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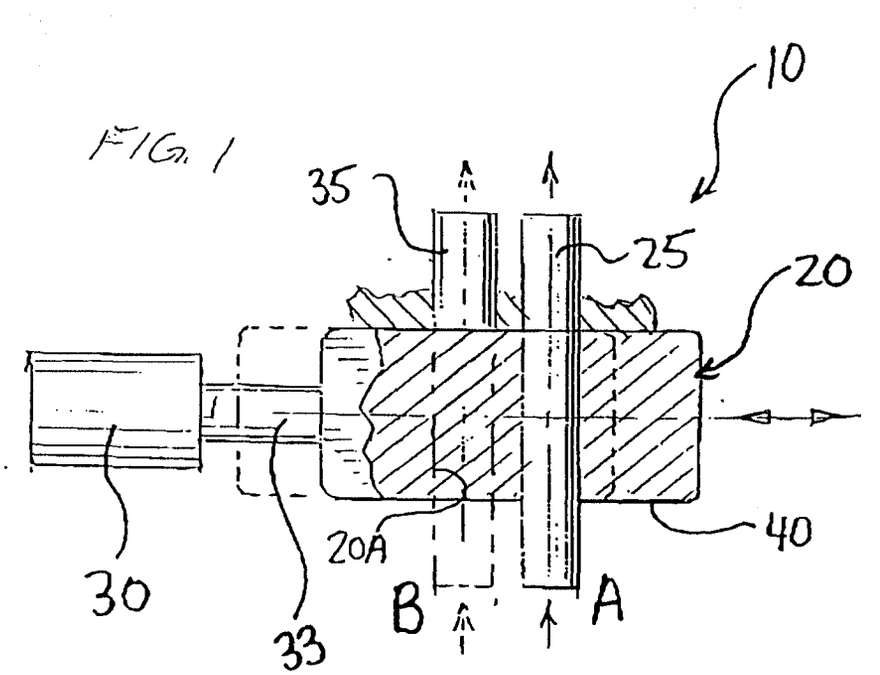
(54) Improved powder feeding apparatus for treaded articles

(57) A continuous-flow powder feeding device for use in applying powder to threaded articles. A by-pass line (25) permits powder to constantly circulate through a powder supply line (35). In response to a signal that a threaded article is in a position for powder to be applied, the powder supply line is automatically moved out of communication with the by-pass line (25), and into communication with a powder application line (35).



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Description

Background Of The Invention

[0001] This invention is generally directed to a powder application system and, more specifically, to an improved powder metering and feeding system for spraying powder onto threaded articles such as nuts in the manufacture of prevailing torque fasteners.

[0002] Powder feeding systems for applying powder to threaded articles have long been know. Powder feeding systems are inherently more accurate when they are operated continuously, i.e., in a steady-state condition, rather than operated in an intermittent or go-and-stop fashion. Intermittent operation is prone to powder surges on start-up and powder dribble at the end of a spray cycle.

[0003] There are useful devices which apply power in an intermittent cycle, as disclosed in U.S. Patent No. 5,362,327. Automatic systems employing continuous-flow powder application devices are also known (see, e. g., U.S. Patent Nos. 4,054,688; 4,100,882; and 5,025,750), in which threaded articles are sprayed in a continuous fashion rather than, an intermittent fashion. The powder application device of U.S. Patent No. 4,060,868 provides a continuous powder flow with intermittent spray air flow, and is susceptible to powder surges and inconsistent powder application.

[0004] Accordingly, it would be advantageous to provide a powder application system for threaded articles which applies powder in an intermittent fashion, yet which takes advantage of the more uniform flow rate and inherent accuracy of a continuous powder feeding operation. The present invention may be used with powder applicators, such as those disclosed in U.S. Patent No. 5,362,327, to provide more consistent torque values in the resulting product.

Summary Of The Invention

[0005] These and other objects are realized by the present invention, which overcomes disadvantages associated with prior art intermittent-flow powder feeding applications for threaded articles, and also provides new advantages not found with such existing systems or apparatus.

[0006] In one preferred embodiment, a continuous-flow powder feeding device is provided for applying powder to a threaded article. The device includes a powder source; a powder spray tube for delivery of powder to the threaded article; a powder by-pass tube for delivery of powder to a collector for receiving powder; and a powder supply tube in communication with the powder source and in selective communication with either the powder spray or powder by-pass tubes. The powder supply tube continuously moves powder through it with the aid of pressurized air. The device automatically moves the powder supply tube into selective communication with the powder spray tube in response to a signal that the threaded article is in a powder application position.

[0007] Preferably, the device automatically moves the powder supply tube into selective communication with the powder by-pass tube in response to a signal that powder has been applied to the threaded fastener. As one example, the device may be used to form a patch on the threaded fastener, and the variation in installation torque of the resulting threaded article is minimized, and relatively uniform. In one preferred embodiment, the device includes a shuttle valve carrying the powder spray and powder by-pass tubes, and an actuator for automatically moving the shuttle valve in response to the signal. The actuator may take the form of a solenoid or air cylinder, as nonlimiting examples. A powder metering apparatus, such as a helical auger, may be used in conjunction with the device for delivering a relatively constant amount of powder from the powder source to the powder supply tube.

[0008] In another preferred embodiment, the present invention involves a method for applying powder to a threaded article employing a continuous-flow powder feeding device. A powder source and a powder spray tube for delivering powder from the powder source to the threaded article are provided, as well as a powder by-pass tube for delivering powder to the powder source or to a second collector for receiving powder. A powder supply tube in selective communication with either the powder spray or powder by-pass tubes is also provided. Powder is continuously moved from the powder source through the powder supply tube using pressurized air. The powder supply tube is automatically moved into selective reciprocating communication with the powder spray tube or with the powder by-pass tube, depending on whether the threaded article is in a position for powder to be applied. Preferably, the powder supply tube is moved in response to a signal indicative of the position of the threaded article.

Brief Description of Drawings

[0009] These and other features, objects and advantages of the present invention will become apparent from the following description and drawings wherein like reference numerals represent like elements in the several views, and in which:

FIGURE 1 is a schematic of a preferred embodiment of the present invention employing a flow-diverting valve for a single-nozzle powder system;

FIGURE 2 is a front view of a second, preferred embodiment of the present invention employing a flow-diverting valve for a double-nozzle powder feeding system;

FIGURE 3 is a partial sectional view taken along reference line 3-3 of FIGURE 2;

FIGURE 4 is a graph showing the variation in instal-

lation torque of nuts processed on a single-nozzle, intermittent powder feed system of the type described in U.S. Patent No. 5,362,327, incorporated herein by reference;

FIGURE 5 is a graph showing the variation in installation torque of nuts processed on a single-nozzle, continuous-flow powder feed system of the present invention;

FIGURE 6 is a graph showing the variation in installation torque of nuts processed on a continuous-flow powder feed system similar to FIGURE 4, but using a double-nozzle valve; and

FIGURE 7 is a graph showing the torque variation of nuts processed on a continuous-flow powder feed system of the type described in U.S. Patent No. 4,100,882, incorporated herein by reference;.

Detailed Description of the Preferred Embodiment

[0010] The present invention employs a by-pass line for the powder stream, to provide an intermittent-flow powder application operation, while also taking advantage of the accuracy of a continuous-flow powder application operation. The by-pass line diverts the powder stream during the non-spray portion of the machine cycle. A mechanism is also provided to divert the powder stream from the by-pass line to the spray or application line during the spray portion of the cycle.

[0011] Referring now to FIGURE 1, a preferred embodiment of the intermittent-flow powder feed apparatus of the present invention is generally referred to by reference numeral 10. A shuttle valve 20 having a valve body 40 slides along rod 33, and is shown in the by-pass position labeled "A". In operation, a relatively constant flow of metered powder, flowing in the direction of the arrows, is drawn from a feeder discharge (not shown) by negative pressure developed downstream from shuttle valve 20. The powder passes into by-pass line 25 where it is directed to a suitable collector or returned to a feeder supply hopper (neither enclosure is shown).

[0012] In response to a signal, a threaded article to which powder is to be applied is sensed to be in the proper position for spraying. Now, actuator 30 shifts shuttle valve 20 to the spray position labeled "B". The powder stream passes through aperture 20A within shuttle valve 20, into spray line 35, and is deposited on the threads of the article. When the spray cycle is completed, a second signal activates actuator 30 to shift shuttle valve 20 back to by-pass position A at the same time that the sprayed article is discharged. Also at this same time, the next threaded article moves into the spray position, causing another signal to be generated, and the process is repeated.

[0013] Negative pressure may be continuously developed in both the spray and by-pass lines by air jets, as those of ordinary skill in the art will appreciate from the disclosures in U.S. Patent Nos. 5,620,520 and 5,620,741, each of which is incorporated by reference herein. As one specific example, the samples shown in FIGURES 4-7 (all airflow measurements are in SCFM) were M8 nuts processed with an air vacuum at about 45 SCFM and at a spray speed of about 9.5 SCFM. These figures will vary depending upon the size and type of fastener, and the desired processing speeds and other parameters.

[0014] Actuator 30 may take the form of either a single or double-acting air cylinder, or a solenoid, or any other fast-acting, linear actuators, for example. As one specific, nonlimiting example, a Husky compact cylinder, Model SFM 118 v. 38 VC3 CB555, may be used, and connected to air fitting 43. Signals for activating actuator 30 may be electrical or fluidic in nature; if electrical, they may be generated using fiber optic sensors or microswitches, for example.

[0015] If desirable based on the particular threaded article size, type and shape to which powder is applied, valve stem 47 may be shuttled between stops for more precise positioning alignment within shuttle valve 20.

[0016] In one preferred embodiment, the powder metering device for supplying powder to powder feed apparatus 10 consists of two stacked funnels and a vibrator (not shown). Each funnel is initially filled with powder, and the larger funnel is located on top of the smaller funnel, with the discharge opening of the larger funnel being flush with the powder level of the smaller, lower funnel. Thus, as the power level of the lower funnel increases, it eventually reaches a level such that the powder flow through the upper funnel is automatically shut off. Vibration of the funnels occurs continuously. This approach has been found to provide a desirable, relatively constant powder flow.

[0017] The present invention may be used to accommodate virtually any type of powder feeder which possesses the capability of providing the required accurate metered flow. As examples, an AccuRate helical dry powder feeder available from Schenck AccuRate® of White Water, Wisconsin, or a modified stacked funnel\ valve, vibration-type feeder as described above or in U. S. Patent No. 5,571,323, incorporated herein by reference, may be used.

[0018] Referring to FIGURES 2-3, shuttle valve 20 may be modified as shown to process two or more threaded articles, such as nuts, simultaneously. In this embodiment, spray tubes 35A, 35B receive powder. Tubes 25A, 25B are the by-pass tubes, while tubes 35A, 35B, are the spray tubes. Again, powder flow is shown by the direction of the arrows.

[0019] Cylinder 30 is shown in FIGURE 3 in the extended position, with powder flowing through spray tubes 35A, 35B. When cylinder 30 retracts, powder flows through by-pass tubes 25A, 25B. Still referring to FIGURE 3, L-shaped bracket 46 and threaded fastener 48 mount shuttle valve 20 and cylinder 30 to a suitable fixture. A clevis bracket, generally designated as 55, joins valve stem 47 to cylinder 30 using sleeve 55A, pin 55B, threaded mount 55C and rod 55D. Valve stem 47

moves relative to plate 60, which is fixed by fastener 48 to L-shaped bracket 46. Fixed plate 60 includes apertures 60A, which house the ends of tubes 25A, 25B, and $35A_1$, $35B_1$.

[0020] Referring to FIGURES 4-5, comparison test results are shown in graph form. Referring to FIGURE 4, actual installation torque is shown for nuts processed on a single-nozzle intermittent powder feeding system as described in U.S. Patent No. 5,362,327. Referring to FIGURE 5, the variation in installation torque (i.e., the difference between the actual value and the mean value) is shown for nuts processed on a single-nozzle power feeding system according to the present invention. Sigma (i.e., the measure of the degree of scatter) was 1.697 for the test results shown in FIGURE 4, and 0.198 for the test results shown in FIGURE 5 (0.202 and 0.196 for the first and second 20-lot samples, respectively).

[0021] FIGURE 6 shows the variation in installation torque, similar to FIGURE 5, but for the use of a double-nozzle powder feeding system according to the present invention (as shown in FIGURES 2-3). The Sigma values are as follows: 0.239 (for the entire sample); 0.253 (front nozzle); 0.201 (rear nozzle); 0.223 (first 20-lot samples); and 0.252 (second 20-lot samples). These Sigma values demonstrate the torque uniformity between the two nozzles, and also the torque uniformity over time. In contrast, FIGURE 7 shows the torque variation in a continuous system (such as that according to U.S. Patent No. 4,100,882); the Sigma value is 0.511.

[0022] It will be understood that the invention may be embodied in various specific forms without departing from its spirit or central characteristics. For example, the powder feeding systems of the present invention may be used to form a patch on a self-locking fastener, or to apply a masking or lubricating coating (of, eg, Teflon) as taught in U.S. Patent No. Re. 33,366. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention recited in the claims is not to be limited to the details given here.

Claims

1. A continuous-flow powder feeding device for applying powder to a threaded article, comprising:

   a powder source;
   a powder spray tube for delivery of powder to the threaded article;
   a powder by-pass tube for delivery of powder to a collector for receiving powder;
   a powder supply tube in communication with the powder source and in selective communication with either the powder spray or powder by-pass tubes, the powder supply tube continuously moving powder therethrough with the aid of pressurized air; and
   a device for automatically moving the powder supply tube into selective communication with the powder spray tube in response to a signal that the threaded article is in a powder application position.

2. The continuous-flow powder feeding device of Claim 1, wherein the device automatically moves the powder supply tube into selective communication with the powder by-pass tube in response to a signal that powder has been applied to the threaded fastener.

3. The continuous-flow powder feeding device of Claim 1, wherein the powder is used to form a patch, and wherein the variation in installation torque of the resulting threaded article is minimized.

4. The continuous-flow powder feeding device of Claim 1, wherein the powder is used to form a patch, and the installation torque of the resulting fastener is relatively uniform.

5. The continuous-flow powder feeding device of Claim 1, wherein the device comprises a shuttle valve carrying the powder spray and powder by-pass tubes, and an actuator for automatically moving the shuttle valve in response to the signal.

6. The continuous-flow powder feeding device of Claim 5, wherein the actuator comprises a solenoid.

7. The continuous-flow powder feeding device of Claim 5, wherein the actuator comprises an air cylinder.

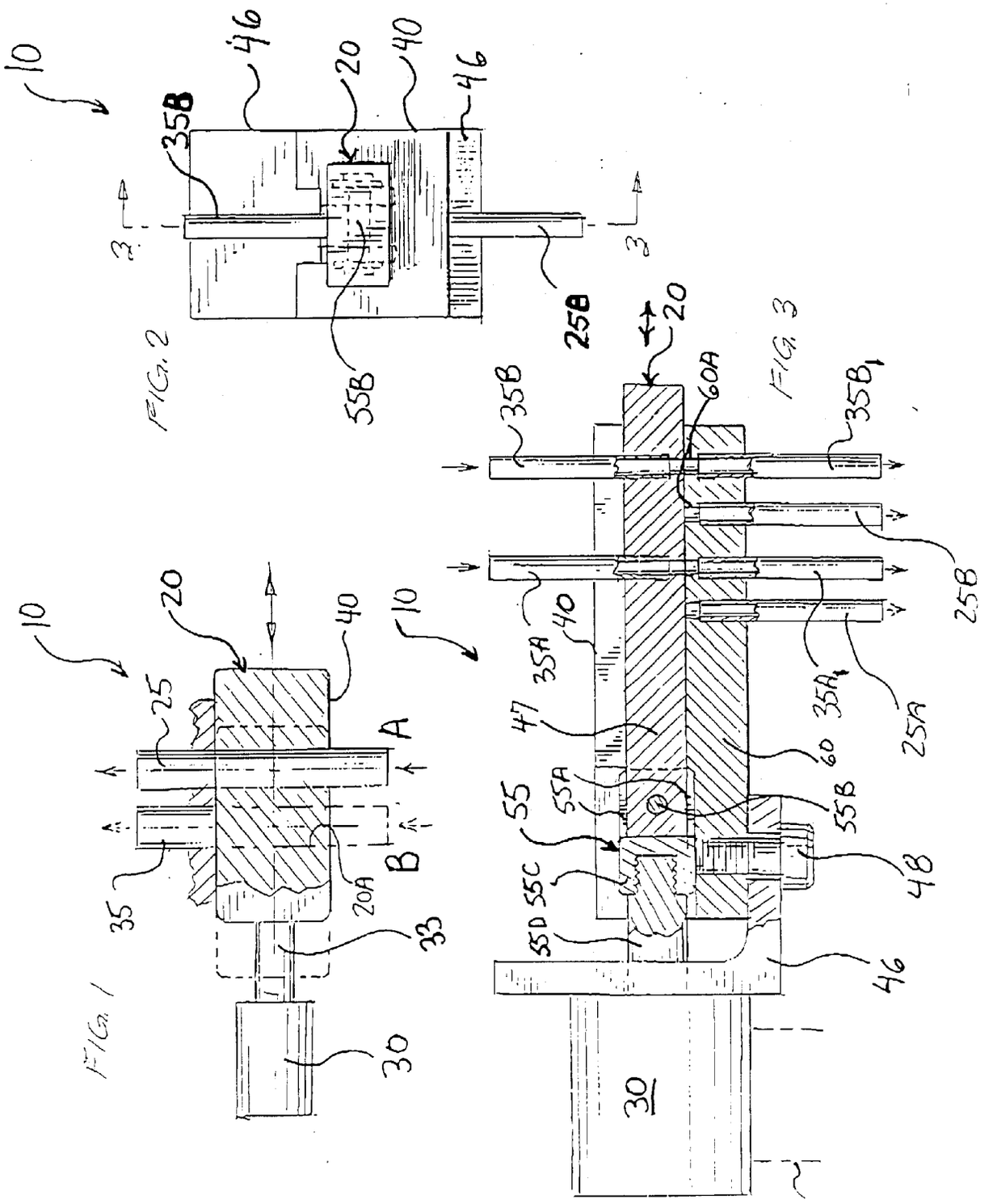
8. The continuous-flow powder feeding device of Claim 1, further comprising a powder metering device for delivering a relatively constant amount of powder from the powder source to the powder supply tube.

9. A method for applying powder to a threaded article employing a continuous-flow powder feeding device, comprising the steps of:

   a. providing a powder source and a powder spray tube for delivering powder from the powder source to the threaded article;
   b. providing a powder by-pass tube for delivering powder to the powder source or to a second collector for receiving powder;
   c. providing a powder supply tube in selective communication with either the powder spray or powder by-pass tubes;
   d. continuously moving powder from the powder source through the powder supply tube using pressurized air; and

e. automatically moving the powder supply tube into selective reciprocating communication with the powder spray tube or with the powder by-pass tube, depending on whether the threaded article is in a position for powder to be applied.

10. The method of Claim 8, wherein the powder supply tube is moved in response to a signal indicative of the position of the threaded article.


10
46
20
40
46
35B
3
3
55B
FIG. 2
25B
20
35B
60A
35B1
25B
35A
40
35A1
25A
47
60
55
55A
55B
55C
55D
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20
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25
A
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20A
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FIG. 1
FIG. 3

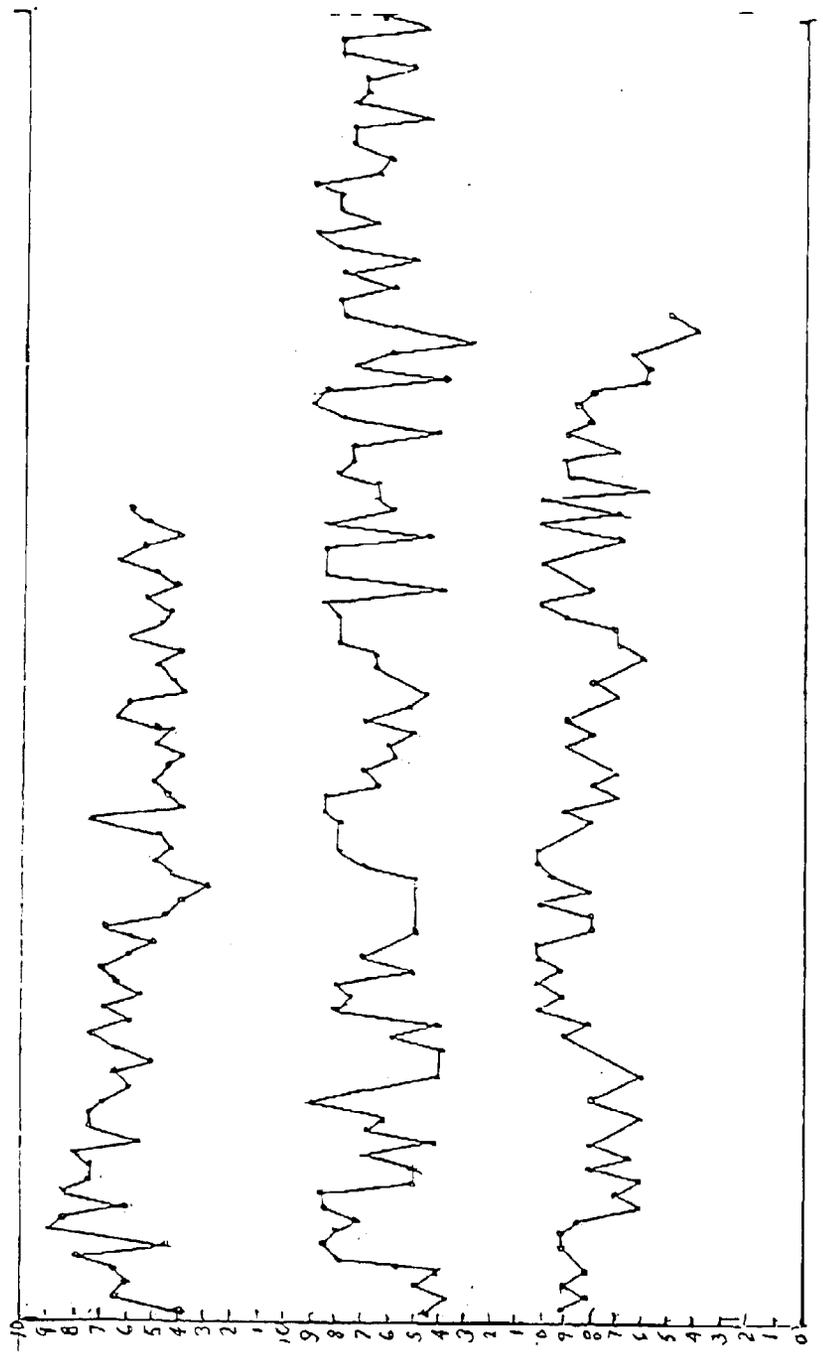

FIG. 4 (PRIOR ART)

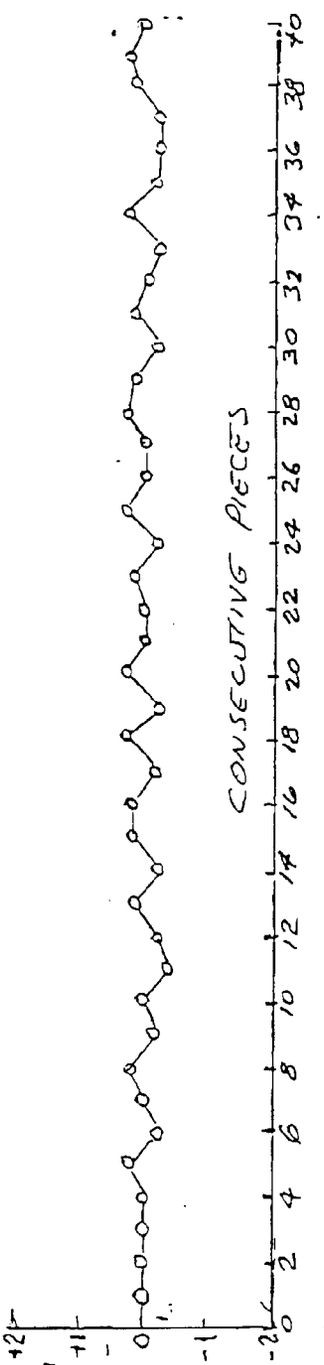

FIG. 5

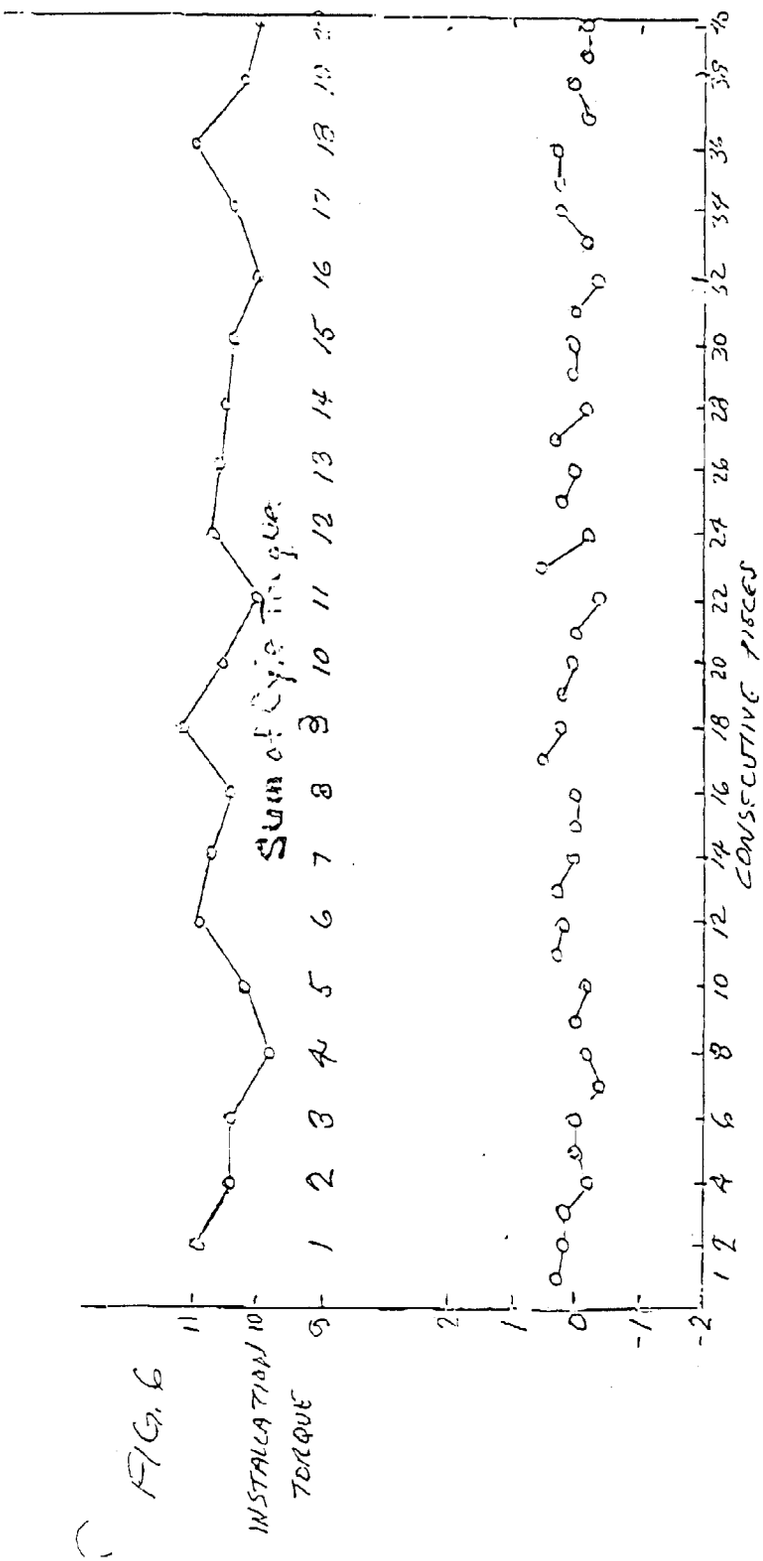
INSTALLATION TORQUE
CONSECUTIVE PIECES

FIG. 6

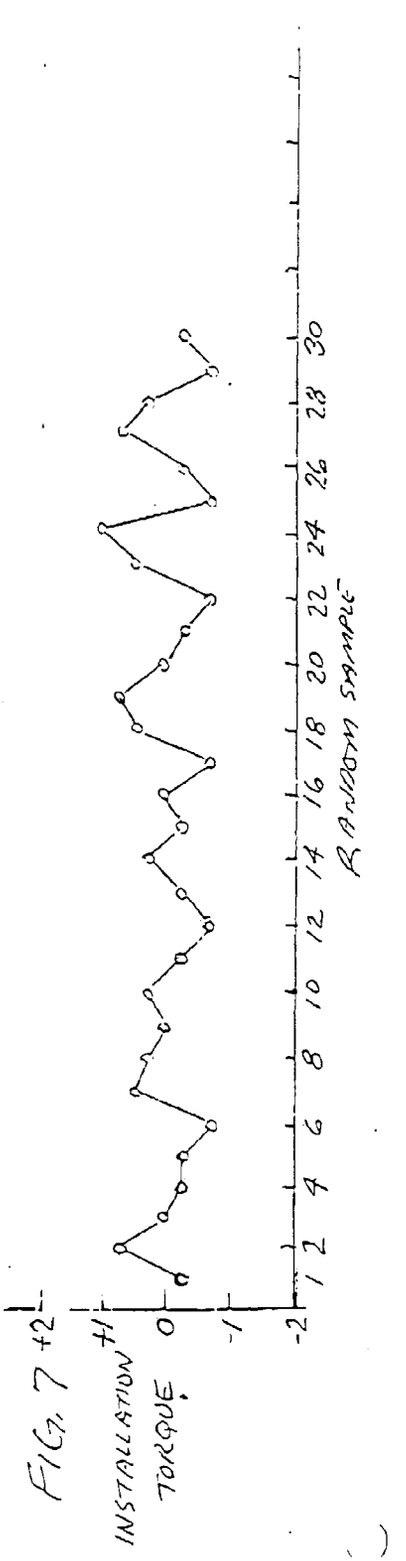
INSTALLATION TORQUE
RANDOM SAMPLE

FIG. 7