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(54) VALVE STEM INSTALLATION SYSTEM AND METHOD OF INSTALLING VALVE STEM

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(60) Provisional application No. 60/453,262, filed on Mar. 10, 2003. Provisional application No. 60/460,153, filed on Apr. 3, 2003.

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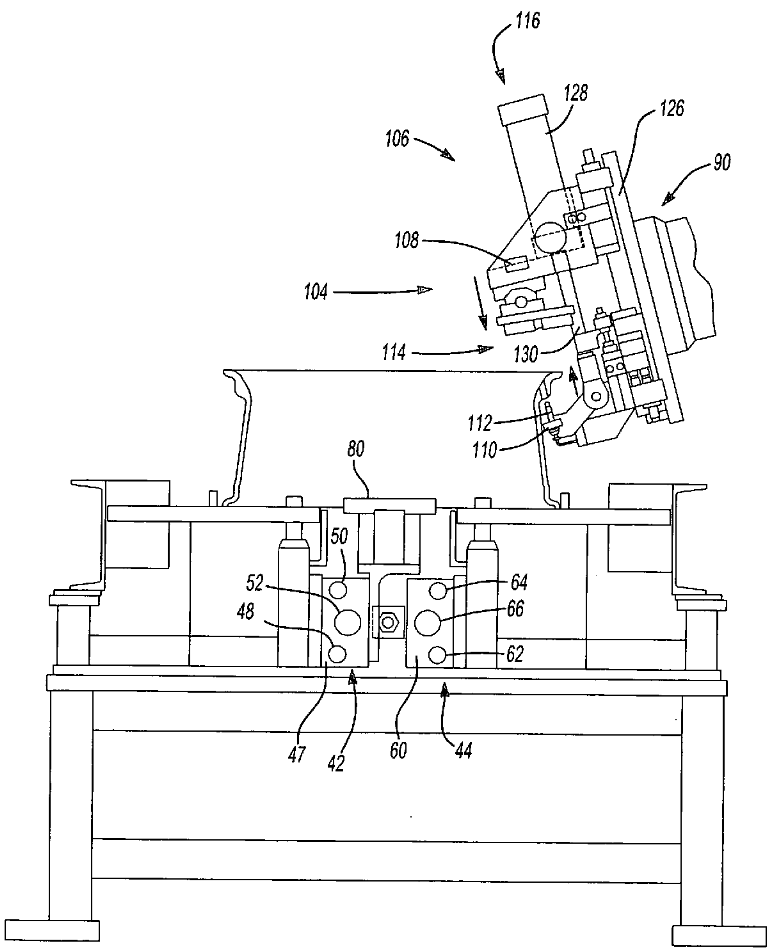
(57) **ABSTRACT**

A valve stem installation system includes a robotic arm for moving a valve stem insertion device around the lip of wheel. The system also includes a pair of valve stem aperture sensors positioned on the robotic arm adjacent the valve stem insertion device and moveable around the lip of the wheel. The sensors can be positioned on opposite sides of the valve stem insertion device. When the first sensor locates the valve stem aperture, movement of the robotic arm can be slowed. When the second sensor locates the valve stem aperture, movement of the robotic arm can be stopped. The conveyor unit can include an identification station to sense the configuration of the wheel. A controller can select the appropriate valve stem to insert in the valve stem aperture in response to the sensed configuration of the wheel.



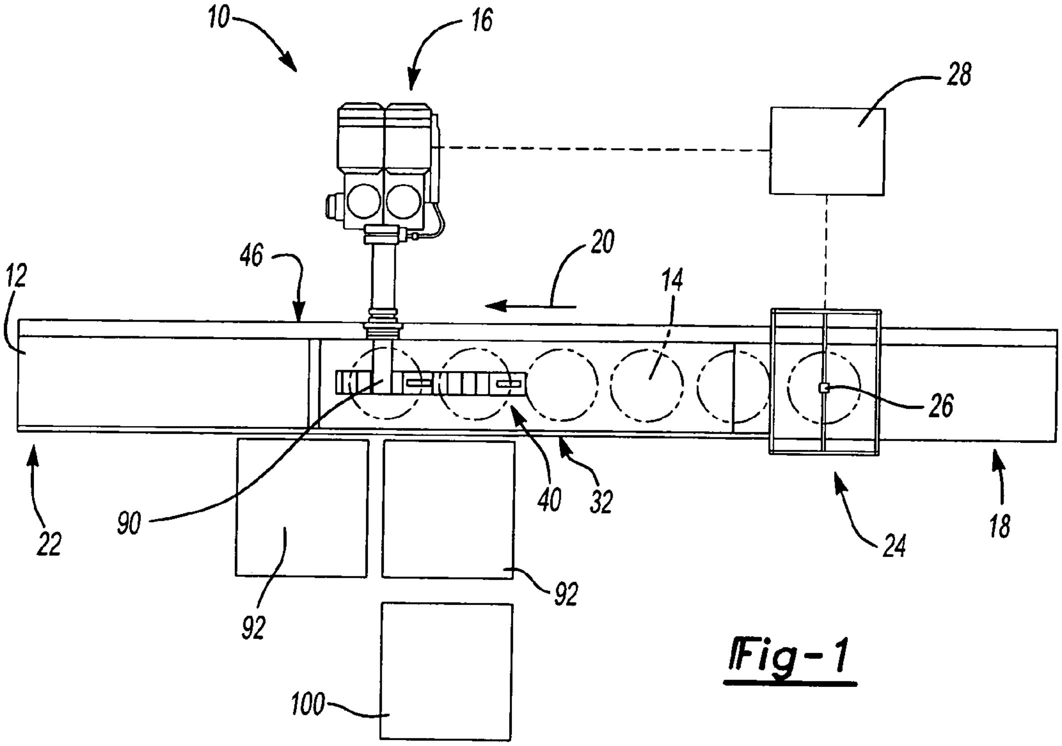


Fig-1

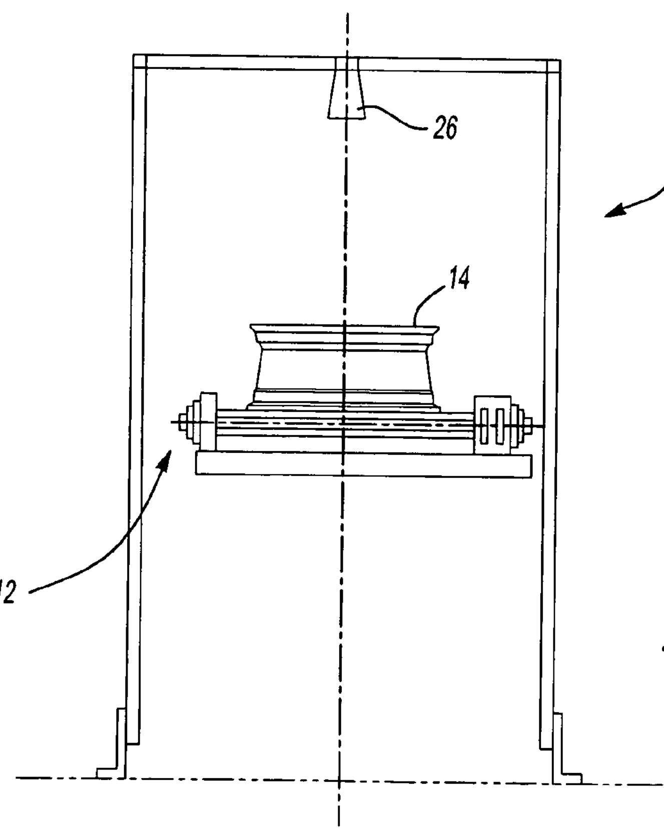


Fig-2

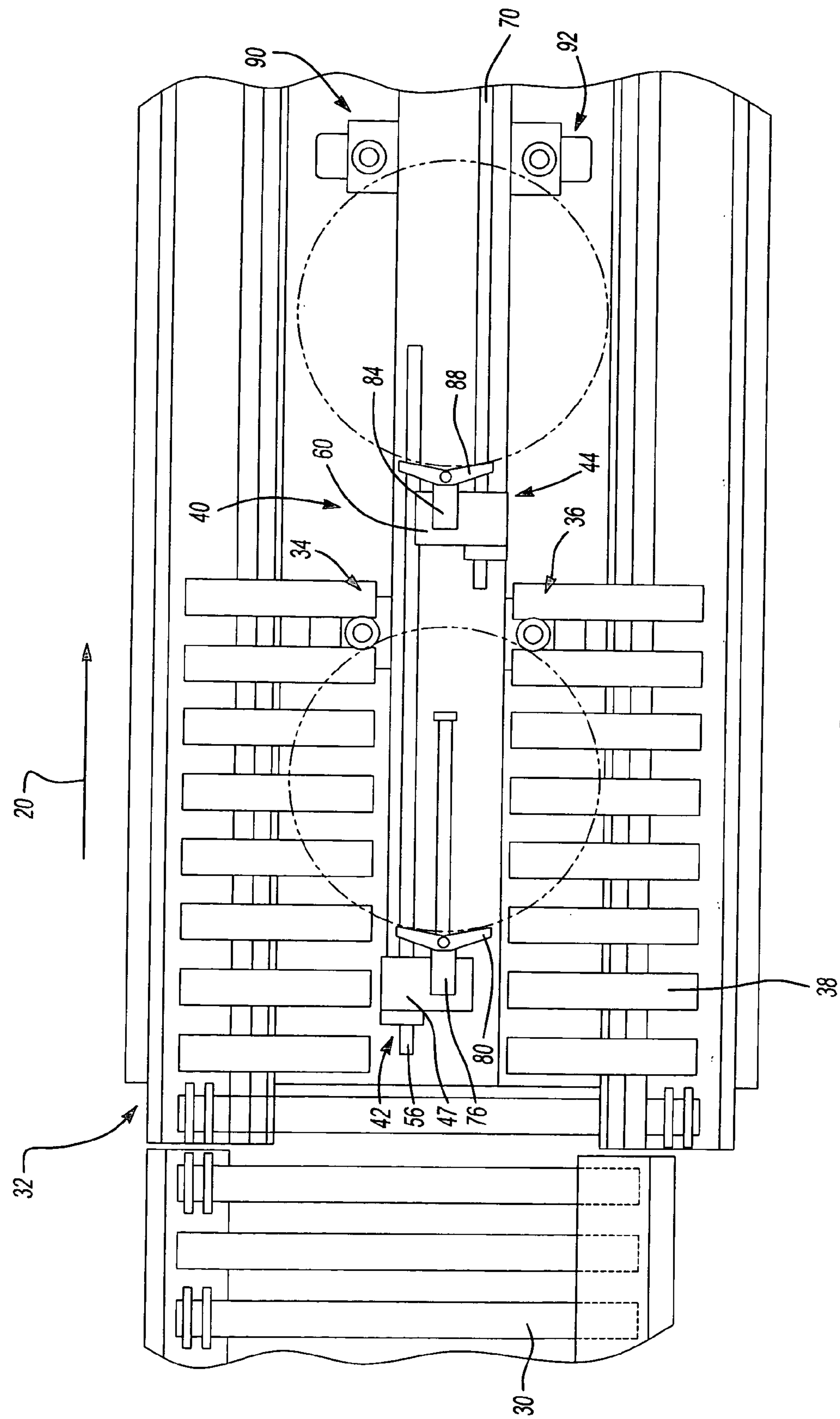


Fig-3

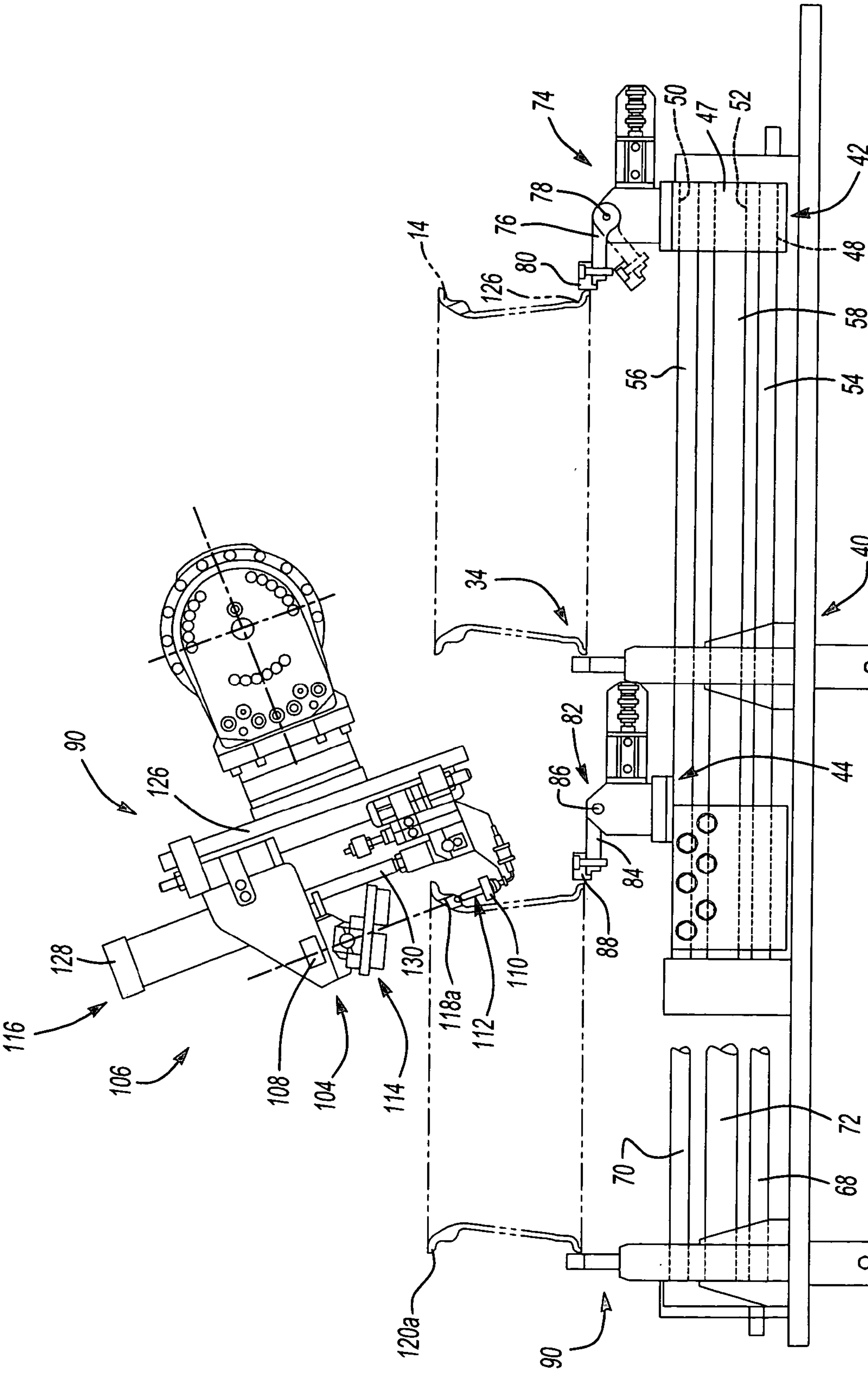

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Fig-4

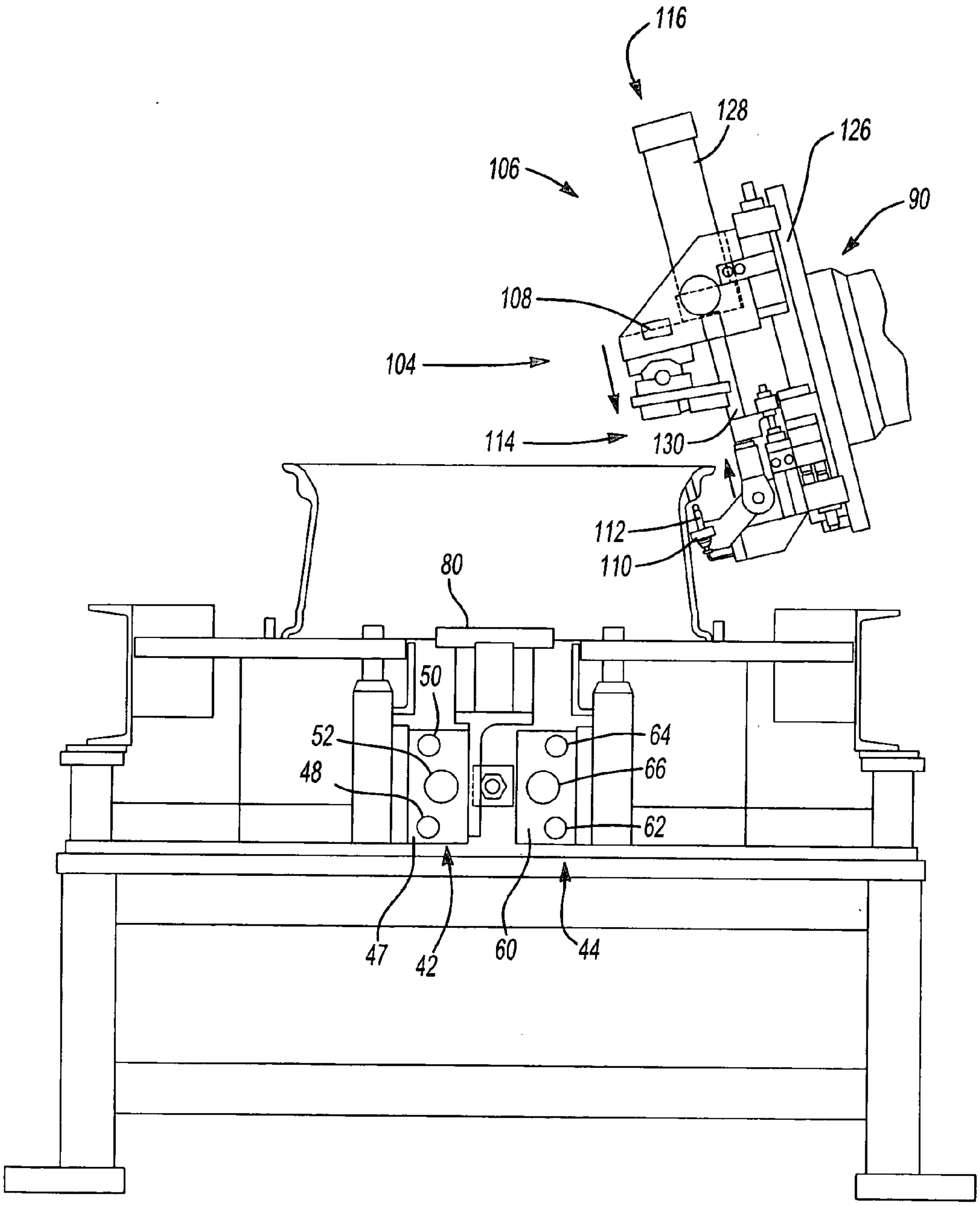
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Fig-5

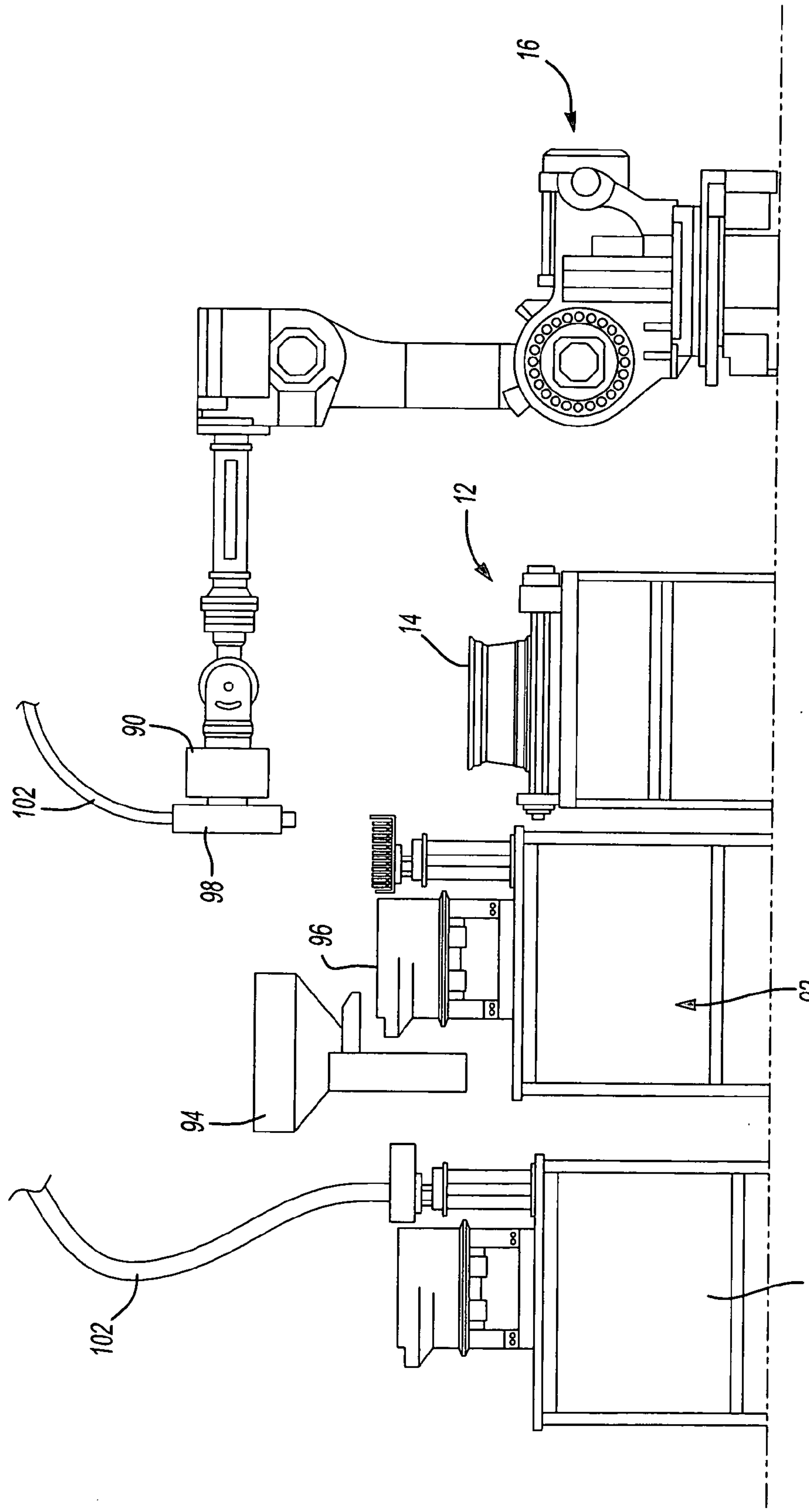

Fig-6

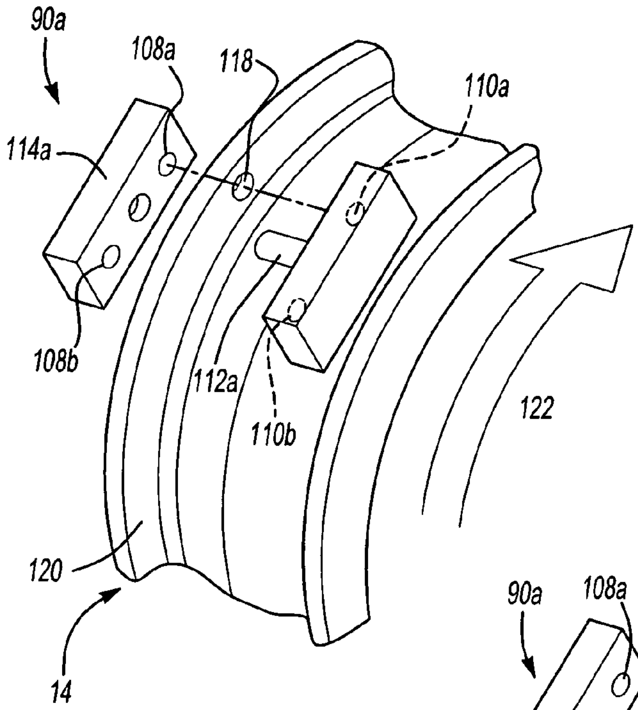

Fig-7

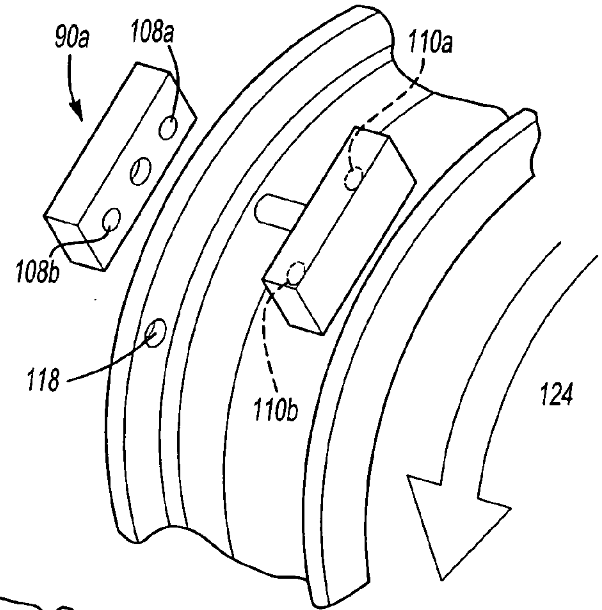

Fig-8

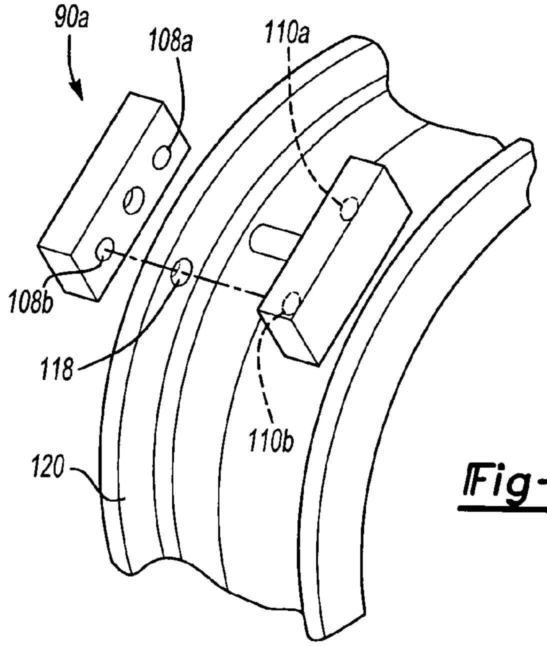

Fig-9

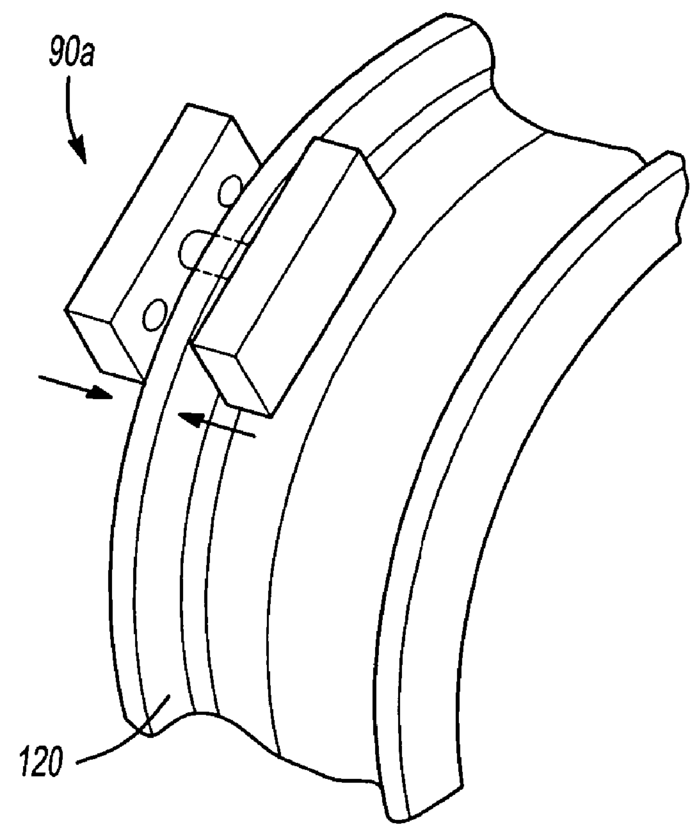

Fig-10

VALVE STEM INSTALLATION SYSTEM AND METHOD OF INSTALLING VALVE STEM

RELATED APPLICATIONS

[0001] This application claims the benefit of the provisional patent application 60/453,262 for a VALVE STEM INSTALLATION SYSTEM AND METHOD OF INSTALLING VALVE STEM, filed on Mar. 10, 2003, and claims the benefit of the provisional patent application 60/460,153 for a TIRE PRESSURE MONITORING VALVE STEM INSTALLATION SYSTEM AND METHOD OF INSTALLING TIRE PRESSURE MONITORING VALVE STEM, filed Apr. 3, 2003, which are hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

[0002] The subject invention relates to the assembly of wheels, and more particularly to an apparatus and method for locating a valve stem aperture in a wheel and mounting the valve stem to the wheel.

BACKGROUND OF THE INVENTION

[0003] In the past, a valve stem was manually mounted to a wheel with a stem-inserting tool. Such manual processes are expensive because of the labor and time involved. In addition, operations performed manually are subject to a relatively greater frequency of processing errors in comparison to robot-performed processes.

[0004] Several prior art patents disclose processes for mounting a valve stem to a wheel with programmable machines. For example, U.S. Pat. No. 6,481,083 teaches a valve stem assembly line that includes an input conveyor to supply wheels, a locator station positioned at the end of the input conveyor to locate the valve stem aperture defined by the wheel, and a robotic manipulator to grasp the wheel in the locator station and to move the wheel to the mounting station where a valve stem is inserted. U.S. Pat. No. 6,026,552 teaches a spinning device to spin the wheel, an optical sensor to locate the valve stem aperture while the wheel is spinning, and press fitting device that can slide relative to a wheel and insert a valve stem after the valve stem aperture has been located. U.S. Pat. No. 5,940,960 teaches and automatic valve stemming apparatus including a spinning device to spin the wheel, an optical sensor to locate the valve stem aperture, and a valve stem insertion tool to insert a valve stem after the valve stem aperture has been located.

[0005] One of the areas of continuous development and research is the pursuit of flexible systems operable to receive and process several differently configured rims. Another area is the pursuit of less costly valve stem insertion devices. Costliness can be defined by the capital investment required for putting the valve stem insertion system on the factory floor as well as the operating cost associated with the system. In pursuit of these goals, it would be desirable to develop a valve stem insertion system having improved flexibility, cost and efficiency.

BRIEF SUMMARY OF INVENTION

[0006] The invention provides an apparatus and method for locating a valve stem aperture in a wheel and inserting the valve stem in the valve stem aperture. The valve stem and the valve stem aperture are moved relative to one another at a predetermined relative speed in a first rotational direction along a curved path of the wheel perimeter to align the valve stem with the valve stem aperture. The valve stem is supported with a pin and the pin is moved around the wheel with a robotic apparatus. A first sensor locates the valve stem aperture when the valve stem and the valve stem aperture are a first angular distance from one another along the curved path. In response to the first sensor locating the valve stem aperture, the relative speed of movement between the valve stem and the valve stem aperture is reduced. A second sensor locates the valve stem aperture when the valve stem and the valve stem aperture are a first angular distance from one another along the curved path.

[0007] One of the advantages of the present invention is that processing time for inserting the valve stem in the valve stem aperture is reduced. Specifically, the relative movement between the valve stem and the valve stem aperture can be maximized prior to the locating step and the first and second sensor can be spaced from one another to accommodate the braking capacity of the system. In other words, the invention substantially eliminates time delays associated with confirming the location of the valve stem aperture that are common in prior art locating systems.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0009] **FIG. 1** is an overhead schematic view of a valve stem installation system according to the exemplary embodiment of the invention;

[0010] **FIG. 2** is a side view of an identification station for the valve stem installation system shown in **FIG. 1** for identifying an individual wheel from a plurality of differently configured wheels;

[0011] **FIG. 3** is a top view of a portion of the valve stem installation system shown in **FIGS. 1 and 2** showing pin stop assemblies positioned along a roller conveyor for preventing movement of a wheel along the roller conveyor;

[0012] **FIG. 4** is a partial cross-sectional view of the valve stem installation system shown in **FIGS. 1-3** showing a positioning device for positioning a wheel and a locating and inserting assembly for inserting a valve stem in a valve stem aperture defined by a wheel;

[0013] FIGS. **5** is a partial cross-sectional view of the valve stem installation system shown in **FIGS. 1-4** and offset ninety degrees from the view in

[0014] **FIG. 4**, showing the positioning device and the locating and inserting assembly;

[0015] **FIG. 6** is a side view of the valve stem installation system shown in **FIG. 1** with additional structural details; and

[0016] **FIGS. 7-10** are perspective views illustrating a sequence of locating a valve stem aperture and inserting a valve stem in the valve stem aperture.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Referring now to **FIG. 1**, the present invention provides a method and apparatus **10** for inserting a valve stem in a valve stem aperture defined by a wheel. The apparatus **10** includes a conveyor **12** for moving wheels **14** past a robotic apparatus **16**. Valve stems are inserted in the valve stem aperture defined by the wheel **14** by the robotic apparatus **16**. Wheels **14** can be received at a beginning **18** of the conveyor **12** and move in a direction **20** to an end **22** of the conveyor **12**.

[**0018**] Referring now to **FIGS. 1 and 2**, during movement of the wheel **14** between the beginning **18** and end **22** of the conveyor **12**, the wheel **14** passes through an identification station **24**. The identification station **24** can include a camera **26** for identifying the wheel **14** from a plurality of differently configured wheels. When a wheel **14** moves within the visual range of the camera **26**, the camera **26** communicates an image of the wheel **14** to a controller **28**. The image includes structural features of the wheel **14** including the position of the valve stem aperture. The controller **28** compares the image received from the camera **26** with a plurality of images stored in memory. The images in memory correspond to all of the differently configured wheels that can pass through the identification station **24**. Each of the images stored in memory is associated with structural characteristics and physical dimensions of a corresponding wheel **14**. The controller **28** controls processing steps performed downstream of the identification station **24** based, at least in part, on the physical dimensions of the wheel **14** identified from the image received from the camera **26**.

[**0019**] Referring now to **FIGS. 1 and 3**, the conveyor **12** includes clutch-assisted, driven rollers **30** to move the wheel **14** from the identification station **24** to a first position **32** along the conveyor **12**. The wheel **14** can move along the conveyor **12** in the direction **20** until the wheel **14** engages a pair of pin stops **34**, **36**. The conveyor **12** includes undriven rollers **38** between the first position **32** and the pin stops **34**, **36**. The pin stops **34**, **36** are actuated between an extended position above the conveyor **12** and a retracted position below the conveyor **12** to stop movement of the wheel **14** in the direction **20** along the conveyor **12**. The pin stops **34**, **36** are controlled in movement by the controller **28**. Sensors (not shown) are positioned along the conveyor **12** to sense the position of the wheel **14** along the conveyor **12** and communicate the sensed position of the wheel **14** to the controller **28**.

[**0020**] Referring now to **FIGS. 1 and 3-5**, a positioning device **40** is disposed along the conveyor **12** adjacent the robotic apparatus **16**. The positioning device **40** includes a first positioning mechanism **42** and a second positioning mechanism **44**. The positioning mechanisms **42**, **44** are substantially similar with respect to one another and are disposed along the conveyor **12** between the first position **32** and a second position **46**. The first positioning mechanism **42** includes a housing **47**. The housing **47** defines apertures **48**, **50** and **52** for receiving guide tracks **54**, **56** and **58**, respectively as best seen in **FIGS. 4 and 5**. The guide tracks **54**, **56** and **58** guide movement of the housing **48** along the conveyor **12**. A metal piston (not shown) is disposed internally of the guide track **58** and cooperate magnetically with the housing **48**. For example, the housing **48** houses a magnet to attract the metal piston in the guide track **58**. The piston is moved by selectively directing pressurized air to opposite sides of the piston in the guide track **58**. The housing **48** moves in response to movement of the piston. The second positioning mechanism **44** is structured similarly and function similarly as the first positioning mechanism **42**. For example, the second positioning mechanism **44** includes a housing **60** defining apertures **62**, **64**, **66** for receiving guide tracks **68**, **70**, **72**, respectively, as best shown in **FIGS. 4 and 5**. A metal piston is disposed internally of the guide track **72** and cooperates with the housing **60** to move the housing **60** along the conveyor **12**. Movement of the pistons inside the tracks **58**, **72** are controlled by the controller **28**.

[**0021**] Referring now to **FIGS. 3-5**, the first positioning mechanism **42** includes an engaging device **74** for engaging and moving the wheel **14** along the conveyor **12**. The engaging device **74** is connected to the housing **47** and includes an arm **76** rotatable about an axis **78**. An engaging portion **80** is disposed at the end of the arm **76** and is shaped to correspond to the shape of the wheel **14**. During movement of the housing **47** along the conveyor **12** in the direction **20**, the arm **76** is located in a first position shown in solid line in **FIG. 4**. After the housing **47** has moved a predetermined distance along the conveyor **12** in the direction **20**, the arm **76** is moved to a second position shown in phantom in **FIG. 4**. The arm **76** is moved to the second position to prevent the engaging portion **80** from interfering with movement of a following wheel moving along the conveyor **12** and is therefore positioned below the conveyor **12**. The positioning device **42** moves the wheel **14** along the conveyor **12** to a position along the conveyor **12** at which the second positioning mechanism **44** can engage the wheel **14**. The second positioning mechanism **44** includes an engaging device **82** structured similarly and functioning similarly as the first engaging device **74**. For example, the engaging device **82** includes an arm **84** rotatable about an axis **86** and an engaging portion **88** positioned at the end of the arm **84**. The second positioning mechanism **44** moves the wheel **14** away from the robotic apparatus **16** after a valve stem has been inserted in the valve stem aperture defmed by the wheel, a process described in greater detail below. Once the second positioning mechanism **44** moves the wheel **14**, the first positioning mechanism **42** moves a second wheel **14** along the conveyor **12** until the second wheel **14** engages a second pair of pin stops **90**, **92**.

[**0022**] Referring now to **FIGS. 1 and 6**, after the wheel **14** is positioned adjacent the robotic apparatus **16** by the positioning device **40**, the robotic apparatus **16** inserts a valve stem in the valve stem aperture defined by the wheel **14**. The robotic apparatus **16** moves a locating and inserting assembly **90** around the wheel **14**, shown schematically in **FIGS. 1 and 6**. The assembly **90** receives valve stems from one or more valve stem feeding stations **92** disposed along the conveyor **12**. Each station **92** includes a hopper **94** for receiving valve stems and a sorting device **96** for sorting the valve stems and arranging the valve stems in an orientation to be received by the assembly **90**. The different valve stem feeding stations **92** sort different configurations of valve stems. A nut runner **98** is attached to the assembly **90** to insert nuts on valve stems that require nuts. The nut runner **98** receives nuts from a nut feeding station **100** through a conduit **102**. The station **100** can be disposed along the conveyor **12**.

[**0023**] Referring now to **FIGS. 4 and 5**, the assembly **90** includes a locating device **104** and a stem inserting device **106**. The locating device **104** includes a pair of light emitters, such as light emitter **108**, and a pair of light receivers, such as light receiver **110**. The inserting device **106** includes a valve stem holding pin **112**, a support plate **114**, and a moving device **116** for moving the holding pin **112** and the support plate **114** relative to one another.

[**0024**] The method for locating the valve stem aperture in the wheel is shown schematically in **FIGS. 7-10**. In **FIG. 7**, the embodiment of the assembly **90***a* includes a pair of light emitters **108***a* and **108***b*, as well as a pair of light receivers **110***a* and **110***b*. The assembly also includes a support plate **114***a* and a valve stem holding pin **112***a*. The assembly **90***a* is moved around the wheel **14** in the direction **122**. The light emitters **108***a*, **108***b* are disposed on an opposite side of a lip **120** of the wheel **14** with respect to the light receivers **110***a*, **110***b*. The valve stem aperture **118** is defined in the lip **120**. The assembly **90***a* is moved in the direction **122** and the light receiver **110***a* receives light from the light emitter **108***a* through the valve stem aperture **118**. The assembly **90***a* moves in the direction **122** at a predetermined angular velocity and is slowed by the controller **28** in response to the communication between the light emitter **108***a* and the light receiver **110***a* through the valve stem aperture **118**.

[**0025**] Referring now to **FIG. 8**, the assembly **90***a* is stopped after passing the valve stem aperture **118**. Due to the delay between sensing the light by the first receiver **110***a*, signaling the controller **28**, the assembly **90***a* typically passes the aperture **118** prior to stopping the robot **16**. The assembly **90***a* is moved in the direction **124** until the light receiver **110***b* receives light from the light emitter **108***b* through the valve stem aperture **118**, shown in **FIG. 9**. In response to the communication between the light receiver **110***b* and the light emitter **108***b* through the valve stem aperture **118**, the assembly **90***a* is moved in the direction **122** until the valve stem holding pin **112** is aligned with the aperture **118** and the valve stem is then inserted, as shown in **FIG. 10**. The assembly **90***a* moves much faster in the direction of arrow **122** than in the direction of arrow **124** because more distance is typically traveled to first locate the aperture **118**. Once the aperture **118** is located, the assembly moves at a slower rate in the direction of arrow **124** to determine a more precise location of the aperture **118** prior to aligning the stem holding pin **112***a* with the aperture **118**.

[**0026**] Referring now to **FIGS. 4 and 5**, the valve stem is inserted in the valve stem aperture **118***a* defined in the lip **120***a* of the wheel **14** by engaging the moving device to move the valve stem holding pin **112** relative to the support plate **114**. The moving device **116** includes a plate **126** attached to the robotic apparatus **16**. The moving device **116** also includes a cylinder **128** attached to the plate **126** and a rod **130** extendable and retractable with respect to the cylinder **128**. The valve stem holding pin **112** is fixedly associated with the end of the rod **130** and the support plate **114** is rotatably associated with the cylinder **128**. After the valve stem aperture **118** has been located the robotic apparatus moves the support plate **114** to engage the lip **120***a* of the wheel **14**. The rod **130** is retracted in the cylinder **128**, moving the valve stem holding pin **112** through the aperture **118***a*. The rod **130** is extended to remove the valve stem holding pin **112** from the aperture **118***a*, leaving the valve stem in the valve stem aperture **118***a*.

[**0027**] Referring now to **FIGS. 3 and 4**, after the valve stem has been inserted in the valve stem aperture **118***a*, the second positioning mechanism **44** moves the wheel with the inserted valve stem along the conveyor **12** past the retracted pin stops **90-92**. The wheel **14** now continues along the conveyor **12** for further processing operations.

[**0028**] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims. These antecedent recitations should be interpreted to cover any combination in which the incentive novelty exercises its utility. In addition, the reference numerals in the claims are merely for convenience and are not to be read in any way as limiting.

1-16 (Canceled)

17. A method for assembling a valve stem to a wheel rim having an aperture formed therein comprising the steps of

determining a location of the aperture relative to a gauging station;

coaxially aligning a central axis of the aperture and a longitudinal axis of the valve stem with respect to one another prior to insertion of the valve stem through the aperture; and moving the valve stem relative to the rim along a programmable path of travel during the coaxially aligning step and along the aligned axes to insert the valve stem through the aperture, the path of travel defined with a programmable robotic manipulator having an arm capable of compound, multi-axial movement and having a plurality of programmed paths corresponding to a plurality of different size wheel rim and valve stem combinations to be assembled.

18. The method of claim 17 wherein the determining step further comprises the step of:

identifying at least one physical feature of the rim with a machine vision system.

19. The method of claim 17 wherein the aligning step further comprises the step of:

selectively moving the valve stem to the gauging station from one of a plurality of valve stem delivery stations in response to the determining step, each delivery station having a differently configured valve stem mounted thereon.

20. The method of claim 17 wherein the determining step further comprises the step of:

identifying the rim as one of a plurality of different types of rims in response to inspection with a machine vision system.

21. The method of claim 17 wherein the determining step further comprises the steps of:

positioning the rim on a rotatable table;

directing an optical sensor at the rim;

rotating the table and the rim; and

stopping rotation of the table and rim when the optical sensor is directed at the aperture.

22. The method of claim 17 further comprising the step of:

tightening a nut over a threaded portion of the valve stem extending from the rim after the valve stem has been inserted with respect to the aperture.

23. The method of claim 22 wherein the nut is tightened to the valve stem by a nut runner mounted on the robotic manipulator.

24. The method of claim 22 wherein the nut is tightened to the valve stem by a nut runner mounted adjacent to the gauging station.

25. The method of claim 17 further comprising the step of:

conveying valve stems to the delivery station in a serial fashion with conveying means.

26. The method of claim 17 wherein the moving step further comprises the steps of:

holding the rim substantially stationary; and urging the valve stem toward the rim with the robotic manipulator.

27. The method of claim 17 further comprising the step of:

moving the rim and attached valve stem from a gauging station to a subsequent processing station such that the rim is oriented with the valve stem in a predetermined angular position relative to the subsequent processing station.

28. The method of claim 17 further comprising the step of:

grasping the valve stem with the robotic manipulator and moving along the path of travel in response to computer-controlled signals.

29. The method of claim 28 further comprising the step of:

actuating the robotic manipulator to move the valve stem to the rim located at a delivery station.

30. The method of claim 17 further comprising the step of:

grasping the valve stem with the robotic manipulator computer-controlled and having a valve-stem-gripper-attachment articulatable and positionable to be in a predetermined orientation with respect to the aperture in the rim.

31. The method of claim 30 further comprising the step of:

orienting the aperture of the wheel rim in a predetermined location with respect to the valve-stem-gripper-attachment as a result of articulation and positioning of the valve-stem-gripper-attachment by the robotic manipulator prior to the inserting step.

32. The method of claim 30 further comprising the step of:

orienting the aperture of the wheel rim in a predetermined location with respect to gauging station as a result of rotational movement of the rim until the aperture is properly located with respect to the gauging station prior to the inserting step; and

the inserting step performed with the valve-stem-gripper-attachment in a predetermined position with respect to the gauging station as a result of articulation and positioning of the valve-stem-gripper-attachment by the robotic manipulator prior to the inserting step.

33. An apparatus for assembling a valve stem to a wheel rim having an aperture formed therein comprising:

means for determining a location of the aperture relative to a gauging station;

means for coaxially aligning the central axis of the aperture and a longitudinal axis of the valve stem with respect to one another prior to insertion of the valve stem through the aperture; and

means for moving the valve stem relative to the rim along a programmable path of travel including alignment of the central axis of the aperture with the longitudinal axis of the valve stem and along the aligned axes to insert the valve stem through the aperture, the path of travel defined with a programmable robotic manipulator having arm capable of compound, multi-axial movement and having a plurality of programmed paths corresponding to a plurality of different size wheel rim and valve stem combinations to be assembled.

34. The apparatus of claim 33 wherein the means for determining further comprises:

a machine vision system to identify at least one physical feature of the rim.

35. The apparatus of claim 34 wherein the aligning means further comprises:

the robotic manipulator to selectively move the valve stem from one of a plurality of delivery stations having different valve stems mounted thereon in response to the identification by the machine vision system.

36. The apparatus of claim 33 wherein the means for determining further comprises:

a machine vision system to identify the rim as being one of a plurality of different rims.

37. The apparatus of claim 37 wherein the means for tightening further comprises: a nut runner mounted on the robotic manipulator.

38. The apparatus of claim 33 wherein the means for tightening further comprises:

a nut runner mounted adjacent to a gauging station where the valve stem is moved relative to the rim to insert the valve stem with respect to the aperture.

39. The apparatus of claim 33 further comprising: means for supplying valve stems in a serial fashion to a delivery station where the valve stem is moved relative to the rim to insert the valve stem with respect to the aperture.

40. The apparatus of claim 33 wherein the means for moving further comprises: the robotic manipulator to urge the valve stem toward the rim.

41. The apparatus of claim 33 further comprising: the robotic manipulator for moving the rim and attached valve stem from a gauging station where the valve stem is mounted with respect to the aperture to a processing station while maintaining the valve stem in a predetermined angular position relative to the processing station.

42. The apparatus of claim 33 further comprising:

means for grasping the valve stem with the robotic manipulator computer-controlled and having a valve-stem-gripper-attachment articulatable and positionable to be in a predetermined orientation with respect to the aperture in the rim.

43. The method of claim 42 further comprising:

means for orienting the aperture of the wheel rim in a predetermined location as a result of movement of the rim at the gauging station prior to the valve stem being inserted by the robotic manipulator.

44. A method for assembling a valve stem to a wheel rim having an aperture formed therein comprising the steps of:

determining the location of the valve stem aperture in the rim; and operably engaging the valve stem with a robotic manipulator; moving the valve stem relative to the rim along a programmable path of travel;

coaxially aligning the valve stem and the aperture; and

inserting at least a portion of the valve stem through the aperture in the rim, wherein the path of travel is defined with a programmable robotic manipulator having an arm capable of compound, multi-axial movement and having a plurality of programmed paths corresponding to a plurality of different size wheel rim and valve stem combinations to be assembled.

45. The method according to **44** further comprising the steps of operably engaging the valve stem and moving the valve stem towards the rim.

46. The method according to claim 44 further comprising the step of securing the valve stem to the rim by tightening a nut over a threaded portion of the valve stem extending from the rim.

47. The method of claim 44 further comprising the step of:

grasping the valve stem with the robotic manipulator computer-controlled and having a valve-stem-gripper-attachment articulatable and positionable to be in a predetermined orientation with respect to the aperture in the rim.

48. The method of claim 47 further comprising the step of:

orienting the aperture in the rim to a predetermined location during movement of the valve stem with the robotic manipulator as a result of articulation and positioning of the valve-stem-gripper-attachment.

49. The method of claim 47 further comprising the step of:

orienting the aperture in the rim to a predetermined location at a station prior to the inserting step.

50. An apparatus for assembling a valve stem to a wheel rim having an aperture formed therein comprising:

means for determining the location of the valve stem aperture in the rim; and

means for operably engaging the valve stem;

means for moving the valve stem relative to the rim along a programmable path of travel; and

means for coaxially aligning the valve stem and the aperture to insert at least a portion of the valve stem through the aperture in the rim, wherein the path of travel is defined with a programmable robotic manipulator having an arm capable of compound, multi-axial movement and having a plurality of programmed paths corresponding to a plurality of different size wheel rim and valve stem combinations to be assembled.

51. The apparatus of claim 50 further comprising:

means for grasping the valve stem with the robotic manipulator computer-controlled and having a valve-stem-gripper-attachment articulatable and positionable to be in a predetermined orientation with respect to the aperture in the rim.

52. The apparatus of claim 51 further comprising:

means for orienting the aperture of the wheel rim in a predetermined location with respect to the valve-stem-gripper-attachment as a result of articulation and positioning of the valve-stem-gripper-attachment by the robotic manipulator prior to inserting the valve stem.

53. The apparatus of claim 52 further comprising:

means for orienting the aperture of the wheel rim in a predetermined location with respect to gauging station as a result of rotational movement of the rim until the aperture is located with respect to the gauging station prior to inserting the valve stem; and

the grasping means including the valve-stem-gripper-attachment in a predetermined position with respect to the gauging station as a result of articulation and positioning of the valve-stem-gripper-attachment by the robotic manipulator prior to inserting the valve stem.

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