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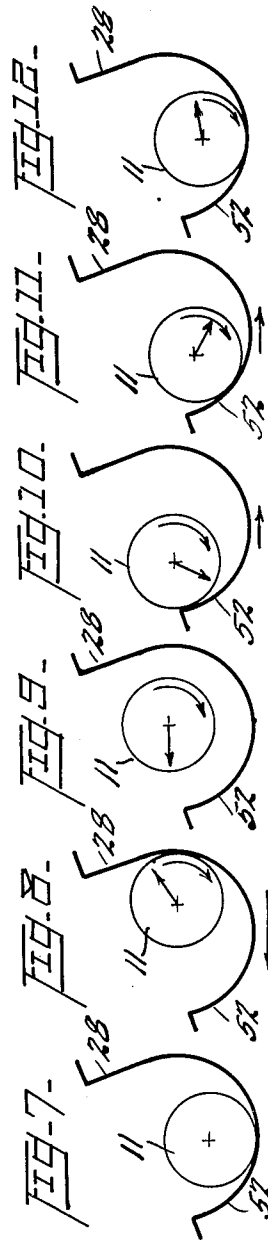
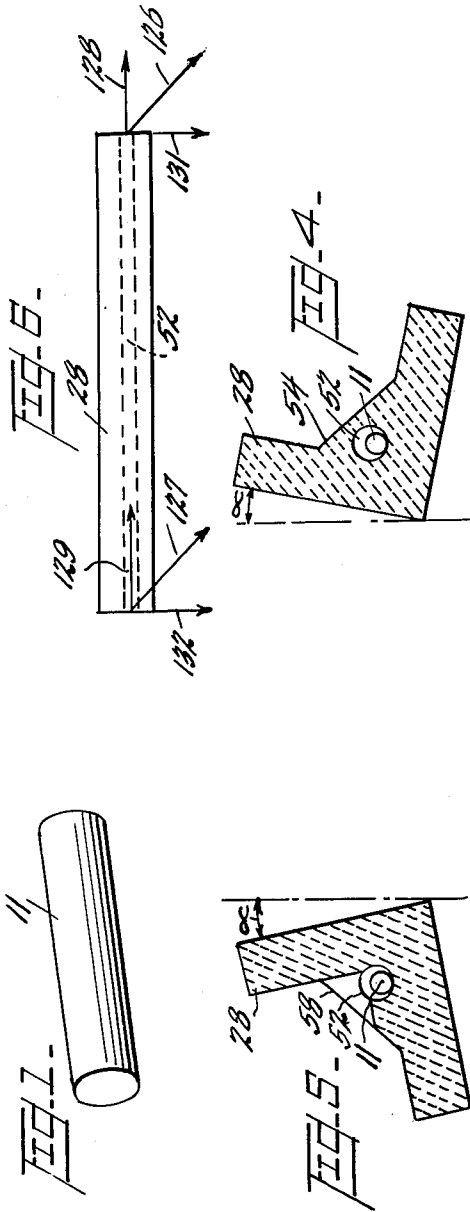
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ARTICLE COATING APPARATUS HAVING VIBRATORY FEED

Filed June 28, 1962

3 Sheets-Sheet 1



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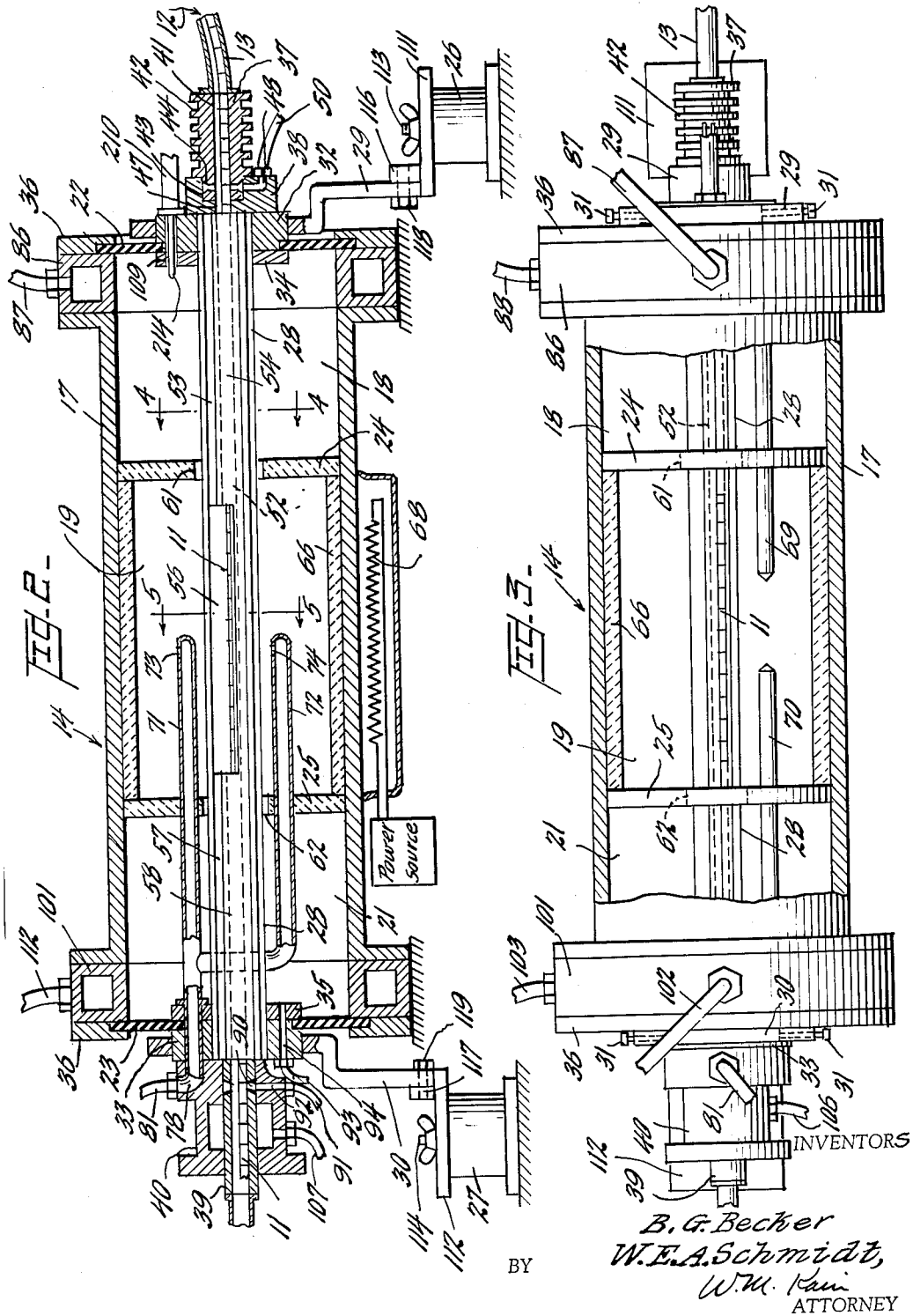
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ARTICLE COATING APPARATUS HAVING VIBRATORY FEED

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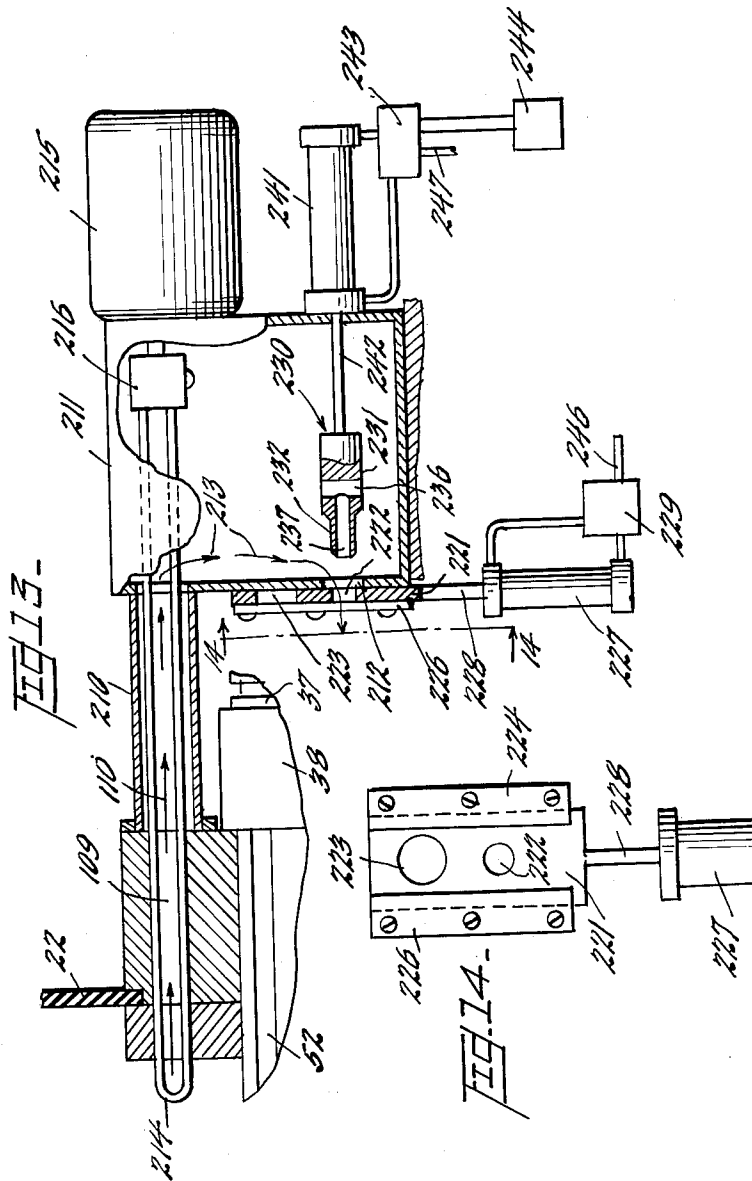
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ARTICLE COATING APPARATUS HAVING VIBRATORY FEED

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17 Claims. (Cl. 118—47)

This invention relates to article coating apparatus having a vibratory feed and more particularly to article coating apparatus having a special vibratory feeding system for transporting and rotating articles during the coating thereof.

The apparatus according to this invention is especially suitable for producing electrical resistors including a non-conductive core having a coating of carbon or other electrically conductive material deposited thereon.

In many industrial operations it is necessary to subject an article to an atmosphere under such conditions that material from the atmosphere is deposited upon the article. Where it is desired to produce a large number of articles each having identical coatings which are highly uniform, regular, and symmetrical, it is usually necessary to subject each article to be coated to a uniform coating atmosphere for identical periods of time and under identical conditions necessary to produce the coating.

In the manufacture of one variety of deposited carbon resistor, for example, large numbers of generally cylindrical ceramic cores must be coated with a predetermined amount of carbon in such a manner that an identical, symmetrical, and uniform carbon coating, having an accurately controlled thickness, is produced on each core. In order to produce such carbon coatings, it has been the practice to rotate the cores and expose them to a carbonaceous coating atmosphere for a controlled period of time as they pass through a heated chamber. Typically, the coating atmospheres employed in producing such coatings include a carbonaceous gas, for example, nitrogen. The ceramic cores are heated to a temperature such that the carbonaceous gas is "cracked," that is, pyrolytically decomposed, and a hard coating of carbon deposited on the surface of each core. A wide range of coating atmospheres may be used for this purpose, the particular atmosphere being chosen in accordance with desired product characteristics.

It is the object of this invention to provide a new and improved article coating apparatus having a vibratory article feeding system which transports and rotates articles during the coating thereof.

A further object of this invention is to provide a new and improved article feeding system of the vibratory type which simultaneously rotates and transports articles of a predetermined configuration while ejecting articles having other than the predetermined configuration.

An additional object of this invention is to provide apparatus for depositing a uniform coating of carbon on generally cylindrical ceramic cores as they are simultaneously transported and rotated by a vibratory feeding system extending through a fixed coating chamber.

A further object of this invention is to provide article coating apparatus having a vibratory feeding system and a new and improved exhaust clearing system the action of which is enhanced by the action of the vibratory feeding system.

With these and other objects in mind, this invention contemplates coating apparatus including a vibratory feeding system for advancing articles through a coating chamber. The vibratory feeding system includes a special vibratory article carrier having a pathway, or carrier chan-

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nel, thereon which extends through the coating chamber and is driven by devices which intermittently impart components of force to the carrier in directions transverse and longitudinal to the pathway thereon. Articles on the carrier channel are both rotated and advanced through the coating chamber.

When used for depositing carbon on ceramic cores in the manufacture of electrical resistors, this invention may contemplate coating apparatus including a coating furnace divided generally into three chambers: a preheat chamber, a coating chamber, and a cooling chamber. The preheat and cooling chambers contain, or are flushed with, a neutral gas, while the coating chamber contains a carbonaceous atmosphere for producing a hard carbon coating on the cores as they are simultaneously rotated and advanced through the coating chamber by the special vibratory feeding system, above outlined. The vibratory feeding system is sealed into the coating furnace by means of flexible diaphragms. This coating furnace may include an exhaust passage to which is sealed an exhaust clearing system for maintaining the flow of exhaust gases from the furnace free of obstruction by solid waste and also maintains desired back pressures on the furnace. The action of the exhaust clearing system is enhanced by the action of the vibratory feeding system.

These and other objects and advantages of this invention will become apparent from a reading of the following detailed description and accompanying drawings illustrating a preferred embodiment thereof.

Referring to the drawings:

FIG. 1 is an enlarged perspective view of a cylindrical core upon which carbon is to be deposited by apparatus embodying principles of this invention;

FIG. 2 is a front elevation, partially in section, of article coating apparatus in accordance with principles of this invention including a three-chambered coating furnace, a special vibratory feeding system extending through the chambers thereof, and conduits for supplying certain desired atmospheres to such chambers and carrier system;

FIG. 3 is a plan view, partially in section, illustrating details of the coating furnace illustrated in FIG. 2, particularly associated cooling apparatus and temperature monitoring elements;

FIG. 4 is a sectional view of a portion of the vibratory feeding system shown in FIGS. 2 and 3 taken along line 4—4 of FIG. 2;

FIG. 5 is a sectional view of a portion of the vibratory feeding system shown in FIGS. 2 and 3 taken along line 5—5 of FIG. 2;

FIG. 6 is a schematic force diagram illustrating vibratory forces and components thereof applied to the vibratory feeding system;

FIGS. 7—12 illustrate the operation of the vibratory feeding system shown in FIGS. 2—5 as it imparts rotation to articles being transported therealong;

FIG. 13 is an elevation, partially in section, illustrating an exhaust clearing system in use with the article coating apparatus shown in FIGS. 2 and 3; and

FIG. 14 is an elevation of a detail of the exhaust clearing system viewed from line 14—14 of FIG. 13.

In FIG. 1, there is shown an enlarged cylindrical ceramic core 11 upon which carbon is to be deposited by coating apparatus according to this invention to form the body of a deposited carbon resistor. As indicated by arrow 12 (FIG. 2), cores 11 may be introduced into a feeding tube 13 of the article coating apparatus designated generally by the number 14. This apparatus comprises two principal portions, a coating furnace, and a special vibratory feeding system for feeding ceramic cores 11 through the coating furnace.

In outline, coating furnace 14 includes an elongated rigidly mounted, cylindrical furnace tube 17 which is divided into three chambers: a preheat chamber 18, a coating chamber 19, and a cooling chamber 21. The preheat and cooling chambers are bounded at their outermost ends by flexible diaphragms 22 and 23, respectively. These flexible diaphragms are made of heat resistant, elastic material, for example, Silicone rubber. Baffles 24 and 25 bound the innermost ends of the preheat and cooling chambers, respectively, and enclose the coating chamber therebetween. The coating furnace also includes apparatus for introducing desired atmospheres into chambers 18, 19, and 21 and apparatus for controlling the temperature therein. An exhaust clearing system (FIGS. 13 and 14) is also part of the coating furnace.

In general, the vibratory feeding system comprises electromechanical vibrators 26 and 27 which serve to impart vibrations to an elongated carrier 28 of generally V-shaped cross section (FIGS. 4 and 5) which extends through preheat chamber 18, coating chamber 19, and cooling chamber 21. Vibrations produced by vibrators 26 and 27 are transmitted to carrier 28 by means of coupling brackets 29 and 30. Set screws 31 lock the coupling brackets to carrier holders 32 and 33 which, in turn, are secured to carrier 28. Locking rings 34 and 35 both grip carrier 28 and serve to seal flexible diaphragms 22 and 23 about the vibratory feeding system. The flexible diaphragms are sealed to the coating furnace as by means of annular locking rings 36. Being flexible, the diaphragms prevent vibrations of the vibratory feeding system from being transmitted to the coating furnace and facilitate vibrational control of the carrier 28. Devices for introducing uncoated cores into, and accepting coated cores from carrier 28 are also included within the vibratory feeding system. These include a hollow adapter 37, a bushing 38, and an exit tube 39 having a cooling jacket 40 thereabout.

Coating furnace and vibratory feeding system

Because of the action of the vibratory feeding system, cores 11 introduced into feeding tube 13 are caused to progress through the coating furnace. Thus, cores 11 fed into feeding tube 13, as by means of nip rollers (not shown), progress into passage 41 within hollow adapter 37. This adapter is provided with cooling fins 42 for dissipating heat which may be transmitted to adapter 37 from the coating furnace. Adapter 37 is provided with a cylindrical projection 43 having a groove 44 therein which communicates through a series of ports with passage 41.

Upon leaving passage 41, cores 11 enter passage 47 within bushing 38. Bushing 38 is provided with a gas conduit 48 which communicates with groove 44 and is connected to a source of pressurized neutral gas (not shown), for example nitrogen, through a gas tube 50.

Progressing through passage 47, cores 11 enter a carrier channel 52 (FIGS. 2-5) which extends along the length of carrier 28 and provides a pathway for the cores. As best seen in FIGS. 4 and 5, carrier channel 52 is of generally circular cross section. While this generally circular configuration is especially effective for transporting cylindrical articles, such as cores 11, a wide range of other generally channel-shaped configurations may also be employed.

Carrier 28 is divided into three sections along its length: a bridged section 53 provided with a covering web 54 (see FIGS. 2 and 4), an open or exposed section 56, and a bridged section 57 provided with a covering web 58 (FIGS. 2 and 5). The carrier member is constructed of heat resistant, preferably ceramic, material. It may conveniently be formed by molding or extruding a desired length of ceramic material having the cross section shown in FIG. 4, and making a single milling cut so as to produce the cross section shown in FIG. 5 along the length of open section 56.

The three sections of the carrier 28 correspond to the three chambers of the coating furnace, that is, bridged section 53 extends within preheat chamber 18, open section 56 extends within coating chamber 19, and bridged section 57 extends within cooling chamber 21. As best seen in FIG. 2, cores 11 conveyed along carrier 28 are protected from the atmospheres in preheat chamber 18 and cooling chamber 21 because carrier channel 52 is sealed in these chambers by covering webs 54 and 58 and are exposed to the atmospheres within coating chamber 19.

Baffles 24 and 25 are provided with apertures 61 and 62 (FIG. 2), respectively. These apertures correspond in shape to the cross section of carrier 28 but are sufficiently large so as not to interfere with the vibration thereof. Apertures 61 and 62 may be relieved in the vicinity of covering webs 54 and 58, thereby further venting coating chamber 19 to the preheat and coating chambers.

In order to assure that cores 11 have reached the requisite temperature at the time of first exposure to the coating atmosphere, the cores are heated in preheat chamber 18 prior to their exposure in coating chamber 19. The temperature within the preheat chamber is controllable by the cooling action of water jacket 86 which is provided with a water inlet tube 87 and a water outlet tube 88 (FIG. 3). Further cooling is accomplished by cooling fins 42 on adapter 37.

Thus heated, the cores pass from preheat chamber 18 into coating chamber 19. Coating chamber 19 is defined by baffles 24 and 25 and by a cylindrical liner 66. Baffles 24 and 25 and liner 66 may be formed of ceramic refractory materials and cemented together within furnace tube 17.

An electrical heater 68 having a suitable electric power source is arranged to heat coating chamber 19. Thermocouples 69 and 70 (FIG. 3) project through baffles 24 and 25, respectively, and into coating chamber 19. The thermocouples are connected by means of appropriate circuitry to instruments (not shown) suitable for continuously monitoring the temperature conditions within the coating chamber. The thermocouples may also be connected to circuitry for regulating the power through heater 68 to maintain desired temperatures within coating chamber 19.

Tubular conduits 71 and 72 provided, respectively, with lateral gas ports 73 and 74, extend through apertures in baffle 25. These conduits are connected through a passage 78 which is formed in locking ring 35, carrier holder 33, and cooling jacket 40 to a pressurized source of coating gas (not shown) by means of a gas tube 81. Lateral gas ports 73 and 74 are so directed within coating chamber 19 as to cause the coating gas to have a swirling action within the coating chamber.

As indicated above, methane is a suitable coating gas for use in depositing carbon upon cores 11. However, as is well-known in the art, a wide range of carbonaceous gases may be used for this purpose. If desired, various other materials may be introduced along with the carbonaceous gas in order to alter the characteristics of the coating deposited on cores 11.

Once coated, the cores pass into cooling chamber 21, where they are subjected to a flow of neutral gas, nitrogen in this example, introduced under pressure into carrier channel 52 and exit tube 39 through a series of ports communicating with groove 90. This neutral gas is derived from a source (not shown), passes through gas tube 91, conduit 92, and into groove 90. Neutral gas, which may be derived from the same source, is introduced through gas tube 93, conduit 94, and into cooling chamber 21.

The temperature of the cooling chamber 21 is controllable by the action of a water jacket 101 having a water inlet tube 102 and a water outlet tube 103 (FIG. 3).

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Coated cores which have progressed through exit tube 39 may be further cooled by the action of cooling jacket 40 which is provided with coolant inlet 106 (FIG. 3) and coolant outlet 107 (FIG. 2).

From the foregoing it will be seen that various gases are introduced into the coating furnace and that a coating reaction takes place therein. The coating furnace is vented for the removal of exhaust gases and reaction products by exhaust passage 109 (FIGS. 2 and 13). Such gases and products exit the furnace as indicated by arrow 110 (FIG. 13).

Vibratory feeding system details

As discussed briefly above, vibrators 26 and 27 provide vibrational energy to the vibratory feeding system, thereby causing the system to convey articles through the coating furnace. Vibrators 26 and 27 are provided with clamping plates 111 and 112 (FIGS. 2 and 3), respectively, which plates are apertured to receive vibrator positioning bolts 113 and 114, respectively. The orientation of vibrators 26 and 27 under clamping plates 111 and 112, and hence the axis along which vibrations are produced, may be adjusted by means of bolts 113 and 114.

Clamping plates 111 and 112 are provided with driving lugs 116 and 117 (FIG. 2). Bolts 118 and 119 pass through coupling brackets 29 and 30, and are threaded into driving lugs 116 and 117, thereby coupling the vibrational energy of vibrators 26 and 27 to the carrier 28.

Vibrators 26 and 27 are powered by a source half wave rectified alternating current (not shown) and hence, when under power, periodically apply in phase driving pulses to the above-described vibratory carrier system at a frequency corresponding to that of the applied alternating current. While electromechanical vibrators so powered are a particularly convenient source of vibratory energy for use in the vibratory feeding system, it should be understood that other vibrating motors, for example, air powered motors capable of delivering intermittent driving pulses generally along a predetermined axis, may also be employed.

Exhaust clearing system

After some period of operation during which coating and neutral gases and reaction products pass through the coating furnace, solid waste, soot, and the like would tend to collect in exhaust passage 109 if not removed. Such an accumulation would interfere with a smooth flow of gases through the furnace, build up a back pressure, and have a possibly deleterious effect on the uniformity of the coating produced on the cores. In order to prevent this, the coating furnace is provided with an exhaust clearing system illustrated in FIGS. 13 and 14.

The exhaust clearing system includes a flexible exhaust pipe 210 which is sealed over the mouth of exhaust passage 109 and connects to exhaust chamber 211. The exhaust chamber is stationary and vibrations which might otherwise be imparted thereto by the vibratory feeding system are absorbed by the flexible exhaust pipe. The exhaust chamber is vented by exhaust port 212. Arrow 213 indicates the general path of exhaust from exhaust pipe 210 through exhaust port 212.

Scraper 214, shown for purposes of illustration as a generally U-shaped loop of resilient wire dimensioned to make sliding contact within exhaust passage 109, is positioned within the exhaust passage as shown in FIGS. 2 and 13. Scraper 214 is mechanically connected to motor 215 by means of block 216 and may be maintained in rotation within exhaust passage 109 by the motor. Motor 215 is fixed to exhaust chamber 211.

A slide 221, having a small vent 222 and a large vent 223 therein, is mounted over exhaust port 212 by means of retaining plates 224 and 226. The retaining plates permit movement of slide 221 vertically while retaining the slide in sealing relation on exhaust chamber 211 over exhaust port 212. Slide 221 may be vertically positioned

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by means of air cylinder 227 acting through piston rod 228 to place either of vents 222 or 223 over exhaust port 212. Solenoid valve 229 may be actuated by electrical circuitry (not shown) to admit air to cylinder 227 and selectively place either of vents 222 or 223 over exhaust port 212.

A plunger 30 having a large cylindrical portion 231 of a diameter equal to that of vent 223, and a small cylindrical portion 232 of a diameter equal to that of vent 222, is arranged in alignment with exhaust port 212.

Plunger 230 is provided with radial ports 236 and axial passage 237 which communicates with the radial ports.

Air cylinder 241, acting through piston rod 242 controls the position of plunger 230 and may drive the plunger through exhaust port 212 causing the plunger to scrape either of vents 222 or 223. Air cylinder 241 is controlled by solenoid valve 243, which, in turn, is under the control of timer 244.

A source of pressurized air (not shown) is connected to lines 246 and 247 and may be admitted to air cylinders 227 and 241 by solenoid valves 229 and 243, respectively.

Operation

The general mode of operation of this invention will be apparent from the above-description which sets out the detailed structure of an embodiment thereof while tracing the path of a core 11 from feeding tube 13 to exit tube 39. Below are set forth further details of the mode of operation.

In order to prepare the coating apparatus under consideration for operation, it is necessary to adjust the vibratory feeding system so that cores 11 will be simultaneously rotated and transported therealong. It is also necessary to introduce the required atmospheres into the apparatus and to create the requisite temperature and gas flow conditions therein.

The vibratory feeding system is adjusted and put into operation as follows. Set screws 31 (FIG. 3) are loosened and carrier 28 is tilted about its longitudinal axis so as to take the configuration illustrated in FIGS. 4 and 5, that is, with one leg of the carrier 28 tilted through an angle α , approximately 15° past the vertical in a direction counterclockwise as viewed in FIG. 5. Set screws 31 are then tightened to lock carrier 28 in this orientation. Next, the wing nuts on bolts 113 and 114 are loosened and vibrators 26 and 27 are turned under clamping plates 111 and 112 so that their axes of vibration are generally parallel to each other and at an angle with the longitudinal axis of carrier 28. Taking the longitudinal axis of carrier channel 52 as a reference, this arrangement is such that the longitudinal components 128 and 129 (FIG. 6) of vibratory forces applied to the feeding system add in the direction opposite to that in which cores 11 are to be transported along carrier 28. The transverse components 131 and 132 (FIG. 6) are directed so as to add and drive the feeding system leftwardly as viewed in FIG. 5.

With the vibratory feeding system so adjusted and oriented, the vibrators 26 and 27 under power, cores 11 introduced into feeding tube 13 are subjected to pulsating forces resulting from the pulsating forces applied to the feeding system. With each successive driving pulse (pulses result from the powering of the vibrators with half wave rectified alternating current) the feeding system moves rapidly relative to the cores. This is so because the forces of inertia of the cores are too great to be overcome by the frictional forces applied to them by the rapidly moving feeding system. However, at the cessation of each driving pulse, when the carrier system returns relatively slowly to its normal position, the forces of friction are sufficiently strong to overcome the inertia of the articles. Thus, cores 11 fed into feeding tube 13 tend to remain stationary while the carrier system is under

the influence of longitudinal components 128 and 129 (FIG. 6) and to be transported (leftwardly as viewed in FIGS. 2 and 3) during the intervals between driving pulses. By this process, cores 11 are transported by the carrier system.

The transversely acting forces, represented by transverse components 131 and 132 (FIG. 6) have a corresponding effect on the cores as they are transported along carrier 28 and cause the cores to rotate within carrier channel 52 as they are transported. This action may best be understood by referring to FIGS. 7-12, wherein the curved arrow on core 11 indicates the direction of rotation of the core, the straight arrow on core 11 indicates its direction of linear movement, and the arrow under FIGS. 8, 10 and 11 indicates the direction and magnitude of driving force applied to carrier 28 by the vibrators.

In FIG. 7, the core is shown at rest in the bottom of carrier channel 52. A sharp, leftward driving pulse (vectors 131 and 132) is imparted to the carrier 28 (FIG. 8) and the core tends to remain stationary due to its inertia. The core is thus forced upwardly by rounded sides of the carrier channel, and due to frictional engagement with the carrier channel is driven into rotation. The terminal portion of the leftward driving pulse causes the core to be pitched toward (FIG. 9) and strike the left side of the carrier channel while rotation continues. In the meantime, the driving pulse terminates and the vibrator returns relatively slowly (FIG. 10) toward the normal position. During this slower return cycle, the core rolls downwardly into the carrier channel (FIG. 11), passes the neutral point (FIG. 12), and the process is repeated as the next sharp, leftward driving pulse is imparted to the carrier.

The net effect of the transverse driving forces is to cause a relatively smooth rotation of the cores as they progress along the article feeding system. This rotation is clockwise as viewed in FIG. 5.

The above-described tipping adjustment of the vibratory feeding system about the longitudinal axis of carrier 28 permits the ejection of defective cores from carrier 28 as the cores pass across open section 56. A defective core, being acted upon irregularly by the transverse driving pulses does not achieve the smooth, uniform rolling action imparted to the perfect cores, and is caused to be pitched out of carrier channel 52 and off of carrier 28.

As indicated above, carrier channels having a wide range of cross sectional configurations will serve to impart rotation to the cores when driven intermittently. For example, if a simple V-shaped carrier channel is employed, the cores will tend to remain stationary with each driving pulse and thus to be lifted up the side of the channel. Then, at the cessation of the driving pulse, will roll downwardly. Rotation is thus produced by successive driving pulses. The circular configuration illustrated in FIGS. 4, 5, and 7-12 gives superior performance, especially with round workpieces, because of the relatively smooth rolling action of workpieces around confines of carrier channel 52.

It should be apparent that a wide range of orientations of the vibrators 26 and 27 relative to carrier 28 will produce the requisite longitudinal and transverse components of force on the vibratory feeding systems. It should also be clear that a wide range of orientations of the feeding system about the longitudinal axis of carrier 28 will serve satisfactorily to permit the carrier 28 to eject defective cores. If desired, the cores may be transported along carrier channel 52 by auxiliary feeding apparatus, for example, nip rolls (not shown), while making use of the transversely acting forces, components 131 and 132 to rotate the cores.

The particular orientations selected for discussion above, are especially suitable and effective for transporting, rotating and ejecting generally cylindrical ceramic

cores of the sort used in manufacturing deposited carbon resistors along a carrier channel of generally circular cross section.

With the vibratory article feeding system adjusted and set into operation, pressurized nitrogen is introduced into gas tubes 50, 91, and 93. Also, methane is introduced into gas tube 81. Heater 68 is turned on and regulated as desired to heat coating chamber 19 and preheat chamber 18. Cooling water is pumped into and drained from cooling jacket 40 and water jackets 86 and 101 by means of their respective coolant inlet and outlet tubes.

Motor 215 (FIG. 13) of the exhaust clearing system is turned on to rotate scraper 214. Solenoid valve 229 is actuated to place either of vents 222 or 223 (FIGS. 13 and 14) over exhaust port 212 in accordance with the desired back pressure within the coating furnace. Timer 244 (FIG. 13) is set to periodically actuate solenoid valve 243 and thereby start plunger 230 in periodic reciprocating motion into and out of the selected vent (vent 222 or 223).

After the coating furnace and vibratory feeding system is properly adjusted and put into operation, cores 11 are introduced into feed tube 13. Due to the above-described feeding action, possibly supplemented by a forced feeding of the cores into feed tube 13, the cores are transported into the coating furnace.

While within feed tube 13, passages 41 and 47, and within bridge section 53 of carrier 28, the cores are bathed by a flow of nitrogen. Introduced by means of gas tube 50, this gas passes through gas conduit 48, through groove 44 and into passage 41 where it divides, one portion flowing along carrier channel 52 to protect the cores from undesired chemical reactions and from premature exposure to the coating atmosphere while in the preheat chamber, the other portion passing toward feeding tube 13 to flush the newly introduced cores of contaminants, especially oxygen.

Thus cleansed and protected by neutral gas, the cores are transported through preheat chamber 18, the temperature of which is regulated (as hereinbefore described) to bring cores up to the desired coating reaction temperature prior to their exposure to the coating atmosphere within coating chamber 19. This temperature is that at which the coating gas, methane in this example, will crack and deposit the desired hard coating of carbon on the core.

When the cores pass out from under covering web 54, they are no longer protected by neutral gas, and are immediately exposed to the coating atmosphere.

Rotation of the cores as they pass through the coating chamber, together with the swirling action of the coating gases introduced therein, promotes the production of a highly uniform and symmetrical coating of carbon on the cores. This coating reaction takes place until the cores reach covering web 58. There, due to a flow of neutral gas moving rightwardly in carrier channel 52, the coating reaction is cut off sharply.

Once within cooling chamber 21, cores 11 are progressively cooled and cleansed of any undesirable reaction products by the neutral gas flowing in carrier channel 52. Nitrogen, which serves this purpose, is introduced into gas tube 91, passes along gas conduit 92, into groove 90, and into exit tube 39 through the ports communicating with groove 90. This flow of gas divides in exit tube 39, part flowing along carrier channel 52 to perform the above-described cooling and cleansing function, and part moving in the opposite direction to protect the coated cores until they have reached room temperature (or other desired temperature).

Neutral gas forced into gas tube 93 passes through conduit 94 and flows into cooling chamber 21. This flow of gas further cools this chamber and prevents any accumulation of undesirable hydrocarbon gases and solid products in the cooling chamber.

Cooled by the action of water jacket 101 and by the flow of neutral gas, the cooling chamber is maintained at such a temperature that cores passing therethrough are brought close to room temperature (or other desired temperature) as they pass therethrough. As the cores enter exit tube they are subjected to the further cooling action of cooling jacket 40, which is regulated by controlling the flow of coolant therethrough so as to bring the cores precisely to the desired temperature prior to their removal from the coating furnace.

Neutral gas introduced into cooling chamber 21 passes through aperture 62 (FIG. 2) and into coating chamber 19 where it mingles with coating and neutral gases therein. This mixture of gases passes through aperture 61 into preheat chamber 18. The flow of neutral gas from cooling chamber 21 through coating chamber 19 tends to flush the latter chamber of troublesome hydrocarbon products which might, in the absence of such gas flow, produce reformed hydrocarbons and contaminate the surface of the cores. This mixture of gases is finally exhausted from preheat chamber 18 through exhaust passage 109 as indicated by arrow 110 (FIG. 13). The flow of gases within preheat chamber 18 both heats the chamber and tends to exclude undesired accumulations of reaction products therein.

Solid reaction products which might otherwise accumulate in exhaust passage 109 are scraped loose by the rotation of scraper 214 and carried with exhaust gases through exhaust pipe 210 into exhaust chamber 211. When necessary, such solid reaction products may be removed from the exhaust chamber floor. It will be noted that scraper 214, which is fixed to motor 215 and hence is stationary except for a rotational motion, does not vibrate with the vibratory feeding system. The walls of exhaust passage 109, on the other hand, do vibrate. The resulting relative vibratory motion between the scraper and the walls of passage 109 enhances the cleaning action of the scraper.

Gaseous exhaust products flowing as indicated by arrows 110 and 213 (FIG. 13) pass through exhaust port 212 and through whichever of vents 222 or 223 as has been selected to provide the proper back pressure in the coating furnace.

The selection of vent size will determine the back pressure and therefore the density of the gas passing through the coating furnace. This gas density has a material effect on the coated product produced thereby. When the coating furnace is used to coat small cores, a relatively rapid flow of gas may be desired and a larger vent, e.g., vent 223, will be selected. When larger cores are to be coated, it may be desired to have a slower flow of gases through the coating furnace, and a relatively smaller vent may be selected, e.g., vent 222. Slide 221 may be provided with a series of vents related in size and number to the variety of products to be produced by the coating furnace. Likewise, air cylinder 227 may be appropriately actuated to select the proper vent in relation to the product and may instantaneously shift the slide 221 when it is desired to produce a different product.

As the coating furnace is operated, solid reaction products may accumulate within exhaust port 212 and vents 222 and 223. Such an accumulation would tend to inhibit the flow of gases through the furnace, if not removed. Based on experience and product uniformity requirements, timer 244 may be set to periodically actuate air cylinder 241 and drive plunger 230 through exhaust port 212 and through the vent then over port 212, to clean both vent and port. If small vent 222 is in use, small cylindrical portion 232 will clean the vent while large cylindrical portion 231 will clean exhaust port 212. If large vent 223 is in use, the leftward (FIG. 13) motion of plunger 230 will not be stopped by slide 221 and large cylindrical portion 231 will clean both large vent 223 and exhaust port 212. In order to prevent a sudden

increase in back pressure on the coating furnace when vent 222 or 223 is being cleaned by plunger 230, radial ports 236 and axial passage 237 within plunger 230 temporarily vent exhaust chamber 211 to the atmosphere. The provision of radial ports 236 and axial passage 237, together with the capacity of exhaust chamber 211, permit a practically uninterrupted flow of gases through the coating furnace as vent 222 or 223 is cleaned.

When the cores 11 have passed through the coating furnace, operated as above-described, they are collected at the end of exit tube 39 or otherwise passed to subsequent fabricating operations not within the contemplation of this invention.

It is to be understood that the above-described arrangement of apparatus and construction of elemental parts is simply illustrative of an application of the principles of this invention and that many other modifications may be made without departing from the invention.

What is claimed is:

1. Apparatus for treating cylinder-like articles comprising

a treating chamber,

an article carrier member having a longitudinally extending pathway thereon which extends into the treating chamber, and

means for intermittently imparting components of force to the carrier member which are transverse and longitudinal to the pathway, which pathway imparts the force components to the articles to rotate the articles about their major axes within the pathway and to transport the articles along the pathway.

2. Apparatus for coating cylinder-like articles comprising

a coating chamber,

an elongated article carrier member having a longitudinal pathway formed thereon for transporting articles into and through the coating chamber,

means covering the pathway except in the area where the pathway extends within the coating chamber, thereby excluding undesired atmospheres from the surface of the articles prior to their entry into and after their withdrawal from the coating chamber, and

vibratory means for intermittently imparting components of force to the carrier member which are transverse and longitudinal to the pathway, which pathway imparts the force components to the articles to rotate the articles about their major axes within the pathway and to transport the articles along the pathway.

3. Apparatus for coating cylinder-like articles comprising

a coating chamber,

an elongated article carrier member having a longitudinal pathway formed thereon receptive to components of force transverse and longitudinal to the pathway, the pathway extending through the coating chamber for exposing articles on the pathway,

means for introducing and swirling a coating atmosphere about the elongated article carrier member to subject exposed articles to said swirling atmosphere, and

vibratory means for intermittently imparting components of force to the carrier member which are transverse and longitudinal to the pathway, which pathway imparts the force components to the articles to rotate the articles about their major axes within the pathway and to transport the articles along the pathway.

4. Apparatus for coating generally cylindrical cores comprising

a furnace tube including therewithin

a preheat chamber,

a cooling chamber, and

a coating chamber intermediate the preheat and cooling chambers;
 means for heating the coating chamber;
 means for introducing a coating atmosphere into and exhausting the coating atmosphere from the coating chamber;
 means for introducing neutral gas into and exhausting neutral gas from the preheat and cooling chambers;
 an elongated carrier member having a straight carrier channel of generally circular cross section therein mounted within the furnace tube and extending through the preheat, coating, and cooling chambers;
 cover means for sealing the carrier channel against the atmospheres within the preheat and cooling chambers and for exposing a portion of the carrier channel to the coating atmosphere within the coating chamber; and

vibratory means for intermittently applying forces to the carrier member which are longitudinal and transverse to the carrier channel, which channel imparts the forces to the cores to rotate the cores about their major axes within the carrier channel and to transport the cores along the carrier channel.

5. Apparatus for coating cores according to claim 4, including means for positionally adjusting the elongated carrier member about its longitudinal axis.

6. Apparatus for coating cores according to claim 4, including means for positionally adjusting the axis of vibration of the vibratory means relative to the longitudinal axis of the carrier member.

7. Apparatus for treating cylinder-like articles comprising a treating chamber, a carrier member having a longitudinal pathway therein for transporting articles into the treating chamber, vibrating means for intermittently imparting to the carrier member components of force which are transverse and longitudinal to the pathway, which pathway imparts the force components to the articles to rotate the articles about their major axes within the pathway and to transport the articles along the pathway, and a least one flexible diaphragm sealed about the carrier member and both sealing a portion of the treating chamber against the escape of the atmosphere therewithin, and preventing the transmission to the chamber of vibratory forces applied to the carrier member.

8. Apparatus for treating cylinder-like articles as defined in claim 7, wherein the treating chamber is open at both ends, means are provided for rigidly supporting the chamber against movement, the carrier member extends through and projects beyond the ends of the chamber, a pair of resilient flexible diaphragms seal the ends of the chamber and are sealed about the carrier member, and the vibrating means includes a pair of vibrators located at both ends of the carrier member, the axis of vibration of the vibrators being at angles which are acute to the longitudinal axis of the longitudinal pathway.

9. Apparatus for conveying cylinder-like articles comprising a carrier member having a longitudinally extending carrier channel of generally circular cross section thereon, and means for intermittently imparting components of force to the carrier member which are transverse and longitudinal to the carrier channel, which channel imparts the force components to the articles to rotate articles about their major axes within the carrier channel and to transport the articles along the carrier channel.

10. Apparatus for conveying cylinder-like articles comprising

an elongated carrier member having a longitudinally extending bore therethrough to form a carrier channel, and having a portion thereof cut away to expose a section of the carrier channel, and
 means for intermittently imparting components of force to the carrier member which are transverse and longitudinal to the carrier channel, which channel imparts the force components to the articles to rotate the articles about their major axes within the

carrier channel and to transport the articles along the carrier channel.

11. Apparatus for conveying articles according to claim 9, wherein the means for intermittently imparting components of force comprise at least one vibrator, the axis of vibration of which is adjustable relative to the longitudinal axis of the carrier channel.

12. Apparatus for conveying generally cylindrical cores comprising

an elongated carrier member having a longitudinally extending circular bore therethrough to form a carrier channel, and having a portion thereof cut away to expose a section of the carrier channel,

vibrator means for intermittently imparting transverse and longitudinal components of force to the carrier member, which member imparts the force components to the cores to impart rotation to the cylindrical cores about their major axes in the carrier channel and to advance the cylindrical cores along the carrier channel, and

means for adjusting the position of the carrier member about its longitudinal axis.

13. In an article treating apparatus including a treating chamber, means for introducing a desired atmosphere into the treating chamber, and an exhaust passage for exhausting gaseous and solid waste from the treating chamber,

a vibratory feeding system for transporting articles through the treating chamber,

a cleaning element within the exhaust passage for clearing solid waste therefrom,

means for mounting the cleaning element and for isolating the element from the vibration of the vibratory feeding system,

means for driving the cleaning element within the exhaust passage,

an exhaust chamber sealed over the exit end of the exhaust passage having an exhaust port therein, plunger means, and

power means for driving the plunger through the exhaust port to clear any deposited solid waste in the port.

14. In a coating apparatus including a coating chamber, means for introducing a desired atmosphere into the treating chamber, and an exhaust passage for exhausting gaseous and solid waste from the treating chamber,

a vibratory feeding system for transporting articles through the treating chamber, the vibratory system imparting motion to the exhaust passage,

a cleaning element within the exhaust passage for clearing solid waste therefrom,

means for mounting the cleaning element and for isolating the element from the vibration of the vibratory feeding system to effectuate relative vibratory motion between the cleaning element and the exhaust passage,

means for driving the cleaning element within the exhaust passage,

an exhaust chamber having an exhaust port therein, a flexible exhaust pipe connecting the exhaust passage with the exhaust chamber,

a movable slide having a plurality of different sized vents therein which are alignable over the exhaust port,

power means for moving the slide to selectively position a vent in alignment with the exhaust port, plunger means, and

power means for driving the plunger through the exhaust port and the selected vent to clean both port and vent of solid waste.

15. Coating apparatus according to claim 14, wherein said plunger has a plurality of portions of different cross sections each corresponding in shape to a vent in the slide.

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16. Coating apparatus according to claim 14, wherein the plunger is provided with an internal passage for venting the exhaust chamber to the atmosphere when the plunger is within a selected vent.

17. Coating apparatus according to claim 14, wherein the power means for driving the plunger include timer controlled actuating means for periodically energizing the power means and operating the plunger.

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