



(19) **United States**

(12) **Patent Application Publication**

Duffy et al.

(10) **Pub. No.: US 2004/0219291 A1**

(43) **Pub. Date: Nov. 4, 2004**

(54) **PROCESS AND APPARATUS FOR THE APPLICATION OF FLUOROPOLYMER COATING TO THREADED FASTENERS**

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(21) Appl. No.: **10/428,162**

(22) Filed: **May 1, 2003**

Publication Classification

(51) **Int. Cl.⁷ B05D 1/12**
(52) **U.S. Cl. 427/180**

(57) **ABSTRACT**

A process and apparatus are provided for the application of a fluoropolymer coating to the threads of an internally threaded fastener. The fastener has a body and a threaded bore extending to opposing ends of the body to define opposing first and second openings in the fastener. The fastener is moved on a conveyor along a path of travel with its threaded bore in a predetermined orientation. As the fastener moves along its path of travel, the first opening is closed by means of an obstructing member, while an air stream carrying entrained fluoropolymer powder is directed from a nozzle through the second opening and into the threaded bore. The nozzle is stationary and is located at an axially displaced position relative to the second opening of the fastener and immediately adjacent the conveyor. Preferably, the nozzle includes a diffuser which directs the air stream and entrained fluoropolymer powder into the fastener bore in a diverging pattern. After the fluoropolymer powder is deposited onto the threads of the fastener, the conveyor moves the fastener through a heating station where the fluoropolymer powder is raised to its melting temperature causing it to melt and fuse into a generally continuous film covering the fastener's threads.

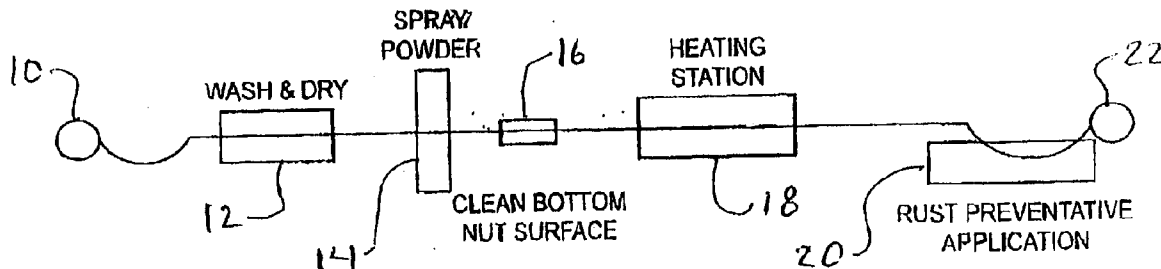


FIG. 1

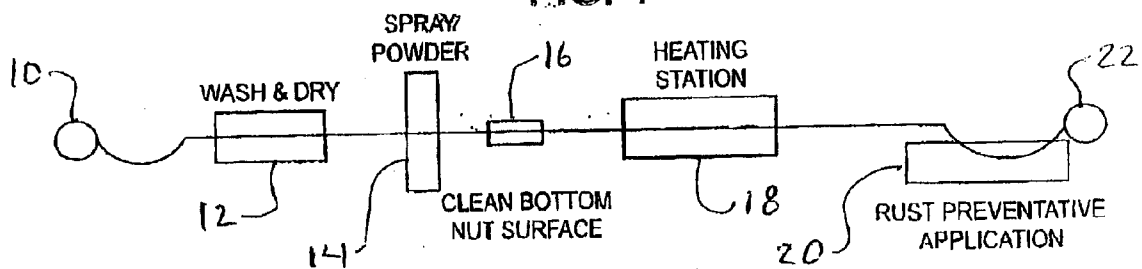


FIG. 2

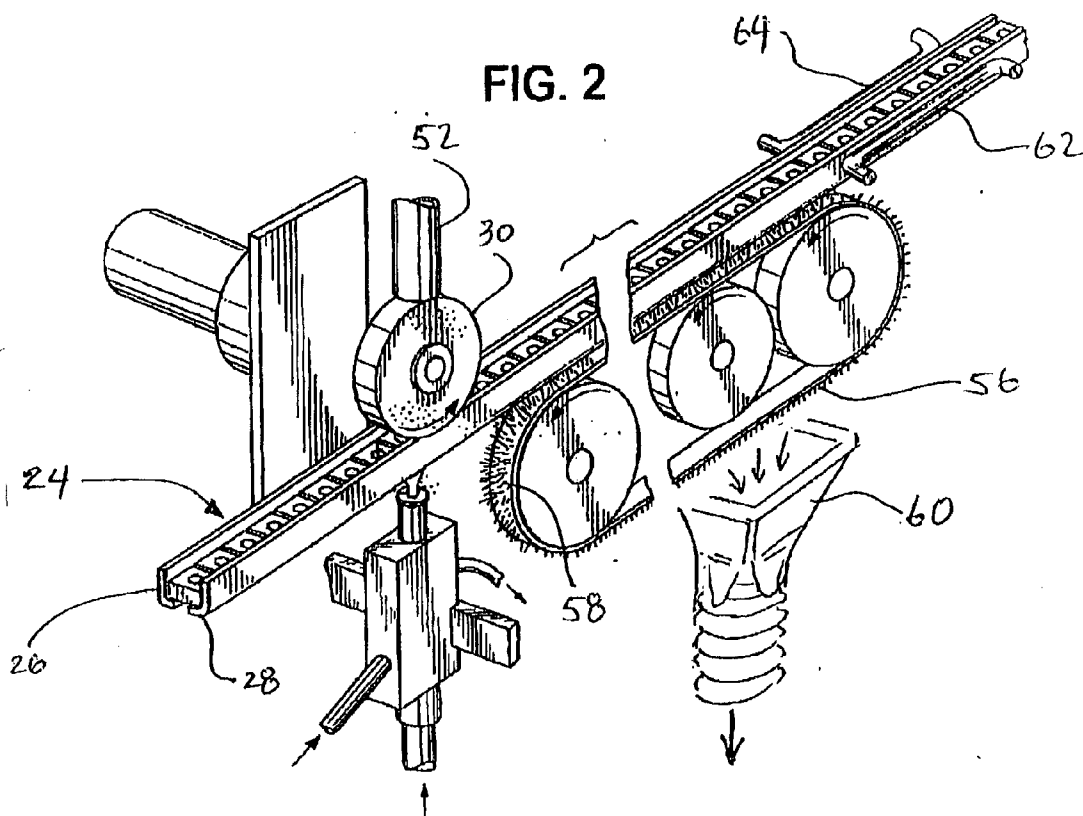


FIG. 3

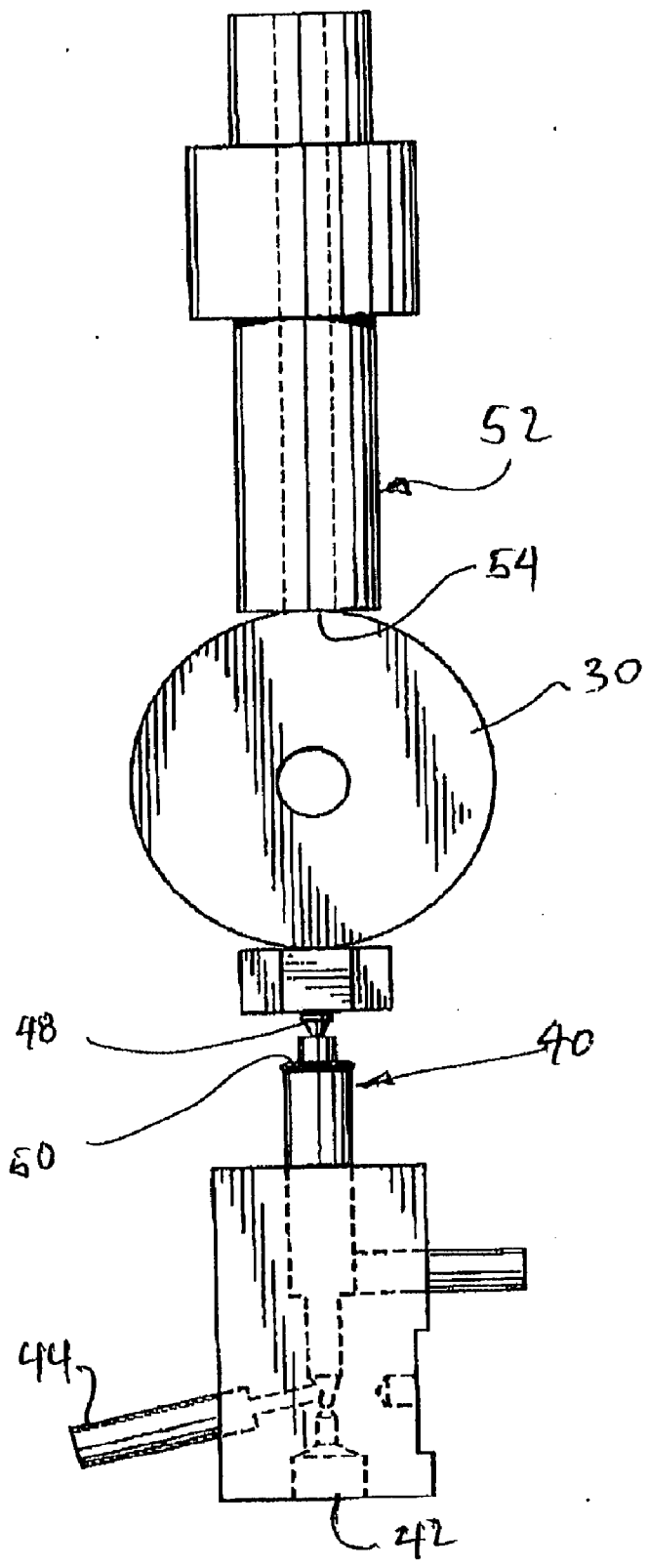
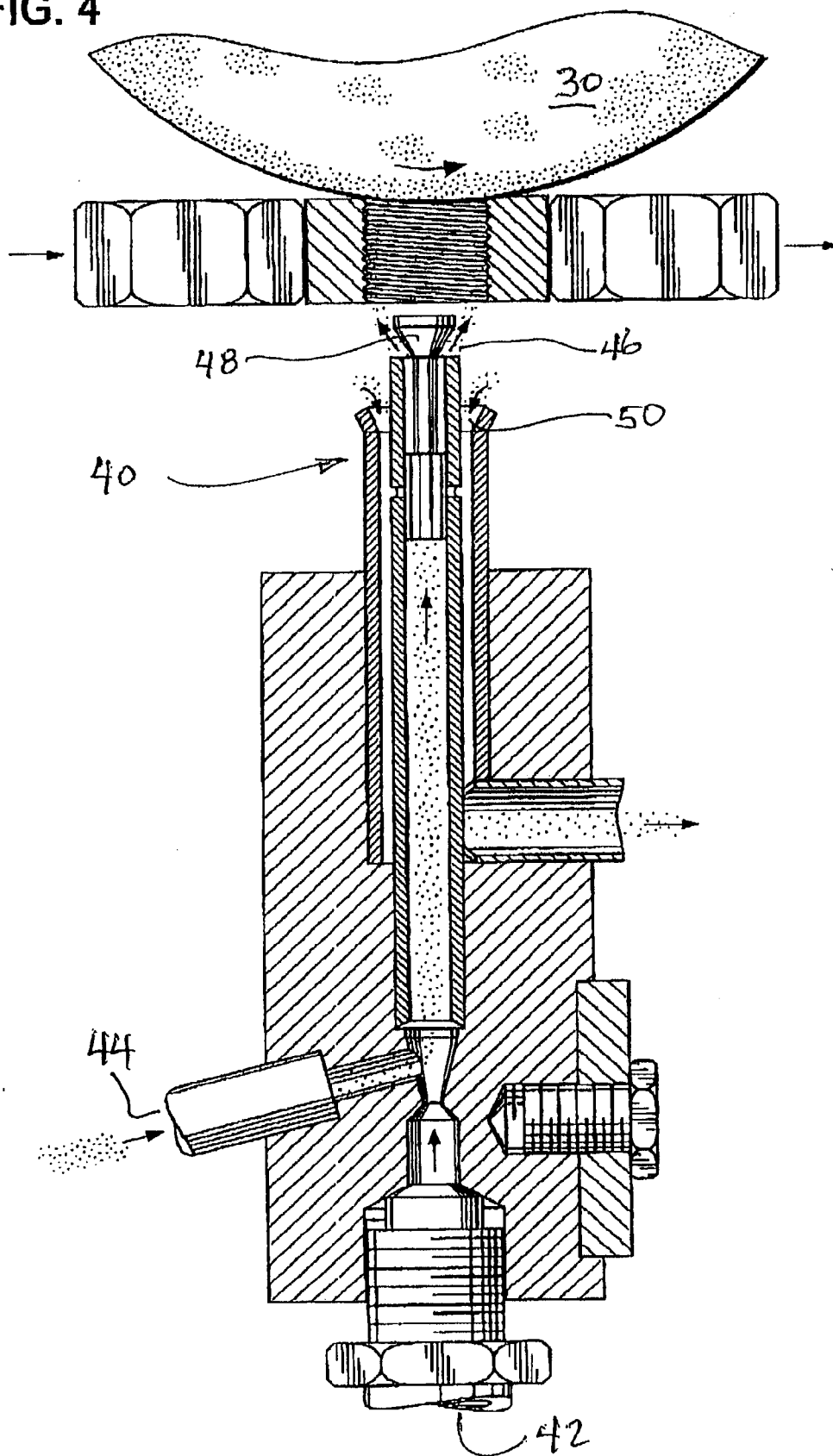


FIG. 4



**PROCESS AND APPARATUS FOR THE
APPLICATION OF FLUOROPOLYMER COATING
TO THREADED FASTENERS**

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to coatings for threaded fasteners. More particularly, the invention relates to a process and apparatus for the application of fluoropolymer coatings onto the threads of internally threaded fasteners.

[0002] It is now well known that fluoropolymer coatings may be advantageously employed to mask or protect the threaded portions of fasteners from various contaminants, such as paint primer, anticorrosion materials, weld spatter and the like. A preferred technology for the application of these coatings uses a fluoropolymer which is applied in dry powder form and is heated to form a thin continuous coating over the fastener threads. Typically, the powdered fluoropolymer is entrained in an air stream which is directed onto the threads of the fastener by means of specially designed nozzles. Examples of this preferred technology are illustrated in U.S. Pat. Nos. 4,835,819, 5,221,170, 6,156,392 and 6,395,346, whose disclosures are incorporated herein by reference.

[0003] One problem with the known prior art processes occur when coating internally threaded fasteners. Because of the need for generally uniform and continuous coatings, it has heretofore been the practice to insert the nozzle within the threaded bore of the fastener during powder application. This practice requires a reciprocating nozzle design which can be mechanically complex and costly. It also results in generally lower production rates as compared with other powdered coating techniques with a stationary nozzle design.

[0004] It would be desirable, therefore, to employ a stationary nozzle design for the application of fluoropolymer coatings to internally threaded fasteners, while still maintaining a high degree of coating uniformity and continuity over the fastener threads.

SUMMARY OF THE INVENTION

[0005] In accordance with the present invention, it has been found that uniform and continuous fluoropolymer coatings may be obtained across the threads of internally threaded fasteners, using a stationary nozzle positioned adjacent one end of the fastener. Surprisingly, the desired coating is achieved, in part, by blocking or closing the opposite end of the fastener while the powder is applied.

[0006] In one aspect of the invention, a process and apparatus are provided for the application of a fluoropolymer coating to the threads of an internally threaded fastener. The fastener has a body and a threaded bore extending to opposing ends of the body to define opposing first and second openings in the fastener. The fastener is moved on a conveyor along a path of travel with its threaded bore in a predetermined orientation. As the fastener moves along its path of travel, the first opening is closed by means of an obstructing member, while an air stream carrying entrained fluoropolymer powder is directed from a nozzle through the second opening and into the threaded bore. The nozzle is stationary and is located at an axially displaced position

relative to the second opening of the fastener and immediately adjacent the conveyor. Preferably, the nozzle includes a diffuser which directs the air stream and entrained fluoropolymer powder into the fastener bore in a diverging pattern. After the fluoropolymer powder is deposited onto the threads of the fastener, the conveyor moves the fastener through a heating station where the fluoropolymer powder is raised to its melting temperature causing it to melt and fuse into a generally continuous film covering the fastener's threads.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The novel features which are characteristic of the present invention are set forth in the appended claims. However, the invention's preferred embodiments, together with further objects and attendant advantages, will be best understood by reference to the following detailed description taken in connection with the accompanying drawings in which:

[0008] **FIG. 1** is a schematic illustration of an exemplary embodiment, showing the overall arrangement of a process and apparatus for application of fluoropolymer onto threaded fasteners in which the present invention finds particular utility;

[0009] **FIG. 2** is a perspective view illustrating details of construction for one preferred embodiment of the present invention;

[0010] **FIG. 3** is a side elevational view showing further structural details for a powdered fluoropolymer application station employed in one preferred embodiment; and

[0011] **FIG. 4** is another side elevational view in partial cross section and illustrating still further structural details for the application station shown in **FIG. 3**.

**DETAILED DESCRIPTION OF THE
PREFERRED EMBODIMENTS**

[0012] The process and apparatus of the present invention may be advantageously used with any variety of internally threaded fasteners. Such fasteners include a fastener body having a threaded bore extending to the opposing ends of the body, thereby defining first and second openings at each end of the fastener body. The fasteners may be supplied as individual items, in bulk, or strung together on a wire and supplied on a reel.

[0013] **FIG. 1** illustrates a process for applying fluoropolymer to the threads of internally threaded fasteners where the fasteners are joined by a wire carrier and supplied from a feed reel **10**. The fasteners are conveyed from the feed reel through a washing station **12**, a powder application station **14**, a cleaning station **16**, a heating station **18** and an anticorrosion station **20**, and finally to a take up reel **22**.

[0014] Any of a variety of fastener conveyors well known to those of skill in the art can be used to move the fasteners along a path of travel through the various processing stations. Where the fasteners are supplied loose in bulk, conveyors as shown in U.S. Patents Nos. Re. 33,766, 5,792,512, and U.S. Pat. No. 6,296,573 B1 may be used.

[0015] When the fasteners are strung on a carrier wire, the conveyor may take the form of a track **24**, as shown in **FIG.**

2, having parallel channel rails **26** and **28**, with the fasteners being moved along the desired path of travel by one or more drive wheels **30**.

[0016] At the powder application station, the fastener's first opening (as shown in the drawings, the "first" opening is at the top of the fastener body) is closed by an appropriate obstructing member which may take the form of a plate or belt or, as illustrated, a rotating wheel. Thus, in the preferred embodiment, wheel **30** serves both to move the fasteners along the track **24** and to close the upper opening of each fastener as it passes through the powder application station. Wheel **30** may be made of rubber-neoprene or polyurethane with a durometer range of Shore A **30** to **70**. Alternately, the wheel should be soft enough in construction to form a seal so as to close the upper opening of each fastener.

[0017] While the first or upper opening of the fastener is closed by wheel **30**, an air stream carrying entrained fluoropolymer powder is directed from nozzle **40** through the second or lower opening and into the threaded bore of the fastener.

[0018] The nozzle **40** is stationary and is positioned immediately adjacent the fasteners' path of travel. The nozzle **40** includes a pressurized air inlet **42**, a powder inlet **44** and an outlet port **46** which directs the air stream and entrained fluoropolymer powder into the fastener's threaded bore. Preferably, the nozzle also includes a diffuser or deflector **48** axially mounted within outlet port **46** which generates a diverging air stream carrying the fluoropolymer powder into the fastener bore. The angle of the diffuser or deflector is preferably 60 degrees from the axis of the outlet port, however, a range between 30 to 80 degrees may be used as well. An annular vacuum port **50** may also be situated adjacent outlet port **46** to collect fluoropolymer powder which is not deposited on the threads of the fastener. The vacuum level may be adjusted to control the uniformity of the powder coating deposited onto the threads of the fastener. For larger sized fasteners, it has been found that more vacuum may need to be used to maintain a uniform coating. The amount of coating applied to the fastener may be determined by the volume of powder applied and the number of powder applications.

[0019] The wheel **30** may pick up fluoropolymer powder on its outer circumferential surface, and this powder may be removed by a vacuum cleaner **52** whose port **54** is positioned adjacent the wheels circumference.

[0020] Any fluoropolymer powder deposited on the lower surface of the fastener may be removed at the cleaning station **16**. In the preferred embodiment this cleaning is accomplished using a belt **56** with bristles or a Velcro surface **58**. Once again the powder build up on the cleaning belt **56** may be removed via vacuum cleaner **60**.

[0021] The fluoropolymer powder collected from vacuum devices **50**, **52** and **60** may be recirculated to the powder supply which feeds nozzle **40**.

[0022] After the fluoropolymer powder is deposited on the fastener's threads, the fastener moves through a heating station, such as induction heater elements **62** and **64** to raise the fluoropolymer to its melting temperature whereby the individual powder particles melt and fuse into a generally uniform and continuous film coating. A preferred particle size is from 20 microns to 35 microns.

[0023] As those of skill in the art will appreciate, the process and apparatus of the present invention is mechanically simple, requiring only very basic mechanical components. Because there is no need to reciprocate the powder application nozzle into and out of the fastener bore, the fasteners may move continuously and production rates may be enhanced.

I claim:

1. A method for the application of a fluoropolymer coating to the threads of an internally threaded fastener, said fastener having a body and a threaded bore extending to opposing ends of the body to thereby define opposing first and second openings in the fastener, said method comprising the steps of:

moving the fastener along a path of travel with its threaded bore in a predetermined orientation;

closing the first opening of the fastener;

directing an air stream carrying entrained fluoropolymer powder through the second opening and into the bore of the fastener while the first opening is closed, said air stream emanating from a nozzle located at a position axially displaced from the second opening of the fastener, thereby forming a fluoropolymer powder coating on the threads of the fastener; and

heating the fluoropolymer powder coating to form a generally continuous fluoropolymer film on the threads of the fastener.

2. The method of claim 1 wherein the first opening of the fastener is closed by positioning an obstruction across the first opening.

3. The method of claim 2 wherein the obstruction comprises a rotating wheel having an outer surface which abuts the end of the fastener and thereby closes the first opening of the fastener.

4. The method of claim 3 wherein the wheel also assists in moving the fastener along its path of travel.

5. The method of claim 1 wherein said nozzle is stationary while the air stream with the entrained fluoropolymer powder is directed into the fastener.

6. The method of claim 1 wherein the nozzle includes a diffuser to generate a diverging air stream with entrained fluoropolymer powder entering the fastener.

7. An apparatus for the application of a fluoropolymer coating to the threads of an internally threaded fastener, said fastener having a body and a threaded bore extending through the body to opposing ends of the body to thereby define first and second opposing openings in the fastener, said apparatus comprising:

a conveyor to move the fastener along a path of travel with the fastener's threaded bore in a predetermined orientation;

an obstruction member positioned adjacent the fastener path of travel and having a surface which engages an end of the fastener body and closes the first opening of the fastener;

a nozzle positioned adjacent the fastener path of travel and axially displaced from the second opening of the fastener, said nozzle having a pressurized air input, a fluoropolymer powder input and an outlet port to thereby direct an air stream carrying entrained fluoropolymer

powder through the second opening and into the bore of the fastener while the first opening is closed, thereby forming a fluoropolymer powder coating on the threads of the fastener;

a heating element positioned along the fastener path of travel to heat the fluoropolymer powder to its melting point to form a fluoropolymer film on the threads of the fastener.

8. The apparatus of claim 7 wherein the obstruction member is a rotating wheel having an outer surface which

abuts the end of the fastener and thereby closes the first opening of the fastener.

9. The apparatus of claim 7 wherein the nozzle outlet port includes a diffuser so that the air stream carrying the entrained fluoropolymer powder is discharged in a diverging pattern.

10. The apparatus of claim 7 wherein the nozzle includes an annular vacuum port adapted to collect fluoropolymer powder not deposited on the threads of the fastener.

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