, 32 as shown in the drawing, or is made of two parts. The outer discharges are electrically operated in the same sense. On one side, baffle sheets 35 are provided. The inner working chamber 34 is defined by limiting electrode 36 and 37. Furthermore, a grid 38 is provided in the working chamber 34 to be used as an auxiliary electrode and surrounding the two object carriers 19 and 11 with the preparations 15. The two-piece object carrier 11 is positively pressed against the central carrier tube 7 by means of helical springs 14. The cathode is designated by reference number 39 and the anode by 40. The gaps between the double-walled cylinders 31 and 32 and the limiting electrode 37 are designated by reference number 41, the coolant feed pipe leading to the cylinders by 42, and the gas feed pipe leading to the working chamber by 43.

The cooling cylinder 31, 32 is of the split type because the gases introduced for the layer formation from the gas phase are liable to condense on the cooling walls and to cause an objectionably high amount of gas consumption. For that purpose, in the variant shown in FIG. 5, the working chamber 34 is defined by the thin cylindrical limiting electrode 34. This electrode protrudes only slightly into the two cylinders 31 and 32, leaving a narrow gap 41. This arrangement produces considerable thermal insulation in the vacuum. A similar effect is obtained by the provision of a sheet metal cylinder inserted in a through cooling cylinder without adjoining the same directly. The two-piece cooling cylinder 31, 32 offers the advantage of permitting its transformation into a closed cooling cylinder simply by providing an adjacent interme-

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diate metal sheet, leaving the central space, however, clear for the provision of inserts or feed pipes.

In spite of this arrangement, objectionable gases from the remaining vacuum are admitted to the working chamber 34 through the limiting cylinders only and are precipitated when the cylinder is cooled and a discharge is in progress. Already as a result of the considerable length of the free path of the gas particles the gap 41 has an arresting effect on the passage of gas. Therefore, a higher or lower working pressure can be maintained in the working chamber 34 than in the other portions of the apparatus, by the control of the gas admission directly to the working chamber and by limiting sheets which may be slidable and rotatable.

FIG. 6 illustrates yet another embodiment of the invention, particularly suitable for the treatment of solid specimen 44 of the type occurring in metallography, for example. In this case, no special holders for the specimen are provided and it is also possible to treat a plurality of specimen at the same time.

The container 2 of this device is also surrounded by a magnet coil 28. Inside the container a double-walled cylindrical cooling vessel 45 is provided, which surrounds the gas discharge chamber proper. Instead of this cooling vessel 45 a cooling coil could be used. Inside the cooling vessel 45 a pair of electrodes 47, 48 is provided. The electrode 48 operated as an anode is disk-shaped and carries the specimen 44. The electrode 47 operated as a cathode is in the shape of a bell which is open in the direction of the anode. Between the electrodes 47 and 48 a gas discharge can be ignited in the usual manner at an underpressure varying from approximately 10^{-2} torr up to several millimeters. If the magnet coil 28 is connected, the discharge can be maintained as far as the required low pressures in the magnetic field produced by the coil.

The devices required for the cooling of the specimen, if necessary, which have been omitted from FIG. 6 so as to provide greater clarity, can be of a similar design as the cooling tube assembly 7 shown in FIG. 5. Another cooling facility for the specimen, also not shown in the drawings, consists in a cooling vessel 45 which, similar to the type illustrated in FIG. 5, is composed of two pieces, a cooling bridge, such as a cooling bar, being inserted in the gap between the two pieces of the cooling vessel, the inner extremity of the said bar being in contact with the specimen carrier 44 formed by the anode.

Through the feed pipe 43 defined gases to be used for the performance of the gas discharge, are delivered in measured quantities to the discharge chamber 46 proper between the two electrodes 47 and 48. This produces a slightly higher pressure in the discharge chamber 46 than prevails in the other chambers of the container 2, so that objectionable gases or vapors, unless held clear of the cooled walls of the device, are pushed back by the reaction gas expanding in the vacuum.

According to the arrangement illustrated in FIG. 7 the container 2 is surrounded by two magnet coils 28 to be operated either collectively or individually, as the case may be. The preparation 44 and the treatment chamber 46 proper are again surrounded by a cylindrical cooling vessel 49 connected to a cooling system in a manner not shown in the drawing. The preparation 44 is mounted on a heatable or coolable specimen carrier 19 as shown in FIG. 2, fixed on a carrier tube 7 serving for the supply and recirculation of a cooling or heating medium. It is possible to arrange a plurality of preparations for simultaneous treatment on the carrier 19. This embodiment of the invention again offers the possibility of installing a heating coil remaining in the cooling medium in the tube 7.

In the device shown in FIG. 7, the preparation 44 can be treated by means of ions or electrons extracted from a Penning discharge to be ignited between the electrodes designated by "+" and "-" respectively.

By means of a discharge a neutral plasma is produced

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consisting of electrons and ions in equal proportions. Depending on the charge of the specimen carrier 19 and/or the suction electrode 50, it is possible to direct electrons or ions to the preparation 44 and to accelerate them as required. For cathode sputtering ions are used, whereas electrons are employed for the transformation of organic preparations by dehydration into a carbon structure which is morphologically equivalent.

For example, one of the two magnet coils 28 can be used as an electromagnetic lens, the focal length of which is determined by the amperage applied to the magnet coil 28.

The electrodes of the Penning discharge are designed in such a manner that although the electrons and ions are allowed to occur in the direction of the specimen 44 as far as they are attracted by appropriately choosing the potential of the electrode 50, yet losses from charge carriers in other directions are practically avoided. Besides, the shape of the electrodes is such as to make it possible to vaporize the preparation 44 through the free space in the area of the longitudinal center axis of the container 2, within the positive electrodes either simultaneously or at different times directly from the shuttle 51.

It is also possible to enlarge the device shown in FIG. 7 by the incorporation of additional electrodes (not shown) surrounding the preparation 44 in such a manner that the preparation can be treated by means of discharges as described in connection with FIGS. 1, 5 and 6.

In the embodiment of the invention shown in FIG. 8, the wall of the container 52 itself constitutes a coolable surface surrounding the preparation 54 mounted on a carrier 53. The temperature of the specimen carrier 53 can be regulated, for example, by the admission of a liquified gas into the tube 7 holding the carrier 53 or by having gases of different predetermined temperatures flow through the said tube.

The specimen 54 is surrounded by the anode 55 and located inside the field of a magnet 56 whose pole pieces surround the container 53. The magnet coil 28 of the magnet 56 is provided for the purpose of allowing the gas discharge as hereabove explained, to be operated as a Penning discharge.

The whole assembly is accommodated in a Dewar vessel 57 whose charge 58 consists of liquid nitrogen as a cooling medium, for example.

The apparatus shown in FIG. 8 will be used preferably in such instances where an object 54 is to be eroded from both sides simultaneously, as in that case the charged particles are allowed to act upon the specimen 54 from both sides at the same time. This method is used, for example, for purposes of electron microscopy.

As materials for the component parts of the apparatuses hereabove described and illustrated in the drawings, glass and stainless steel have shown to be particularly satisfactory. Commercial glasses nowadays permit heating up to several hundred degrees centigrade and resist sudden changes of temperature very well. The sealings of the conductors leading to the cooling chambers allow the passage of liquid nitrogen without any preliminary cooling.

By means of the device according to the invention it is therefore, possible to produce thin layers on carriers by the action of electron rays depending on the depth of their penetration. The alteration of organic substances by means of electron rays may be cited as an example. Electron rays are known to cause progressive conversion into carbon. The accelerating voltage applied should be such as to cause penetration of electrons, depending on the required thickness of the layers. For thin layers, the accelerating voltage varies between a few hundred up to a thousand volts.

However, where oxygen and hydrocarbons are available in such quantities as are common in conventional treatment equipment, either layers are eroded or polymers produced haphazard. For example, only with a device designed according to the invention is it possible to

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achieve conversion into carbon in such a manner as to maintain the original structure to a large extent as is required for purposes of electron microscopy. Superficial etching may be a first step in this direction although operating conditions must again be strictly defined.

A particularly important application of this invention consists in the continuous and absolutely uniform coating of wires with layers of specific materials in the required thickness without any material loss, which had formerly not been possible.

I claim:

1. A device for the production and treatment of thin layers on objects by means of electric gas discharges at low pressure, comprising an evacuable container, inlets and outlets for the treatment media on the said container, a double-walled hollow cylinder located in the said container and containing a cooling medium, a treatment chamber defined by the inner walls of the said hollow cylinder, a carrier tube installed in the said hollow cylinder in coaxial relation to same, inlets and outlets on the said carrier tube for the passage of cooling and heating media through the carrier tube, at least one specimen carrier operated as an anode and arranged on the said carrier tube in slidable connection with same, spring means on the said specimen carrier for the purpose of clamping the same to the said carrier tube, a cathode installed in the said treatment chamber, and a magnet coil surrounding the said container and producing a magnetic field in same.

2. A device according to claim 1, wherein the said hollow cylinder is divided into two conductively interconnected segments in coaxial relation to each other, the said treatment chamber extending in the area between the said two segments of the hollow cylinder.

3. A device according to claim 1, wherein at least one coolant feed pipe and one coolant recirculating pipe are provided on the said hollow cylinder.

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4. A device according to claim 1, wherein the said hollow cylinder is designed as a Dewar vessel.

5. A device according to claim 1, wherein baffle sheets are provided in transverse relation to the axis of the said hollow cylinder for the purpose of directing diffusing gases to the cooling surfaces.

6. A device according to claim 1, wherein a hollow cylindrical body defines the said specimen carrier and consists of two segments which are symmetrical in relation to a longitudinal central plane of the hollow cylindrical body, holders for the objects to be treated being provided on the outer surface of the said hollow cylindrical body, closed annular helical springs forming the said spring means and encompassing the said hollow cylindrical body along its circumference.

7. A device according to claim 1, comprising a stepped-down hollow cylindrical body defining the said specimen carrier and consisting of two segments which are symmetrical in relation to a longitudinal central plane of the said body, an annular flange at one extremity of the said body, holders for the objects to be treated mounted on the outer front end of the said annular flange.

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U.S. Cl. X.R.

204—164, 192