March 25, 1969 D. F. POBST, JR 3,434,808

METHOD AND MEANS FOR PUMPING POWDERED SOLIDS

Original Filed July 5, 1966 Sheet 1 of 4

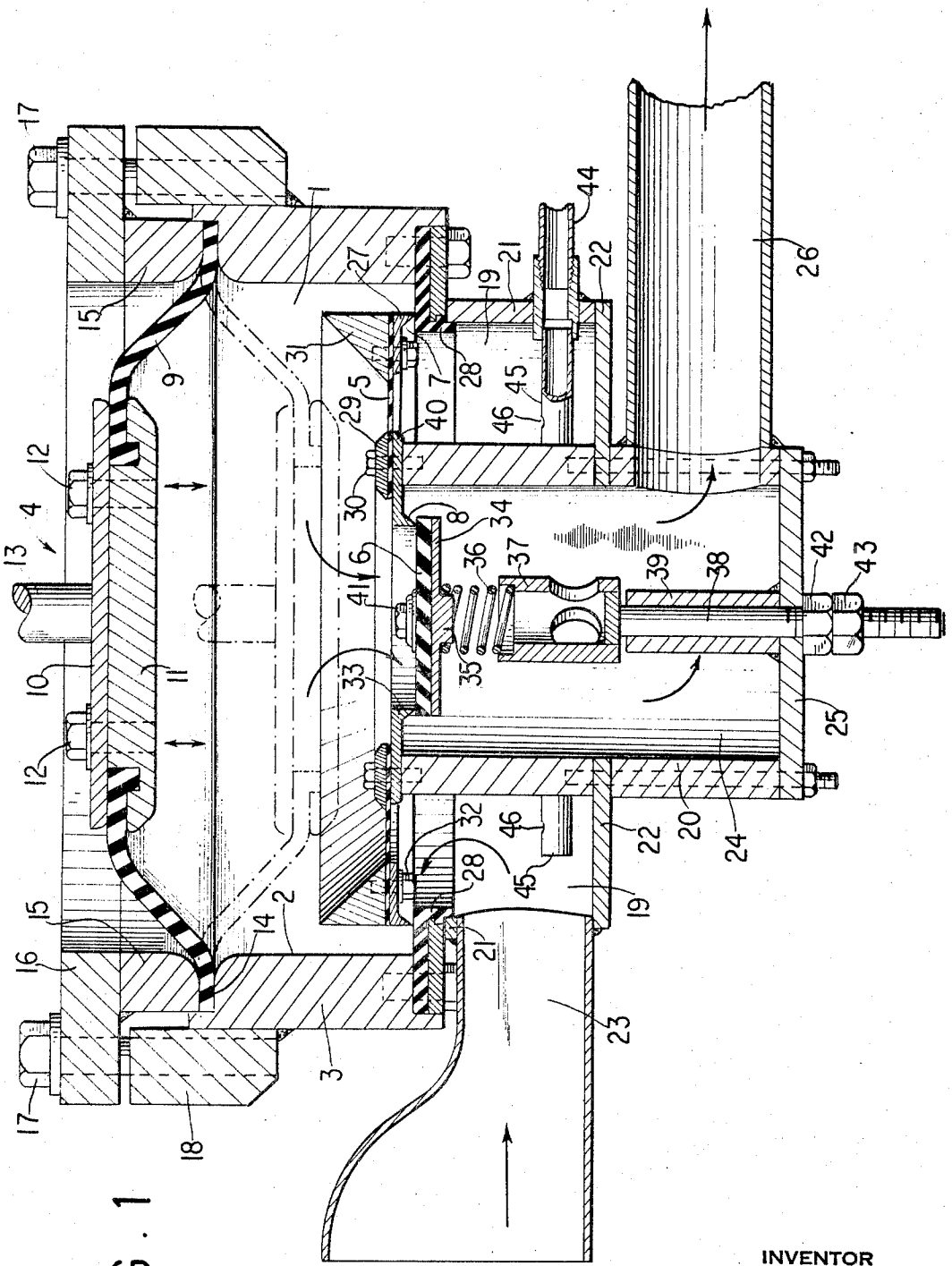


FIG. 1

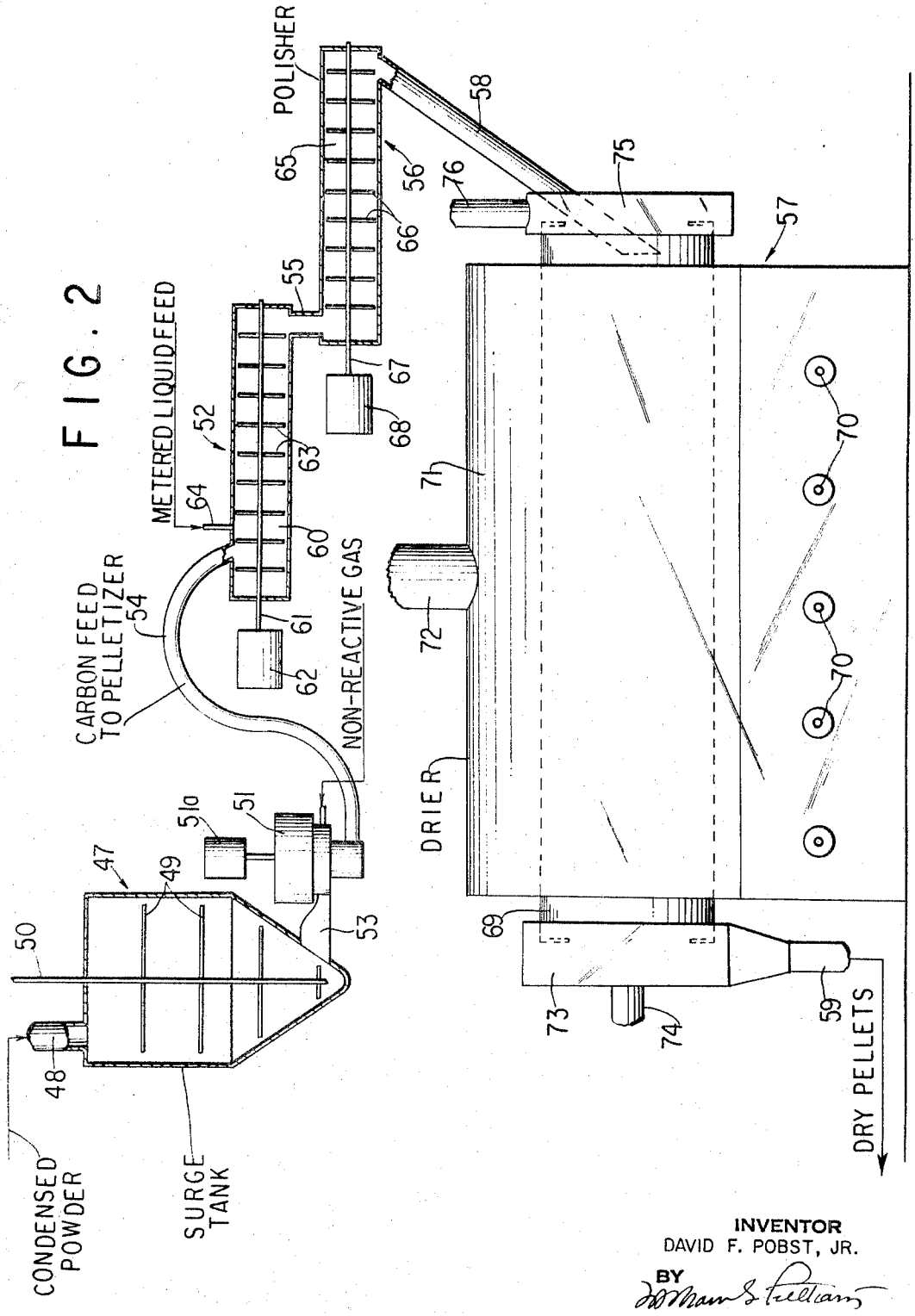
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METHOD AND MEANS FOR PUMPING POWDERED SOLIDS

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FIG. 2

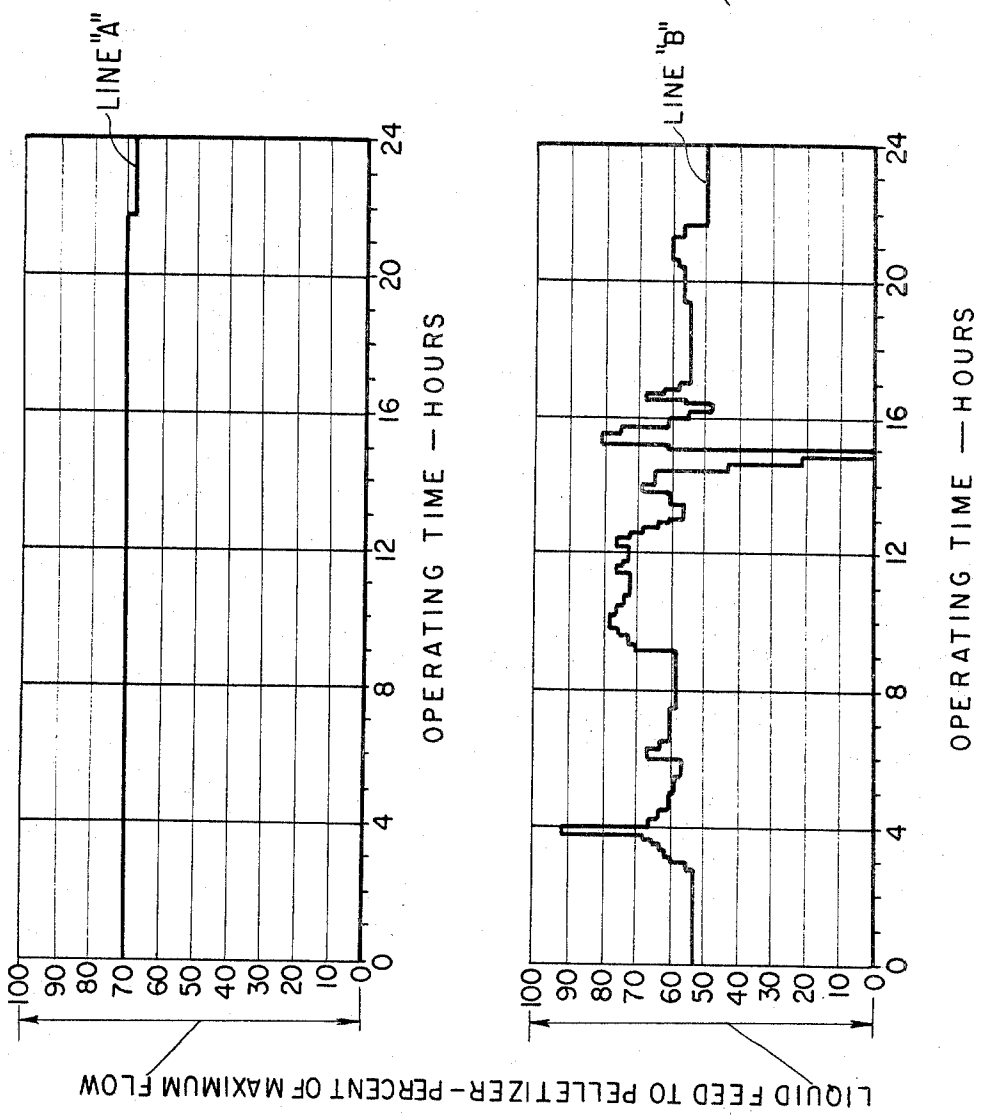


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FIG. 3



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METHOD AND MEANS FOR PUMPING POWDERED SOLIDS

Original Filed July 5, 1966 Sheet 4 of 4

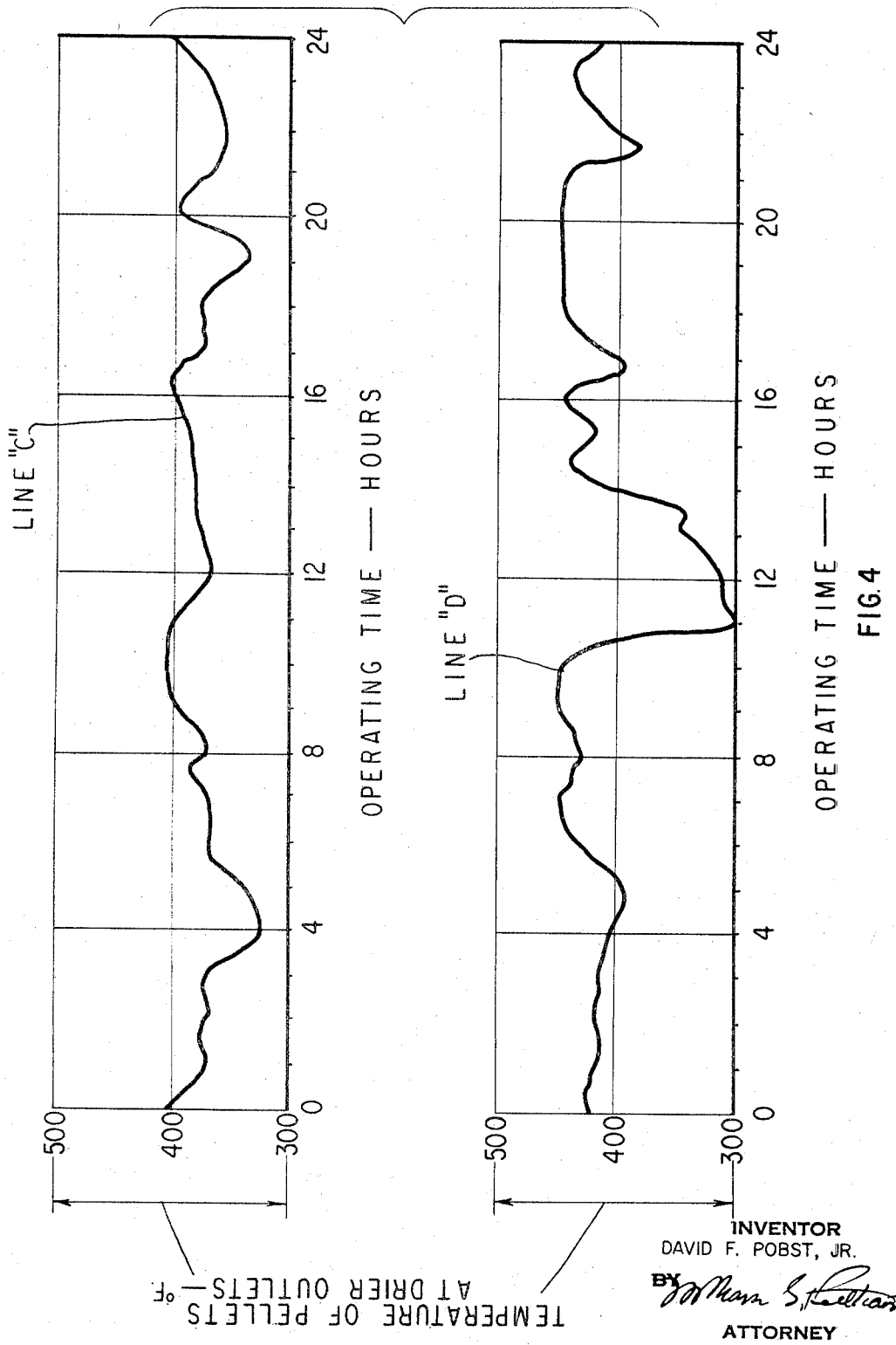


FIG.4

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METHOD AND MEANS FOR PUMPING POWDERED SOLIDS

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Continuation of application Ser. No. 562,758, July 5, 1966. This application Dec. 21, 1967, Ser. No. 692,612
Int. Cl. C01b *31/14;* C09c *1/58*
U.S. Cl. 23—314
21 Claims

ABSTRACT OF THE DISCLOSURE

Dry powder, such as carbon black, is aspirated into a closed chamber. The inlet opening is then sealed off, and the powder is positively discharged in the opposite direction through a coaxial outlet opening by mechanical displacement. Successive repetition of the aspiration and discharge steps results in the pumping of the powder from the chamber as a pulsating stream under pressure.

SUMMARY OF THE INVENTION

This application is a continuation of Ser. No. 562,758 filed July 5, 1966, and now abandoned.

As used herein, the term "condensed carbon black powder" refers to carbon black in particulate, flocculent form, the black not being entrained in a gas, as in an aerosol, but having sufficient gas entrained therein to render the powder freely flowing. Condensed carbon black powder is, therefore, distinguished from both powder in the aerosol form and pellets produced by deliberate aggregation of powdered particles.

DETAILED DESCRIPTION OF THE INVENTION

Condensed carbon black powders that are substantially dry have a moisture content below the amount that results in caking or the formation of pastes or slurries of the powder. Such substantially dry, condensed carbon black powders are commonly produced during carbon black manufacturing processes when the black particles are fractionated from an aerosol within cyclones, bag filters or other types of suitable separating equipment. After separation, the condensed powder may be stored in a reservoir, such as a surge tank or storage bin, prior to packaging or further processing.

The conveying and metering of such substantially dry, condensed carbon black powder are subject to well-known difficulties. For example, the material may bridge in the discharge hopper of a reservoir, thus interrupting gravitational flow to an outlet through which powder is fed to a meter or conveying apparatus. The maintaining of a constantly controlled feed rate is, as a result, difficult to achieve.

To overcome these difficulties, various means such as screw conveyors, variable belt conveyors, and various types of pumps, including a screw type powder pump, have been used. These means have not been entirely satisfactory, however, in controlling feed rates. This is due in part to the constantly changing density of the powder as air is de-entrained from it. It is also due to the tendency of some powders to flow like a liquid when well fluidized or, alternately, to refuse to flow without bridging when not fluidized. For these reasons, it has heretofore been necessary to convert condensed powder to aerosol form prior to conveyance through ordinary pipe. In the condensed state, it could not be pumped or piped without encountering frequent plugging in the piping system or in the pump itself. The forming and conveying of the aerosol are undesirable due to the need for more costly and elaborate equipment for these purposes.

It is an object of the present invention to provide an improved method and apparatus for pumping condensed carbon black powder.

It is another object of this invention to provide a pumping method and apparatus obviating the necessity for converting the condensed carbon black to aerosol form.

It is another object of this invention to provide a pumping method and apparatus by means of which a constantly controlled powder feed rate may be achieved.

It is a further object of this invention to provide a powder pumping method and apparatus in which the bridging and plugging tendencies of the powder are minimized.

With these and other objects in view, the present invention shall be described and claimed hereinafter with respect to the accompanying drawings in which:

FIGURE 1 is a vertical cross-section of a pump for conveying substantially dry, condensed carbon black powder;

FIGURE 2 is a diagrammatic view showing an apparatus arrangement for wet pelletizing carbon black powders while employing the pump illustrated in FIGURE 1 as the metering pump for conveying the powder from a surge tank to a wet pelletizing machine;

FIGURE 3 shows plots of liquid feed rate to a wet pelletizing machine vs. time expressed in hours and compares liquid feed rates when using the diaphragm pump of FIGURE 1 (Line A) and a helical screw (Line B) as a feeder for carbon black powder;

FIGURE 4 shows plots of pellet temperature as removed from a drum drier vs. time expressed in hours of operation and compares temperature when using the diaphragm pump of FIGURE 1 (Line C) and a helical screw (Line D) as a feeder for the carbon black powder.

The objects of the present invention are accomplished by aspirating a quantity of substantially dry, condensed carbon black powder into a closed chamber through an inlet opening in the chamber and thereafter sealing off the chamber inlet opening and discharging the powder as a fluid-solid stream through an outlet opening by mechanical displacement means that provide forceful and positive discharge of the powder from the chamber. The chamber outlet is then sealed off, and another charge of carbon black powder is aspirated into the chamber. By successively repeating the steps of aspiration and discharge, a pulsating suction can be provided at the chamber inlet opening for drawing powder into the chamber. Similarly, carbon black in dry, fluid-solid form can be discharged from the chamber outlet opening as a pulsating stream under pressure. By means of the present invention, a more constant rate of carbon black flow has been achieved than is obtainable by previous means that are susceptible to bridging of the non-fluidized material and plugging of the feed system. The pulsating suction has a tendency to overcome bridging, as results, for example, when gravity alone is relied upon to transport the powder from a feed hopper into a conveying system. At the same time, the positive displacement nature of the pump prevents free flow of highly fluidized material through the pump. Furthermore, it has been found that the present invention permits the fluid-solid discharge stream to be conveyed through a surprisingly small piping that can be quickly and economically installed.

In one embodiment of this invention, suction and discharge pressures are supplied to a pumping chamber by means of a material displacement member arranged to move back and forth in the chamber space. The material displacement member can conveniently be a flexible diaphragm that seals one end of the closed chamber space and is adapted to flex back and forth in the interior space of the closed chamber. In a preferred arrangement, the chamber inlet and outlet openings for passage of material

are located opposite the internal face of the mechanical displacement member, one of the openings having an annular configuration and the other located centrally with respect thereto.

The method and apparatus of the present invention may be conventiently adapted to provide pulsating suction and discharge pressures having essentially reproducible values on each pulse. The invention may thus be used for the volumetric feeding of carbon black powder in processes requiring an essentially uniform rate of carbon black feed. In the wet pelletizing of carbon black powders, for instance, control over the pelletizing process and the quality of the resulting pellets is greatly enhanced by means of the present invention.

In order to more fully describe the present invention, an embodiment thereof is hereinafter described with reference to the accompanying drawings. In FIGURE 1, a closed pump chamber **1** is bounded by the internal wall **2** of a cylindrical pump casing **3**, the internal face of the material displacement member **4**, and the top surfaces of flexible ring **5** associated with the inlet valve **7** and seal disc **6** associated with the outlet valve **8**.

The displacement member represented at **4** consists of a flexible rubber diaphragm **9**, plunger plate **10** and clamp **11**. Plunger plate **10** and clamp **11** are fastened together with bolts **12** and securely grip the diaphragm **9** to permit flexure thereof by up and down movement of the plunger rod **13**. The peripheral edge of the diaphragm is tightly fastened to a register surface **14** of the pump casing **3** by clamp ring **15** compressed by clamping bars **16** and the associated bolts **17** screwed into receptacles **18** that are attached to pump casing **3**.

Beneath the pump chamber **1** is an annular material inlet passage **19** bounded by an inner cylinder **20**, an outer cylinder **21**, and a floor piece **22**. Material drawn into the pump enters the annular passage **19** through conduit **23** and subsequently passes through the inlet valve, represented at **7**, into the pump chamber **1**. Centrally located within the annular material inlet passage **19** is a material outlet passage **24** bounded by the internal wall of the inner cylinder **20** and end piece **25**. Material being discharged from the pump leaves chamber **1**, passes through the outlet valve represented at **8**, enters the outlet chamber **24**, and subsequently leaves the pump through conduit **26**.

The inlet valve represented at **7** is essentially a check-valve and consists of a flexible ring **5**, suitably made of rubber, a ring-shaped seat **27** and a ring-shaped seal **28**. The internal edge of the flexible ring is clamped in position over the cylindrical inner wall **20** by means of clamp ring **29** and associated bolts **30**. The ring-shaped seat **27** is fastened to the lower surface of flexible ring **5** by means of a clamping ring **31** and associated bolts **32**. The ring-shaped seal **28** is located beneath the ring-shaped seat **27** for complete uniform contact between the opposing surfaces of each when the inlet valve is closed. When arranged as shown in the drawing, the inlet valve opens when the material displacement member **4** is raised sharply upwards away from the flexible ring **5**, thus creating a suction in chamber **1**. The higher pressure in the annular inlet **19** forces the flexible ring **5** to flex upward lifting seat **27** from seal **28**, thus creating an inlet opening into pump chamber **1**. Since the seat and seal are ring-shaped, the inlet opening extends all the way around the bottom of pumping chamber **1** and, therefore, has an annular configuration. Inlet valve **7** is closed when the pressure in the chamber **1** is greater than that in inlet passage **19** or when no pressure differential exists between those two spaces. Therefore, valve **7** closes when the material displacement member is moved downward toward flexible ring **5**, and the valve remains closed when the displacement member is at rest.

The outlet valve represented at **8** is also essentially a check-valve and consists of a seal **6**, a circular seat **33**, a backing disc **34** having a spring mount **35**, a spring **36**, and a spring seat **37** attached to a spring compression adjustment rod **38** arranged for axial movement through a guide **39**. The circular seat **33** is located around a center opening in a rigid ring-shaped plate **40** bolted onto cylinder **20** by means of clamping ring **29** and bolts **30**. The seal disc **6** is maintained rigid by means of the backing disc **34** and is attached thereto by bolts and washers **41**. In the arrangement shown in the drawing, the outlet valve opens when the material displacement member is moved downward toward the seal disc **6**, thus creating a pressure in chamber **1**. As a result, seal disc **6** of the outlet valve is displaced from contact with seat **33** when the pressure in pump chamber **1** is greater than the compressive force of the spring **36** urging seal disc **6** upward, thus creating an outlet opening between seal disc **6** and seat **33** for passage of material out of chamber **1**. The outlet valve closes when the material displacement member is moved away from seal disc **6**, thus creating a vacuum in chamber **1** since the seal disc is urged into contact with seat **33** by the spring **36**. Furthermore, the outlet valve remains closed when the material displacement member is at rest.

Prefereably the aforementioned seats and seals are provided with flat contacting surface having an annular cross-section. The seats are preferably provided with a tapered side wall extending away from the seal contacting surfaces. Ideally, the seal-contacting surfaces of the seats have a cross-sectional configuration of a thin ring, since the tendency for carbon black to cake on the contacting surfaces is greatly reduced by minimizing their area of contact. Suitable seats and seals may be made of hard metal and rubber, respectively, but it will be understood that other designs and materials of construction may be employed.

In order to optimize pumping efficiency, the pressure employed to seat seal disc **6** may be regulated by adjusting the compression of spring **36**. This may be accomplished by turning the adjustment rod **38** in nut **42**, which is affixed to the end plate **25**, thereby moving the spring seat **37** up or down and thereby adjusting the compression on spring **36** so that the amount of pressure required to unseat the seal disc is correspondingly altered. Once the compression of the spring is properly adjusted further movement of the rod **39** is prevented by tightening lock nut **43** against nut **42**.

When pumping carbol black powders of certain types, it is sometimes beneficial to introduce small amounts of a nonreactive gas into the interior of the pump either intermittently or continuously. In the pump shown in FIGURE 1, the gas may be fed in through conduit **44** which supplies a ring **45** having a series of exhaust openings **46**. Introduction of the nonreactive gas into the pump is intended to render the carbon black powder more fluid without forming an aerosol, or the gas may be introduced intermittently but forcefully in order to clean the inlet and outlet valves of deposits which may cake thereon.

To operate the pump, the plunger rod **13** is moved up and down through a pre-established distance at a constant rate with a suitable drive means, not shown. This results in flexure of diaphragm **9** so that the material displacement member moves back and forth within the pump chamber **1** to produce, alternately, vacuum and pressure within the chamber. Since the stroke of the material displacement member is constant during each pumping cycle, the vacuum and pressure produced within the pump chamber **1** is reproducible from one cycle to the next. Where desired, means may be employed for re-establishing the pumping cycle rate or the length of stroke, and since such means will be apparent to one skilled in the art, they need not be described herein.

In accordance with FIGURE 1, powder is aspirated into the pump when the material displacement member is moved upwards. Conduit **23** is interconnected with a reservoir for the powder, and upon creating a vacuum within chamber **1**, inlet valve **7** opens and a quantity of the powder is pulled into the chamber.

As the cycle continues, the material displacement member moves downward, outlet valve **8** is forced open by pressure created within chamber **1**. At the same time, inlet valve **7** closes to prevent reversal of flow out of the inlet opening. Continued downward movement of the material displacement member holds the outlet valve open so that material is discharged from the chamber outlet opening into outlet chamber **24** and finally passes out conduit **26** which interconnects with a point of delivery for the powder. When the material displacement member moves upward, the outlet valve closes and remains closed until the chamber is again pressurized, thus preventing reversal of flow through the chamber outlet opening.

It will be apparent that successively repeated in and out movement of the material displacement member results in a pulsating suction at the pump inlet, and a pulsating discharge at the pump outlet, thus effecting a pulsating pumping action. The resulting pulsating flow of powder to and from the pump is highly beneficial in overcoming plugging or bridging which could interrupt the pumping operation. The pulsations produced provide an effect akin to vibration that is created by repeated interruption of suction and discharge pressures.

Flow of powder through the pump itself is greatly facilitated by arrangement of the inlet and outlet openings in accordance with FIGURE 1. It can be seen that powder enters the pumping chamber axially, in respect to movement of the material displacement member, and then leaves the chamber axially in the opposite direction without having to travel from one side of the pump chamber to the other beneath the diaphragm. Placement of the chamber inlet and outlet openings opposite the face of the material displacement member, while locating one opening centrally of the other, minimizes lateral movement of the powder during transit through the pump. This placement at the same time permits both openings to have a maximum size in respect to the displacement member employed. In the pump illustrated in FIGURE 1, the inlet and outlet openings are located coaxially and centered opposite the point of maximum flexure of the diaphragm. Since the outlet is centrally located, powder may be discharged through the outlet while minimizing lateral displacement of the powder.

Although the illustrated pump has an annular chamber inlet with an outlet located centrally thereof, it will be understood that this arrangement can be reversed by suitable revision of the valves. Furthermore, the material displacement member need not necessarily consist essentially of a diaphragm as herein described, but may consist of a piston, bellows or the like.

The carbon black pumping rate is determined, of course, by a number of factors subject to variation. These include the size of the pump, speed of cycling and length of the stroke. When desired, the discharge streams from two or more pumps may be joined together to increase the rate of material flow.

FIGURE 2 is a diagram illustrating a wet pelleting process for converting carbon black powders into pellets, wherein the pump of FIGURE 1 is employed for conveying a metered stream of condensed carbon black powder from a surge tank to a wet pelletizing machine. Carbon black powder that has been freshly condensed from an aerosol is fed into a process surge tank **47** through conduit **48**. Within the tank, the dry powder is slowly stirred with agitating members **49**, mounted on a rotating shaft **50**, to promote settling of the powder. Pump **51**, having drive means represented at **51***a*, is interconnected with tank **47** and a wet pelletizing machine, represented at **52**, through an inlet conduit **53** and a discharge conduit **54**. Wet pellets formed in the pelletizing machine are passed through conduit **55** into a pellet polisher **56** and subsequently into a drier, generally represented at **57**, through conduit **58**. Dried pellets are removed from the drier through discharge spout **59**.

The wet pelletizing machine **52** consists essentially of an elongated conduit **60** having an axially mounted shaft **61** rotated by drive means, represented at **62**, and provided with agitating members **63** which project radially from the shaft. A metered stream of liquid feed, e.g. water, oil, or an aqueous solution of binder for the powder particles, is fed into conduit **60** through line **64**. Metered streams of carbon black powder and liquid are thus fed into the wet pelletizer at carefully proportioned rates which result in pellets having a desired size, shape, and liquid content when the mixture of powder and liquid are subjected to agitation within conduit **60**. Variations in feed rate of powder or liquid may result in pellets having improper shape or size, "dusting out" or "mudding out" of the pelletizer, or overloading of the drier due to excessive liquid content of the pellets.

Within the polisher **56**, the wet pellets are subjected to additional agitation for further rounding and smoothing thereof. Construction of the polisher is akin to that of the wet pelletizing machine, since it likewise consists essentially of an elongated conduit **65** that houses agitating members **66** affixed to a rotating shaft **67** and extend radially therefrom, the shaft being rotated with a drive means represented at **68**.

The drier represented at **57** is employed for removal of liquid incorporated into the pellets during formation, but undesirable in the finished product. A horizontally elongated rotating drum **69** is heated externally by means of hot gases generated by burners **70**. The drum **69** is enclosed with an insulated shell **71** which directs the flow of hot gases around and in contact with the surface of the drum before passing out of exhaust stack **72**. The left-hand end of the drum is sealed with a hood **73** having the pellet discharge spout **59** and an inlet conduit **74** for introducing purge gases through the interior of the drum. The right-hand end of the drum is sealed with another hood **75** having an outlet through which liquid vapors and purge gases are removed from the interior of the drum during the drying operation.

In the wet pelletizing machine **52**, the carbon black powder and wetting liquid are subjected to agitation by bars **63** as the wetted powder mass advances axially from left to right. Ideally, the rotational speed of the shaft **61** and the feed rates of both powder and liquid are all held constant, for when such is the case, little or no variation occurs in the quality of the wet pellets once optimum conditions have been established. In practice, however, control of the powder feed rate has proven very difficult because of problems with bridging, plugging and variation in bulk density of the powder. Frequent adjustments in liquid feed rate were necessary to compensate for fluctuations in powder feed rate since the latter resulted in consequential variations in pellet quality. In accordance with the present invention, the pump of FIGURE 1 may be employed as a metering pump for the carbon black feed stream passed into the wet pelletizer, and when such is the case, regulation of the liquid feed rate may be substantially reduced in degree and frequency, thus providing pellets of higher quality.

Example

Substantially dry, freshly condensed carbon black (ISAF grade) was conveyed from a surge tank to a wet pelletizing machine substantially in accordance with the process as shown in FIGURE 2 except that two pumps, arranged in parallel, were employed instead of one.

Each pump was constructed substantially in accordance with FIGURE 1, having an internal chamber diameter of 11 inches, annular material inlet passage of 5¾" I.D. x 9¾" O.D. and a cylindrical material outlet passage of 4½" diameter. The outside diameter of the inlet valve seat was 10 inches, and the inside diameter of the outlet valve seat was 3 inches. Inside diameter of the inlet and outlet conduits, at the pump, was 2 inches. The total distance over which the diaphragm was flexed back and

forth within the pump chamber space (stroke) was 3 inches. The operating speed of the pump was 90 cycles per minute, which effected a carbon black pumping rate of approximately 2,290 lbs./hr. for the two pumps. Air was fed into the pump for aeration of the carbon black powder at the rate of about 2 s.c.f.m.

From the pump, the fluid-solid stream of carbon black was conveyed through 60 feet of 2 inch I.D. flexible pipe to a wet pelletizing machine into which an aqueous solution of binder material was also introduced at the rate of 335 gallons per hour. Within the wet pelletizing machine the carbon black powder and binder solution were mixed together under agitation to form wet pellets which were subsequently polished and dried to produce dry pellets having a moisture content not exceeding 1% by weight.

It can be seen from Line A of FIGURE 3 that almost no regulation in the flow rate of the aqueous solution of the binder fed into the wet pelletizing machine was required over a 24 hour operating period. Line B shows the amount of regulation required when attempting to maintain the same feed rates for carbon black powder and liquid to the pelletizing machine when employing a helical screw as a feeder for the powder. It was not possible to maintain a constant powder feed rate with this screw feeder because of variations in bulk density and bridging in the feed hopper. Consequently, variations in the powder feed rate required that the liquid rate be frequently adjusted in attempt to maintain pellet quality.

In a like manner, Line C of FIGURE 4 shows the temperature of pellets being removed from the outlet of the drier during the same 24 hour period when using the diaphragm pump as a powder feeder for the pelletizer, while Line D shows the temperature of the pellets at the outlet when using the screw feeder mentioned above. In the drying of carbon black pellets, quality is influenced by drying temperature, i.e. the surface chemistry of the carbon black particles may be altered by excessive drying temperatures or substantial fluctuations therein. Since these surface chemistry effects markedly influence the performance of compounds in which the black is incorporated, adequate control of drying temperature is very important. Comparison of Lines C and D indicate that more desirable drying conditions existed when employing the diaphragm pump as the powder feeder for the pelletizing machine since a generally lower temperature of drying was maintained, with less fluctuation than was experienced when using the helical screw as the powder feeder.

While the invention has been described herein with reference to particular embodiments thereof, it will be readily apparent to those skilled in the art that various changes and modifications can be made therein within the scope of the invention as set forth in the appended claims.

I claim:

1. In a process for treating carbon black, the method of feeding the carbon black as an essentially dry, condensed powder at a uniform predetermined rate comprising:

(a) aspirating a quantity of substantially dry, condensed carbon black powder through an inlet into a closed chamber by means of a vacuum imposed therein by the movement of a mechanical displacement member in one direction within said closed chamber;

(b) sealing off said inlet and discharging the carbon black powder from said closed chamber by means of positive pressure created by movement of the mechanical displacement member through said closed chamber in the opposite direction;

(c) thereafter aspirating another quantity of powder into said chamber and successively repeating the steps of aspirating and discharging powder from said closed chamber;

(d) passing the discharged powder as a pulsating stream of dry carbon black powder into a treating zone requiring input of said carbon black powder at a predetermined rate, whereby a pulsating action is provided that tends to break the bridging of non-fluidized carbon black and also provides a pulsating, flowing stream of condensed carbon black powder through the system so that a relatively uniform, predetermined rate of flow into said treating zone is maintained.

2. In a feed system for transporting essentially dry, condensed carbon black powder, pumping means resulting in improved carbon black flow rate characteristics and reduced tendency of the carbon black to plug the feed system comprising:

(a) a closed chamber having an inlet opening adapted to receive carbon black powder and an outlet opening adapted to discharge carbon black powder from the closed chamber, one of said openings having an annular configuration and the other being located centrally with respect thereto;

(b) a material displacement member adapted to move back and forth in the interior space of said chamber, the internal face of said member comprising one end of said closed chamber;

(c) means for opening the chamber opening having an annular configuration when said material displacement member is moved in one direction within said chamber and for closing said opening when said material displacement member is moved in the opposite direction within said chamber, said means comprising:

(1) a ring-shaped seal around the chamber opening having an annular configuration,

(2) a flexible ring adapted to flex back and forth in the same relation as said material displacement member,

(3) a ring-shaped seat mounted on said flexible ring, said ring-shaped seat being displaced from contact with the ring-shaped seal by flexure of the flexible ring when said material displacement member is moved in one direction, and said ring-shaped seat being in contact with the ring-shaped seal when said material displacement member is moved in the opposite direction,

(d) means for opening said chamber opening located centrally with respect to the opening having an annular configuration when said material displacement member is moved in a direction so as to close said opening having an annular configuration and for closing said chamber opening when said material displacement member is moved in a direction so as to open the chamber opening having an annular configuration,

whereby movement of said material displacement member in one direction creates a suction within said chamber capable of aspirating a quantity of condensed carbon black powder into the interior space of said chamber and movement of said material displacement member in the opposite direction creates a pressure within said chamber capable of discharging said carbon black powder from said chamber, said back and forth movement of said material displacement member thereby being capable of achieving a relatively uniform pulsing flow of condensed carbon black powder through the feed system with minimum bridging of said powder and plugging of said feed system.

3. The apparatus of claim 2 in which the material displacement member is a flexible diaphragm.

4. The apparatus of claim 2 and including a wet pelletizing apparatus in communication with the discharge opening of said pumping means, said pelletizing apparatus comprising an elongated conduct having a feed inlet for said carbon black powder and a discharge outlet for wet carbon black pellets, a rotatable shaft running axially

through said elongated conduit, agitating members affixed to said rotatable shaft, means for rotating said shaft, and a means for introducing a stream of liquid into said elongated conduit.

5. The apparatus of claim 2 in which said inlet and outlet openings are located opposite said internal face of the material displacement member.

6. The apparatus of claim 2 in which the means for opening and closing the chamber opening located centrally with respect to the opening having an annular configuration comprises:

(a) a circular seat around said centrally positioned opening for the passage of carbon black,

(b) a seal disc that engages said seat, said seal disc being in contact with said circular seat when the material displacement member is moved in one direction and said seal disc being displaced from contact with said circular seat when said material displacement member is moved in the opposite direction.

7. The apparatus of claim 6 in which the opening having an annular configuration is an inlet through which material is drawn into the closed chamber and the ring-shaped seat is displaced from contact with the ring-shaped seal by movement of the material displacement member away from said flexible ring.

8. The apparatus of claim 7 in which the centrally positioned opening is an outlet through which material is discharged from the chamber, the disc seal being displaced from contact with the circular seat by movement of the material displacement member toward the disc seal.

9. The apparatus of claim 8 in which the disc seal and the ring-shaped seat are arranged for linear axial movement in relation to their respective seat and seal.

10. The apparatus of claim 8 and including spring means urging the seal disc into contact with said circular seat.

11. The apparatus of claim 10 and including means for adjusting the compressive force provided by said spring.

12. The apparatus of claim 8 in which the valve seals have flat faces for contact with said seat and the seal-contacting surfaces of the valve seats are flat and have the cross-sectional configuration of a thin ring.

13. The apparatus of claim 8 in which the closed chamber outlet empties axially into a confined space having a diameter significantly greater than the seat and seal of the outlet valve.

14. The apparatus of claim 13 in which material is supplied to the inlet opening through a second confined space surrounding said axial confined discharge space.

15. A method of pumping condensed carbon black powder in which improved flow rate characteristics and reduced tendency for plugging of the flow system are obtained comprising:

(1) aspirating a quantity of substantially dry, condensed carbon black powder through an inlet into a closed chamber by means of a vacuum imposed therein by the movement of a mechanical displacement member in one direction within said closed chamber;

(2) sealing off said inlet and discharging the carbon black from said closed chamber coaxially but in the opposite direction to the flow of carbon black into the closed chamber by means of positive pressure created by the movement of the mechanical displacement member through said closed chamber in the opposite direction, and

(3) thereafter aspirating another quantity of carbon black powder into said chamber and successively repeating the steps of aspirating and discharging powder from said closed chamber,

whereby a pulsating suction is provided that tends to break the bridging of non-fluidized material and also provides a pulsating, flowing stream of condensed carbon black powder that tends to prevent the free flow of highly fluidized material through the system so that a relatively uniform rate of flow can be obtained.

16. The method of claim 15 in which the pulsating stream of dry powder is passed into a continuous process requiring input of said powder at an essentially constant rate.

17. The method of claim 16 in which said continuous process requiring input of powder at an essentially constant rate is a wet pelletizing process for converting carbon black powder into beads.

18. The method of claim 15 and including the mixing of a non-reactive gas with the carbon black powder within said closed chamber, thereby aerating the powder before it is discharged from said chamber.

19. The method of claim 15 in which said aspirating into and discharging of the carbon black powder from said closed chamber are accomplished by flexing a diaphragm back and forth within the closed chamber, a suction being created within said chamber when said diaphragm is flexed in the opposite direction, the flexure of said diaphragm back and forth thereby causing the pumping of said carbon black powder.

20. In a wet pelletizing process for forming beads from carbon black powder, the method of feeding the carbon black powder into the pelletizing zone at a uniform, predetermined rate comprising:

(a) aspirating a quantity of substantially dry, condensed carbon black powder through an inlet into a closed chamber by means of a vacuum imposed therein by the movement of a mechanical displacement member in one direction within said closed chamber;

(b) sealing off said inlet and discharging the carbon black powder from said closed chamber by means of a positive pressure created by movement of the mechanical displacement member through said closed chamber in the opposite direction;

(c) thereafter aspirating another quantity of carbon black powder into said chamber and successively repeating the steps of aspirating and discharging powder from said closed chamber;

(d) passing the discharged carbon black powder as a pulsating stream of dry powder into a wet pelletizing zone wherein the carbon black powder is converted into pellets, said wet pelletizing zone requiring input of carbon black powder at a predetermined rate;

whereby a pulsating action is provided that tends to break the bridging of non-fluidized carbon black powder and also, provides a pulsating, flowing stream of condensed carbon black powder through the system so that a relatively uniform, predetermined rate of flow of said powder into the wet pelletizing zone is maintained.

21. Apparatus for pelletizing carbon black comprising:

(a) an elongated conduit having a feed inlet for essentially dry, condensed carbon black powder and a discharge outlet for wet pellets of said powder which are formed within the conduit;

(b) a shaft axially mounted within said conduit and rotatable therein;

(c) a series of powder-agitating members which extend radially outward from the shaft;

(d) means for introducing a stream of liquid into said conduit at a predetermined rate;

(e) a closed chamber having an inlet opening adapted to receive essentially dry, condensed carbon black powder and an outlet opening adapted to discharge said powder from the closed chamber to said elongated conduit;

(f) a material displacement member adapted to move back and forth in the interior space of said chamber;

(g) means for opening the chamber inlet when the material displacement member is moved in one direction within said chamber and for closing said opening when said material displacement member is moved in the opposite direction within said chamber; and

(h) means for opening said chamber outlet when said material displacement member is moved in a direction so as to close said chamber inlet and for closing said chamber outlet when said material displacement member is moved in a direction so as to open said chamber inlet;

whereby movement of said material displacement member in one direction creates a suction within said chamber capable of aspirating a quantity of essentially dry powder into the interior space of said chamber and movement in the opposite direction creates a pressure within said chamber capable of discharging said powder from said chamber into said elongated conduit, said back and forth movement of said material displacement member thereby achieving a relatively uniform pulsating flow of the essentially dry, condensed carbon black powder into said elongated conduit with minimum bridging of said powder and plugging of the system.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,434,808 Dated March 25, 1969

Inventor(s) David F. Pobst, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, Claim 19 should appear as follows:

19. The method of Claim 15 in which said aspirating into and discharging of the carbon black powder from said closed chamber are accomplished by flexing a diaphragm back and forth within the closed chamber, a suction being created within said chamber when said diaphragm is flexed in one direction, and a pressure being created within said chamber when said diaphragm is flexed in the opposite direction, the flexure of said diaphragm back and forth thereby causing the pumping of said carbon black powder.

SIGNED AND
SEALED
MAR 17 1970

(SEAL)
Attest:

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