Jan. 3, 1956 P. PAWLYK 2,729,190

APPARATUS FOR PLATING THE INTERIOR OF HOLLOW OBJECTS

Filed Oct. 8, 1951 3 Sheets-Sheet 1

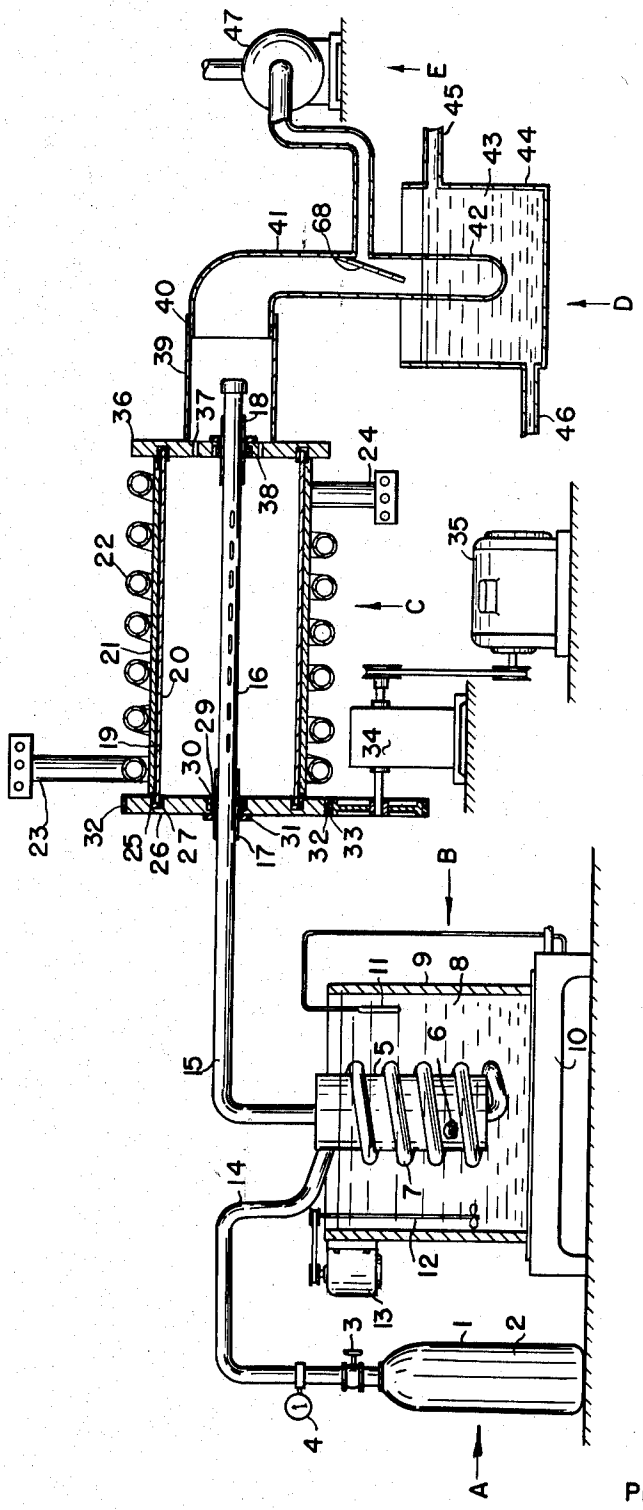


FIG-1

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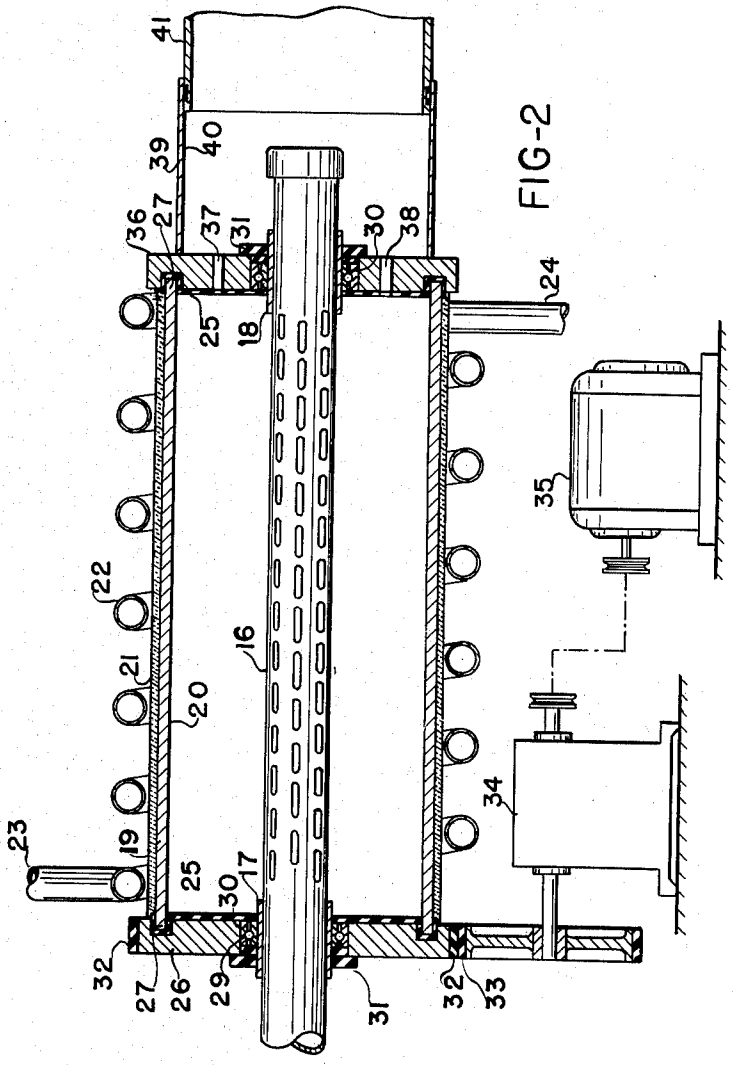


FIG-2

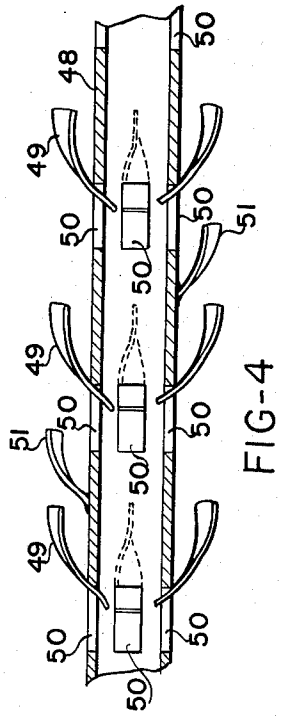


FIG-4

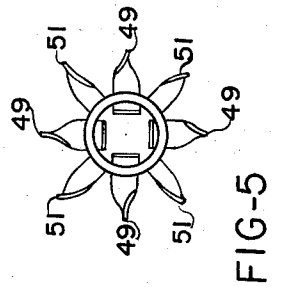


FIG-5

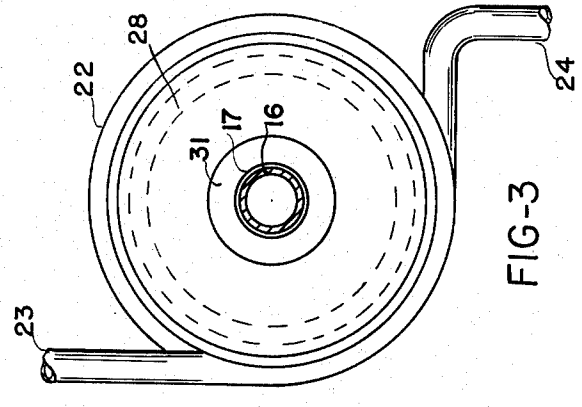


FIG-3

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Filed Oct. 8, 1951 3 Sheets-Sheet 3

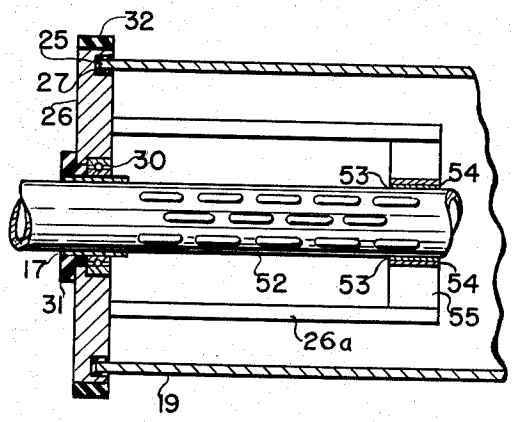


FIG-6

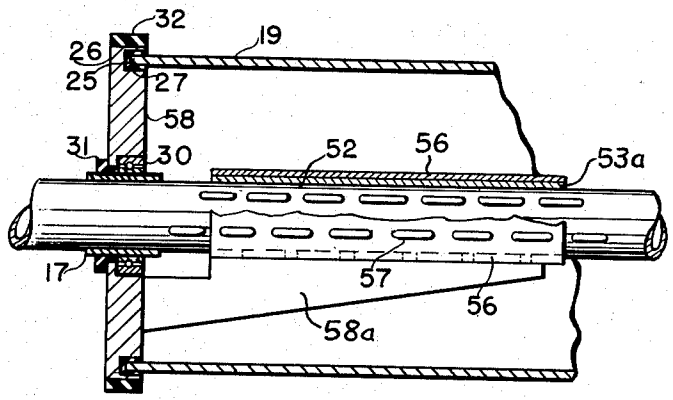


FIG-7

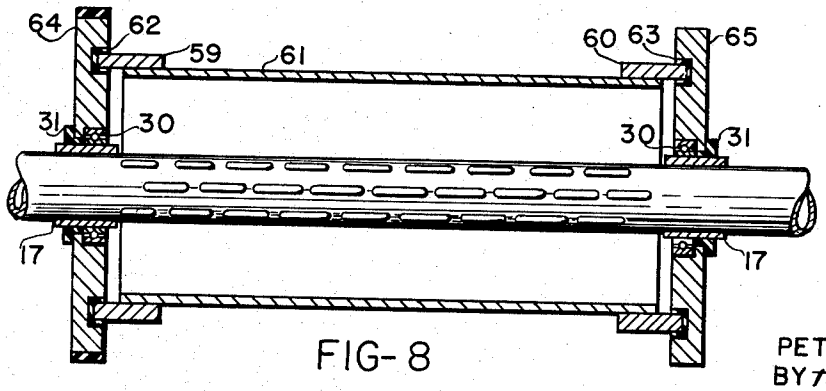


FIG-8

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APPARATUS FOR PLATING THE INTERIOR OF HOLLOW OBJECTS

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Application October 8, 1951, Serial No. 250,306

6 Claims. (Cl. 118—48)

This invention relates to apparatus and methods for the coating of metallic bases with metallic coats deposited from the vapor state by the thermal decomposition of metal-bearing gases. More particularly the invention relates to the uniform coating of the interior of hollow objects of tubular structure such as gun barrels and cylindrical bearing surfaces.

A primary object of the present invention is to provide improved apparatus whereby the interior plating of hollow objects may be uniformly achieved.

An important object of the present invention is to provide equipment for the plating of hollow objects on a mass production basis.

A principal object of the invention is to provide an improved method for the interior plating of hollow objects.

The invention comprises a gas plating system in which the object to be plated itself forms walls of the plating chamber, and which object is rotated about a slotted tube adapted to bear the volatilized metal-bearing compound to the object. Features of the system include means for the mounting of the hollow object about the slotted tube for the rotation of the object, means to direct the flow of the plating gases uniformly to the interior walls of the object, and means to provide for the uniformity of plating gas flow through the system.

The invention also includes the feature of ready interchangeability of plating objects which facilitates the use of mass production methods in the gas plating of hollow objects. Substantially all materials which decompose under the influence of heat are operable in the process of invention, the compounds containing chromium and nickel, e. g. nickel carbonyl being most suitable.

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

Figure 1 is a schematic representation of one embodiment of the apparatus of invention;

Figure 2 is an enlarged sectional view of the object to be plated including means illustrating the mounting thereof;

Figure 3 is a view of the left hand end of the structure shown in Figure 2;

Figure 4 is a view in section of a modification of the slotted tube of Figure 2;

Figure 5 is an end view of the structure of Figure 4;

Figure 6 illustrates a modified form of the invention particularly adapted for the plating of long hollow objects;

Figure 7 is a view of a modification of the structure of Figure 6; and

Figure 8 illustrates a method of mounting a hollow object to secure plating of the entire interior surface.

Referring to Figure 1 the apparatus is shown to comprise the following general components: a source A of inert carrier gas; a substantially constant temperature source B of metal-bearing gas; a plating chamber system C; a recovery system D; and a vacuum pump system E for controlling plating gas flow.

Source A may comprise a conventional cylinder 1 containing carbon dioxide 2 under pressure. The cylinder is provided with a valve 3 for the control of gaseous carbon dioxide flow therefrom and a gauge 4 for indicating the flow rate.

The source B of metal-bearing gas includes a shell 5 containing a solid powdered metal-bearing compound, chromium carbonyl 6. The shell 5 is surrounded by a hollow coil 7, and the coil and shell are submerged in oil 8 of tank 9, the whole assembly being adapted to be heated by electric heater 10 to a substantially constant temperature at which chromium carbonyl has a relatively high vapor pressure. To assure of adequate temperature control, the oil 8 contacts one element 11 of a thermostatic control which is suitably connected with heater 10 in the known manner for regulation of heat input to the system. To avoid localized heating, a stirrer 12 driven by motor 13 may be employed.

The coil 7 surrounding shell 5 is connected at one end through hollow tube 14 to the valve 3 and the other end thereof is secured in an opening in the lower portion of shell 5. The upper portion of shell 5 is provided with a second opening in which hollow insulated tubing 15 is secured.

Where coil 15 is of the same material as apertured tube 16 of plating chamber C, now to be described, the members 15 and 16 may be integral.

Plating chamber system C, as more clearly shown in Figure 2, comprises a hollow, apertured tube 16 of a ceramic material and has the opposing ends thereof on the outer circumference secured in gas tight relation to cylindrical metallic bearing members 17 and 18. Members 17 and 18 each extend along a sufficient length of the circumference of tube 16 to provide adequate support therefor.

Surrounding the gas carrying apertured tube 16 is a hollow object 19 in the form of an open ended hollow cylinder and which is to be plated on the interior wall 20. Cylinder 19 is provided on the outer circumference with a layer of heat insulating material, as asbestos, 21, on which there is superimposed a resistance heating coil 22 connected to electrical inlet and outlet 23 and 24, respectively.

The left hand end of cylinder 19 is provided with a ring gasket 25 which is secured in position by a novel flange member 26 recessed as at 27 for engaging the gasket and cylinder along area 28 (Figure 3). Flange 26 is provided with a central bore 29 into which extends a bearing 30 for rotating engagement with the cylindrical member 17 when the same is passed through bore 29. As the rate of rotation for member 19 will always be relatively slow, a satisfactory gas seal between the cylindrical shaped members 17 and 30 is established by providing a neoprene gasket 31 about the member 17 in tight fitting relation with the lateral outward portion of member 26.

The outer circumference 32 of member 26, as at 32, is provided with a surface of friction material, as for example, rubber bonded securely to the metal of the flange member, and this surface is engaged by a second friction member 33 driven through suitable reduction gearing 34 by a motor 35.

Flange 36 at the right end of cylinder 19 is constructed similarly to flange 26, and accordingly will not be described in detail. However flange 36 is not driven directly but is rotated with flange 26 and cylinder 19 by means of motor 35. This flange 36 also differs from flange 26 in that it is provided with a cylindrical member 39 having an internal bearing surface 40, the purpose of which will be described hereinafter; also flange 36 has openings as at 37 and 38 which serve as exhaust ports for the flow of waste gases to recovery system D through the member 39.

Recovery system D comprises an enlarged removable pipe line 41 having the inlet end engaging bearing surface 40 and the other end of which terminates in a trap 42 for the condensation of metal-bearing vapors. Line 41 may be force fitted into the system and a feature thereof is the ready removability for mass production purposes. The line 41 contains a baffle 68 for directing the flow of gases to a trap 42 which is surrounded by cooling water 43 contained in vessel 44 having inlet 46 and outlet 45 for the passage of the water.

The outlet end of trap 42 is secured to a vacuum pump 47. Pump 47 is not an essential requirement of the system where high flow rates may be obtained by pressure means in the earlier parts of the apparatus but is essential where it is desirable to maintain low pressures in the plating chamber.

In the operation of the apparatus of Figures 1, 2 and 3, the object 19 to be plated, after the customary cleaning of the interior surface with acid and alcohol or any convenient means, is first wound on the outer side with the layer 21 of asbestos. The heating coil is then slipped over the insulating material and the gasket 25 fitted over the object end. This assembly is then pressured onto flange 26 over the ceramic tube 16 each of which components are initially secured to the apparatus extending to the left of Figure 1. Flange 36 and gasket 25 are then pressured onto the right hand end of object 19 and the removable exhaust line section 41 is fitted into the bearing surface 40 of hollow cylindrical member 39 to connect the same with the permanently positioned apparatus extending to the right of Figure 1. This system is then swept clear of air by flushing as with carbon dioxide or other inert gas.

Where the carburetor contains, as in the present instance, chromium carbonyl, the temperature of the oil 8 in tank 9 is stabilized at approximately 240° F. and then valve 3 of tank 1 is opened to permit a measured flow of carbon dioxide through line 14 and coil 7 wherein it becomes heated to substantially the temperature of the oil; the heated carbon dioxide then passes into the carburetor 5.

The solid chromium carbonyl having been heated to approximately the temperature of the oil has thereby attained a relatively large vapor pressure, but without the application of external pressure to the vapors very little flow thereof takes place. The heated carbon dioxide gas driven by the pressure from cylinder 2 and expanding under the influence of the heat absorbed from oil 8 will sweep the carbonyl vapors with it to line 15 thus reducing or tending to reduce the carbonyl vapor pressure in the chamber, allowing more carbonyl to vaporize. Also since the carbon dioxide carrier gas is at substantially the same pressure as the carburetor, substantially no cooling of the chromium carbonyl will be effected by contact with the carrier gas.

The gases passing through insulated tubing 15 enter the chamber defined by hollow object 19 through the slots in the ceramic tube 16. The motor 35 which as noted is adapted to drive object 19 in rotation has meanwhile been started, and the entering carrier gases will be given a slight circular motion as they approach the wall 20. The resistance heater 22 having been brought up to a temperature of about 650° F. prior to entry of the plating gas has heated the wall 20 and upon contact of the gases with the wall the gases decompose depositing cromium thereon.

The uniformity of the chromium deposit is improved by rotation of the object 19 since the gases are more uniformly distributed within the object.

The waste gases from the thermal decomposition are drawn under the influence of pump 47 which was activated just prior to starting gas flow, to the pipe 41 and are passed to trap 42 wherein any chromium carbonyl, remaining undecomposed, is deposited, through the effect of cooling water 43 circulating about trap 42.

The waste gases of decomposition such as carbon monoxide then pass on to the pump and the atmosphere.

The object 19, if assumed to be approximately 1" in internal diameter, may be thus coated with a .001" of chromium in about 15 minutes, when utilizing a carbon dioxide flow rate at valve 3 of one liters per minute and an oil bath temperature of 240° F., the pressure within the object or plating chamber being maintained at about 12 pounds per square inch absolute.

Various modifications of portions of the structure of Figure 1, particularly relating to the structure of plating chamber system C, are set forth in Figures 4 to 9, inclusive. Thus in Figures 4 and 5 there is shown a slotted tube 48 provided with fins 49 extending therefrom adjacent slots or openings 50, other fins 51 being provided between the slots. The fins 49 serve to direct the flow of gases from the openings 50, while the fins 51 when used serve to prevent the formation of gas pockets at low gas flow rates. It will be apparent that fins 49 and 51 may be used together or individually as desired.

Figures 6 and 7 illustrate a modification of the slotted tube of Figure 1 which is particularly suitable in applications where the object to be plated is relatively long. Since the gas carrying tube of ceramic or other material must be substantially co-extensive with the object in order to provide for uniform deposition of metal the weight of the ceramic tube may cause a buckling along the length, resulting in short life of the equipment. The device of Figures 6 and 7 eliminates this difficulty by providing the slotted tube 52 with bearing surfaces 53 which contact in sliding engagement the bearing surface 54 of a member 55 in the form of a U having the arm carrying the surface 54 foreshortened. The circular member 55, having internal bearing surface 54, is coupled by arms 26*a* to the flange 26. Figure 7 shows a modification of Figure 6 in which a long cylindrical member 56 is secured to flange 58 (similar to flange 26) by a brace 58*a* to provide support for tube 52. The cylindrical member 56 and elongated bearing surface 53*a* are slotted as at 57 to prevent the formation of dead spots in the plating chamber. This support structure may of course also be provided on a flange similar to 36 of Figure 1 or supports may, where required, to be extended from both flanges.

It will be noted that in Figure 1 the ends of the object 19 are covered to a slight extent by the gaskets and flanges, thus preventing deposition of metal to the very end of the structure. The apparatus of Figure 8 overcomes this objection by providing cylindrical elements 59 and 60 which are secured over the object 61 at opposing ends. Attachment of gaskets 62 and 63 and flanges 64 and 65 is then made over elements 59 and 60 and the interior of the object may then be completely plated. Elements 59 and 60 must be heat conductive in order to insure that the wall portions of object 61 opposite the elements are completely heated.

This application is related to copending applications, Serial Nos. 250,301; 250,302; 250,303; 250,304; 250,305; and 250,307; all filed October 8, 1951, and all by the same inventor as the present application.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In apparatus for gas plating, the structure comprising opposed end flanges adapted to support a tubular object therebetween, said flanges being provided with bores, means to heat said object, a long multi-apertured tubular member having opposed ends extending through said bores, said flanges being rotatably supported on said tubular member, and a support extending from one

said flange toward the other, said support surrounding a portion of said tubular member and slidingly engaging the same along a portion of the length thereof, and means to rotate said hollow cylinder and flanges about said tubular member.

2. Apparatus for gas plating hollow objects comprising a fixed tubular member, a pair of flanges journalled for rotation on and about the axis of said tubular member in axially spaced relation, said tubular member having a multiplicity of apertures in its wall between said flanges, means carried by said flanges adjacent their peripheries for supporting between them a hollow object to be plated, means extending from at least one of said flanges toward the other providing support for the portion of said tubular member between said flanges, and heater means coaxial with said tubular member and encompassing an object to be plated when mounted between said flanges, means to conduct plating gases to said tubular member, and an exhaust port in one said flange to allow escape of products of decomposition of said gas from a chamber formed by said object and said flanges.

3. Apparatus for gas plating hollow objects comprising a fixed tubular member, a pair of flanges journalled for rotation on and about the axis of said tubular member in axial spaced relation, said tubular member having a multiplicity of apertures in its wall between said flanges, means carried by said flanges adjacent their peripheries for supporting between them a hollow object to be plated, there being a central bore in each said flange and elongated bearing means within each said bore and extending beyond said flanges to engage and support said tubular member, heater means coaxial with said tubular member and encompasing an object to be plated when mounted between said flanges, means to conduct plating gases to said tubular member and an exhaust port in one said flange to allow escape of products of decomposition of said gas from a chamber formed by said object and said flanges.

4. Apparatus for gas plating hollow objects comprising a pair of rotatably journalled axially spaced flanges, there being a central bore in each said flange, bearing means within said bores, a fixed multi-apertured tubular member extending between said flanges and through said bores, said apertures being between said flanges, a support extending from one said flange along said tubular member and slidingly engaging the same along a portion of its length between said flanges, an annular recess adjacent the periphery of said flanges and a ring gasket therein adapted to support a hollow object to be plated, heater means surrounding said tubular member coaxially thereof, said heater means encompassing an object to be plated when mounted between said flanges, and an exhaust port in one said flange to allow escape of products of decomposition of said gas from a chamber formed by said object and said flanges.

5. Apparatus for gas plating hollow objects comprising a fixed tubular member, a pair of flanges journalled for rotation on and about the axis of said tubular member in axial spaced relation, said tubular member having a multiplicity of apertures in its wall between said flanges, a cylindrical element carried by said flanges and adjacent the periphery of said flanges adapted to support a hollow object to be plated axially spaced from said flanges, there being a central bore in each said flange and elongated bearing means within each said bore and extending beyond said flanges to engage and support said tubular member, heater means coaxial with said tubular member and encompassing an object to be plated when mounted between said flanges, means to conduct plating gases to said tubular member and an exhaust port in one said flange to allow escape of products of decomposition of said gas from a chamber formed by said object, cylindrical element, and flanges.

6. The apparatus according to claim 5 in which a support extends from one said flange along said tubular member and slidingly engaging the same along a portion of its length between said flanges.

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