COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952
CONVENTION APPLICATION FOR A STANDARD PATENT

We, NORDSON CORPORATION, of 555 Jackson Street, Amherst, Ohio 44001, United States of America hereby apply for the grant of a standard patent for an invention entitled:

"ADJUSTABLE FLAT PATTERN POWDER SPRAY GUN"

which is described in the accompanying complete specification.

DETAILS OF BASIC APPLICATION

Number of Basic Application:– 811,632

Name of Convention Country in which Basic Application was filed:– United States of America

Date of Basic application:– 20 December 1985

Our address for service is:–

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DATED this NINETEENTH day of DECEMBER 1986

NORDSON CORPORATION

By: [Signature]


TO: THE COMMISSIONER OF PATENTS

AUSTRALIA

SBR:JMA:55F
COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a
patent for an invention entitled:
"Adjustable Flat Pattern Powder Spray Gun"

I/US

Thomas L. Moorhead

of
517 Devonshire Court
Bay Village, Ohio 44140, USA

do solemnly and sincerely declare as follows:

1. I/US

(or, in the case of an application by a body corporate)

1. I am/US authorised by NORDSON CORPORATION

the applicant(s) for the patent to make this declaration on
its/our behalf.

2. The basic application(s) as defined by Section 141 of the
Act was/were made

in the United States of America

on December 20, 1985

by Richard E. Schaupp

3. Richard E. Schaupp

of 521 Rosemore Avenue
Modesto, California 95351, U.S.A.

(respectively)

is/are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/are entitled to make the application are
as follows:

Nordson Corporation is the assignee of the
actual inventor.

4. The basic application(s) referred to in paragraph 2 of this
Declaration was/were the first application(s) made in a Convention
country in respect of the invention(s) the subject of the application.

Declared at Westlake, this 3d day of November 1986

Ohio, USA

Thomas L. Moorhead

Signature of Declarant(s)

To: The Commissioner of Patents

Thomas L. Moorhead
Vice President-Law
(54) ADJUSTABLE FLAT PATTERN POWDER SPRAY GUN
(71) NORDSON CORPORATION
(21) 66774/86 (22) 19.12.86 (24) 20.12.85
(31) 811632 (32) 20.12.85 (33) US
(43) 25.6.87
(51) B05B 5/04
(72) RICHARD E. SCHAUPP
(74) SF
(55) Claim
(1) An electrostatic spray gun for spraying solid particulate powder materials comprising:
an electrically non-conductive housing,
a powder transport tube supported by said housing, and having an inlet end and an outlet end,
a nozzle connected to the outlet end of said transport tube, said nozzle having an orifice through which powder from said transport tube is ejected onto a substrate in a pattern, the width of said pattern being determined by the boundary of said orifice,
said nozzle having mounted thereto a rotatable orifice restricting element with a pair of edges simultaneously movable across said orifice so as to change opposite sides of the effective boundary of said orifice to change the pattern width.
### Complete Specification

For Office Use:

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Complete Specification Lodged:

- Accepted:
- Published:

Priority:

Related Art:

Name of Applicant: **NORDSON CORPORATION**

Address of Applicant: 555 Jackson Street, Amherst, Ohio 44001, United States of America

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Complete Specification for the invention entitled:

"ADJUSTABLE FLAT PATTERN POWDER SPRAY GUN"

The following statement is a full description of this invention, including the best method of performing it known to us.

SBR: JMA: 55F
Abstract of the Disclosure

An electrostatic spray gun for spraying solid particulate powder materials entrained in a gas medium in a flat pattern including an electrically non-conductive housing and a nozzle to which is rotatably mounted an orifice restricting element with a pair of edges which move across the nozzle orifice as the element is rotated to adjustably restrict the orifice and thereby vary the width of the flat powder spray pattern.
Adjustable Flat Pattern Powder Spray Gun

This invention relates to electrostatic powder spray systems and more particularly to an improved powder spray gun for use in such systems.

Electrostatic powder spray systems operate on the principle of transporting a finely divided powder, generally on the order of 150 mesh, to a spray gun or spray head while the powder is entrained in an air or gaseous stream. The air entrained powder is transferred from the nozzle of the gun to a target article or substrate by an electrostatic charge applied to the powder and an effectively opposite charge on the substrate. Once applied to the substrate, the powder is generally heated and melted so as to adhere the powder to the substrate as a film when the molten powder subsequently cools.

A characteristic of nearly all electrostatic powder spray applications is that less than half of all the sprayed powder adheres to the target article or substrate. The oversprayed powder thus must generally be collected, cleaned, and recycled in order
for a powder spray system to operate efficiently and economically. Generally, the cost of collecting and recycling the powder is substantially greater than the cost of initially applying the powder. Consequently, it is very important to the economy of powder spray systems that as high a percentage as possible of the initial sprayed powder be adhered to the target article or substrate so that a minimum of the sprayed powder need be recycled or lost if the powder is not to be recycled.

The efficiency or percentage of sprayed powder which adheres to the target is a function of many variables, including the size and density of the sprayed powder, the velocity of the air stream in which the powder is ejected from the spray gun, the charge applied to the powder, and the configuration of the powder spray pattern.

It is difficult with existing powder spray guns to convert from one powder spray pattern to another because each application requires a different combination of spray nozzle characteristics to optimize the percentage of sprayed powder adhered to the substrate. Presently existing powder spray guns do not lend themselves to rapid adjustment of all of these variables and often require replacement of one gun with another or the replacement of one spray nozzle with another in order to change from one spray pattern to another or in order to maintain an optimum
spray pattern when other variables affecting the pattern are changed.

It has therefore been one objective of this invention to provide an improved powder spray gun which lends itself to rapid and inexpensive adjustment of the spray pattern or conversion from one spray pattern to another.

Still another objective of this invention has been to provide an improved powder spray gun wherein the spray pattern may be controlled or changed, or the characteristics of the spray nozzle changed without substitution of the nozzle or gun.

In any given electrostatic powder spray system, the number of applications in which the amount of oversprayed powder can be optimally minimized is dependent on the variety and number of nozzles available to define the spray pattern and to focus the powder spray. It has therefore been still another objective of this invention to provide an electrostatic powder spray gun which has a nozzle adjustable to continuously vary the powder spray pattern or continuously vary the focus of the powder spray over a given range.

These objectives are achieved by, and this invention is in part predicated upon, the concept of providing a powder spray gun in which the nozzle is adjustable so as to change the geometry of the nozzle orifice to control the pattern of powder spray. The
adjustability of the nozzle is achieved by providing a nozzle having a fixed orifice in relation to which is adjustably positioned a sleeve or other orifice restricting element with a pair of edges which can be simultaneously moved across the nozzle orifice as the element is rotated to vary the effective boundary of the nozzle opening to shape the pattern and focus the powder spray.

Electrostatic powder spray guns often employ flat spray nozzles producing flat fan patterns. Minimizing the amount of overspray has heretofore required selection of a nozzle which produces a pattern with a width only sufficient to encompass the work. In many applications, the fan pattern is achieved through the use of a slotted nozzle with the width of the slot determining the width of the fan pattern. It is a further objective of this invention to provide a powder spray gun which has a nozzle adjustable to vary the width of a fan spray pattern by varying the dimensions of the nozzle slot which determines the pattern width.

An advantage of the present invention is that it provides a powder spray gun which, with a single nozzle, will direct powder spray patterns with widths which vary over a wide range. In the embodiment shown, the spray pattern is continuously adjustable to any width over a 9 to 1 range.
The primary advantage of this gun is the ease with which it facilitates adjustment of the powder spray pattern of an electrostatic powder spray gun without change of the gun nozzle.

These and other objects and advantages of this invention will be more readily apparent from the following description of the drawings in which:

Figure 1 is a side view of an electrostatic powder spray gun incorporating the invention of this application.

Figure 2 is a cross-sectional view through the discharge end of the gun shown in Figure 1.

Figure 3 is a front view of the nozzle of the gun shown in Figures 1 and 2 with the nozzle adjusted for maximum pattern width.

Figure 4 is a front view of the nozzle of the gun shown in Figures 1 and 2 with the nozzle adjusted for minimum pattern width.

The powder spray gun of this invention is intended for use as a part of a powder spray system, such as that disclosed in Berkmann Patent No. 4,245,551. Within such a system, air entrained powder is supplied to a powder spray gun through a supply hose while simultaneously, a very high voltage electrical charge is supplied to the gun from a source of electrical power. The electrostatic spray gun is operative to dispense the air entrained powder in a predetermined pattern while simultaneously applying a
charge to the powder. The electrical charge then is operative to transport the powder from the nozzle of the gun to a target article or substrate which is of an opposite charge from that applied to the powder by the gun. Generally, a negative charge is applied to the powder by the electrostatic spray gun and the target article or substrate to which the powder is to be applied is grounded so that the powder is attracted to the article and adheres thereto as a consequence of the charge on the powder.

Referring first to Figure 1, there is illustrated an embodiment of a powder spray gun incorporating the invention of this application. This powder spray gun comprises a housing upon which there is mounted a nozzle and an electrode support. The housing comprises a pair of spaced mounting blocks between which there are supported a pair of tubes and . The uppermost one of these tubes is a resistor support tube and the lowermost tube is a powder transport tube. Components and are electrically nonconductive, while component is electrically conductive to provide conductance to ground.

The forwardmost one of the mounting blocks has a lower through-bore therein which may be threaded and an upper blind recess as is illustrated more fully in Figure 2. The blind recess is threaded as indicated at . Intersecting this
blind recess 21 there is an angled threaded bore 23. The electrode support 13 is threaded into the bore 23 and the forward threaded end 24 of the resistor support tube 16 is threaded into the threaded section 22 of the recess 21. The threaded forward end 25 of the powder transport tube 17 is threaded into and through the threaded bore 20 of the mounting block 14 so that the forwardmost end 25 of the powder transport tube 17 extends forwardly beyond the front face 26 of the mounting block 14. The nozzle 12, which is a conventional slotted nozzle, is threaded onto this forwardmost end 25 of the powder transport tube 17. The powder transport tube 17 is locked to the mounting block 14 by a jam nut 27 threaded over the rearwardmost threaded portion of the threaded forward end 25 of the powder transport tube 17.

The rear mounting block 15 is provided with a pair of through-bores 30, 31. The powder transport tube 17 extends through the lowermost one of these through-bores. The uppermost bore 31 is threaded for reception of the threaded rear end of the resistor support tube 16 and for reception of the threaded forward end 33 of a cable adapter 34. The rear end of the cable adapter 34 is also threaded for connection to a conventional electrical shielded cable (not shown).

Extending transversely through the rear mounting block 13 there is a transverse bore 36. This
transverse bore 36 is intersected by a threaded bore 37 within which there is a set screw 38. The transverse bore 36 enables the rear mounting block 15 and thus the gun 10 to be secured to a mounting rod and fixed thereon by the set screw 38 as is conventional in this art.

Mounted internally of the resistor support tube 16 there is an electrical resistor 40. At the rear, this resistor 40 is connected via an electrically conductive spring 41 to an insulated electrical cable 42 contained internally of a conventional shielded cable (not shown) adapted to be connected to the cable adapter 34.

The forward end of the resistor 40 is electrically connected to a smaller resistor 44 contained internally of the electrically non-conductive casing of the electrode support 13. This small resistor 44 is connected via a conventional connector 45 to the forward end of the large resistor 40. At its forward end, the small resistor 44 is attached to the powder charging electrode 46 which extends forwardly beyond the forward end of the casing of electrode support 13. In electrostatic powder spray guns, the illustrated placement of the electrode is only one of many. Such electrodes are, for example, also alternatively disposed within the nozzle of the gun. When an electrically shielded cable (not shown) is connected to the cable adapter 34,
electrical contact is established between the conductor contained within the electrical insulated cable 42 of the shielded cable (not shown) and the electrode 46 via the spring 41, the resistor 40, the connector 45, and the small resistor 44.

When a source of air entrained powder, such as a conventional powder feed hopper, is connected via a hose (not shown) to the rearward end 48 of the powder transport tube 17, air entrained powder may be transported through the tube and ejected from an orifice 49 in the forward end of the nozzle 12. In the illustrated embodiment, the nozzle 12 is a conventional slotted nozzle which is a type which will more fully benefit by this invention. However, any type of powder spray nozzle may be utilized in the practice of this invention as long as the width of the spray pattern is determined by the effective position of the boundary of the nozzle orifice. The powder ejected from the nozzle orifice 49 is electrically charged during the course of passage through an electrostatic field created by the electrode 46. That powder then adheres to an effectively oppositely charged substrate (not shown) toward which the powder is ejected.

The nozzle 12 has an outer surface which includes a cylindrical portion 52, a truncated conical portion 53 forward of the cylindrical portion 52, and a circular planar end portion 54, the axes of the
three portions being the same. The orifice 49 of the nozzle 12 is an elongated rectangular slot centered on the diagonal of the circular end 54 of the nozzle 12, and extending onto and terminating on the conical portion 53 of the surface of the nozzle 12. In typical operation, the powder sprayed from a nozzle of this type would be effected in a wide fan pattern, the width of the pattern being determined by the position of the slot ends 55.

It is important to the efficient use of a powder spray gun that the pattern of the powder ejected from the nozzle of the gun be sufficiently wide to encompass the entire work to be coated, but no wider than necessary to do so. Due to a substitution of workpieces of different sizes, or due to some other change of parameters, it may become necessary to widen or narrow the spray pattern to maintain the optimum efficiency in coating the work piece.

To accomplish this result, the illustrated embodiment of the invention is provided with a sleeve 61 rotatably attached to the outer surface of the nozzle 12. The sleeve 61 includes a cylindrical portion 62 which fits in close conformity with the cylindrical portion 52 of the outer surface of the nozzle 12, and a truncated conical portion 63 which fits in close conformity with the conical portion 53 of the outer surface of the nozzle 12. The forward edge 64 of the sleeve 61, which is the smaller end of
the conical portion 63 of the sleeve 61, is in the plane of the circular end 53 of the nozzle 12.

The rotatably mounted sleeve 61 is dimensioned so as to be retained on the nozzle 12 by friction. An O-ring seal 66 is set in an annular groove 67 in the cylindrical portion 52 of the outer surface of the nozzle 12.

Referring to Figure 3, the sleeve 61 is shown positioned on the nozzle 12. In the forward end of the sleeve 61 is a hole 72 which is shaped so that the sleeve partially blocks the orifice 49 of the nozzle 12 to differing degree depending on the angular position of the sleeve 61 on the nozzle 12.

The shape of the hole 72 is best described with reference to Figure 3. In the illustrated embodiment, the hole is defined by three superimposed shapes. One is a circle defined by the forward edge 64 of the sleeve 61. The second is a diametrically positioned rectangular slot 73 centered on and bisecting the circle 64, and of the same dimensions as the maximum cross-section of the orifice 49. The third shape is a pair of identical segments 75 of an elliptical curve defined by the section of the conical surface 63 intersected by a plane. These curves join the slot ends 76 with the circular edges 64 in opposite quadrants of the sleeve 61 to form continuously curved edges in those quadrants. On any diagonal, opposite edges of the hole 72 are at the
same radius from the center of the hole. This radius is continuously decreasing moving along the curves 75 from the slot ends 76 to a point in tangential juncture with the circular edge 64. The edge of the hole 72 which crosses the orifice 49 thus defines the effective end boundary of the orifice 49, and the width of the nozzle slot.

In Figure 3, the sleeve 61 is shown in a position where the effective orifice of the nozzle 12 is wide open, with the ends 76 of the hole aligning with the ends 55 of the orifice 49. When the sleeve is in the position shown in Figure 4, the circular edge 64 forms the effective edge of the slot 73 defining the narrowest setting of the orifice 49. In the embodiment shown, the shape of the hole is such that as the sleeve 61 is rotated clockwise through ninety degrees, from the position shown in Figure 3 to the position shown in Figure 4, the effective width of the nozzle orifice 49 is continuously decreased from a maximum to a minimum width to produce a correspondingly wide to narrow fan pattern of the ejected powder spray. As a result, in a typical application, a flat fan pattern of powder spray is produced which is capable of being infinitely adjustable from, for example, a maximum of eighteen inches to a minimum of two inches without change of the nozzle.
While we have described only two embodiments of our invention, persons skilled in the art to which this invention pertains will appreciate numerous changes and modifications which may be made without departing from the spirit of this invention. Therefore, we do not intend to be limited except by the scope of the following appended claims:

Having described our invention we claim:
The claims defining the invention are as follows:

(1) An electrostatic spray gun for spraying solid particulate powder materials comprising:
   an electrically non-conductive housing,
   a powder transport tube supported by said housing, and having an inlet end and an outlet end,
   a nozzle connected to the outlet end of said transport tube, said nozzle having an orifice through which powder from said transport tube is ejected onto a substrate in a pattern, the width of said pattern being determined by the boundary of said orifice,
   said nozzle having mounted thereto a rotatable orifice restricting element with a pair of edges simultaneously movable across said orifice so as to change opposite sides of the effective boundary of said orifice to change the pattern width.

(2) The powder spray gun of Claim 1 wherein said orifice restricting element is a sleeve rotatably attached to said nozzle.

(3) The powder spray gun of Claim 2 wherein said sleeve has an opening therein with an edge adjacent said orifice, said opening being configured so that its opposing edges move across said orifice as the sleeve is rotated with respect to said nozzle so as to change the effective boundary of the nozzle orifice.
(4) The powder spray gun of Claim 1 wherein:
said nozzle is a slotted nozzle and wherein
said nozzle orifice is elongated for producing a fan
shaped powder spray pattern the width of which is
determined by location of the ends of the slot,
said orifice restricting element is
rotatable to a first position at which said orifice is
opened so that the ends thereof define the maximum
width of the slot and of the powder spray pattern
ejected therefrom, and to a second position at which
said orifice is narrowed so that the ends thereof
define the minimum width of the slot and of said
powder spray pattern, and
the location of the ends of the slot are
determined by the position of the edges of said
element.

(5) The powder spray gun of Claim 4 wherein the
edge of said opening includes a section continuously
contoured so that the width of said slot is
continuously adjustable between said positions of
maximum and minimum width whereby the width of the
pattern ejected from said nozzle is continuously
adjustable between maximum and minimum width.

(6) The powder spray gun of Claim 5 wherein:
in said first position, the boundary of said
opening of said orifice restricting element surrounds
said slot so that the boundary of said slot determines the effective boundary of the nozzle orifice,
in said second position, the edge of said sleeve opening determines the effective boundary of said orifice which determines the pattern width, and said edge is contoured so as to continuously narrow said slot as said element is rotated from said first to said second positions whereby the width of said pattern continuously narrows as said sleeve is moved from said first toward said second positions.

(7) The electrostatic spray gun of Claim 1 wherein said orifice restricting element has a curved surface and wherein each of said edges is defined by the intersection of a plane with said curved surface.

(8) The electrostatic spray gun of Claim 7 wherein said surface is a cone having an axis which coincides with the axis of the nozzle and wherein each of said edges defines an elliptical curve.