

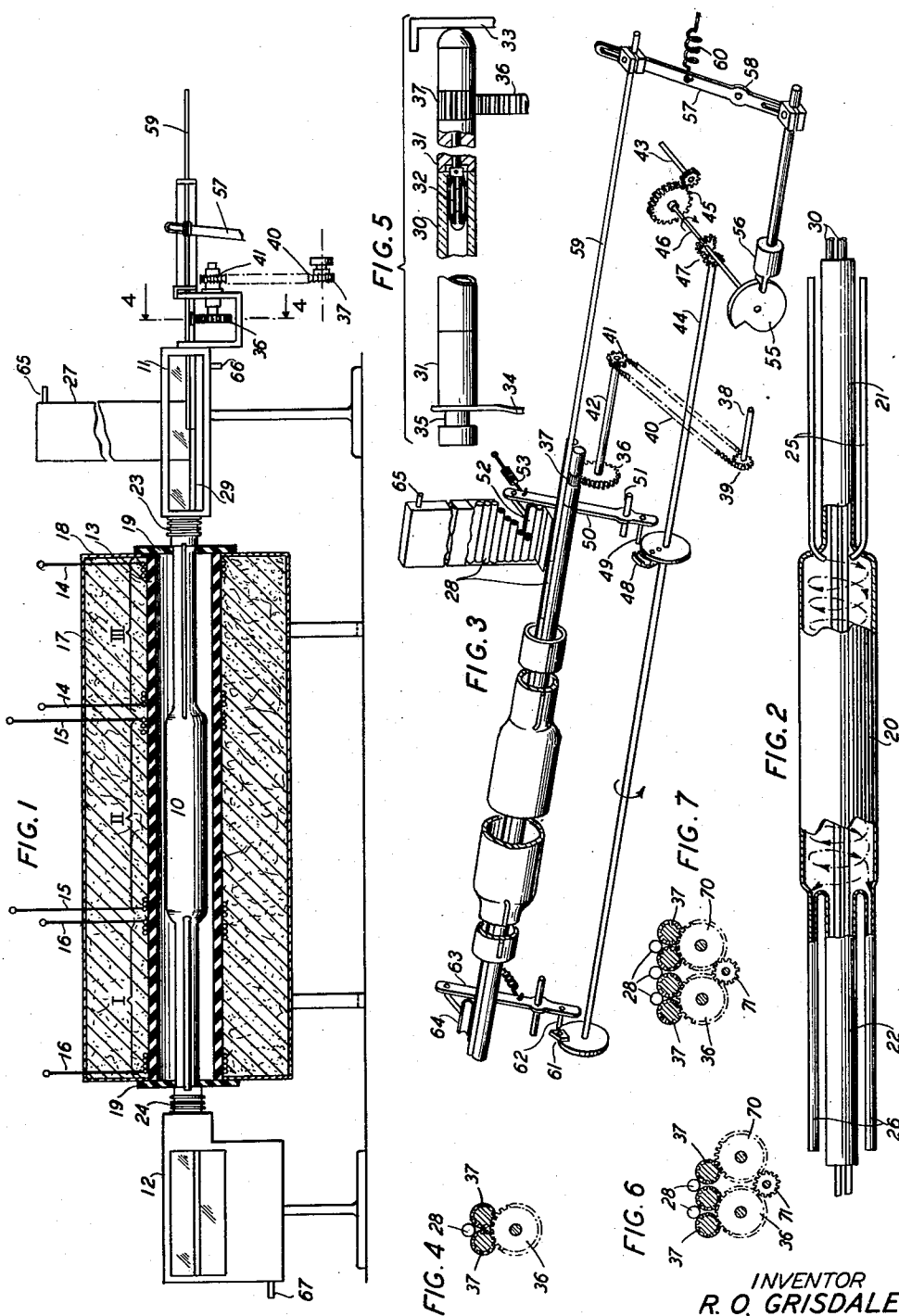
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COATING APPARATUS

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COATING APPARATUS

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This invention relates to coating apparatus and more particularly to apparatus for coating bodies with a thin layer of hard carbon by thermal deposition from a carbonaceous gas or atmosphere.

It is well known that a coating of hard carbon can be deposited upon ceramic bodies by heating the bodies to a suitable temperature in a hydrocarbon gas. When thus heated the hydrocarbon is decomposed and carbon is deposited upon the bodies as a coating of a thickness depending primarily upon the duration of the treatment, the concentration of the hydrocarbon, and the temperature. Difficulty, however, has been experienced in obtaining a coating which is uniform in thickness over the entire body and one which is free from soot or tarry products.

It is an object of the present invention to apply on the surface of ceramic or other bodies a uniform coating of hard carbon which is free from soot and complex organic matter. It is a further object to apply such a coating by means of a process in which the bodies to be coated are conveyed along a fixed path through the apparatus in a continuous stream.

To accomplish these and other objects and in accordance with the features of the invention, there is provided a coating furnace in which the end zones are maintained at higher temperatures than the central zone in which the bodies are subjected to the hydrocarbon gas and decomposition takes place. As a result of maintaining the end zones at temperatures higher than the central zone, those tarry or sooty products having high molecular weight which the hydrocarbons yield when condensed, are prevented from diffusing into the end zones of the apparatus.

In accordance with another feature the parts to be coated are continuously rotated as they are conveyed through the coating zone and the hydrocarbon gas is given a rotational movement as it passes through this zone thus insuring the deposition of a uniform coating.

The various features of the invention may be more clearly understood by reference to the accompanying drawing in which:

Fig. 1 is an elevation view partly in section of a furnace embodying the features of the invention;

Fig. 2 is a view on an enlarged scale of the furnace core disclosed in Fig. 1;

Fig. 3 is a diagrammatic view showing the feeding and conveying mechanism;

Fig. 4 is a view illustrating the method of rotating the bodies to be coated;

Fig. 5 is a view on an enlarged scale of one of the rotatable conveying tubes; and

Figs. 6 and 7 illustrate modifications in which a plurality of sets of ceramic bodies are conveyed through the furnace and coated simultaneously.

Referring to the drawing there is disclosed a furnace core 10, shown on an enlarged scale in Fig. 2, extending between a feeding chamber 11 and a receiving chamber 12. This core which is of fused silica, sillimanite or similar refractory material is enclosed within the furnace tube 13 which is of aluminum oxide or similar refractory material and is surrounded by heating windings 14, 14, 15, 15 and 16, 16 connected to suitable terminals. A layer of asbestos or other heat insulating material 17 surrounds the windings and is in turn enclosed by a casing 18. End pieces 19, 19 which are of suitable refractory material are provided with suitable openings to permit the ends of the core 10 to extend therethrough. The furnace core may comprise a central chamber 20 which serves as a coating chamber and tubular members 21 and 22 through which the bodies to be coated are conveyed. It is essential that the cross-sectional area of the coating chamber 20 be kept as large as possible (about twice as large at least) as the cross-sectional area of the tubular members 21 and 22. In order to allow for thermal expansion, the outer ends of tubular members 21, 22 are cemented into Sylphon bellows 23, 24 which are rigidly secured in housings 11 and 12, respectively.

As will be more clearly seen by referring to Fig. 2, a carbonaceous gas is passed into the feeding end of the chamber 20 by means of refractory tubes 25, 25 which have their ends so positioned as to give the entering gas a rotational motion as shown by the dotted arrows. The tubes 25 are of small diameter so that the gas passing through them has a high linear velocity. A similar pair of tubes 26, 26 but of larger diameter is provided at the opposite end of the core for exhausting gases or vapors from the chamber. A magazine 27, in which the bodies 28, 28 which are to be coated are placed, opens into the housing 11. This housing is preferably provided with a transparent plate 29 to permit observing the operation of the feeding mechanism. As the bodies leave the magazine 27, they are supported by a pair of rotatable refractory members 30, 30 which extend through the furnace core and into the receiving apparatus. These rotatable members are provided at either end with metallic extension members 31, 31 which cooperate with suitable bearings and maintain the tubes in perfect alignment. A ba-

nana type of plug 32 as disclosed in Fig. 5 is provided as a friction clutch between the metallic members and the rotatable members 30. To take care of the thermal expansion of the rotatable members 30, the metallic extension members at one end are adapted to bear against fixed supports 33 and to be held at the opposite end by forked spring members 34 extending into suitable slots 35 in the end members 31. The rotatable members 30 are caused to rotate in the same direction by means of gear 36 engaging gears 37 in the metallic end pieces 31 at the feeding end of the mechanism. Gear 36 is driven from a slow speed motor shaft 38 through the medium of sprocket 39, chain 40, sprocket 41 and shaft 42.

The conveying mechanism as shown diagrammatically in Fig. 3 is driven by shaft 43 of a slow speed motor, not shown. The shaft 44 which is driven from shaft 43 through gear train 45, shaft 46, and gear train 47, is provided with a cam lever 48 adapted to engage pin 49 of lever 50 pivoted at 51. At the opposite end of lever 50 is provided a pusher plate 52 which operates to push one of the bodies 28 out on the rotatable members 30, 30 and then is withdrawn by retractile spring 53. Also positioned on shaft 46 is a cam 55 engaging with member 56 and operating through the lever 57 pivoted at 58 to control the movement of pusher rod 59. This rod engages the end of one of the bodies 28 and causes its longitudinal movement along the rotatable members 30, 30 by the action of cam 55. As the pusher rod 59 meets the end of its stroke as determined by cam 55, it is drawn back by retractile spring 60 and immediately thereafter cam 48 operates to cause another body 28 to be pushed in position on the rotatable members 30, 30. At the receiving end of the feeding mechanism, the cam 61 operating against pin 62 in cooperation with lever 63 and pusher plate 64 causes the coated bodies to be removed from rotatable members 30, 30 in proper sequence. A tube connection 65 is provided in the magazine and a similar tube connection 66 is provided in the feeding housing to permit the flow of an inert gas into the housing and through tubular member 21 into the coating chamber 20. A similar tube connection 67 is provided at the housing 12 to permit the flow of nitrogen or other inert gas over the coated bodies and through tubular member 22 into the coating chamber 20. This inert gas is withdrawn through the exhaust tubes 26, 26 along with the spent carbonaceous gas. While only two rotatable members 30 are shown in Figs. 1 to 4, it is obvious that to meet certain requirements, a plurality of sets of ceramic bodies may be conveyed through the furnace and coated simultaneously. In the arrangement of Fig. 6, three rotatable members 30 are employed to support two sets of bodies 28. These rotatable members are rotated in the same direction by using in addition to the gear 36, a second gear 70 and an idler 71. Fig. 7 illustrates a similar arrangement in which three sets of bodies are handled simultaneously coating more than one set of bodies, a corresponding number of magazines 27, pusher rods 59 and pusher plates 52 and 64 will be required.

As a source of carbonaceous gas or vapor, a suitable arrangement is to employ a washing bottle in which nitrogen is bubbled from a diffusing stone through a liquid hydrocarbon such as benzene. The mixture of nitrogen and hydrocarbon is then admitted to the coating cham-

ber through the tubes 25, 25. Other hydrocarbon liquid such as hexane or toluene may be employed in place of benzene or a hydrocarbon gas such as methane or butane, diluted with nitrogen may be admitted to the coating chamber through tubes 25, 25.

By supporting the bodies to be coated on the rotatable members 30 as they are uniformly conveyed through the furnace tube 10, it is possible to pass these bodies through the furnace core 10 with their axes in fixed alignment along some axis through the core. The momentary line contact which the bodies make with the rotatable members 30 does not effect the uniformity of the coating and the turbulence given to the gas further insures a uniformly deposited coating. Furthermore, the fact that the end zones I and III are maintained at temperatures considerably above the temperature of the coating zone II prevents the diffusion of high molecular weight decomposition products into the outer ends of the core. By keeping the preheating zone III at a temperature higher than the coating zone II, it has been found that the coated bodies are not contaminated with tar or soot and that the higher the speed with which the bodies pass through the furnace or the larger their heat capacity, the greater must be the temperature differential to achieve this result. By keeping the differential sufficiently great, it is possible to produce completely clean carbon films under the most varied conditions. By keeping the after-heating zone I at a temperature above the coating zone II complex organic materials which are probably absorbed along the crystal boundaries are decomposed, these compounds yielding free carbon and stabilizing the properties of the film. As disclosed the desired temperatures are obtained by employing three different heating windings but obviously similar results may be obtained by connecting the windings in series and employing more turns on the end zones than on the coating zone so that the required power will be available for obtaining the desired temperatures.

While the furnace core disclosed in Fig. 2 is a preferred type, it will be obvious that other arrangements of refractory tubes may be employed in which the core is separated into three distinct zones.

What is claimed is:

1. A carbon deposition furnace comprising a coating chamber, means for conducting a carbonaceous gas through said chamber, means for maintaining said chamber at a temperature suitable for causing the decomposition of said carbonaceous gas and tubular members through which bodies to be coated are conveyed into said chamber and discharged therefrom, said tubular members being maintained at temperatures higher than that of the coating chamber.

2. A carbon deposition furnace comprising a coating chamber, means for conducting a carbonaceous gas through said chamber comprising a separate tube for conveying the carbonaceous gas into one end of the coating chamber the end of said tube extending into said chamber and having its end portion so positioned as to produce a rotational turbulence to the carbonaceous gas, a separate tube extending from the opposite end of the coating chamber for discharging the carbonaceous gas from said chamber, means for maintaining said coating chamber at a suitable temperature to cause decomposition of the carbonaceous gas, means for maintaining the portions outside of the coating chamber through

which the bodies to be coated are conveyed at temperatures higher than that of the coating chamber, and means for conveying bodies to be coated through said chamber.

3. A carbon deposition furnace comprising a coating chamber, means for maintaining said chamber at a temperature suitable for causing the decomposition of a carbonaceous gas, a tubular member through which bodies to be coated are conveyed into said coating chamber, a second tubular member in alignment therewith through which the coated bodies are conveyed out of said coating chamber, means for maintaining said tubular members at temperatures higher than that of said coating chamber, and means for conducting a carbonaceous gas through said coating chamber.

4. A carbon deposition furnace comprising a coating chamber, means for conducting a carbonaceous gas through said chamber, means for maintaining said chamber at a temperature suitable for causing the decomposition of said carbonaceous gas and a pair of rotatable members upon which the bodies to be coated are supported as they are conveyed through the furnace and a feeding mechanism for propelling said bodies at a uniform speed through said coating chamber.

5. A carbon deposition furnace comprising a coating chamber, means for conducting a carbonaceous gas through said chamber, means for maintaining said chamber at a temperature suitable for causing the decomposition of said carbonaceous gas, rotatable members upon which the bodies to be coated are supported as they are conveyed through the furnace, said rotatable members at each end being provided with metallic extension members frictionally engaging therewith and serving as bearing members therefor.

6. A carbon deposition furnace comprising a coating chamber, a tubular member through which bodies to be coated are conveyed into said chamber, a second tubular member in alignment therewith through which said bodies are conveyed out of said chamber, a tube for passing carbonaceous gas into one end of said chamber and a second tube for removing said carbonaceous gas at the opposite end of said chamber, means for maintaining said chamber at a suitable temperature for causing decomposition of said carbonaceous gas and means for maintaining said tubular members at a temperature higher than that of said coating chamber.

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