Jan. 26, 1965 C. R TOMPSON 3,167,454

FLUIDIZED-BED TYPE OF COATING APPARATUS

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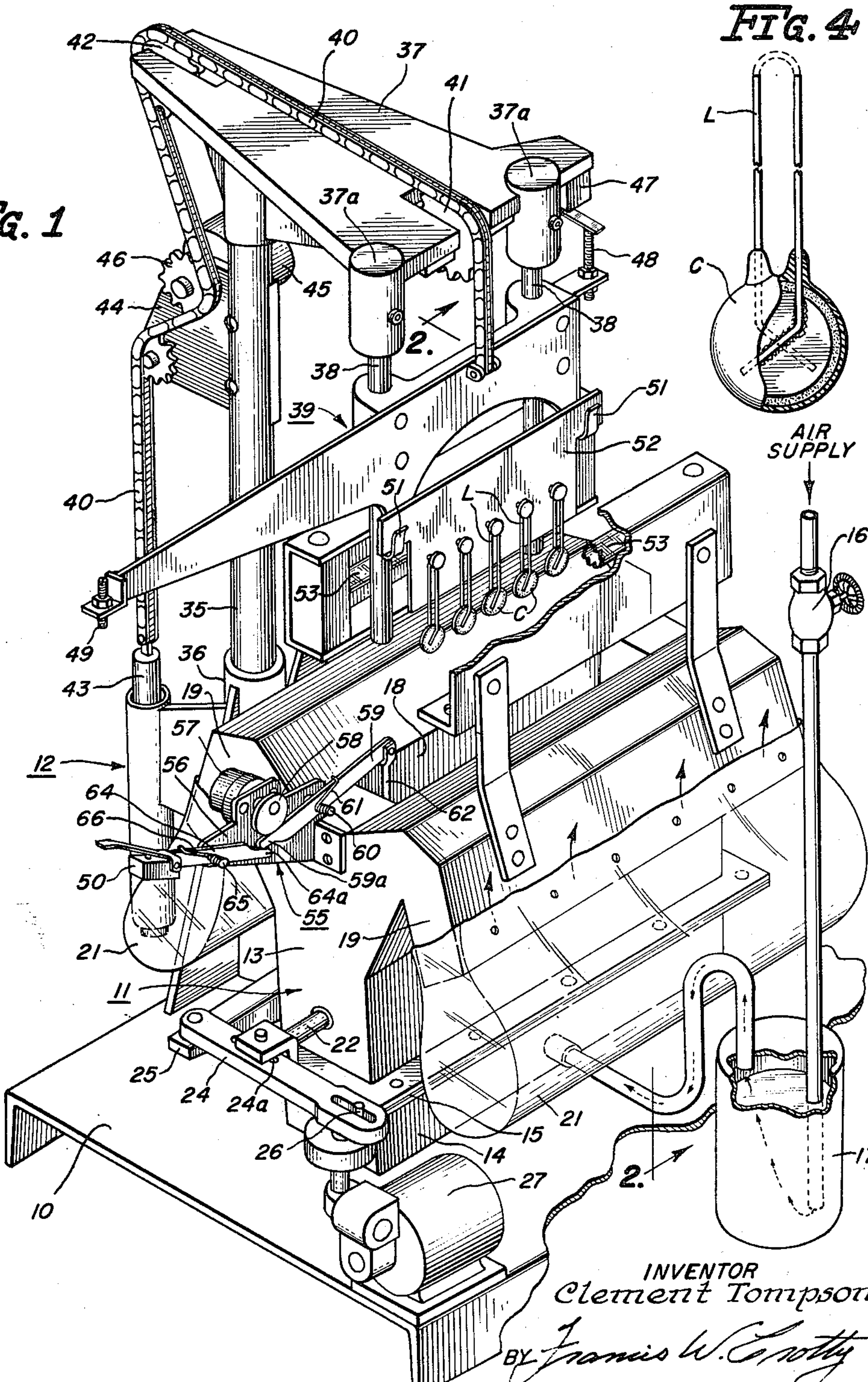
FIG. 4

FIG. 1



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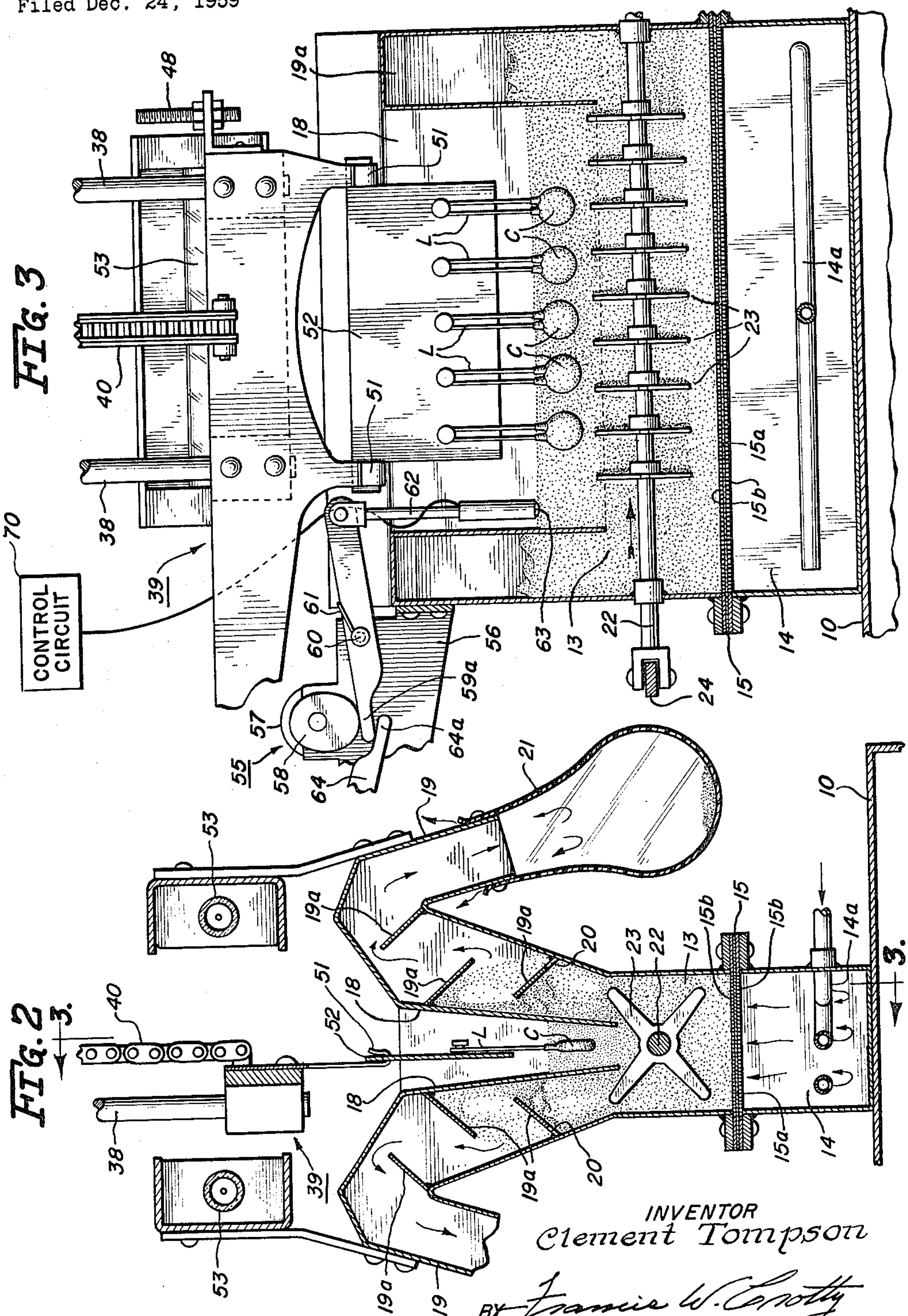

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FLUIDIZED-BED TYPE OF COATING APPARATUS

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The present invention concerns apparatus for applying a coating to an article. It is especially directed to coating apparatus of the so called fluidized-bed type. That type of apparatus is characterized by the use of pulverulent material contained within a chamber and through which an inert gas under pressure passes to establish the material in a fluidized state into which an article to be coated may be immersed.

Apparatus of this type is most beneficial in applying coatings of uniform thickness to articles, even articles which have irregular surfaces. Generally, the article is preheated to a temperature close to the melting or sintering temperature of the coating material and, when so heated, it is immersed in the fluidized material which then adheres and coalesces to the article and thereby deposits a layer or coating. Repeated heating and dipping permits the deposition of a coating of a desired and uniform thickness.

The nature of the coating to be applied is of no particular moment in the sense that coatings may be deposited through such apparatus for any of a wide variety of needs. For example, one may apply a coating to protect an article from chemicals, to preserve it against abrasions, to enhance its electrical characteristics, to make it either conductive or insulating as desired; any such coating may be applied through this kind of apparatus so long as the nature of the coating material lends itself to deposition by coalescing as described.

Apparatus for applying coatings in this fashion have been proposed heretofore. They have been subject to one deficiency which restricts their application particularly in processing components, such as capacitors, which are to be included in electrical systems. The difficulty that has been encountered heretofore stems from the fact that the gas relied upon to establish the fluidized condition gives rise to turbulence at the surface of the coating material. The nature of this turbulence is very similar to the surface condition of a container of boiling water in that bubbles appear and burst in irregular fashion at random throughout the surface. Because of this surface condition, the extent to which a coating is applied on an article suspended in the material is variable and in certain instances, particularly in the preparation of capacitors, it is highly desirable to accurately control the portion of the device that is coated.

Accordingly, it is an object of the present invention to provide a fluidized-bed type of coating apparatus which avoids the aforementioned difficulty of prior devices.

It is another object of the invention to provide improved coating apparatus especially for processing electrical components such as ceramic capacitors.

It is a specific object of the invention to provide an improved fluidized-bed type of coating apparatus in which the height of the coating applied to an article may be precisely controlled.

It is another specific object of the invention to improve a fluidized type of coating apparatus to the end that immersion of the article to be coated takes place in an area of the fluidized material which experiences substantially no turbulence.

Still another object of the invention is to provide novel means for controlling the depth of immersion of the article to be coated in relation to the height of the fluidized bed within its confining chamber.

A fluidized-bed type of coating apparatus constructed in accordance with the invention comprises a chamber for containing a coating material in pulverulent form. There are means for admitting a gas under pressure into that chamber, the gas being directed vertically upwardly to establish the coating material in a fluidized condition. Means are provided for presenting an article to be coated vertically downward into a preselected area of the fluidized material. Finally, there are means positioned within the chamber for agitating the fluidized material physically to displace particles of the coating material into localized low-resistance paths for the gas that may develop within the fluidized material.

In one particular embodiment of the invention a series of members of X-shape are disposed across the chamber and spaced from one another along a common supporting shaft. This shaft is oscillated at a low frequency to establish low-resistance paths for the gas which are directed away from the immersion area of the article to bo coated so that this area is characterized by substantially no turbulence attributable to the passage of the gas through the fluidized bed.

In accordance with another feature of the invention, the depth to which an article is immersed into the fluidized material is controlled by a sensing device, which may conveniently be a photocell arrangement and which controls the immersion in relation to the height of the fluidized bed.

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a perspective view of a fluidized powder coating apparatus embodying the present invention;

FIGURE 2 is a transverse cross-sectional view taken on line 2—2 of FIGURE 1;

FIGURE 3 is a longitudinal view, in section, as seen from line 3—3 of FIGURE 2; and

FIGURE 4 is an enlarged, detailed view of a ceramic capacitor as it appears after being plastic-coated by the apparatus of the instant invention.

As best seen in FIGURE 1, wherein a complete structure embodying the principles of the instant invention is illustrated, a base 10 provides a mounting means for a dipping vat 11 and a work support structure 12. Vat 11 is comprised of an upper chamber or reservoir 13 in which a coating material, such as a polyethylene powder, is contained and a lower chest or manifold 14 through which inert gas under pressure is introduced to establish the coating material in a fluidized condition. Reservoir 13 and manifold 14 are separated by a diffusing element 15 comprised of a sheet of filter paper 15*a* sandwiched between two perforated support plates 15*b*, as best seen in FIGURES 2 and 3. Filter paper 15*a* is of necessity pervious to air but impervious to the powdered coating material which it supports.

A supply of compressed gas or air (not shown) is coupled through a metering valve 16 into a moisturizing chamber 17, wherein the air is humidified and subsequently directed to manifold 14 where an air distribution tube 14*a* (see FIGURES 2 and 3) having a plurality of holes drilled in its underside, dispenses the air evenly throughout the manifold. Air from manifold 14 then passes vertically upwardly through diffusing element 15 and into reservoir 13 to maintain the charge of powdered material contained within the reservoir in a suspended and fluidized condition. The air, after passing through the powdered coating material, is expelled principally through ducts formed in the upper portion of vat 11 by a pair of baffle plates 18 in conjunction with the upper sections of the side walls of chamber 13 which are flared outwardly as shown in FIGURE 2. Plates 18 constitute the side walls of an inner chamber mechanically affixed to the housing of vat 11 and projecting downwardly into the fluidized material to define a preselected area, specifically the central area, of the fluidized bed into which articles to be coated are inserted. This inner chamber may have end walls as well although they are not essential. A series of baffles 19*a* extend transversely of the two ducts defined by each baffle 18 and an associated side wall of chamber 13. Certain of the baffles may have ports 20 to facilitate the return of the powder back into the fluidized bed. The arrangement of baffles in each duct precludes a direct exit path for gas and serves to prevent most of the powdered particles from passing out to the exhaust. Collector bags 21 are attached to the exhaust terminations of each duct to collect such of the powder as may escape with the exhausting air.

In order to facilitate the exhaust of most of the air through the aforementioned ducts rather than through the portion of the bed residing in the inner chamber defined by plates 18, there are means positioned within chamber 13 for agitating the fluidized material physically to displace particles of the coating material into localized low-resistance paths for the gas that may develop within the fluidized bed. For the specific embodiment of the invention illustrated this means also serves to establish localized paths of low resistance for the gas through the fluidized material which paths are directed upwardly and away from the area confined by inner chamber 18. These last-mentioned low-resistance paths are directed more particularly toward the exhaust ducts. To accomplish this result there should be at least one, but preferably several, members 23 having a V-shaped portion positioned within chamber 13 beneath and subtending the immersion area defined by baffle plates 18 with their apices directed downwardly. As a practical matter, it is convenient to construct these members with the configuration of an X as indicated in FIGURE 2.

More particularly, a plurality of such X-shaped members 23 is supported by and spaced from one another along a shaft 22 which extends through reservoir 13 in alignment with the center of the area set off by inner chamber 18. The diagonal lengths of these members 23 are sufficient to extend beyond the lower ends of baffle plates 18 and these members are physically displaced from time to time by oscillating shaft 22 in the direction of its longitudinal axis. Oscillatory motion is imparted to the shaft by an arm 24 upon which the end of shaft 22 is pivotally affixed in a slot 24*a*. Arm 24 is itself pivoted at one end to a stationary bracket 25 and at its opposite end has a slot which receives a crank pin 26. This pin is driven in a circular path by a motor and gear reducer 27 and through its coupling to link 24 causes the rotary motion to be translated to oscillatory motion of shaft 22.

A work support structure 12 provides means for presenting an article to be coated vertically downwardly into the area of the fluidized bed set off by the inner chamber including baffle plates 18. The structure 12 comprises a vertical column 35 supported by a pedestal 36 affixed as by welding to base 10. The upper end of column 35 carries a plate 37 disposed in a horizontal plane and extending over vat 11. Plate 37 is provided at its forward corners with two vertically disposed sockets 37*a* in which two depending guide rods 38 are rigidly held. A carriage, generally designated 39, is journalled on these guide rods and is held in a suspended position over vat 11 by a chain 40 trained over idler sprockets 41 and 42, and carrying at its lower opposite end a counterweight 43. A bracket 44, attached to column 35, provides a mounting means for a

reversible motor and gear reducer 45 which raises or lowers chain 40 by means of a drive sprocket 46.

The upper limit of travel of carriage 39 is determined by an upper limit switch 47 which may be engaged by an adjustable stop pin 48 supported on carriage 39. The actuation of switch 47 de-energizes motor and gear reducer 45, which, because of the presence of counterweight 43 maintains carriage 39 in its upper position. When motor 45 is next energized it drives the carriage downward until another adjustable stop pin 49, depending from the underside of carriage 39, engages a lower limit switch 50 to de-energize motor 45 and maintain carriage 39 in its lower position. Of course, subsequent energization of motor 45 will cause the cycle to repeat itself.

Carriage 39 is provided with two hooks 51 which support a removable work holder 52 from which a plurality of capacitors C are suspended. In the upper position of carriage 39, the flat surfaces of capacitors C face front and rear infra-red heaters 53, which serve to pre-heat the capacitors to a temperature above the fusing point of the polyethylene particles contained within vat 11. These heaters and their energizing circuit (not shown) are entirely conventional.

In order to insure precise control of the coating of capacitors C there are means responsive to the height of the fluidized bed for controlling the descent of carriage 39 and the immersion of the condensers into the fluidized material. This means comprises limit switch 50 in conjunction with a photo-cell type of sensing device 55, which senses the height of the fluidized bed and automatically positions limit switch 50 to arrest the downward travel of carriage 39 at a proper level. This control compensates for the changing height of the bed within chamber 18 as the powdered material is consumed or as the air pressure in chest 14 may vary.

Sensing device 55 is comprised of a bracket 56, attached to the side wall of vat 11 and upon which a small motor and gear reducer 57 is mounted. This motor drives a cam 58 the peripheral edge of which engages one end of a pivoted lever 59 to rock the lever about a pivot 60 against the bias of a torsion spring 61. At the opposite end of lever 59, a bifurcated rod 62 is suspended into inner chamber 18 and carries at its lower end a photo-cell 63 as best seen in FIGURE 3. Photo-cell 63 is mounted so that its light-sensitive element faces down and is therefore sensitive only to light that is reflected off the top surface of the fluidized bed. The photo-cell is connected to a control circuit 70 which usually includes an amplifier and relay for closing a circuit to motor 57 during intervals in which there is an output from the photo-cell. As cam 58 rotates from the position shown lever 59 rocks in a clockwise direction and photo-cell 63 moves downward in a probing action until the face of the photo-cell is immediately adjacent the interface of the fluidized bed. When this occurs, the light input to the cell is cut off, and motor 57 is de-energized. In this fashion, the mechanism senses the level or height of the fluidized bed, maintaining a constant relation thereto as the coating material is used during the coating process.

The position assumed by lever 59 under the influence of the photo-cell is directly translated to a second pivoted lever 64. To this end, the terminal portion or finger 59*a* of lever 59 overlaps the terminal portion 64*a* of lever 64 which is spring biased in a counter-clockwise direction by a spring 66. Consequently lever 64 rocks about its pivot 65 whenever cam 58 initiates a change in the position of lever 59. Limit switch 50 is mounted on the outer end of lever 64 and consequently is adjusted in position to compensate for variations in the bed level as required to assure immersion of the articles to be coated to a fixed depth in the bed.

Before considering the operation of the described apparatus, it is appropriate to comment on the article to be coated which, for the case at hand, is a ceramic capacitor shown in FIGURE 4. The capacitor has a body portion of a high di-electric ceramic which has the configuration of a wafer. The usual electrode areas are deposited on the opposed faces of this wafer and an electrode lead is secured to each such electrode to facilitate incorporating the capacitor into an electrical circuit. As shown in FIGURE 4, it is convenient to take a length of conductor L and form it into a U. Its ends are then solder-connected to the opposed electrode surfaces of the capacitor. This step, in effect, provides a conductive loop extending from the capacitor which is suitable for mounting the capacitor to plate 52 by passing the loop over work holding projections carried on the plate. The length of the loop is selected to have the capacitors extend a desired fixed amount below plate 52. This is desirable to make certain the control of the depth to which a capacitor and its conductor loop is immersed into the fluidized bed.

In preparing the apparatus to coat a series of such capacitors which plate 52 may accommodate, one determines initially the type coating material to be employed which will be assumed to be polyethylene. This determination is necessary in order to ascertain the preheating required of the capacitors before their immersion into the fluidized bed. It is also convenient at this juncture to comment on the possibility of color coding which permits the value of the capacitor to be determined upon visual inspection. One may, for example, assign a particular color of the coating to represent a specific value of capacitance while other colors of the coating identify other known values of capacitance. This determination is necessary because the heat absorbing properties of materials are affected by their color, the darker colors absorb heat more readily than the lighter ones. For this reason the coating of a particular thickness may require fewer passes into the fluidized bed where the coating is of a dark color than in the case where lighter color coatings are employed. Having determined these matters, one can ascertain the preheat temperature required of the capacitors and the number of immersions to obtain a desired coating thickness.

The chamber 13 is now charged with a coating material to a height that does not exceed the height of photocell 63 as represented in FIGURE 3 and valve 16 is opened to admit air under pressure through humidifier 17 to manifold 14*a*. This air in passing vertically upward through the coating material establishes it in a fluidized condition.

If the charge of the coating material in chamber 13 is such that the top surface of the bed is less than that represented in FIGURE 3, and this is the preferred initial condition, ambient light reflected from the surface of the coating results in an output from the photo-cell. This output after amplification in control circuit 70 operates a relay to energize motor 57 and drive cam 58 from its rest position illustrated in FIGURE 3. Rotation of this cam displaces lever 59 in a clockwise direction and lowers photo-cell 63 toward the upper surface of the fluidized bed. When the photo-cell reaches that surface, its output is reduced to zero or to such a small value that control circuit 70 de-energizing motor 57 and the movement of the photo-cell is arrested. This process by which the photo-cell senses the surface of the fluidized bed positions lower limit switch 50 through the mechanical interconnection of levers 59 and 64 and the position of the lower limit switch makes certain that capacitors C, when immersed into the bed by the downward motion of carriage 39, penetrate to a known and predetermined amount.

The apparatus is now in condition to coat the capacitors carried by work holder 52. In practical installations a timing mechanism of conventional form will be associated to cause work carriage 39 to execute a desired cycle in which it is initially in its uppermost position as represented in FIGURE 1 for a particular period of time and is then displaced to its lowermost position where it remains for another time period and then returns to its first-described position. No claim of invention is predicated on the structure of the programming mechanism which may be entirely conventional; for this reason it has been omitted from the drawing.

When the machine is placed into operation whether under the control of such a programming mechanism or through manual control of its movable parts, carriage 39 is initially in its uppermost position which is determined by the operation of upper limit switch 47 when engaged by stop adjustment 48. With the carriage in this position, the capacitors are exposed to heating elements 53 and are heated thereby for the time required to raise their temperature to approximately the fusion or sintering temperature of the coating material. When that temperature has been attained, motor 45 is energized to lower carriage 39 and immerse capacitors C into the fluidized bed. The downward travel of the carriage is limited when stop adjustment 49 engages lower limit switch 50. This results in the immersion of the capacitors to a known depth in the fluidized bed. The fluidized material impacts each condenser and so much of the electrode leads as are immersed in the bed and the coating particles adhere to or coalesce upon the capacitor. The capacitors remain in the bed until their temperature has decreased to the point where there is no further incremental addition to the coating thickness because the temperature of the capacitors has become less than that required to effect adhesion.

The carriage 39 is now returned to its initial position and the capacitors are reheated. Thereafter they are returned to the bed and a second layer of coating is applied. The cycle of preheat and coating is repeated until the desired thickness of coating has been achieved.

During this coating process, motor 27 causes shaft 22 to oscillate at a relatively low rate. The oscillation of the shaft displaces members 23 in a direction normal to their flat surfaces, resulting in an agitation of the coating particles so that if there is a tendency for a low-resistance path to develop in the bed, through which the gas may exhaust or blow out, coating particles will be displaced into that area before any damage may result from a blow-out spot. With members 23 disposed directly under the immersion area, their agitating of the coating particles is especially effective in minimizing or obviating the occurrence of blow outs within the portion of the bed into which the articles being coated have been immersed. This ensures freedom from turbulence in the coating area which, of course, is required if the coating process is to be closely controlled.

It will also be appreciated that the reciprocating motion of members 23 produces alternate compression and rarefaction of the powdered coating material. The compressed areas represent high resistance paths for the air admitted to the chamber from manifold 14 whereas the rarefied sections of the coating charge constitute localized low-resistance paths through the fluidized bed. Because of the disposition and dimension of members 23, these localized low-resistance paths, while directed upwardly through the fluidized bed, are directed away from the immersion area defined by inner chamber 18; they lead to ducts 19 disposed on either side of inner chamber 18. As a consequence the turbulence at the interface of the fluidized bed with the atmosphere is experienced substantially only in the discharge ducts and the interface of that portion of the fluidized bed confined within inner chamber 18 experiences little, if any, such turbulence. For that reason the deposition of coating material on the capacitors C and their electrode leads is accurately controlled in location. Generally, the immersion of the capacitors and their leads, through the adjustment of the lowermost position of carriage 39, is such that the coating material is applied on the ceramic wafer and less than ¼ inch of the electrode lead immediately contiguous to the wafer. This is a highly desirable result and obviates the need of further processing of the coated particles which would be the case were the coating permitted to extend further along the electrode leads as a result of turbulence which is characteristic of previous efforts to coat articles in fluidized-bed type equipment.

As the coating process continues, the height of the bed may fall but the sensing action of photo-cell **63** repositions and readjusts low limit switch **50** as required to make certain that the immersion of the capacitors into the bed remains at the desired preselected amount.

Experience teaches that coating materials which are good insulators develop strong electrostatic charges as a consequence of the agitation to which the material is subjected in response to the oscillation of shaft **22** and other motion induced by the flow of gas. Where this is encountered, an object brought near to the surface of the bed attracts uncontrolled amounts of the powder and occasions a coating of uncontrolled height. This is obviated or minimized in the apparatus of FIGURE 1 by the humidifying action of reservoir **17** through which water is introduced into the air stream directed through the bed in establishing the fluidized condition. The water dampens by cohesion the particles of coating material and, in addition, provides a leakage path for the static charge. The water has no adverse effect on the coating because it is driven off in a subsequent heating of the coated article.

In one arrangement of the machine the members **23** had at a diagonal dimension of approximately 2½ inches and a spacing of ⅞ of an inch along shaft **22**. The dimension of the inner chamber, corresponding to the separation of baffles **18** at the lowermost extremities, was ¾ inch and the frequency of oscillation of shaft **22** was approximately 83 cycles per minute. The air pressure of manifold **14** was 25 pounds per square inch and the coating material was polyethylene powder of 60–100 mesh. The capacitors were initially preheated to 270° F. and then immersed for 5 seconds. This 5 second interval was the time required for the condensers to leave the preheat stage, enter the immersion bed and return to the preheat stage and the time in the bed was approximtaely 2 seconds. The second preheating was at a temperature of 350° F. followed by a similar immersion and successive reheat temperatures of 385, 405 and finally 425° F. were employed, each such reheat being introduced by a 2 second immersion into the bed. The color of the polyethylene powder was blue and the coating of the capacitors was eminently satisfactory. The thickness of the resulting coating was .047 inch.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made therein without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; and means, in addition to said gas admitting means, positioned within said chamber beneath said preselected area of said fluidized material to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

2. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition and tending to establish localized areas in which a low resistance

path is presented to said gas; a pair of baffle plates spaced from one another and projecting downwardly into said fluidized material to define a preselected area into which an article to be coated is immersed; means for presenting an article to be coated vertically downwardly into said preselected area of said fluidized material; and agitating means positioned within said chamber beneath said preselected area of said fluidized material for displacing particles of said coating material into said localized areas.

3. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; and at least one member having a V-shaped portion positioned within said chamber beneath said preselected area of said fluidized material with the V-shaped portion thereof extending across said chamber with its apex extending down to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

4. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish sad coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; at least one member having a V-shaped portion positioned within said chamber beneath said preselected area of said fluidized material with the V-shaped portion thereof across said chamber with its apex extending down; and means for physically displacing said member from time to time to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

5. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; a plurality of members, individually having a V-shaped portion, spaced from one another along a given axis and positioned within said chamber beneath said preselected area of said fluidized material with the V-shaped portion thereof across said chamber with its apex extending down; and means for physically displacing said members along said axis from time to time to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

6. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; a plurality of members, individually having a V-shaped portion, spaced from one another along a given axis and positioned within said chamber beneath said preselected area of said fluidized material with the V-shaped portion thereof across said chamber with its apex extending down; and means for oscillating said members along said axis to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

7. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; a plurality of X-shaped members spaced from one another along a given axis and positioned within said chamber beneath said preselected area of said fluidized material; and means for oscillating said members along said axis to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

8. A fluidized-bed type of coating apparatus comprising: a chamber for containing a coating material in pulverulent form; means for admitting a gas under pressure into said chamber directed vertically upwardly to establish said coating material in a fluidized condition; a pair of baffle plates spaced from one another and projecting downwardly into said fluidized material to define a preselected area into which an article to be coated is immersed; means for presenting an article to be coated vertically downwardly into a preselected area of said fluidized material; a plurality of members, individually having a V-shaped portion, spaced from one another along a given axis and poistioned within said chamber beneath

said preselected area of said fluidized material with the V-shaped portion thereof subtending the space between said baffle plates; and means for physically displacing said member along said axis from time to time to physically displace particles of said coating material and establish for said gas localized low-resistance paths through said fluidized material directed upwardly but away from said preselected area thereof.

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