United States Patent [19]

Saito

[11] **3,920,153**

[45] **Nov. 18, 1975**

[54] **POWDER SPRAYER**

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[73] Assignee: **Nikka Kabushiki Kaisha**, Tokyo, Japan

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[30] **Foreign Application Priority Data**

Oct. 8, 1974 Japan 49-121536

[52] **U.S. Cl.** **222/14;** 118/7; 118/308; 118/DIG. 1; 198/37; 222/59; 222/66; 222/412

[51] **Int. Cl.²** **B67D 5/30**

[58] **Field of Search** ..... 222/52, 55, 56, 59, 60, 222/63, 66, 64, 410, 412–414, 14, 17; 198/37, 232; 118/7, 308, DIG. 1

[56] **References Cited**

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Primary Examiner—Robert B. Reeves
Assistant Examiner—H. Grant Skaggs
Attorney, Agent, or Firm—Johnson, Dienner, Emrich & Wagner

[57] **ABSTRACT**

An elongated powder spray chamber is connected with a powder storage chamber by way of a screw conveyer. The screw conveyer extends through a perforated pipe disposed within the spray chamber in the longitudinal direction thereof. Adjacent and opposite to the open end of the pipe is provided a swing plate to be displaced by powder, fed and accumulated in the spray chamber, the displacement of which is detected by a photoelectric detecting means, whereby an electrical control means controls a driving motor of the screw conveyer.

4 Claims, 7 Drawing Figures

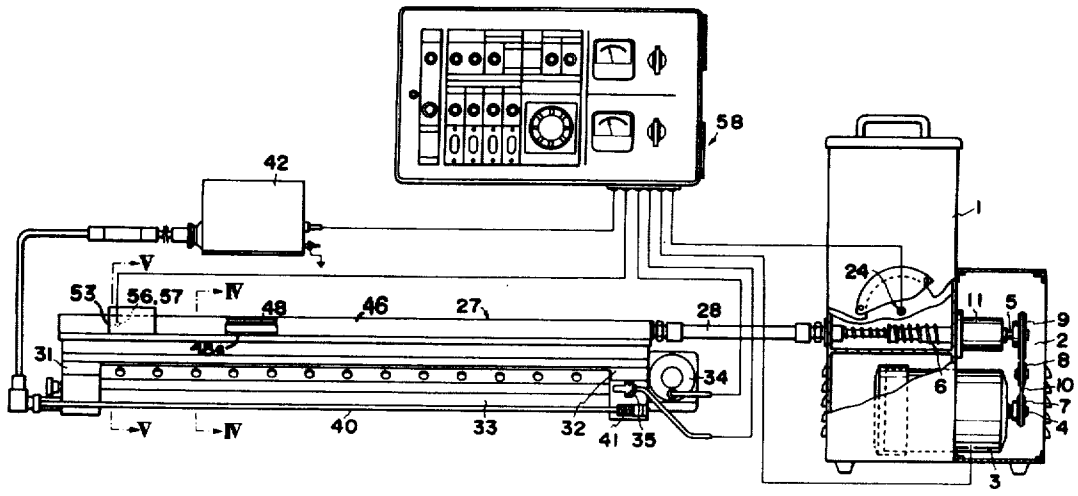

FIG. 1

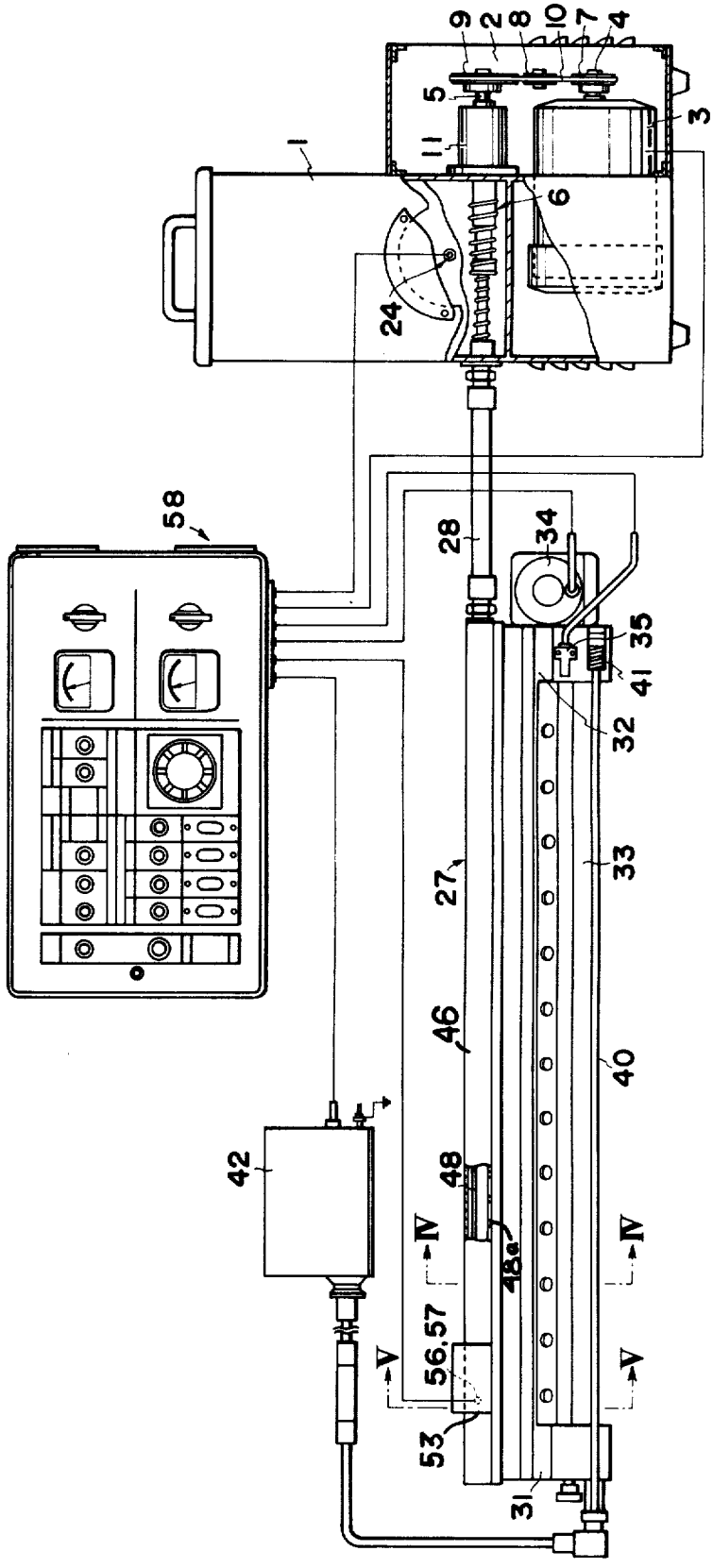
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FIG. 2

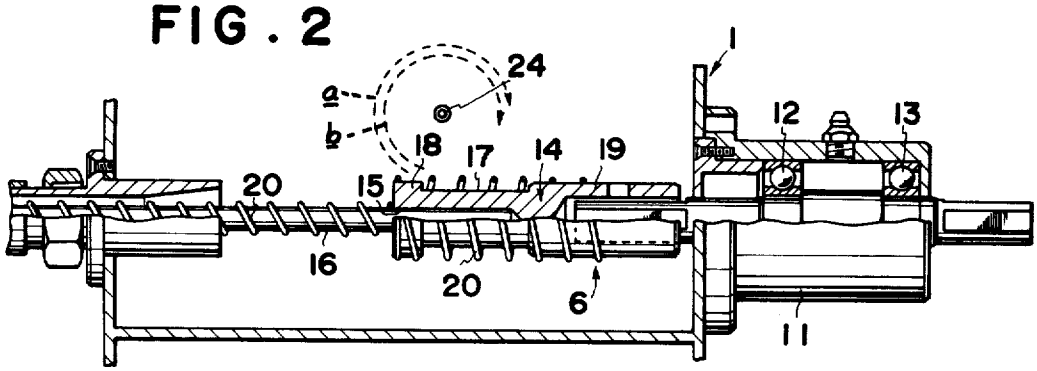


FIG. 3

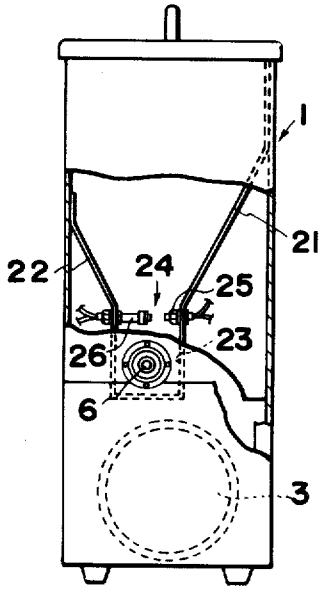


FIG. 5

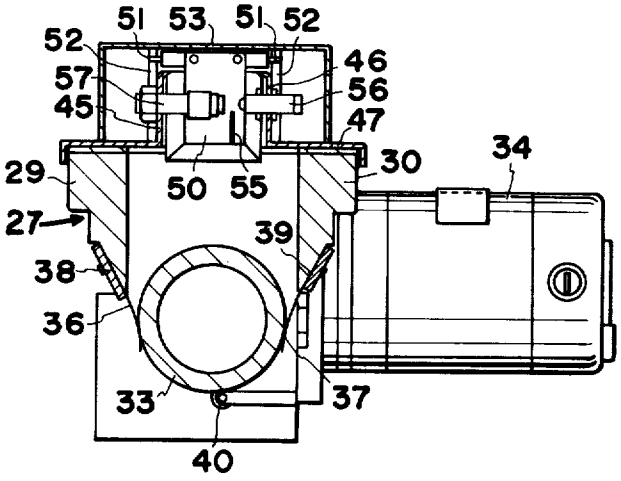


FIG. 4

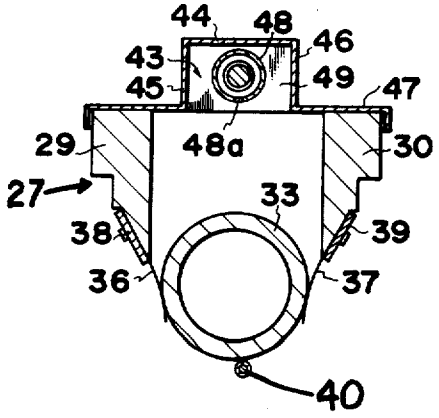


FIG. 6

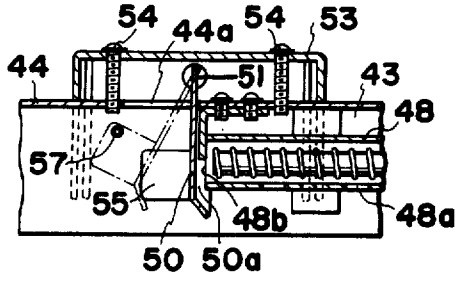
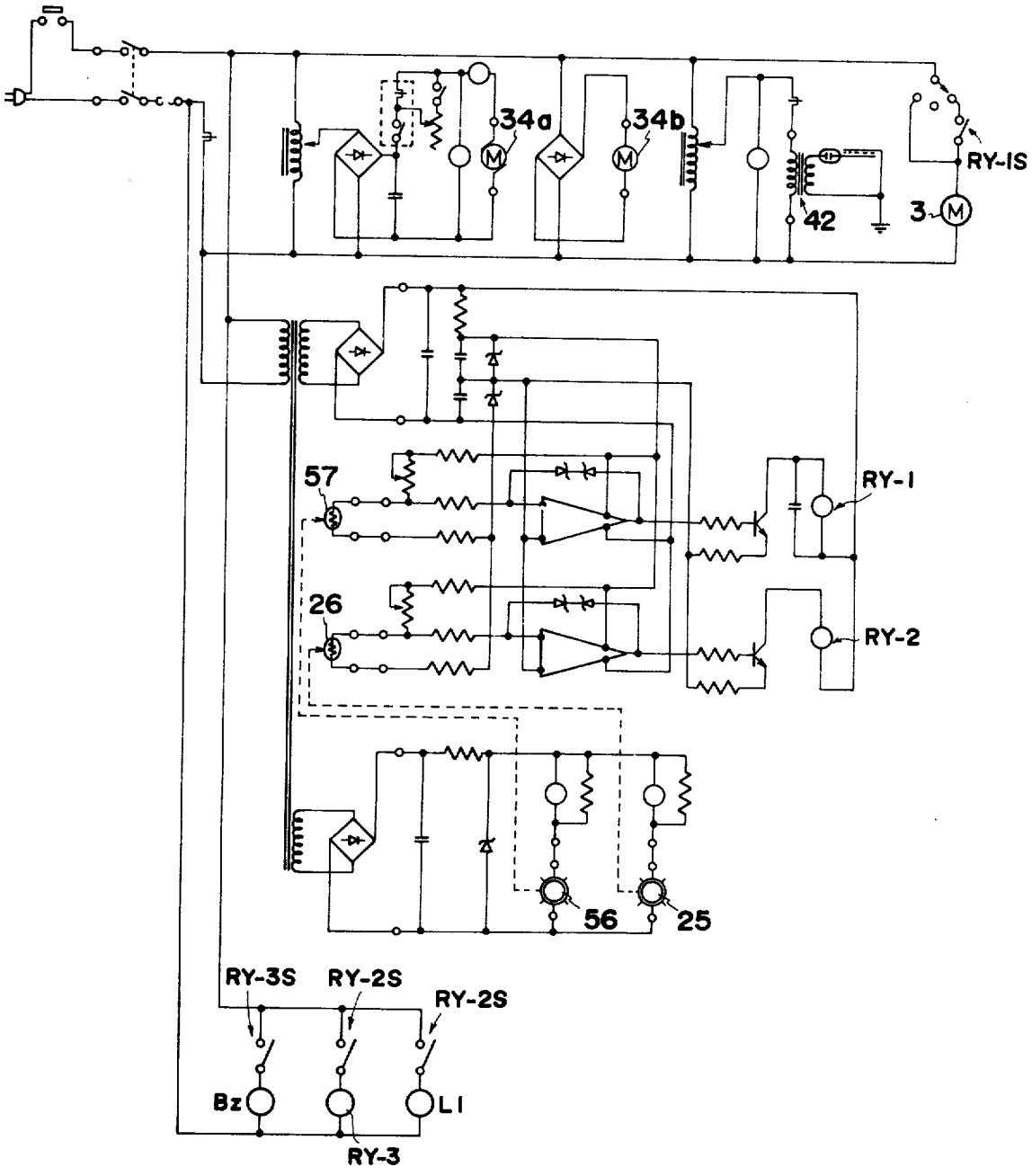


FIG. 7



POWDER SPRAYER

BRIEF SUMMARY OF THE INVENTION

This invention relates to an apparatus for spraying powder upon the surface of papers and synthetic films to prevent ink offset on any printed sheet and to eliminate blocking in the processing of synthetic film or rubber sheeting.

In my U.S. Pat. No. 3,604,981, issued Sept. 14, 1971, I have disclosed a powder sprayer in which powder is continuously spplied in a spray chamber from a powder box and superfluous powder not discharged outside of the spray chamber is circulated and recovered in the power box. This sprayer has an advantage that a predetermined amount of powder is always stored in the spray chamber. However, since the powder used in the sprayer usually has a thin coating of synthetic resin for facilitating separation and slippage among the particles, the resin coating on the powder tends to fall off while the powder travels and circulates for a long way through the spray chamber along the screw conveyer. If the resin coating on the powder falls off, the powder would become lumpy and, thereby, clog the circulation passage of the sprayer.

Accordingly, a main object of the present invention is to provide a powder sprayer in which a desired amount of powder is automatically stored and accumulated in a powder spray chamber without the thin resin thereon being removed.

Another object of the present invention is to provide a powder sprayer in which the decrease of powder in a storage chamber is automatically detected for replenishment.

A further object of the present invention is to provide a powder sprayer in which detection of accumulated powder in the spray chamber and the detection of the decrease of powder in the storage chamber for replenishment are reliably carried out.

In a powder sprayer according to the present invention, an elongaged powder spray chamber is connected with a powder storage chamber by way of a screw conveyer. The screw conveyer extends through a perforated pipe to an open end portion thereof, which pipe is disposed in the spray chamber and extends away from the powder supply side of the spray chamber. Adjacent and outwardly of the open end of the perforated pipe there is provided a swinging plate adapted to be displaced by the powder fed to and accumulated in the spray chamber. A predetermined amount of displacement of the swinging plate by rotation thereof is detected by a photoelectric detecting means having a lamp and a photocell, whereby an electrical control means actuates a driving motor for the screw conveyer when a light from the lamp is received by the photocell, and stops operation of the driving motor when the light beam is interrupted by the swing plate.

Preferably, the screw conveyer inside of the powder storage chamber has an enlarged portion in the outer surface of which an annular groove is formed adjacent to the front or inner end thereof. A spiral wire constituting the screw conveyer is wound round the enlarged portion substantially with the same diameter, so that the amount of powder carried forward between the annular groove and the spiral wire thereabout is greater than that carried by the enlarged front end portion and far greater than that carried by the remaining portion of the conveyer having a smaller diameter, with the result that the speed of movement of the powder carried forward along the annular groove is decelerated as it goes to the front or inner end of the enlarged portion and the screw conveyer portion of smaller diameter and, therefore, the powder is partially prevented from advancing forward and is caused to circulate above the annular groove. Another photoelectric detecting means comprising a lamp and a photocell is disposed in the storage chamber above the front end portion of the annular groove in the screw conveyer for detecting the amount of powder accumulated in the storage chamber. In such an arrangement, since the powder circulates about the detecting portions of the second photoelectric detecting means, when the powder in the storage chamber decreases to a level below the detecting means, there need be no fear that the powder will adhere to the detecting surfaces of the lamp and the photocell and, thereby, reliable detection is insured. Further, as a part of the powder in the storage chamber is thus circulated, no powder bridge is formed above the screw conveyer in the storage chamber, so that the supply of powder to the storage chamber is homogeneous.

The aforementioned and other objects and features of the present invention will become apparent from the following detailed description of specific embodiments thereof, when read in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWING FIGURES

FIG. **1** is a front view partly in section showing a power sprayer according to an embodiment of the present invention,

FIG. **2** is a fragmentary front view partly in section showing, on an enlarged scale, the screw conveyer means in a powder storage chamber of the powder sprayer of FIG. **1**,

FIG. **3** is a side view partly in section showing the powder storage chamber of FIGS. **1** and **2**,

FIG. **4** is a transverse sectional view taken along the plane of line IV—IV of FIG. **1**,

FIG. **5** is a transverse sectional view taken along the plane of line V—V in FIG. **1**,

FIG. **6** is a front sectional view showing an arrangement of photoelectric detecting means disposed in an end portion of a powder spray chamber, and

FIG. **7** is a diagram showing an electric circuit adapted to the powder sprayer in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the powder sprayer as shown particularly in FIGS. **1** and **2** of the drawings, a powder storage chamber **1** is provided on the right hand end. Below the powder storage chamber **1** is provided a housing **2** in which an AC motor **3** is disposed. An output shaft **4** of the motor **3** is operatively connected to a driving shaft **5** for a screw conveyer **6** by means of pulleys **7, 8** and **9** and belt **10**. The driving shaft **5** is rotatably supported in bearings in a casing **11** fixed to the outer surface of the powder storage chamber **1** and containing therein thrust bearings **12** and **13**, and extends partially into the storage chamber **1**, as is best shown in FIG. **2**.

A generally cylindrical sleeve member **14** is keyed to the inner free end portion of the driving shaft **5**. The cylindrical member **14** has an axial recess **15** extending through one end portion thereof, through which a flexible shaft formed of a wire bundle **16** is inserted and secured thereto. The cylindrical member **14** also has a circumferential recess **17** formed on the outer surface

thereof, thereby providing the inner and outer end portions 18 and 19 of larger diameter. A wire 20 is helically coiled around the cylindrical sleeve 14 maintaining a constant diameter, so that small spaces are formed between the inner circumferential surfaces of the coiled wire 20 and the outer surface of the circumferential recess 17. Beyond the inner end 18 of the sleeve 14 the wire 20 continues to be helically coiled around the wire bundle 16 with the same pitch and diameter as said wire bundle along the entire length thereof. Thus, the screw conveyer 6 is composed of the cylindrical member 14, the wire bundle 16 and the coiled wire 20.

As shown in FIG. 3, partition walls 21, 22 are secured to the front and back inner surfaces of the storage chamber 1 and arranged in such a manner that they converge downwardly toward each other for a predetermined distance and then continue downwardly in parallel relation to form a channel shaped recess 23. The screw conveyer 6 is disposed in the channel shaped recess 23.

A photoelectric detecting means 24 comprising a lamp 25 and a photocell 26 is secured to the partition walls 21 and 22, respectively, at the upper portion of the channel shaped recess 23, as shown in FIG. 3 and above the inner end portion of the annular recess 17 in the cylindrical member 14, as shown in FIGS. 1 and 2.

In such an arrangement, after filling the storage chamber 1 with the powder, when the screw conveyer 6 is rotated in the clockwise direction by the motor 3 in the arrangement shown in FIG. 3, the powder about the screw conveyer in the storage chamber 1 advances in the left hand direction in FIGS. 1 and 2. At this time, the amount of powder conveyed during each rotation of the screw conveyer is greatest in the area where the annular recess 17 is formed round the cylindrical member 14 and decreases as it advances to the front or inner end portion 18 thereof, because of the space which is provided between the coiled wire 20 and the annular recess 17. The amount of powder conveyed during each rotation of the screw conveyer further decreases as it advances to the conveyer portion composed of the wire bundle 16 and the coiled wire 20, because the diameter of the coiled wire at that portion is less than that of the cylindrical member 14. Accordingly, the amount of powder conveyed along the annular recess 17 of the cylindrical member 14 decreases as it advances to the front or inner end portion thereof and to the conveyer portion of smaller diameter, because the powder around the latter becomes compacted and forms a so-called "wall." It has been noted in such a structure that the powder conveyed along the annular recess 17 of the cylindrical member 14 moves upwards at the inner end portion 18 and circulates in a path substantially as shown by the arcuate dotted lines *a* and *b*, and in the direction of the arrows associated therewith as shown in FIG. 2.

The photoelectric detecting means 24 set forth above is located in the midst of where the power circulates, so that when the powder in the storage chamber 1 decreases to a level below the photoelectric detecting means, there will be no powder accumulated or on the surface thereof interrupt the beam from the lamp 25 to the photocell 26. Further, due to the circulation of the powder in the storage chamber 1, the powder therein will not form a cavity about the screw conveyer, or a so-called "bridge," to prevent the conveyance of the powder.

Referring again to FIG. 1, the powder storage chamber 1 is connected to a powder spray chamber 27 through the screw conveyer composes of the wire bundle 16 and the coiled wire 20 and covered with a flexible pipe 28, one end of which extends partially in the powder storage chamber 1.

The powder spray chamber 27 has, as shown in FIGS. 1, 4 and 5, an elongated front plate 29 and back plate 30, the ends of both of which are attached to and supported by plates 31 at the left and right ends thereof respectively. A roller 33, the peripheral surface of which is roughly formed, is rotatably supported by the plates 31 and 32 and connected to a drive motor 34. The rotation of the roller 33 is detected by a detector 35, which produces an electric signal through an electric circuit as shown in FIG. 7 in an abnormal case where the driving force of the motor 34 is not correctly transmitted as the rotary movement of the roller 33. This detection system does not constitute a part of the present invention, so that detailed explanation shall be omitted here.

The front and back plates 29 and 30 of the spray chamber 27 are tapered at their lower ends, respectively, on which doctor blades 36 and 37 are fixed by mounting plates 38 and 39, respectively, in such a manner that the lower end portions of the doctor blades 36 and 37 contact the peripheral surface of the roller 33 as shown in FIGS. 4 and 5.

Disposed closely adjacent to the lower peripheral surface of the roller 33 is an insulated electric wire 40, which is supported at both ends thereof by the left and right side plates 31 and 32 of the spray chamber 27 and stretched by a compression spring 41 provided in a recess of the right side plate 32 to urge the enlarged right end of the wire toward the right. Thus, the relationship between the roller 33 and the insulated wire 40 is the same along the entire length of the roller 33. The left end of the insulated wire 40 extends beyond the plate 31 and is connected to a high-tension generating device 42 having a transformer which can change the primary voltage of 100 volts a.c. to the secondary voltage of 7 kv. The high-tension generating device 42 is further connected to a control box by a conductive wire, which shall be referred hereinafter.

At the upper part of the spray chamber 27, there is provided a narrow compartment 43 (FIG. 4) defined by an upper plate 44 and front and back walls 45 and 46. The narrow compartment 43 is open at the lower portion thereof and communicates with the space defined by the front and back plates 29 and 30 and the left and right side plates 31 and 32 of the powder spray chamber 27. Preferably, the narrow compartment 43 removably rests upon the front and back plates 29 and 30 of the spray chamber 27 by shoulder portion 47 thereof.

Within the narrow compartment 43 there is provided a perforated pipe 48 extending near the left side plate 31 of the chamber 27. Perforations 48*a* of the pipe 48 are provided through the lower circumferential portions and along the length thereof at substantially equal intervals of about 25 mm. Preferably, the diameter of the perforations gradually becomes larger as the pipe 48 extends in the narrow compartment 43. The perforated pipe 48 is fixed in position by a plurality of rubber packings 49 wedged between the front and back walls 45 and 46 of the narrow compartment 43 at locations between the perforations 48*a* so they will not be blocked. The screw conveyer composed of the wire bundle 16 and the coiled wire 20 extends through the

perforated pipe **48** along the entire length thereof.

Outwardly of and adjacent to the open end **48***b* of the perforated pipe **48** there is provided a swinging plate **50**, the upper end of which passes through an opening **44***a* cut out of the upper plate **44** of the compartment **43** and is pivotally connected to a shift **51** mounted in supporting plates **52**, which are attached to and extend upwardly from the front and back walls of the compartment **43**. The opening **44***a* in the upper plate **44** of compartment **43** is closed by a housing or cover **53**, secured in place by bolts **54** threaded to the upper plate **44**. Preferably, the swinging plate **50** has a concaved space **50***a* facing the open end **48***b* of the perforated pipe **48**, which space **50***a* is defined by the inclined lower and both side edges as will be seen in FIGS. **5** and **6**. In place of forming such a space **50***a*, however, it will be sufficient if only the lower edge portion of the swinging plate **50** is inclined toward the open end **48***b* of the perforted pipe **48** to form an angle of 130–150 degrees as will be seen in the sectional view in FIG. **5**. The swinging plate **50** has a fin **55** at the back thereof or left side thereof as seen in FIG. **6**.

Detecting means including lamp **56** and a photocell **57** are attached tothe upper part of the narrow compartment **43** through the front and rear walls **46** and **45** thereof, respectively, in such a manner that when the swinging plate **50** is displaced, a predetermined amount, by rotation about the shaft **51**, the light beam extending between the lamp **56** and the photocell **57** is interrupted by the fin **55** mounted on the swing plate **50**.

With the arrangement of the powder spray chamber **27** set forth above, the powder carried in the perforated pipe **48** from the powder storage chamber **1**, by the screw conveyer, falls through the perforations **48***a* in the pipe **48** and through the open end **48***b* thereof and is accumulated in the space directly above the roller **33**. The powder attached on or caught by the rough surface of the roller **33** comes outside of the chamber **27** by rotation of the roller and is blown down by "ion-wind" generated by means of corona discharge of the high-tension insulated wire **40**. Thus, the powder is sprayed on a sheet material such as a printed paper (not shown) below the spray chamber **27**. However, the amount of powder conveyed in the spray chamber **27** is greater than that sprayed outside of the chamber, so that the amount of powder accumulated in the space above the roller **33** gradually increases. While the powder is fed in the spray chamber **27** by the conveyer, the powder discharged from the open end **48***b* of the perforated pipe **48** is partially displacing the swinging plate **50** about the shaft **51** by the force produced by the discharge, and when the powder in the spray chamber is accumulated to a predetermined level where the perforations **48***a* in the pipe **48** are substantially closed, most of the powder is discharged through the open end **48***b* thereof and rapidly accumulated about it, with the result that the swinging plate **50** is rapidly displaced to a position shown by the dot-dash lines in FIG. **6** where the fin **55** of the swinging plate **50** intersects the straight line between the lamp **56** and the photocell **57**. While the present powder sprayer is in operation, the lamp **56** emits light continuously. The present powder sprayer is so constructed that, when the light from the lamp **56** is received by the photocell **57**, the driving motor **3** for the powder conveyer is operated and when the light beam from the lamp **56** is interrupted, the driving motor **3** stops operating. Thus, as will be apparent from the disclosure hereinabove, when the powder accumulated in the spray chamber **27** displaces the swing plate **50** to the position shown by the dot-dash line in FIG. **6**, an electric signal is produced to stop the operation of the driving motor **3** of the conveyer screw. Thus, the amount of powder stored in the powder spray chamber **27** is kept to almost constant.

Reference is now made to FIG. **7** showing an electric circuit for controlling the driving motor **3** of the screw conveyer of the powder, which is arranged in a control box **58**.

While the light beam from the lamp **56** in the powder spray chamber **27** is received by the photocell **57**, a relay RY-1 is operated to close its contact RY-1S, so that the screw driving motor **3** is actuated to operate the screw conveyer. On the other hand, when the light from the lamp **56** to the photocell **57** is interrupted, the relay RY-1 is deenergized to open the contact RY-1S, so that the screw driving motor **3** stops operating. Thus, when the swinging plate **50** is displaced by the powder accumulated in the spray chamber **27** and interrupts the light beam from the lamp **56** to the photocell, the screw driving motor **3** stops. Otherwise, the driving motor **3** is operated to feed the powder in the spray chamber by the screw conveyer, so that automatic control of the driving of the screw conveyer is effected in the present powder sprayer.

Referring now to operation of the photoelectric detecting means **24** provided in the powder storage chamber **1**, when the light from the lamp **25** is received by the photocell **26**, a relay RY-2 is actuated to close its contact RY-2S. When the contact RY-2S is closed, an alarm light L-1 in the control box **58** is put on. At the same time, another relay RY-3 is actuated to close its contact RY-3S, so that an alarm buzzer Bz is actuated to notice the lack of power in the storage chamber **1**. As is apparent from the disclosure set forth above, the detecting means **24** is the storage chamber is actuated only when the powder therein is decreased to a level below the line between the lamp **25** and the photocell **26**.

In FIG. **7**, reference numerals **34***a* and **34***b* designate armature and field, respectively, of the motor **34** for driving the roller **33**.

As will be apparent from the disclosure set forth above, according to the present powder sprayer, the powder is automatically accumulated in the spray chamber to a high level by the screw conveyer which is operated by the detecting means in the spray chamber. The powder accumulated in the spray chamber is sprayed outside thereof and not recovered as in the case of the aforementioned U.S. Pat. 3,604,981, so that the thin resin coating on the powder will not be removed. As the detecting means in the spray chamber is operated by the swinging plate, there need be no fear that the detecting portion will be covered by the powder and reduce the efficiency thereof. Further, since the detecting means in the spray chamber is located adjacent to the end portion where the screw conveyer terminates, the powder is accumulated in the spray chamber to a sufficiently high level. Moreover, since the photoelectric detecting means, comprising a lamp and a photocell, is employed for producing an electrical signal to control the screw conveyer driving motor, even a slight displacement of the swinging plate will achieve the desired result because the physical force created by movement of the swinging plate would not be sufficient to actuate a push-type switch.

In the preferred form of the invention, another detecting means is provided in the powder storage chamber where the powder circulates while being fed, the detection of the amount of powder in the storage chamber is accurately performed.

Although the present invention has been described with reference to preferred embodiments thereof, modifications and alterations may be made within the spirit of the present invention.

I claim:

1. A powder sprayer comprising:

a powder storage chamber for storing powder coated with a synthetic resin,

an elongated powder spray chamber for spraying the powder on a material placed therebelow,

a screw conveyer for feeding said powder in said storage chamber to said spray chamber,

a motor for driving said screw conveyer,

a perforated pipe disposed within said spray chamber through which said screw conveyer extends to an open end portion thereof,

a swinging plate provided adjacent and outwardly of the open end of said perforated pipe, said swinging plate being adapted to be displaced by powder fed through and accumulated in said spray chamber,

photoelectric detecting means having a lamp and a photocell disposed adjacent to said swinging plate, the light beam from said lamp directed to said photocell being adapted to be interrupted by the displacement of said swinging plate, and thereby produce an electric signal, and

electrical control means for actuating said screw conveyer driving motor when said light beam from said lamp is received by said photocell and for stopping said driving motor in response to the signal produced when said light beam is interrupted by said swinging plate.

2. A powder sprayer as claimed in claim **1**, wherein said screw conveyer inside of said powder storage chamber has an enlarged portion around which an annular groove is formed on the outer surface thereof adjacent to one end thereof, a wire helically wound around said enlarged portion, winding said annular groove therein, and maintaining a substantially constant diameter throughout the length thereof, said wire constituting the screw of said conveyer, and a second photoelectric detecting means in said storage chamber having a lamp and a photocell and disposed above the front end of said annular groove, and means for producing an electrical signal when a light beam from said lamp of said second detecting means is received by said photocell associated therewith.

3. A powder sprayer as claim in claim **1**, wherein said swinging plate has a fin connected to the back thereof substantially at right angles therewith, adapted to interrupt the beam from the lamp of said electrical control means when said swinging plate is rotated away from the open end of said pipe.

4. A powder sprayer as claimed in claim **3**, wherein the lower end portion of said swinging plate is inclined toward the open end of said perforated pipe to form an angle of about 130°–150° with the plane of said plate.

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