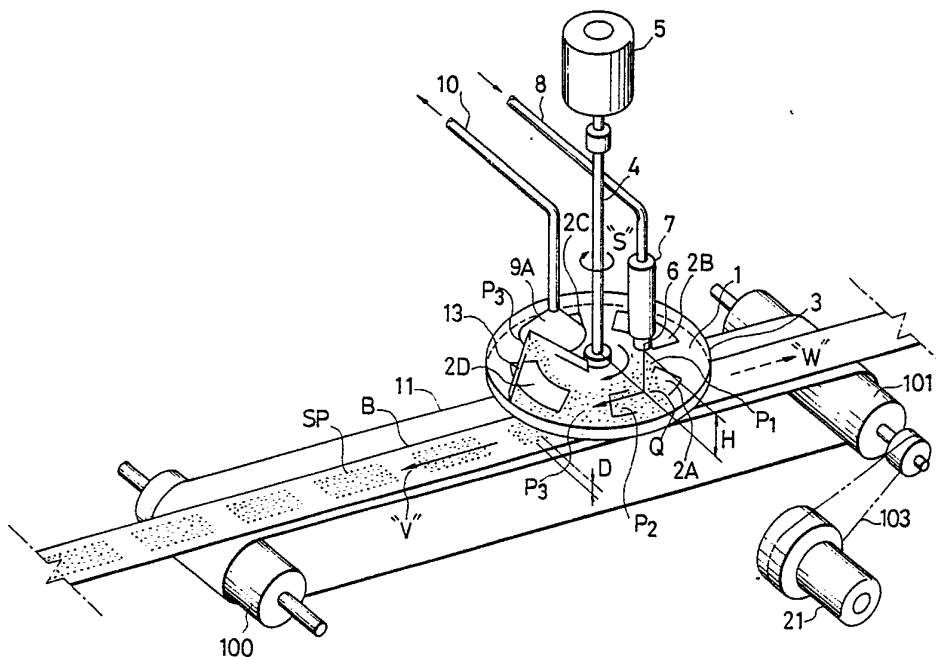


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(71) Applicant (for all designated States except US): NOR-			
DSON CORPORATION [US/US]; 555 Jackson			
Street, Amherst, OH 44001 (US).			
(72) Inventor; and			
(75) Inventor/Applicant (for US only) : TAKADA, Koichiro			
[JP/JP]; 1501-204 Futoocho, Kohoku-ku, Yokohama-			
shi, Kanagawa 222 (JP).			
(74) Agents: OKABE, Masao et al.; No. 209 Fuji Bldg., 2-3,			
Marunouchi 3-chome, Chiyoda-ku, Tokyo 100 (JP).			

(54) Title: POWDER SPRAYING OR SCATTERING APPARATUS AND METHOD



(57) Abstract

Apparatus and method for spraying or scattering solid particulate powders onto a substrate includes powder spraying or scattering means, conveyor for supporting and conveying the substrate and rotatable disc member disposed between the spraying or scattering means and the conveyor which is spaced therefrom. The disc member is formed with at least an opening through which powders sprayed or scattered from the spraying or scattering means pass to reach the substrate on the conveyor. In operation, the disc member is rotated and the substrate is moved by the conveyor in the same direction.

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1 S P E C I F I C A T I O N

Powder Spraying or Scattering Apparatus and Method

5 This invention relates to an apparatus for and
a method of applying a solid particulate powder
material onto a substrate. In particular, the present
invention relates to an apparatus for and a method of
spraying a solid particulate powder material from a
10 nozzle by compressed air or scattering a solid
particulate powder material from a scattering port by
free falling.

Where a solid particulate powder material is to
be intermittently sprayed or scattered onto an elongated
15 substrate running on a conveyer line, it has heretofore
been accomplished by intermittently spraying or
scattering the solid particulate powder material by a
spray device.

Spraying or scattering the solid particulate
20 powder material from the spray device as described
above depends on a severe time of one several thousandth
of a second along with the higher speed of the line,
and this has required a higher degree of technique and
at the same time, has encountered the difficulty that
25 the profile of the pattern of spraying or scattering
onto the surface to be coated is blurred.

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1 It is a first object of the present invention
to solve the above-noted problems and to provide a
method and an apparatus capable of spraying or
scattering a solid particulate powder material at a
5 high speed by a simple technique.

 It is a second object of the present invention
to provide a solid particulate powder material spraying
or scattering method and apparatus capable of obtaining
a relatively clear-cut profile of spraying or
10 scattering pattern.

 It is a further object of the present invention
to provide a solid particulate powder material spraying
or scattering method and apparatus which readily enable
any excess solid particulate powder material to be
15 recovered and reused.

 Figure 1 is an elevational view illustrating
the solid particulate powder material spraying method
and apparatus according to the present invention.

 Figure 2A is a side view illustrating the solid
20 particulate powder material spraying or scattering
apparatus according to the present invention.

 Figure 2B is a plan view of the circular
template portion of the apparatus of Figure 2A.

 Figure 2C shows the spraying or scattering
25 pattern on an elongated substrate to be coated on which
a solid particulate powder material has been sprayed or
scattered by the circular template of Figure 2B.

- 3 -

1 Figure 3A shows the spraying pattern on an elongated substrate to be coated on which groups having a plurality of different spraying patterns and pitches are sprayed at a predetermined pitch.

5 Figure 3B is a plan view of a circular plate for the pattern of Figure 3A.

 Figure 4A shows an example of a hollow pattern.

 Figure 4B is a plan view of a circular template for the pattern of Figure 4A.

10 Figure 5A shows an example of a continuous pattern.

 Figure 5B is a plan view of a circular template for the pattern of Figure 5A.

 Referring to Figures 1 to 2B, a rotary shaft 4
15 of a circular template or disc member 1 forming an essential portion of the apparatus of the present invention is supported by a bearing 16 on the frame 15 (only a portion of which is shown) of the apparatus and further, the shaft 4 is coupled to the shaft of a
20 variable speed motor 5 by a coupling 19. In the circular template 1, a plurality of openings or cut portions 2A, 2B, 2C, ... spaced apart from one another by a predetermined angle and each having a certain shape or profile are formed along a certain circum-
25 ference C on the circular template. A rising marginal edge 3 is provided on the outer periphery of the circular template 1. The direction of rotation of the

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1 circular template 1 may be either, but in Figure 1, it
is a clockwise direction "S".

At the height "H" above a certain point Q on
the circumference C along which said plurality of
5 openings 2A, 2B, 2C, ... of the circular template 1 are
provided, a spray nozzle 6 having a slit-shaped opening
for emitting or spraying solid particulate powder
material of a linear pattern is provided in opposed
relationship with the circular template 1. The nozzle
10 6 is so arranged that the lengthwise direction of the
slit-shaped nozzle opening may be perpendicular to the
rotating direction of the circular template 1 and to
the direction of the movement of the conveyor or the
substrate which will be described later. The spray
15 nozzle 6 is of the so-called air type which injects the
solid particulate powders with the aid of compressed
air. The solid particulate powder material used in the
present embodiment may be various, and may preferably
be a water-absorbent polymer solid particulate powder
20 material. A typical water-absorbent polymer is a
highly water-absorbent acrylic polymer. The external
appearance of such polymer is white powder, which has
a characteristic that when brought into contact with
water, it absorbs 400 times to 1000 times as much water
25 as its weight and hardly releases the once absorbed
water even if more or less pressure is applied thereto.
The water-absorbent polymer of this type has recently

- 5 -

1 been widely utilized in water-absorbing fabrics as new
products, such as diapers, articles for menstruation,
industrial and architectural water-absorbing fabrics,
agricultural and horticultural water-keeping fabrics.

5 The spray nozzle 6 is attached to a spray
assembly 7 fixed to a body frame 15 and is connected by
a pipe 8 to the delivery portion of a solid particulate
powder material recovering filter device 20. The
receiving portion of the device 20 is connected by a
10 pipe 21 to the delivery portion of a solid particulate
powder supply tank 22.

Below the circular template 1, a conveyor 11 is
provided in opposed relationship with the nozzle 6 of
the spray assembly 7 and with a spacing D below said
15 point Q on the circular template 1. The conveyor 11 is
passed over cylindrical pulleys 100 and 101, of which
the driving pulley 101 is driven by a driving variable
speed motor 21 through a driving belt 103 indicated by
dots-and-dash line. An elongated object B to be coated
20 (in the case of the present embodiment, a non-woven
fabric) is placed on the conveyor 11. The object to be
coated is not limited to an elongated one, but may also
be short ones of predetermined dimensions arranged at
predetermined intervals. The direction of movement of
25 the conveyor 11 may be a direction "V" or "W"
perpendicular to a straight line T passing through said
point Q and the center O of the circular template 1,

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1 but in the embodiment illustrated, it is to be
understood that the conveyor 11 is moved in the
direction "W" in accordance with the direction of
rotation "S" of the circular template 1.

5 On the circular template 1, an upper
oversprayed powder sucker 9A and/or a V-shaped scraper
13 is provided at a region substantially symmetrical
about the rotary shaft 4 with respect to the spray
nozzle 6. A lower oversprayed powder sucker 9B is
10 provided below the circular template 1 in opposed
relationship with the upper oversprayed powder sucker
9A or the V-shaped scraper 13. These upper and lower
powder suckers 9A and 9B are connected to the receiving
side of the recovering filter device 20 by pipes 10A
15 and 10B, respectively. Both of the pipes 10A and 10B
are fixed on the body frame 15.

The electric motor 5 for driving the rotary
shaft 4 of the circular template 1 and the electric
motor 21 for driving the conveyor 11 are electrically
20 connected through conductors 28 and 29, respectively,
to a device 30 for setting and tuning the transmission
gear ratios of the two motors.

A solid particulate powder material scatterer
31 for uniformly dropping and scattering the solid
25 particulate powder material by its gravity may be
provided as indicated by dots-and-dash line, instead of
the solid particulate powder material spraying assembly

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1 7. In that case, all the structure except the scatterer
31 is almost similar to what has been described.

Operation will now be described with reference
to Figures 1 and 2A. First, the circular template 1
5 and the conveyor 11 are started, and their directions
of movement "S" and "V" are identical. However, the
peripheral speed of the circular template 1 in its
direction of rotation and the movement speed of the
conveyor 11 can be selected variously. That is, the
10 peripheral speed $\geq$ the movement speed of the conveyor.
The selection of these speeds is determined by the
shape and sharpness of the profile with which spraying
is effected, the thickness of the layer to be coated,
the frequency of intermittence, the amount of spray of
15 the solid particulate powder material, the kind of the
product, the production speed, etc. For example, where
the layer to be coated is relatively thick and the
profile is to be made sharp, it is desirable that the
peripheral speed = the movement speed = a relatively
20 low speed, and where the frequency of intermittence is
great and the profile also may be unsharp, it is
possible that the peripheral speed > the movement
speed, and where the frequency of intermittence is
relatively small and the quantity of production is
25 great, the peripheral speed < the movement speed. In
Figure 1, the object to be coated is an elongated one,
but of course, the present invention is also applicable

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1 to single pieces continuously arranged at a
predetermined pitch.

When the setting of the two speeds and the
supply of the object to be coated onto the line are
5 started in this manner, the spraying operation is
started. In Figure 1, the spraying operation is that
of the solid particulate powder material and therefore,
powders are sprayed linearly and perpendicularly to the
tangential direction of the template 11, from the spray
10 slit nozzle 6 of the spray assembly 7 by the starting
of an ejector pump provided in the lower delivery
portion of the collecting filter device 20. The solid
particulate powder material P_1 thus sprayed drops onto
the rotating circular template 1, but the powder
15 material having dropped into the opening 2A on the
circular template 1 passes through this opening 2A and
drops onto the elongated substrate B on the conveyor 11
moved therebelow (P_2). That is, such solid particulate
powder material is imparted onto the surface of the
20 substrate B as a spray pattern having a profile after
the profile of the opening 2A on the rotating circular
template 1. Subsequently, a similar operation is
performed by the opening 2B on the circular template 1
rotated to below the spray nozzle 6. Thereafter, in a
25 similar manner, the openings 2A, 2B, 2C, ... on the
rotating circular template 1 repeat the same operation
endlessly and can attach spray layers having a required

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1 profile intermittently onto the surface of the
substrate or object at a required pitch.

As described above, the solid particulate
powder material having passed through the openings on
5 the circular template 1 is imparted to the substrate B,
while the solid particulate powder material having not
passed through said openings remains on the circular
template 1 (P_3). When the circular template 1 makes
one half of one full rotation, the solid particulate
10 powder material encounters the fixed V-shaped scraper
13 and is drawn near the V-shaped scraper 13 and
collected to the vertex portion of the V-shape, and
when the solid particulate powder material encounters
a further rotated opening, the powder material drops
15 through that opening and enters the lower solid
particulate powder material sucker 9B, and is further
air-transported with the air sucked in by the negative
pressure in the collecting filter device 20 and is
collected into the same device. Further, the remaining
20 solid particulate powder material having passed through
the V-shaped scraper 13 is likewise collected into the
collecting filter device 20 by the upper solid
particulate powder material sucker 9A provided
immediately behind the scraper 13. In this manner, the
25 remaining solid particulate powder material on the
circular template 1 which has not passed through the
openings is all removed by the upper and lower solid

- 10 -

1 particulate powder material suckers 9A and 9B, and the
circular template 1 thus cleaned continues to rotate
and comes to just beneath the spray nozzle 6, from
which the solid particulate powder material is again
5 sprayed onto the circular template 1, and thus, an
operation similar to what has been described above is
repeated.

The size of the shape of the profile of the
solid particulate powder material imparted onto the
10 object to be coated and the size of the shape of the
profile of the openings provided on the circular
template 1 somewhat differ from each other. The
fundamental difference is that in proportion to the
radius R of each point in the openings on the circular
15 template, the length of said point on the circumference
is determined. That is, the length on the circumference
is shorter ($R_1 \rightarrow R_2$) toward the center of the circular
template. The reason is that since the peripheral
speed is slower toward the center, the time during
20 which the solid particulate powder material is sprayed
from the spray nozzle 6 onto the circular template is
longer.

In the above-described embodiment, the solid
particulate powder material spraying apparatus is
25 first connected from the solid particulate powder
material tank 22 to the solid particulate powder
material collecting filter device 20 by the pipe 21.

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1 Thus, in the present embodiment, any excess or
oversprayed solid particulate powder material is
recovered and the recovered solid particulate powder
material is mixed in the filter device 20 with the
5 fresh solid particulate powder material from the powder
supply tank, and the mixture is supplied to the spray
assembly 7 through the pipe 8.

Generally, however, the supply tank 22 may be
directly connected to the spray assembly 7 without the
10 intermediary of the collecting filter device.

Description will now be made of the relation
between the spray pattern and the circular template
therefor.

The shape of the profile on the circular
15 template for achieving the arrangement at intervals d
(Figure 2C) of quadrilaterals ($h \times l$) which are the
basic form of the spray pattern on the elongated object
is such as shown in Figure 2B. The basis of the shape
of such profile is that the straight line in the
20 direction in which the spray pattern flows lies in the
tangential direction on the circumference at each
point on the circular template, i.e., lies on the
circumference. Accordingly, the upper and lower
straight lines l of each quadrilateral are arcuate on
25 the circular template and become shorter ($l' \rightarrow l_1'$)
toward the center of the circular template in
proportion to the radii thereof. However, the height

- 12 -

1 h of the quadrilateral of the spray pattern and the
height h of the profile on the circular template do not
differ from each other. In Figure 2B, four profiles
are shown on the circular template, but of course, any
5 number of profiles may be provided at equal intervals.

It is possible that a plurality of spray
patterns have different pitches and they in turn form
groups which are arranged at a predetermined pitch.
Reference is now had to Figures 3A and 3B. That is,
10 the pitches between a quadrilateral SP_2 and a triangle
 SP_3 and between the triangle SP_3 and a circle SP_4 are
different pitches P_2 , P_3 and P_4 , and these SP_2 , SP_3 and
 SP_4 form a group R_1 , and next groups R_2 , R_3 , R_4 , ...
are arranged at a predetermined pitch P_1 . In this case,
15 the shape of the openings on the circular template is
such as shown in Figure 3B.

The interiors of all the above-described spray
patterns are immaculate, but hollow spray patterns as
shown in Figure 4A can also be made. In this case,
20 bridges 39 for cores 38 in the openings on the circular
template are provided on the back side of the circular
template (the side which is adjacent to the substrate),
as shown in Figure 4B. The reason is that the
V-shaped scraper and the upper solid particulate powder
25 material sucker are provided in proximity to the upper
surface of the circular template and the lower solid
particulate powder material sucker may be provided

- 13 -

the lower surface of the circular template with
acing therebetween.

All the spray patterns in the above-described
ent are discontinuous, but continuous spray
5 : are also possible and the present example is
ole of them. See Figure 5A, in which is shown a
ontinuous spray pattern. In this case, the
: the openings of the circular template is
d into an inner ring 41 and an outer ring 42,
10 : in Figure 5B, and bridges 43 for coupling them
ided from the back side of the circular
. The present embodiment is suitable for
ar continuous spray patterns of irregular

15 According to the method and apparatus of the
invention, in the operation of intermittently
or scattering a solid particulate powder
onto an elongated substrate, the sprayer or
terer need not be operated intermittently but
20 perated continuously to thereby make spray
intermittently and in addition, any excess
rticulate powder material can be recovered for
l also, the length and pitch of discontinuous
:terns can be changed freely and simply and
25 wasteless spray patterns of clear-cut profiles
otained.

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C L A I M S

1

1. A powder spraying or scattering apparatus comprising:

5 means for spraying or scattering a solid particulate powder material;

conveyor means for supporting and conveying a substrate onto which the solid particulate powder material is to be sprayed or scattered at a
10 predetermined position; and

a rotatable disc member disposed between said spraying or scattering means and said conveyor means and having an opening for passing therethrough the solid particulate powder material sprayed or scattered
15 from said spraying or scattering means and applying the solid particulate powder material to said substrate at said predetermined position and a portion for blocking the passage of the solid particulate powder material.

20 2. A spraying or scattering apparatus according to Claim 1, wherein excess solid particulate powder material recovering means is provided on the side adjacent to said spraying or scattering means in opposed relationship with said disc member.

25

3. A spraying or scattering apparatus according to Claim 1, wherein a plurality of openings are provided

- 15 -

1 at predetermined intervals on a certain circumference
of said disc member.

4. A spraying or scattering apparatus according
5 to Claim 2, where said spraying nozzle has a slit-
shaped opening for forming a linear spray pattern.

5. A powder spraying apparatus characterized in
that:

10 a. a rotatable circular template is provided
above a conveyor with a certain required spacing
therebetween;

b. at least one opening having a predetermined
profile is provided at a predetermined pitch along a
15 certain circumference on said circular template;

c. a slit spray nozzle for a solid particulate
powder material is provided at a certain required
height above said circular template substantially at the
point of intersection between the normal from the center
20 of the rotary shaft of said circular template to the
direction of movement of said conveyor and the
circumference along which said opening is formed;

d. an upper solid particulate powder material
sucker and/or a V-shaped scraper is provided above said
25 circular template on the side opposite to said spray
nozzle with respect to said rotary shaft;

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1 e. a lower solid particulate powder material
sucker is provided below said upper solid particulate
powder material sucker with said circular template
interposed therebetween;

5 f. a motor for driving the rotary shaft of said
circular template and a motor for driving said conveyor
are variable motors which are connected to a device
for setting and tuning the speed ratio of said motors;

g. said spray nozzle, a spray assembly directly
10 connected thereto, and said upper and lower solid
particulate powder material suckers are connected to
the delivery portion of a recovering filter device 20
by pipes;

h. said upper and lower solid particulate powder
15 material suckers are connected to the receiving portion
of said recovering filter device by pipes; and

i. the receiving portion of said recovering
filter device in turn is connected to a solid
particulate powder material supply tank by a pipe.

20

6. A method of applying a solid particulate
powder material to a substrate, characterized by
continuously spraying or scattering the solid particu-
late powder material through an opening of a
25 predetermined profile formed along a certain
circumference on a rotating circular template, forming
a solid particulate powder material spray pattern of a

- 17 -

1 predetermined shape of profile on the surface of the
substrate moved below said certain location and said
circular template, and changing the shape of the spray
pattern by changing the speed ratio of said circular
5 template and said object to be coated.

7. A method according to Claim 6, wherein the
solid particulate powder material is continuously
sprayed or scattered.

10

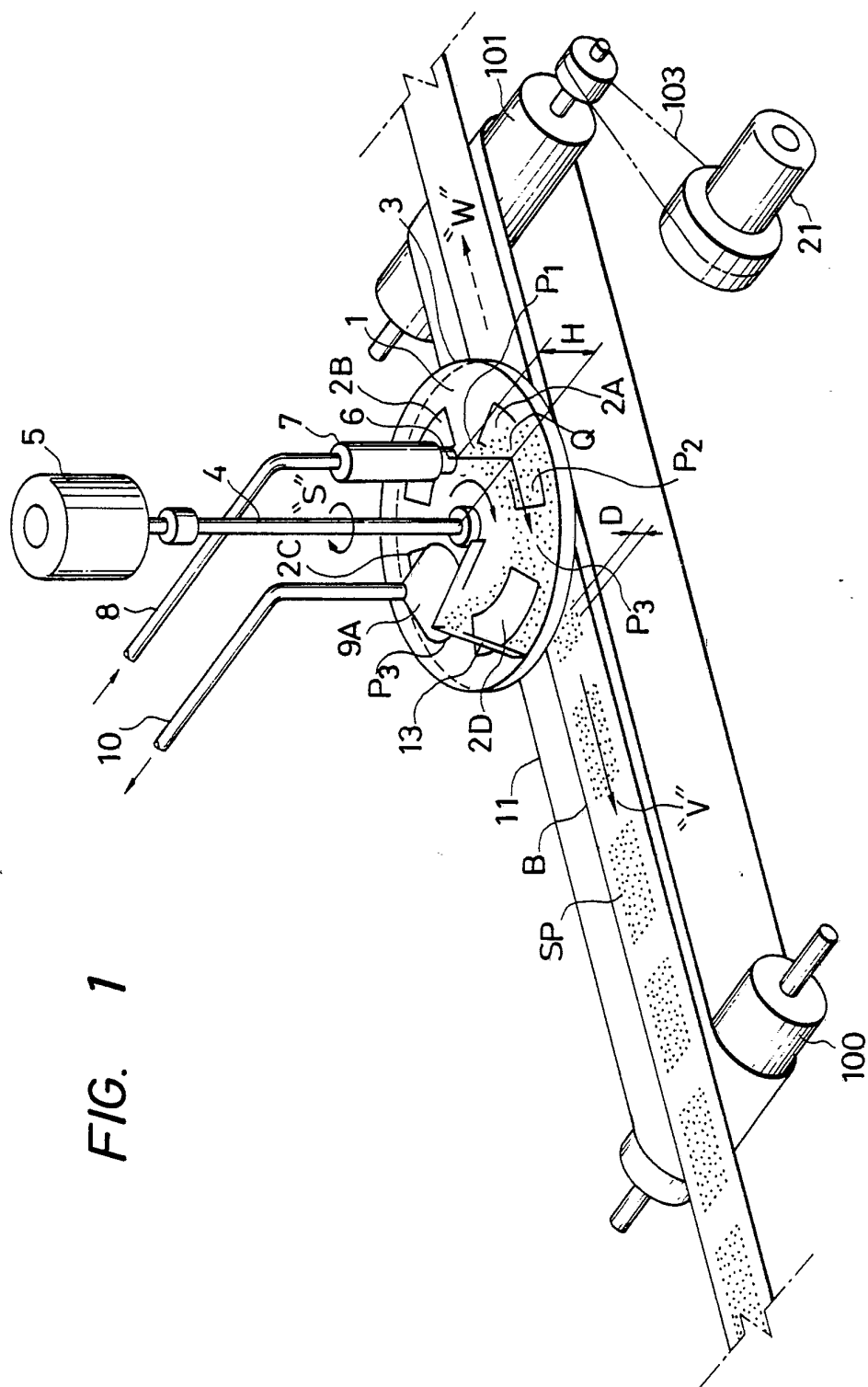
8. A method according to Claim 5, wherein the
solid particulate powder material is intermittently
sprayed or scattered.

15

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FIG. 2A

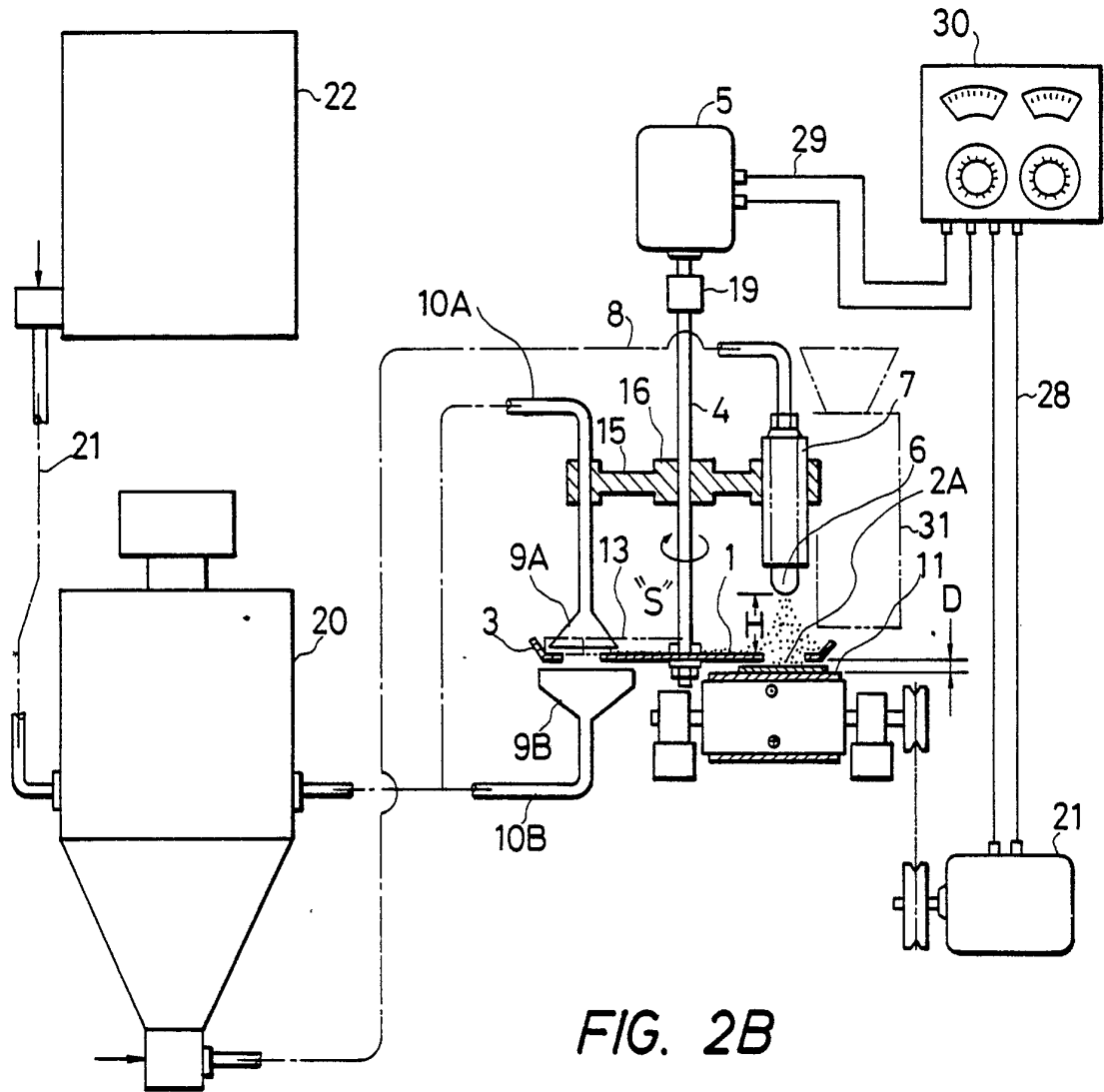
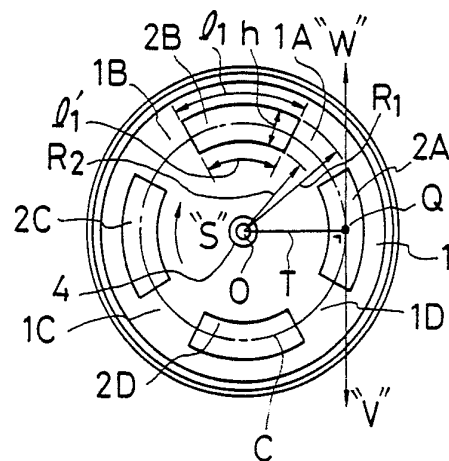


FIG. 2B



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FIG. 2C

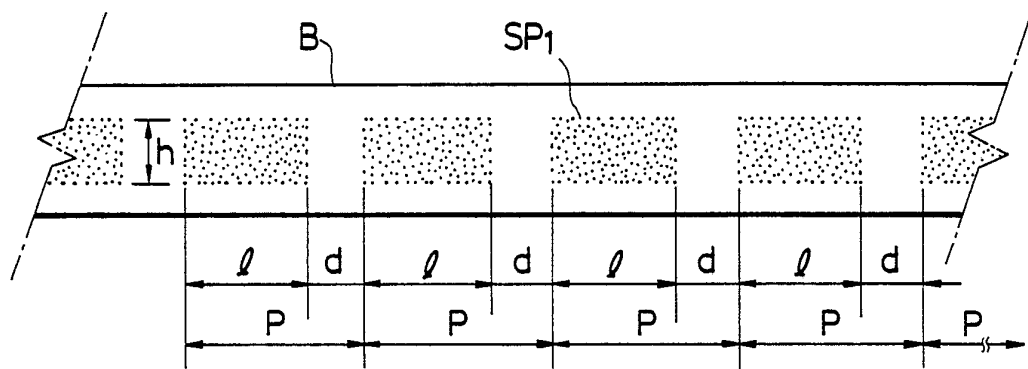


FIG. 3A

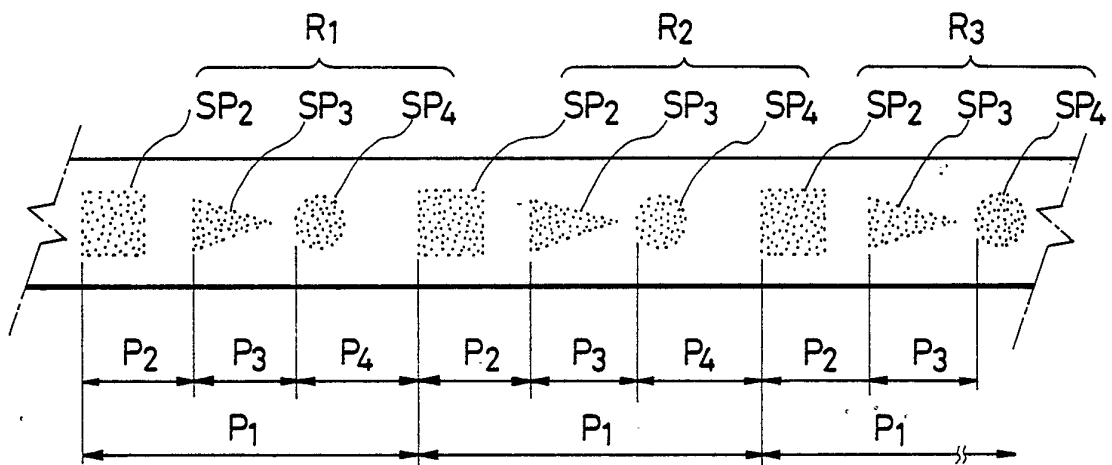
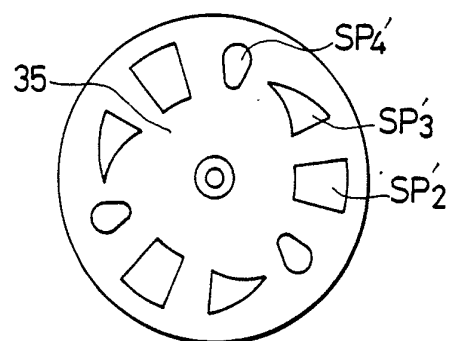


FIG. 3B



4/4

FIG. 4A

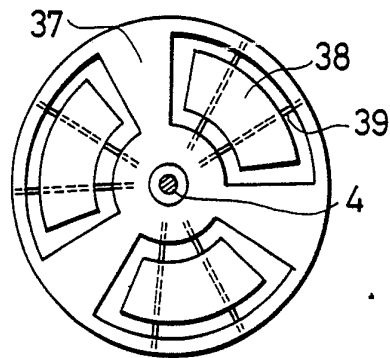
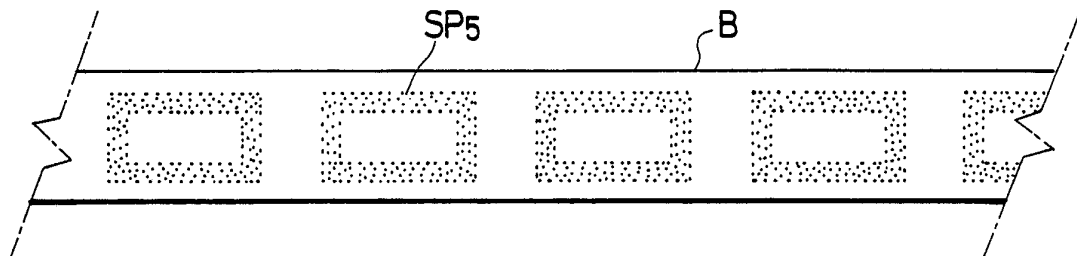


FIG. 4B

FIG. 5A

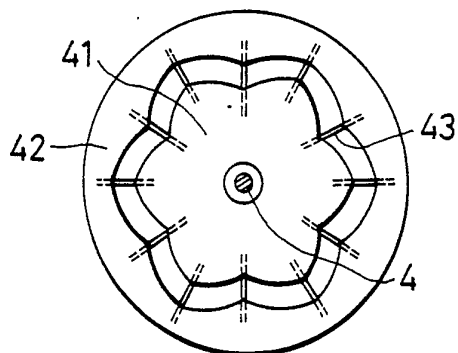
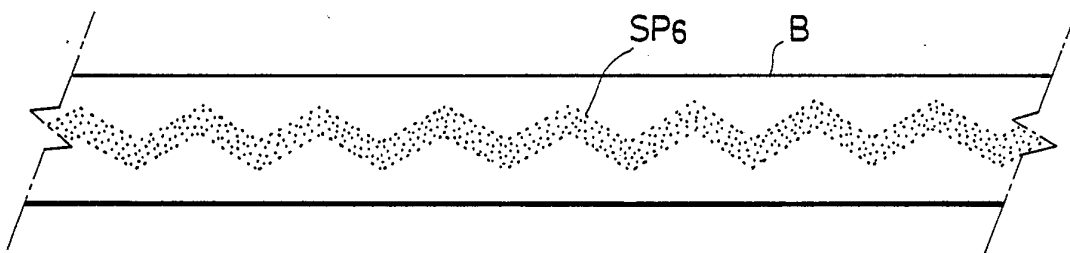


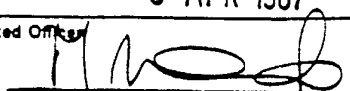
FIG. 5B

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 86/00609

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : B 05 C 21/00; B 05 B 14/04; B 05 D 1/32		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁴	B 05 B; B 05 C; B 05 D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	US, A, 4269874 (T.R. PRYOR et al.) 26 May 1981 see column 3, lines 3-23; figures 1,2	1,5
A		3
A	column 5, lines 56-61; figure 3	2
A	column 4, lines 5-22	8
	--	
	GB, A, 951068 (TECALEMIT LTD.) 4 March 1964	
Y	see page 3, lines 1-25; figure 3; claim 1	1,5
A		7
	--	
A	CH, A, 550070 (SCHAETTI & CO) 14 June 1974 see figure 1, claim 1	1

¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
3 March 1987		- 3 APR 1987
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer M. VAN MOL 

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO.

PCT/JP 86/00609 (SA 15355)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 23/03/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4269874	26/05/81	JP-A- 56034000	04/04/81
GB-A- 951068		None	
CH-A- 550070	14/06/74	None	

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82