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### **RAR2 Advanced Rapid Air Release Valve Pneumatic Tire Seater**

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#### **Abstract**

A pneumatic tire seater for seating a tubeless tire on a rim has an advanced rapid air release (RAR) valve mounted on a tank suitable for containing pressurized air. A nozzle is mounted on one end of the RAR valve, and the other end of the valve is in unconstrained pneumatic communication with the interior of the air tank. A piston is within a cylinder of the RAR valve. A control chamber behind the piston contains a compression spring. Control gas passageways provide constrained pneumatic communication between the control chamber and the air tank, passing control gas into the control chamber. In response to actuating a control mechanism, the air in the control chamber is vented out into the atmosphere causing the RAR valve to rapidly open, producing a blast of air of sufficient magnitude to seat a tire on a rim.

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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] The present application claims priority from and incorporates by reference in its entirety U.S. patent application Ser. No. 17/695,195 filed Mar. 15, 2020 which issued as U.S. Pat. No. 12,285,980, and claims priority from and incorporates by reference in its entirety, U.S. patent application Ser. No. 16/134,095 filed Sep. 18, 2018 which issued as U.S. Pat. No. 11,273,677.

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0002] Various embodiments of the present invention relate to tools, and more specifically, to tools for seating tubeless vehicle tires on wheel rims.

#### Description of Related Art

[0003] Tires for automobiles, trucks and other vehicles are designed to be mounted on wheels or rims. In the past, an inner tube was inflated between the tire and the rim. It was fairly easy to mount a tire on a rim by simply inflating the inner tube until the tire's bead was seated on the rim. Today, however, tubeless tires—that is, tires without inner tubes—have almost entirely supplanted the older technology that relied on inner tubes. Today's tubeless tires last longer, are less prone to going flat, and provide better performance than the older tires utilizing inner tubes. However, tubeless tires tend to be much more difficult to mount on a wheel than the older tires with inner tubes.

[0004] To mount a tubeless tire, each of the beads (edges) of the tire must be held airtight all the way around the two edges of the rim on which they mount to form an airtight chamber within the tire and wheel. When a tire is first placed on a rim prior to being inflated, there is generally a gap between the bead of the tire and the wheel's rim that prevents inflation with an air compressor. Seating the tire on the rim allows the tire to be pressurized. In some cases, smaller tires may be seated by injecting air through the valve stem while pressing the tire's bead against the rim to create a seal (e.g., bicycle or motorcycle tires). But this is extremely difficult to do with larger tires such as truck tires.

[0005] It is known in the art that a high volume of air blown rapidly between the rim and the bead of the tire can seat the tire on the rim. To accomplish this conventional pneumatic tire seaters generally include a large, yet portable, pressurized air tank with a valve leading to a discharge barrel. The tank and discharge barrel may be positioned to blow a high volume of air from the pressurized air tank into the tire. The air tank of conventional devices must be of sufficient volume—e.g., at least 15 liters or more—to hold enough air at a high pressure to expand the tire against the rim, completely filling the volume of the tire to a pressure greater than the atmospheric pressure in order to seat the tire against the rim. The large 15+ liter air tanks of conventional tire seating devices are quite unwieldy and take longer to fill with pressurized air.

#### SUMMARY

[0006] The present inventors recognized a need for a pneumatic tire seater with a smaller air tank that is more convenient to store, lift and carry than conventional devices that require large, unwieldy air tanks. The various embodiments disclosed herein realize these and other benefits. The various embodiments disclose a pneumatic tire seater—sometimes called a bead seater—that includes an air tank for holding pressurized air, an advanced rapid air release (RAR) gas valve in unconstrained pneumatic communication with the interior of the air tank, and a nozzle connected to the RAR gas valve. The RAR gas valve has a piston configured to slide back and forth within a

cylinder of the gas valve. A control chamber formed within the cylinder between the endcap of the gas valve and a proximal end of the piston. The control chamber contains a compression spring and a flexible cushion. The piston has one or more control gas passageways that provide constrained pneumatic communication between the control chamber and the pressurized air in the air tank. [0007] The pneumatic tire seater has a nozzle connected to a distal end of the gas valve. The nozzle has one or more nozzle outlet holes configured to blow air into the gap between the tire and the wheel. A valve control mechanism can be actuated to open a control valve that pneumatically connects the control chamber to the atmosphere outside the tank. In response to the valve control mechanism being actuated, the gas valve releases pressurized air from the air tank through the nozzle in a burst that is sufficient to seat a tire on a rim. In this way a user can direct the nozzle into the gap between an uninflated tire on a rim to blow the pressurized air into the tire and seat the tire's bead on the rim.

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## Description

### DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings, which are incorporated in and constitute part of the specification, illustrate various embodiments of the invention. Together with the general description, the drawings serve to explain the principles of the invention. In the drawings:

[0009] FIG. 1A depicts embodiments of rapid air release (RAR) pneumatic tire seaters with two different tank sizes according to various embodiments disclosed herein.

[0010] FIG. 1B depicts an RAR pneumatic tire seater in the upside down stowed position according to various embodiments disclosed herein.

[0011] FIGS. 2A-C depict oblique views of three RAR transverse tank pneumatic tire seater embodiments.

[0012] FIG. 3A-B depict exploded views of RAR valves according to various embodiments disclosed herein.

[0013] FIG. 3C depicts an oblique view of a piston, a distal O-ring and a slotted lock collar of an RAR valve according to various embodiments disclosed herein.

[0014] FIG. 3D depicts an oblique view from the distal end of an RAR valve cylinder component according to various embodiments disclosed herein.

[0015] FIG. 3E depicts an oblique view from the side of an RAR valve cylinder component according to various embodiments disclosed herein.

[0016] FIGS. 4A-B depict a cutaway side view of a proprietary lock collar with inner removal holes and a proprietary removal tool for removing and replacing the proprietary lock collar, and the cross-sectional shapes of the proprietary removal tool's feet according to various embodiments disclosed herein.

[0017] FIG. 4C-E depicts a lock collar with removal holes on the outer face, a tool for removing and replacing the lock collar, and an oblique view of the tool inserted into the lock collar, according to various embodiments disclosed herein.

[0018] FIGS. 5A-B depict side views of an RAR pneumatic tire seater with a portion of the tank cut away to display the RAR valve inside the tank according to various embodiments disclosed herein.

[0019] FIGS. 6A-B respectively depict a side view and a top view of an RAR pneumatic tire seater to illustrate aspects of the control cluster, according to various embodiments disclosed herein.

[0020] FIGS. 7A-C depict three views of the nozzle according to various embodiments disclosed herein.

[0021] FIG. 7D depicts a nozzle outlet section, according to various embodiments disclosed herein.

[0022] FIG. 8 is a flowchart of a method of using the RAR pneumatic tire seater according to

various embodiments of the invention.

## DETAILED DISCLOSURE

[0023] FIG. 1A depicts embodiments of rapid air release (RAR) pneumatic tire seaters with two different tank sizes according to various embodiments disclosed herein. Disclosed herein are various embodiments of tire seaters with high speed RAR valves for air or other gases, and methods of making and using the same. For the sake of simplicity the RAR valves are described herein in terms of releasing pressurized air held in the air tank **101**. However, in actual practice, the various embodiments of the air tank and the high speed RAR valves may be used to hold and release any type of gas—that is, any type of substance in the gaseous state such as air, oxygen, carbon dioxide, nitrogen, or the like. The term “gas” as used herein is intended to mean a substance in the gaseous state. Also, it is more difficult to mount a cold tire (e.g., 40 degrees Fahrenheit) than a tire that is warmed up (e.g., 70 degrees Fahrenheit). Therefore, for the sake of consistency, it shall be assumed that the mounting of tires as discussed herein takes place with the tire at 70 degrees Fahrenheit and with the air in the tank before opening the valve also at 70 degrees Fahrenheit.

[0024] The RAR valve pneumatic tire seaters **100** and **110** depicted in FIG. 1A each have: air tank **101** (or **102**), RAR valve **103**, nozzle assembly **105**, pistol grip handle **107**, control cluster **109** and carry handle **115**. Each RAR valve **103** is in unconstrained pneumatic communication with its respective air tank **101/102** of the pneumatic tire seaters **100/110**. That is, air passes freely from the tank **101/102** to its RAR valve **103**. In some embodiments the RAR valve **103** may be connected to the tank via pipes, tubes or other passageways. In other embodiments such as those depicted in FIGS. 1A-B the RAR valve **103** extends into the tank leaving only the collar that is affixed to the tank visible from the outside. Further details of the components making up the RAR valve **103** are depicted in FIGS. 3A-D and FIGS. 5A-B, and are discussed in the ensuing pages.

[0025] The embodiments **100** and **110** depicted in FIG. 1A have air tanks **101** and **102**, respectively, with a cylindrical body and rounded ends. The air tank **101** of RAR valve pneumatic tire seater **100** contains 6 liters of space for air. The air tank **102** of RAR valve pneumatic tire seater **110** contains 3 liters of space for air. (The air volume in air tanks **101** and **102** may be slightly less than 6 and 3 liters, respectively, since the RAR valve **103** takes up some space inside the tank.) The 6 liter air tank **101** depicted in FIG. 1A has an outside diameter of approximately 5.5 inches and a cylindrical body length (between the welds at the rounded ends) of approximately 17 inches. The 3 liter air tank **102** depicted in FIG. 1A has an outside diameter of approximately 4 inches and a cylindrical body length (between the welds at the rounded ends) of approximately 19 inches. Various embodiments are implemented with different sized cylindrical air tanks, including for example tanks with outside diameters, or ranges of outside diameters, including: 4.0 inches, 5.0 inches, 6.0 inches, greater than 3.75 inches, greater than 4.75 inches, greater than 5.75 inches, between 3.75 and 6.5 inches; and/or between 3.75 and 10.5 inches in diameter.

[0026] It is a requirement that any air tank sold commercially be certified by one or more governmental agencies. One of the most stringent certification agencies is Conformité Européenne (CE). Various sized tanks of different embodiments disclosed herein are CE certified to at least 200 pounds per square inch (psi). Various other embodiments are certified at pressures falling within other ranges, including the range of no less than 250 psi of air, the range of no less than 300 psi of air, the range of no less than 400 psi of air, and the range of no less than 800 psi of air. Yet other embodiments are certified at ranges different from those listed above, as is known by those of ordinary skill in the art. It should be understood that there is a practical upper limit to all of the above recited pressure certification ranges based on material strength of the components and the safety of the device being used at ultra high pressures. Although the value of the upper limit is not known with precision, an upper limit of 3,000 psi is hereby stated. In practice the tanks are generally filled with considerably less air than the maximum amount they are certified to hold. For example, a given tank embodiment certified at 300 psi of air may often be inflated to an amount within the range of 100 psi to 120 psi for use in seating a tire. The tank pressure used to seat a tire

depends largely upon the tire size, but also depends upon a number of factors, including the flexibility of the tire, and the direction/distance of the nozzle with respect to the gap between the tire and the rim. The ASME Boiler Code includes standards that apply to devices with tanks for holding high pressure gases such as the pneumatic tire seater. However, ASME Boiler Code 2010 Section VIII Division 1 paragraph U-1(c)(2)(i) provides an exception for vessels having an inside diameter, width, height or cross section diagonal not exceeding 6 inches with no limitation on length of vessel or pressure. For this reason, various embodiments disclosed herein are implemented with cylindrical air tanks having an inner diameter of no greater than 6.0 inches. The tank inner diameter is tank diameter as  $D_{sub.T}$  **683** shown in FIG. **6A** minus two-times ( $2\times$ ) the wall thickness—that is, minus the wall thickness on each side.

[0027] In various embodiments the tank **101** has a control cluster **109** mounted on it. Details of control cluster are shown in FIGS. **6A-B**. In various embodiments the control cluster **109** is mounted on the top of tank **101**, near a carry handle **115**, and a pistol grip handle **107** is mounted on the bottom of tank **101**. As shown in FIG. **1B** the air tank **101**, the RAR valve **103** and the nozzle assembly **105** are aligned along a central axis **149**. In other embodiments the air tank **101**, the RAR valve **103** and/or the nozzle assembly **105** may not all be aligned along the same central axis. For example, either the RAR valve **103** or the nozzle assembly **105**, or both, may be mounted off-center with respect to central axis **149** of the air tank **101**. In such off-center embodiments the RAR valve **103** has a different central axis than the central axis **149** of the air tank.

[0028] The carry handle **115** is fastened on tank **101** in a position making it easy to lift and carry the RAR valve pneumatic tire seater **100**. Various embodiments of the carry handle **115** may have a handhold bar that is orthogonal to the central axis **149** of cylindrical tank **101**. When a user holds the RAR valve pneumatic tire seater **100** by carry handle **115**, the tank **101** tilts downward and nozzle assembly **105** tilts upward (at approximately a 60 degree angle). In this way, the RAR valve pneumatic tire seater **100** can conveniently be hung on a hook or specially designed bracket attached to either a ceiling or a wall, allowing the nozzle assembly **105** to point upwards and the tank to hang down. A user can lay the RAR valve pneumatic tire seater **100** on its side and the carry handle **115** will prevent the device from being inadvertently rolled over, damaging the control cluster **109**. A user can also sit the RAR valve pneumatic tire seater **100** upside down as shown in FIG. **1B**, balanced on the handhold bar of carry handle **115** with pistol grip handle **109** pointing upwards. The carry handle **115** provides sufficient clearance to avoid damaging the control cluster **109**.

[0029] In other embodiments the pistol grip handle **107** and control cluster **109** may be mounted in different positions on the RAR valve pneumatic tire seater. For example, in another embodiment the pistol grip handle **107** may be mounted on the right side of tank **101** (e.g., to be held in the right hand of a right handed person), or the pistol grip handle **107** may be mounted on the left side (e.g., to be held in the left hand of a left handed person). Similarly, in other embodiments the control cluster **109** may be mounted on the bottom, or the front, or the rear. In the embodiments depicted in FIGS. **1A-B** the pistol grip handle **107** extends along a line passing through the central axis **149** of tank **101**. In other embodiments the pistol grip handle **107** may extend from the RAR pneumatic tire seater **100** in an orientation other than along lines from central axis **149**, for example, along a line passing 3 inches to the right of the central axis **149**. Typically, the orientation of the pistol grip handle **107**, control cluster **109** and carry handle **115** relative to the output of nozzle **105** can be adjusted by loosening the lock nut on the nozzle assembly **105**, and positioning nozzle assembly **105** in the desired orientation, and then tightening the lock nut down against the distal end of the RAR valve **103**.

[0030] The embodiment depicted in FIGS. **1A-B** with the pistol grip handle **107** and carry handle **115** enables a user to easily hold and manipulate the RAR pneumatic tire seater **100** while mounting a tire. Grasping the pistol grip handle **107** with one hand allows the user to rest the bottom side of tank **101** along their forearm, thus making it easy to move the RAR pneumatic tire

seater **100** into position to seat a tire. The user's other hand can grasp carry handle **115**, if needed. [0031] The two RAR pneumatic tire seater embodiments **100** and **110** are both depicted in FIG. **1A** with a neckdown nozzle as described below in conjunction with FIGS. **7A-B**. In practice, however, the embodiments **100** and **110** and other embodiments are configured removable nozzles that may be replaced with other types of nozzles. In various embodiments a portion of the RAR pneumatic tire seater (e.g., the distal end of the RAR valve) may be configured with female threads that accept various types of nozzles. This allows the user to swap out nozzles to alter the burst characteristics of their pneumatic tire seater, thus providing a larger or smaller burst to suit a particular type of tire being mounted or desired level of pressurized air to be used in the tank. For example, any of the three nozzles depicted in FIGS. **2A-C** can easily and conveniently be interchanged on the embodiments **100** and **110**, as well as other embodiments of the RAR pneumatic tire seater.

[0032] FIGS. **2A-C** depict oblique views of three RAR transverse tank pneumatic tire seater embodiments. The RAR transverse tank pneumatic tire seater features a nozzle mounted transverse to the tank **201**—that is, perpendicular to the central axis of cylindrical tank **201**. Various embodiments of pneumatic tire seaters have an assortment of air tank sizes. The RAR transverse tank pneumatic tire seaters depicted in FIGS. **2A-C** each have a 38 liter tank. The RAR pneumatic tire seater **100** shown in FIG. **1A** has a 6 liter tank. The RAR pneumatic tire seater **110** shown in FIG. **1A** has a 3 liter tank. Other embodiments have various sized air tanks, for example, a 12 liter tank, a 15 liter tank, a 9 liter tank, a 4 liter tank, a 3 liter tank, a 2 liter tank, a 1.9 liter tank, a 1.5 liter tank a 1.0 liter tank, a 50 liter tank and a 38 liter tank. In various embodiments the portable tanks may be any size between 50 liters and 1.0 liter. Tanks over 50 liters may be too large and unwieldy for users to carry and aim. Stationary tanks or wheeled tanks may be any size from 50 to 1500 liters, or more. The two RAR pneumatic tire seater embodiments **100** and **110** depicted in FIG. **1A** each blows a stream of air that can seat a typical pickup truck tire, e.g., 2018 Goodyear Wrangler steel belted radial P235/75R15 sized tire at a temperature of 70 degrees Fahrenheit. The RAR pneumatic tire seater embodiments **100** and **110** can also seat larger sized tires such as that of an 18 wheeler truck, e.g., 11R22.5G sized tires at a temperature of 70 degrees Fahrenheit.

[0033] The tank size can be altered in various implementations to be as large or small as needed for a particular application. For example, a tank may be as large as 100 liters to as little as 0.5 liter, in 0.5 liter increments—e.g., 0.5 liter, 1.0 liter, 1.5 liter, 2.0 liter and so on up to 99.5 liter and 100.0 liter. An upper tank size of 100 liters is an arbitrary limit based on weight. Tanks larger than 100 liters could be used with the various embodiments, but they would be difficult to lift and carry. Tanks larger than 100 liters may be used if either the tank is stationary or mounted on wheels (e.g., an air compressor tank). For example, in a factory or shop setting some embodiments have no need for a portable tank such as tank **101** depicted in FIGS. **1A-B**. Instead, a number of the RAR valves **103** and nozzle assemblies **105** are pneumatically connected directly to a central source of compressed air via an air hose. For example, the RAR valve **103** and nozzle assembly **105** may be attached to an air compressor having a tank size of much greater than 100 liters, e.g., tanks of 100 gallons or more. In other factory implementations a number of pneumatic tire seaters, such as RAR valve pneumatic tire seater **110** of FIG. **1A**, are connected or tethered to a central source of compressed air via an air hose.

[0034] Turning again to FIGS. **2A-C**, each of the three RAR transverse tank pneumatic tire seater embodiments depicted in FIGS. **2A-C** features a different nozzle embodiment. The RAR transverse tank pneumatic tire seater of FIG. **2A** has a neck down nozzle **205** similar to that depicted in FIGS. **1A-B**. The neck down nozzle embodiment is shown in FIGS. **7A-C** and described in further detail in the paragraphs below associated with those figures. FIG. **2B** depicts an RAR transverse tank pneumatic tire seater embodiment with a straight through nozzle **204**. The straight through nozzle **204** has a uniform inside diameter from its proximal end connected to tank **201** outward to the point where the nozzle divides into two air paths. FIG. **2C** depicts an RAR transverse tank pneumatic tire seater embodiment with a cow bell nozzle assembly **206**. The cow bell nozzle

assembly **206** has a shaft **207** that is pinched down in a shape to direct air into the cowbell component **209**. The gap **211** between shaft **207** and the cowbell component **209** allows air to be drawn into the cowbell component **209** in response to pressurized air rushing through the valve of the RAR transverse tank pneumatic tire seater and out the nozzle.

[0035] FIG. 3A depicts an exploded view of an RAR valve **300** illustrating the component parts that are configured as part of the RAR valve **300**, according to various embodiments disclosed herein. The RAR valve **300** features a cylinder **310** and piston **314** that moves back and forth within the cylinder **310** from a closed position to an open position. As depicted in FIG. 3A the RAR valve **300** includes slotted lock collar **320**, O-ring **318**, piston **314**, piston ring **316**, spring **312**, cushion **308**, cylinder **310**, endcap **306** and conduit **304**.

[0036] The endcap **306** is fastened to the proximal end of cylinder **310**. The cylinder **310** extends into the air tank where pressurized air is contained. The cylinder **310** includes a cylinder collar portion **309** that is positioned just outside the hole in the tank through which the cylinder **310** extends. The collar portion **309** and cylinder **310** extending into the tank can be seen in the cutaway view of FIG. 5B. In the embodiment depicted in FIG. 3A the collar portion **309** has a greater diameter than the rest of the cylinder **310**. In some embodiments the collar portion **309** may have the same diameter as the adjacent portion of cylinder **310**, and in other embodiments the collar portion **309** may have a smaller diameter than the adjacent portion of cylinder **310**. In various embodiments the endcap **306** is welded to the cylinder **310**. The piston **314** has an outside diameter that is slightly smaller than the inside diameter of the cylinder **310**. The piston **314** fits within the cylinder **310**, and is loose enough to slide back and forth in the cylinder with little resistance. The embodiment **300**'s piston **314** can be removed. However, it is difficult to get it back into the cylinder **310** without damaging the piston ring **316**. In some embodiments the entire cylinder **310** can be detached (unscrewed) and removed through the front tank hole.

[0037] The spring **312**, a compression spring, is positioned in a partially compressed state within the cylinder **310** between the endcap **306** and the piston **314**. One end of the spring **312** pushes against the endcap **306** which is attached to cylinder **310**. The other end of the spring **312** pushes against the piston **314** which is free to move back and forth within the cylinder **310** from the open position (backward in proximal direction, opposite of distal direction **375**) to the closed position (forward in distal direction **375**). With piston **314** in the closed position the RAR valve **300** prevents air from escaping the tank. In order to lighten the weight of piston **314** and also to provide more room for spring **312**, the proximal end of piston **314** may be hollowed out to provide a receptacle at the back of piston **314**. For example, in some embodiments the proximal end of piston **314** is hollowed out to within approximately 0.5 inches of its distal end. This provides a hole in the back of the piston **314** that the spring **312** fits into. Hollowing out and reducing the weight of the piston **314** has the added benefit of decreasing the force of the piston **314** slamming into the back of the cylinder (e.g., endcap **306** of FIG. 3A). The lighter weight piston **314** decreases wear and tear on the valve as the piston **314** repeatedly slams to the back of the cylinder in the fully open position.

[0038] With the air tank empty the spring **312** tends to push the piston **314** in the distal direction **375** to the closed position—that is, to close the valve **300**. Direction **375** is called the distal direction because, upon opening the RAR valve **300**, the pressurized air blows outward away from the user in the distal direction **375**. The force exerted by the spring **312** has an effect on the operation of the various RAR valve embodiments. The spring must have a sufficient spring rate—that is, produce a sufficient force—to close the RAR valve with the tank empty. A higher spring rate also aids in reducing the force with which the piston hits the endcap **306** as the piston slams to its open position as compared to a spring characterized by a lower spring rate. Another consideration is that, over time impurities from impure air pumped into the tank could possibly build up on the internal parts of the RAR valve, thus resulting in friction on the piston as it moves back and forth in the cylinder. A stiffer spring with a higher spring rate is able to overcome a

certain amount of friction in the cylinder due to the build-up of impurities, making it less susceptible to malfunctions. However, not all the characteristics of a high spring rate spring are beneficial to the RAR valve. The higher the spring rate, the more force it takes to open the valve. A spring having too high of a spring rate will tend to make the RAR valve open more slowly, or not at all, as compared to a spring with just enough spring rate to push the piston to the closed position when the air tank is empty. Thus, the choice of spring rate involves a trade-off between the speed at which the RAR valve opens and reliability of the RAR valve.

[0039] The spring **312** shown in FIG. **3A** for a 2 inch RAR valve has an outside diameter of slightly less than 1.375 inches and is approximately 3.0 inches long in its uncompressed state. The spring **312** is slightly smaller than the inside diameter of the cushion **308** so that it can be placed against the endcap **306** with the cushion **308** fitting snugly around it. The cushion **308** aids in cushioning the piston **314** as it slams back towards the endcap **306** in response to the RAR valve **300** opening. Turning to FIGS. **5A-B**, these figures illustrate the piston **314** pushed back to an open state. With the tank **501** empty and piston **314** closed it takes a certain amount of force applied to the distal end of the piston **314** to begin opening the piston **314**—that is, to push the piston **314** away from the point where it is seated inside the cylinder **310**. The force required to begin opening the RAR valve by pushing on the piston **314** in its seated position is called the “closed-state spring force.” Some embodiments have a closed-state spring force that is within the range of 0.1 ounce to 10 lbs.

Various embodiments have an empty tank spring force within a number of different ranges, including the range of 0.1 ounce to 7 lbs., the range of 0.1 ounce to 5 lbs., the range of 0.1 ounce to 4 lbs., the range of 0.1 ounce to 3 lbs., the range of 0.1 ounce to 2 lbs., the range of 0.1 ounce to 1 lb., the range of 0.05 ounce to 8.0 ounces, and the range of 0.05 ounce to 4.0 ounces.

[0040] A slotted lock collar **320** as shown in FIG. **3A** screws into the female threaded end of cylinder **310**. The slots aid in screwing and unscrewing the slotted lock collar **320**. The female threaded end of cylinder **310** that the slotted lock collar **320** screws into can be more clearly seen in FIG. **3D** just above the air input holes around the sides of cylinder **310**. In at least some embodiments the female threads for the slotted lock collar **320** are finer than the female threads for the nozzle near the output of the cylinder **310**. The slotted lock collar **320** has an inside diameter that is smaller than the diameter of the piston **314**, thus preventing the piston **314** from coming out the distal end of cylinder **310**. The piston **314** as depicted in FIG. **3A** is configured to receive a distal O-ring **318** around its distal end. In the closed position, the distal O-ring **318** seats against the surface of the slotted lock collar **320** opposite the slotted surface. The distal O-ring **318** aids in maintaining an airtight seal while the valve remains in the closed position. In other embodiments the O-ring is mounted on the inside of the RAR valve opening, and the piston **314** slides forward to the closed position, coming in contact with the O-ring to form an airtight seal.

[0041] At the proximal end (back end) of the RAR valve **300** a conduit **304** is fastened between the hole on the endcap **306** shown in FIG. **3A** and a hole in the tank of the pneumatic tire seater, e.g., tank **101** of pneumatic tire seater **100** depicted in FIG. **1A**. A valve control mechanism controllably opens/closes to controllably connect/disconnect a control chamber in the cylinder **310** between the piston **314** and endcap **306** to the outside atmosphere via conduit **304**. The valve control mechanism (e.g., **517** depicted in FIG. **5A**) serves as a switch for the RAR valve to open the valve and release a blast of air from the tank. Further details of the RAR valve may be seen in FIGS. **5A-B**.

[0042] FIG. **3B** depicts an exploded view of an RAR valve **350** illustrating component parts, according to various embodiments disclosed herein. This embodiment **350** has the same basic components as embodiment **300** depicted in FIG. **3A**—except for differences in the piston ring, the piston and the lock collar. Embodiment **350** as depicted in FIG. **3B** includes lock collar **380**, a distal O-ring **318**, a piston **315**, a proximal O-ring **317**, a spring **312**, a cushion **308**, and a cylinder **310**, an endcap **306** and a conduit **304**. Note that the embodiment **350** lacks a piston ring **316** of embodiment **300**, and instead has a proximal O-ring **317**. One advantage of the embodiment **350**



which doesn't have a piston ring **316** is that the piston **315** can be more easily removed through the front of the cylinder **310** for cleaning or repair, and then reassembled. Two embodiments for the lock collar **380** are discussed below in conjunction with FIGS. 4A-E.

[0043] The embodiment **350** has a proximal O-ring **317** on the piston **315** instead of having a piston ring **316** like embodiment **300**. The piston **315** of FIG. 3B has an O-ring trough **333** configured to accept the proximal O-ring **317**. The O-ring trough **333** is shallow enough to push the proximal O-ring **317** outward against the inner wall of cylinder **310**. The O-ring trough **333** may be positioned around piston **315** anywhere along its length. However, in at least some implementations the O-ring trough **333** is positioned away from the proximal end of piston **315** approximately  $\frac{1}{4}$  inch (that is,  $\frac{1}{4}$  inch in the distal direction **375** away from the proximal end of piston **315**). The control gas holes **335** pass from the proximal end of piston **315** to the O-ring trough **333**.

[0044] The control chamber **311** is the area between the proximal end of piston **315** and endcap **306** and includes any hollowed out portion of piston **315** (that is, hollowed out from the piston **315**'s proximal end). The control chamber **311** with the piston in the closed position is indicated by the dotted lines on FIG. 3E. The control gas holes **335** on piston **315** of FIG. 3B serve as a means for filling the control chamber **311** (shown in FIG. 3E) by providing for constrained pneumatic communication between the air tank and the control chamber **311**. The control gas holes **335** allow high pressure air from within the tank (e.g., tank **101**) to pass past the piston **315** into control chamber **311** (sometimes called control reservoir). The piston **315**, with proximal O-ring **317** fitted around it but without control gas holes **335**, would tend to prevent high pressure gas from the tank from passing into the control chamber **311**. The control gas holes **335** allow the pressurized air to bleed past the piston **315** as tank is being filled at a rate fast enough to keep the pressure in the control chamber **311** relatively close to the pressure within tank. The pressure in control chamber **311** in combination with the force of spring **312** keep the valve **350** closed while the tank is being filled with pressurized gas (e.g., pressurized air).

[0045] Various embodiments may have more than two control gas holes **335**. For example, the RAR valve with three or more control gas holes **335** spread equidistance around the back of the piston. The RAR valve can be implemented with only one control gas hole **335**, but this unbalanced implementation causes the piston **315** to shimmy slightly as it is pushed back into the open position. The two control gas holes **335** are approximately 0.25 inch long and 0.08 inch (2 mm) in diameter. In other embodiments more control gas holes **335** the holes are spread symmetrically around the proximal side of piston **315** and have approximately the same total gas flow capacity as the two control gas holes **335** mentioned above that are approximately 0.25 inch long and 0.08 inch (2 mm) in diameter. In some implementations the control gas holes **335** may pass from the O-ring trough **333** to the side of the piston **315** near its proximal end—that is, in the space between the piston **315** and the adjacent cylinder wall. In these embodiments the side of the piston may itself have a small trough or groove on its side from the control gas holes **335** to the proximal end. In yet other implementations the control gas holes **335** may pass from the O-ring trough **333** to inside the hollowed out portion at the proximal end of the piston **315**. In other embodiments the control gas holes **335** may pass from just ahead of the O-ring trough **333** to one of the aforementioned spots behind the O-ring trough **333**. In all such implementations the control gas holes **335** are considered to pass to the proximal end of the piston **315** since they put the pressurized air within the tank in constrained pneumatic communication with the control chamber **311**.

[0046] FIG. 3C depicts an oblique view of a piston **314**, a distal O-ring **318** and a slotted lock collar **320** of an RAR valve **300**. This view shows the male threads on slotted lock collar **320** that fit into the female threads of cylinder **310** shown in FIG. 3C to hold the piston **314** (or piston **315**) in place within cylinder **310**. The slots **321** of slotted lock collar **320** enable a tool to be used to remove the slotted lock collar **320** and disassemble the RAR valve **300**. Upon the slotted lock collar **320** being assembled within the RAR valve **300**, the slots **321** face outward in the distal direction **375**. The inner edge of slotted lock collar **320** opposite the slots **321** depicted in FIG. 3C

is the surface that opposes the piston **314** (or piston **315**) in the closed position. The RAR valve **300** closes to seal air within the air tank by seating a flexible sealing component onto a hard surface. In various embodiments the distal O-ring **318** serves as the flexible sealing component. The distal O-ring **318** mounted on piston **314/315** seats against the inner edge of slotted lock collar **320** with the RAR valve **300** in the closed position. The closed position is air tight because the flexible sealing component-e.g., the O-ring **318**-is forced against the hard smooth surface of the slotted lock collar **320**, flattening the O-ring **318** to some extent and providing an air tight seal. In other embodiments the flexible sealing surface may be mounted on the RAR cylinder **310** itself (e.g., an O-ring), with a flat smooth surface provided on the piston to mate against it and provide an air tight seal.

[0047] FIG. **3E** depicts an oblique view from the side of an RAR valve cylinder **310** according to various embodiments disclosed herein. The dotted line of FIG. **3E** depict the control chamber **311** between the piston **314** (or **315**) and the end cap **306**, with the piston in the closed position. The cushion **308** is contained within the control chamber **311** along with spring **312**. Hence, the air volume of control chamber **311** in the closed position is reduced by the volume of the cushion **308** and the spring **312**.

[0048] Diameter **325** is the inside diameter of cylinder **310**. The various RAR valve embodiments are defined by a number of parameters, including for example, the valve diameter, the piston stroke length, the closed position control chamber volume, cylinder side-hole area. RAR valves are often characterized in terms of the valve diameter since this parameter contributes greatly to the volume of air burst produced by the valve. RAR valves are implemented in a wide range of valve diameters, e.g. from 0.25 inch to 20 inches or more. Two typical sizes are the 1.5 inch RAR valve and the 2.0 inch RAR valve. The 1.5 inch RAR valve produces a burst of air that is easily sufficient to mount an 18 wheeler truck, e.g., 11R22.5G sized tire. The 2.0 inch RAR valve produces a substantially greater burst of air than the 1.5 inch RAR valve.

[0049] FIG. **4A** depicts a cutaway side view of a proprietary lock collar **420** according to various embodiments. The proprietary lock collar **420** is interchangeable with lock collars **320** and **380** of FIGS. **3A-C**. The proprietary lock collar **420** is configured to screw into the female threaded end of cylinder **310**. The female threads of cylinder **310** may be seen in FIG. **3D**. The contoured holes **421** aid in screwing and unscrewing the proprietary lock collar **420** to remove the internal parts of the RAR valve, e.g., the piston, spring, cushion, etc. The inside diameter of proprietary lock collar **420** is smaller than the diameter of the piston **314** (or piston **315**), thus retaining the piston **314** within end of cylinder **310**. In the closed position, the distal O-ring **318** seats against the surface of the proprietary lock collar **420**, providing an air-tight seal with the RAR valve in the closed position.

[0050] Proprietary tool **424** is configured for removing and replacing the proprietary lock collar **420**. The proprietary tool **424** shown in the figure is embodied as a single piece of flexible, hardened material such as spring steel. In other embodiments the proprietary tool **424** may be implemented as a tool consisting two or more pieces designed to hinge in the manner of a pair of pliers. The proprietary tool **424** has two contoured feet **425** configured to fit into contoured holes **421** on the inner surface of the proprietary lock collar **420**. A user may insert the proprietary tool **424** for removal of the proprietary lock collar **420** by squeezing the legs together, positioning the contoured feet **425** over the contoured holes **421**, then sliding the tool **424** slightly outward to seat the feet **425**. In some embodiments the contoured feet **425** may be skewed slightly left and right as seen from looking from above (i.e., one skewed left and the other skewed right). The contoured holes **421** are skewed to match the skewed contoured feet **425**. Skewing the feet **425** and holes **421** helps to seat the proprietary tool **424** and prevent it from slipping out of position as the proprietary lock collar **420** is being removed.

[0051] The contoured feet **425** may have a contoured cross-section in a shape other than round or rectangular, as shown in FIG. **4B**. For example, the contoured feet **425** may be implemented with a horseshoe cross-section **426**, a symmetrical polygon **427** (e.g., trapezoid), a non-symmetrical polygon **428**, an oval **429** (e.g., an ellipse), a non-symmetrical shape **430** or other like shape as are

known to those of ordinary skill in the art. The contoured shape of holes **421** aid in maintaining a grip between the contoured feet **425** and contoured holes **421** as the proprietary lock collar **420** is being loosened or tightened.

[0052] FIG. **4C** depicts a lock collar **440** with removal holes **441** on the distal face and a tool **444** for removing and replacing the lock collar **440** according to various embodiments disclosed herein. The tool **444** has pegs **445** configured to fit into removal holes **441** for tightening and loosening the lock collar **440**. FIG. **4D** depicts tool **444** having two pegs **445**. In other implementations the tool **444** may have three or more pegs. FIG. **4C** also depicts two pairs of holes **441** positioned diametrically across from each other on the distal surface of lock collar **440**. In other implementations the two or more holes **441** may be positioned in a non-symmetrical manner around the distal surface of lock collar **440**. In one embodiment a single removal hole **441** is provided, and the tool **444** is configured with a round portion that is inserted a short distance into the air passage of lock collar **440** before the peg **445**, positioned to the side of the round portion, is received in hole **441**. FIG. **4E** depicts an oblique perspective of a tank **401** with the nozzle removed. The tool **444** is shown inserted into removal holes **441** to allow a user to tighten (or loosen) the lock collar **440**.

[0053] FIGS. **5A-B** depict side views of an RAR pneumatic tire seater with a portion of the tank cut away to display the RAR valve inside the tank according to various embodiments disclosed herein. The RAR valve in each of these views is pushed back and held in the open position to reveal the distal end (forward end) of piston **314**. For the sake of consistency FIGS. **5A-B** use the reference numbers from FIGS. **3A-C** to identify components of the RAR valve as depicted in FIGS. **3A-F**.

[0054] In the embodiments depicted in FIGS. **5A-B** a portion of the RAR valve extends through a hole in the air tank **501** into its interior where the pressurized air is contained. In the embodiments depicted, another small portion of the RAR valve extends out of the hole in tank **501** to the atmosphere outside the tank. In various embodiments the cylinder **310** of the RAR valve is welded to the tank **501** to affix it in an airtight manner. The bead of weld **527** connecting the two components can be seen in FIG. **5B**. In other embodiments the RAR valve is threaded on an outside surface and screws into the tank **501**, allowing it to be removed for repair or replacement, and to enable access to the inside of the tank **501**.

[0055] The valve control mechanism **517** shown in FIG. **5A** serves as a switch for the RAR valve **300** to open the valve and release a blast of air. Various other embodiments may be configured with different types of valve switch components, including for example, a lever, a button, a toggle, a switch, a rotating collar, a bar, a trigger mechanism, and other such valve switch components as are known by those of ordinary skill in the art. In various embodiments the valve control mechanism **517** may be protected by a trigger guard to avoid inadvertently opening the valve **300** and releasing a blast of air from the tank **501**.

[0056] The cylinder **310** is configured with one or more air vents **313** that open into the interior of the tank **501**. In the RAR valve's closed position the piston **314** with its distal O-ring **318** is pushed forward in the distal direction **375** to seat against the slotted lock collar **320** (or proprietary lock collar **420** of FIG. **4A**) and prevent pressurized air within the tank **501** from exiting into the atmosphere. The RAR valve is in the open position with the piston **314** with its distal O-ring **318** pulled back in the proximal direction to unseat from the slotted lock collar **320** and allow pressurized air from the tank **501** to escape through the nozzle **105**. There is a space within the cylinder **310** between the piston **314** and the endcap **306** called a control chamber **311** as shown in a cutaway view in FIG. **5A**. The spring **312** and cushion **308** are contained within the control chamber **311**. The spring **312** act by itself typically has sufficient force to push the piston to the closed position if the tank has little or no pressure in it (e.g., after the RAR valve has been discharged, emptying the tank). As the tank is filled with pressurized air, the air pressure within the control chamber **311** in conjunction with the force of spring **312** act to keep the piston **314** in the

closed position, that is, pushed forward towards in distal direction **375**.

[0057] The force of spring **312** is sufficient to move the piston **314** (or piston **315**) to the closed position if the tank **501** has little or no pressurized air in it, e.g., immediately following discharge of the RAR valve **300**. However, the force of spring **312** alone isn't enough to keep the RAR valve **300** closed as it is filled with pressurized air. Instead, the combined force of spring **312** in conjunction with the air pressure in the control chamber **311** keeps the RAR valve **300** in the closed position, so long as the pressure within the control chamber **311** remains within a predetermined percentage of pressurized air in the tank. The predetermined percentage depends on the spring rate (stiffness) of the spring **312**. A spring with a relatively higher spring rate (more stiff) requires more of a drop in the pressure of the control chamber **311** in order to pull the piston **314** back from its closed state to an open state, as compared to a spring **312** with a spring rate just high enough to close the piston **314** with the tank **501** nearly empty (i.e., less than 5 psi of air pressure).

[0058] The air pressure in control chamber **311** comes from pressurized air bleeding past the piston **314** as the tank **501** is filled with pressurized air. Once the pressurized air bleeds past the piston into the control chamber it's called control gas. In various embodiments a piston ring **316** may be provided on the piston **314** to aid in providing a better seal between the piston **314** and the inner walls of cylinder **310**, thus controlling the rate at which the pressurized air in tank **501** leaks past the piston **314**. Typically, the piston ring **316** is seated within an O-ring trough that runs around the piston **314**. In some embodiments the O-ring trough is located approximately 0.5 inch from the proximal end of piston **314**. The piston ring **316** may be a spring steel piston ring (or other like type of rigid material), or may be a proximal O-ring. The piston ring **316** of the **300** embodiment depicted in FIG. 3A is purposefully provided with a gap to allow some air to bleed past the piston into control chamber **311**. Even though the piston **314**, equipped with a piston ring **316**, and fits snugly within the cylinder **310**, the pressurized air bleeds past the piston **314** at a rate fast enough as tank **501** is being filled to keep the pressure in the control chamber **311** relatively close to the pressure within tank **501**. Similarly, the piston **315** of the **350** embodiment depicted in FIG. 3B is provided with one or more holes **335** that bleed pressurized air into the control chamber **311** as the tank is being filled. The gap in piston ring **316** and the holes **335** in piston **315** both serve as a means for filling the control chamber **311**, and as such, may both be referred to as control gas passageways since pressurized air from the tank's interior bleeds past the piston **314/315** into the control chamber **311** to become control gas. For example, if an air compressor with 150 psi air in an 80 gallon tank is used to fill the tank **501**, the pressure within control chamber **311** remains within 95% of the air pressure in tank **501** as it is being filled. That is, the pressure within control chamber **311** mirrors the air pressure in tank **501** as it is being filled by remaining within no less than 95% of the pressure in tank **501**. Once the tank **501** is full the pressure in the control chamber **311** equalizes with the pressure in tank **501** in just a few seconds—say, within no more than 5 seconds.

[0059] The air in the control chamber **311**, for the purposes of this disclosure, is called “control gas” (or “control air”). This is significant inasmuch as the pressurized air in the air tank vents out through the nozzle in response to the RAR valve being opened. By contrast, nearly all of the control gas vents out through the conduit **304** and control valve **519** shown in FIG. 5A. As discussed above, the source of the control gas is pressurized air leaking past the piston **314** as the tank **501** is being filled. The control chamber **311** is pneumatically coupled to the atmosphere (outside of the tank **501**) via conduit **304** and control valve **519**. The control valve **519** prevents the control air from escaping from control chamber **311** until the valve control mechanism **517** is actuated (e.g., depressed). Actuating the valve control mechanism **517** opens the path between the control chamber **311** and the atmosphere outside the tank **501** via conduit **304**, allowing the control gas in the control chamber **311** to freely release into the atmosphere outside the tank **501**. The control gas being released from control chamber **311** reduces the air pressure in the control chamber **311** that is helping to keep the piston **314** pushed forward in the closed position. As a

result of the control gas being released the force of compression spring **312** is no longer sufficient to maintain the valve **300** in the closed position, and the piston **314** begins to pull back in the proximal direction. As the RAR valve **300** begins to open the pressurized air from tank **501** rushing past the piston **314** aids in opening the piston **314** to the fully open position.

[0060] FIG. 5A shows the conduit **304** connects to an inlet of control valve **519**. The control valve **519** is configured to vent the control gas near the control mechanism **517**. In other embodiments the control valve **519** may be configured with an outlet that vents air out the bottom of pistol grip **507**, or out of the top of grip **507** between the tank **501** and the grip **507**. The volume of control gas released from the control chamber **311** in response to opening the RAR valve **300** is not very large in comparison to the air that vents through the nozzle from air tank **501**. Various embodiments release an amount from 15 to 50 cubic centimeters of control gas, depending upon the inside diameter of cylinder **310**, the size of piston **314** and extent to which it is hollowed out, and the stroke of piston **314** (that is, the distance the piston **314** travels back in the cylinder **310** upon opening the valve). The piston stroke is approximately 0.5 inches, but depending upon the size of the valve and parameters of the implementation, may be as short as 0.10 inch to as great as 2.5 inches, or any length or range within 0.10 inch to 2.5 inches. In some of the larger embodiments the piston stroke may even be greater than 2.5 inches. Larger embodiments of RAR valves release more control gas—an amount that is somewhat less than the volume of the piston **314**.

[0061] The various RAR gas valve embodiments disclosed herein, including the RAR gas valve **300** of FIGS. 5A-B, are two-state open/close gas valves. As such, they are fully closed while holding a pressurized tank of air, before actuating the valve control mechanism **517**, and switch to a fully open state in response to actuating the valve control mechanism **517**. The gas valves used on conventional bead seating devices are multi-state adjustable gas valves—that is, they may be set at fully closed, partially opened, or fully open. The operation of a conventional bead seating device depends largely on how quickly a user can open its multi-state adjustable gas valve. The various RAR gas valve embodiments disclosed herein are two-state open/close gas valves which open much more quickly than a human user could possibly open a conventional gas valve. The rapid opening time aids in seating a tire on a rim. The two-state open/close gas valves disclosed herein are similar to a gun (e.g., a pistol, rifle or shotgun) inasmuch as a gun doesn't fire a bullet at a faster speed (e.g., feet per second) because the user pulls faster or harder on the trigger. The bullet travels out of the gun's muzzle at the same feet-per-second rate regardless of how quickly the user manipulates the trigger mechanism. Similarly, the two-state open/close RAR gas valve embodiments disclosed herein open at the same rate regardless of how quickly the user actuates its valve switch component—e.g., valve control mechanism **517** shown in FIGS. 5A-B.

[0062] The valve opening time at which various RAR valve embodiments opens is dependent upon a number of factors, including for example, the tightness of the piston **314** (and piston ring **316**, if so equipped) within the cylinder **310**, the diameter of the cylinder outlet (e.g., inside diameter of slotted lock collar **320**), the air pressure in the tank, and the spring rate of spring **312**. For the purpose of measuring the valve opening time, the valve begins to open as soon as the piston has traveled back 1/50th of an inch and pressurized air begins passing out the front of the cylinder. Also, for the purpose of measuring the valve opening time, the valve is considered “open” as soon as it reaches 75% of the fully open position—that is, by the time the piston reaches 75% of the total distance it is capable of traveling in the proximal direction. By this time—that is, by the time the piston has traveled 75% of the way back—a great volume of air is already passing out of the valve. For all practical purposes the valve is to be considered open at this point. Thus, the valve opening time is the time it takes from when the valve begins to open and the piston has traveled back 1/50th of an inch to when the piston has traveled 75% of the total distance it is capable of traveling in the proximal direction within the cylinder.

[0063] Various embodiments are characterized by different opening times for a tank inflated to 110+/-10 psi, including but not limited to opening times having ranges of: no greater than 10 ms

(milliseconds), no greater than 20 ms, no greater than 30 ms, no greater than 40 ms, no greater than 50 ms, no greater than 60 ms, no greater than 70 ms, no greater than 80 ms, no greater than 85 ms, no greater than 90 ms, no greater than 100 ms, no greater than 120 ms, no greater than 140 ms, no greater than 150 ms, no greater than 160 ms, no greater than 180 ms, no greater than 200 ms, no greater than 225 ms, or no greater than 250 ms. The various opening times are measured with the air in the tank being at 70 degrees Fahrenheit prior to being released from the tank.

[0064] FIGS. 6A-B respectively depict a side view and a top view of an RAR pneumatic tire seater to illustrate aspects of the control cluster, according to various embodiments disclosed herein. The control cluster provides access to the interior of air tank **601** through a single access inlet. This eliminates the need for separate inlets for filling, releasing air (safety valve) and measuring the pressure inside the tank **601**. The control cluster typically has a multi-connection air manifold (called a control manifold) configured to accept two or more devices. For example, control cluster **609** has a three-way air manifold to which are attached a pressure gauge **655**, an inlet valve **657**, and a relief valve **659**. The control manifold—for example, the three-way air manifold of FIGS. 6A-B—typically has a male threaded connector fitting on the bottom configured to screw into a female threaded access inlet in air tank **601**. The control manifold also typically has two or more female connectors configured to accept devices such as the pressure gauge **655**, the inlet valve **657** and/or the relief valve **659** of control cluster **609** depicted in FIGS. 6A-B.

[0065] The pressure gauge **655** indicates the pressure within air tank **601**. The embodiment depicted in the figures features an analog pressure gauge **655**. Other embodiments have a digital pressure gauge. The air tank **601** is filled from a source of high pressure air via the inlet valve **657**. The inlet valve **657** has a valve control lever (or other mechanism), and a female pneumatic coupler. Other embodiments feature a female pneumatic coupler that closes automatically upon removing the source of high pressure air. Using this type of automatic female pneumatic coupler eliminates the need for an inlet valve control. Various embodiments may be filled with a hand operated tire pump (bicycle pump) in lieu of using an air compressor. This is beneficial in locations that lack an air compressor or the electrical power needed for an air compressor.

[0066] The relief valve **659** prevents an unsafe high pressure from being put into the tank **601** or allowed to build up. The relief valve **659** is designed to open at a predetermined set pressure to protect the air tank **601** from being subjected to pressures that exceed their design limits. In some embodiments the relief valve **659** is adjustable to raise or lower the set pressure value, so as to allow a user or technician to set the limit at a level appropriate for the tank **601**. In other embodiments the relief valve **659** is not adjustable, being permanently set at the factory or purchased having a predetermined set pressure value.

[0067] Configuring the control cluster **609** on the top of the tank **601** eliminates the need for separate inlets for filling, releasing air (safety valve) and measuring the pressure inside the tank **601**, thus avoiding the need for an inlet on the front of the tank. Not having an inlet on the front of the tank allows a relatively larger RAR valve to be used with smaller profile air tanks. This can be quantified using a valve/tank ratio. For example, the 4 inch diameter tank with the control cluster **609** moved to the top can be fitted with an RAR valve having an overall outside diameter 3 inches, as measured by the diameter of the collar portion of the valve. However, the collar portion of a valve can easily be made larger. Therefore, it is preferable to use the inside cylinder diameter (slightly larger than the diameter of the piston) for the valve/tank ratio. The valve/tank ratio is defined as the diameter of the RAR valve as measured by the inside cylinder diameter divided by the outside diameter of the air tank (for tanks having a round cross-section). For tanks with a cross-section that is other than round, the smallest cross-sectional diameter of the tank near the valve is taken as a parameter in place of the round-tank outside diameter. Turning to FIG. 6A, the Valve Diameter is shown as  $D_{sub.V}$  **681**. The Tank Diameter is shown in FIG. 6A as  $D_{sub.T}$  **683**. The valve/tank ratio is illustrated as Valve Diameter  $D_{sub.V}$  **681** divided by Tank Diameter  $D_{sub.T}$  **683**. The valve/tank ratio of a 2 inch valve mounted on a 4 inch tank is 50%. Various embodiments

are implemented with a valve/tank ratio that falls within one or more of the following ranges: equal or greater than 50%; equal or greater than 45%; equal or greater than 40%; equal or greater than 35%; equal or greater than 30%; or any range equal or greater than any given percentage value of from 30% to 50%.

[0068] FIG. 6A depicts a side view of the pneumatic tire seater **600** showing a clearance line **661**. The clearance line **661** of the tank **601** and the carry handle **615** is defined as a line between the points on the back of tank **601** and the carry handle **615** that sit on a planar surface when the pneumatic tire seater **100** is set upside down as in FIG. 1B. Clearance line **661** indicates how much room there is for the control cluster **609** beneath the level of carry handle **615**. So long as the control cluster **609** is beneath the clearance line **661** between the tank **601** and the carry handle **615**, the control cluster **609** won't be damaged by setting it upside down on a planar floor, table, bench, or other flat surface. Previous implementations of the pneumatic tire seater featured one or more devices mounted on the front of the tank, e.g., the pressure gauge, the inlet valve or the relief valve. Using a three-way control cluster **609** enables all three of the devices to be positioned on top of the tank, that is, the pressure gauge **655**, the inlet valve **657** and the relief valve **659** are all mounted on control cluster **609**. Including all three devices on the three-way control cluster **609** avoids the need to have a hole on the front of the tank, thus allowing use of a larger RAR valve as compared to the diameter of the tank. For example, the RAR valve pneumatic tire seater **110** depicted in FIG. 1A features a 2 inch valve mounted on a 3 liter tank with a diameter of approximately 4 inches. This would not have been possible with one of the devices mounted on the front of the tank beside the nozzle assembly **105**.

[0069] Since these three devices are mounted in the area under clearance line **661** they are somewhat protected from damage as the tire seater is set upside down on carry handle **615** or laid flat on a table or countertop. Of these three devices, the pressure gauge **655** is most susceptible to damage. Therefore, the pressure gauge **655** is typically positioned closest to the carry handle so as to be protected if the tire seater is rolled over on a flat countertop.

[0070] FIG. 6B shows the flat portion **663** of carry handle **615** that is configured to sit on a floor, table or other planar surface. The length of the flat portion **663** is typically approximately 3.5 inches in length. In different embodiments the length of the flat portion **663** may be: 1 inch or greater; 2 inches or greater; 2.5 inches or greater; 3 inches or greater or 4 inches or greater. In addition to each of these ranges with no upper limit, are ranges with a same lower limit and an upper limit based on the diameter of the tank **601** plus 20%. For example, a tank **601** may be implemented in many different diameters, including a diameter of 5 inches. (5 inches plus 20% is 6 inches.) The ranges of diameter having an upper limit of 6 inches for a tank **601** include ranges of 2 to 6 inches; 2.5 to 6 inches; 3 inches to 6 inches or 4 inches to 6 inches.

[0071] FIGS. 7A-C depicts three views of the nozzle **705** according to various embodiments disclosed herein. FIG. 7A shows the three sections of nozzle **705**—the nozzle inlet section **769**, the neckdown section **767**, and the nozzle outlet section **765**. In various embodiments the nozzle outlet section **765** has a “Y” shaped outlet that disperses air around the inside of the wheel and tire rather than blowing a single stream of air directly at the hub of the wheel. The nozzle **705** may also be configured with a tab **777** mounted between the arms of the “Y” shaped nozzle outlet. A user can position the tab **777** against the rim so as to hold the pneumatic tire seater nozzle **705** steady while aiming it between the gap between the tire and the wheel. Various embodiments of the pneumatic tire seater do not have tab **777** since it tends to be more effective in seating a tire to hold the pneumatic tire seater nozzle **705** an inch or more away from the gap between the tire and the wheel and the tab **777** tends to obstruct the air flow between the Y intersection of the nozzle outlet.

[0072] Turning again to FIG. 7A, the figure depicts the inside diameter **771** of the neckdown section **767**, the inside diameter **775** of nozzle outlet section **765**, and the inside diameter **773** of nozzle inlet section **769**. In various embodiments the inside diameter **771** of the neckdown section **767** is less than the inside diameter **773** of nozzle inlet section **769**. This neckdown in the tube size

of air path serves to increase the velocity of the air released from the RAR valve through the Venturi effect. Various embodiments of the nozzle have an assortment of different neckdown and inlet dimensions.

[0073] The embodiment depicted in FIG. 7A of nozzle **705** has a neckdown section inside diameter **771** of 1.5 inches and an inlet section inside diameter **773** of 2.125 inches. Since the nozzle **705** neckdown section **767** and inlet section **769** are both round, the respective approximate areas of these passageways are: neckdown section **767** area is 1.8 square inches; and inlet section **769** area is 3.6 square inches. The ratio between the areas of the two passage ways has an impact on the degree of the Venturi effect that is realized. The ratio of the nozzle inlet area to the neckdown section area is referred to herein as the nozzle neckdown ratio (nozzle inlet area/the neckdown section area). The nozzle neckdown ratio of the nozzle **705** embodiment depicted in FIG. 7A is 2.0 (3.6 in.sup.2/1.8 in.sup.2). Various embodiments of the nozzle have nozzle inlets and neckdown cross-sections with a number of different shapes aside from round, including for example: square, rectangular, oval, oblong, rectangular with rounded ends, non-symmetrical, triangular, or other such shapes as are known to those of ordinary skill in the art. These various embodiments of the nozzle have an assortment of nozzle neckdown ratios. For example, in different embodiments the nozzle neckdown ratio may be 1.2 or greater, may be 1.5 or greater, may be 1.75 or greater, may be 2.0 or greater, or may be 2.5 or greater. In some embodiments the nozzle neckdown ratio may be 1.2 to 1.8, may be 1.5 to 2.5, may be 1.75 to 3.5, may be 2.0 to 4.0, or may be 2.5 to 5.0.

[0074] FIG. 7B is an oblique view of nozzle **705** according to various embodiments disclosed herein. In various embodiments the nozzle **705** is provided with male threads on its proximal end (opposite the nozzle output). The male threads are configured to fit female threads just inside the distal end of cylinder **310** as shown in FIG. 3D. A lock washer **797** may be provided on the male threads of the nozzle **705** proximal end. The lock washer **797** may be tightened down in order to properly align the nozzle **705** with the pneumatic tire seater, e.g., to align a line bisecting the pair of nozzle outlet holes **789** with the flat portion **663** of carry handle **615** shown in FIG. 6A.

[0075] FIG. 7C is an oblique view showing the nozzle outlet at distal end of nozzle **705**. The nozzle may be attached to an RAR pneumatic tire seater by screwing the male threaded end of the nozzle into the female threads of the RAR valve cylinder and tightening the lock nut **793** against the outlet surface of the RAR valve cylinder (e.g., cylinder **310** depicted in FIG. 3D). The nozzle outlet is “Y” shaped to direct air around the inside of the tire and wheel rather than blowing a single stream of air directly at the hub of the wheel. The throat **781** of nozzle **705** is the crotch of the “Y” shape. Various embodiments of nozzle **705** are configured with a gap or vent **779** that spans the surface of the throat **781**. The vent connects from the nozzle outlet hole **789** of one nozzle outlet arm **787** to the nozzle outlet hole **789** of the other nozzle outlet arm **787**. Initially it was thought that this vent **779** simply aided in distributing the pressurized air around the inside of the tire and wheel.

Recently, however, it was discovered that the vent **779** pulls air in from the atmosphere near the nozzle **705** to go into the tire, in addition to the pressurized air blown from within the tank. To promote this effect some embodiments of the nozzle **705** are constructed without tab **777**, since tab **777** tends to impede air being pulled into the tire-wheel gap by the pressurized air flowing from vent **779**. In the embodiment depicted in FIG. 7A-D, the nozzle width **791** (just outside the outlet holes **789**) is approximately 4.25 inches. In various embodiments the nozzle width **791** may be no greater than 3.0 inches, no greater than 4.5 inches, no greater than 5.0 inches, no greater than 7.0 inches, or no greater than 12.0 inches. Other embodiments may have predefined nozzle widths that are wider or narrower than these specified ranges.

[0076] FIG. 7D depicts nozzle outlet section **765**, according to various embodiments disclosed herein. Nozzle outlet section **765** is “Y” shaped, and as such, has two nozzle outlet arms **787** and a throat **781** between the two nozzle outlet arms **787**. Line **783** is drawn across the tips (extreme distal points) of the two nozzle outlet arms **787**. A vent **779** is configured within the throat **781** of the nozzle outlet section **765** along the inner surface of each nozzle outlet arm **787**. To distinguish



the vent **779** from the nozzle outlet holes **789**, the vent **779** is defined as the gap (or gaps) in the nozzle throat **781** from a point 15% inward from the tips of each nozzle outlet arm **787** to 100% of the depth of the throat in a proximal direction, as shown in FIG. 7D. (The line **785** is drawn parallel to line **783** and inward 15% of the way into the throat of the nozzle.) The vent **779** is an opening (or multiple openings) into the interior of nozzle outlet section **765** that allow(s) air to pass out in addition to the air passing out of the nozzle outlet holes **789**. The section of the nozzle from 0% to 15% inward from the tips may either be open, as shown in FIG. 7C, or may be closed-depending upon the particularities of the given nozzle implementation.

[0077] The ratio of the area of the outlet holes **789** to the area of the vent **779** has an impact on the effectiveness of the air being pulled into the gap between the tire and the rim. This ratio is referred to herein as the nozzle outlet-vent ratio. In the embodiment depicted in FIGS. 7A-D each of the outlet holes **789** has an area of approximately 0.645 square inches, and the area of the vent **779** (between the 15% points in FIG. 7D) is approximately 0.773 square inches. The area of both outlet holes **789** together is 1.290 square inches ( $0.645 \times 2$ ). Hence, the nozzle outlet-vent ratio of the FIGS. 7A-D embodiments is  $1.290/0.773$ , or 1.667. The various embodiments have a nozzle outlet-vent ratio that conform to one or more of the following ranges: 0.2 or greater; 0.5 or greater; 0.8 or greater; 1.0 or greater; 1.2 or greater; 1.5 or greater; 2.0 or greater; between 0.2 and 1.0; between 0.5 and 1.5; between 0.8 and 20.0; between 1.0 and 2.5; between 1.2 and 3.0; between 1.5 and 3.5; between 2.0 and 4.0; less than 1.0; less than 1.5; less than 2.0; less than 3.0; less than 4.0; or less than 5.0.

[0078] FIG. 8 is a flowchart depicting the use of the RAR pneumatic tire seater according to various embodiments of the invention. The method begins at block **801** and proceeds to block **803** where an air tank is provided. The air tank may be one such as those depicted in FIG. 1A or the tank depicted in FIGS. 2A-C. Upon procuring a tank the method proceeds to block **805** where the RAR valve is attached to the tank. In various embodiments the RAR valve is inserted through a hole of the appropriate size in the distal (front) end of the tank. The RAR valve has a conduit attached to its proximal end such as the conduit **504** depicted in FIGS. 5A-B. In some embodiments, when inserting the RAR valve in the front hole of the tank the conduit is inserted first and lined up to just pass through a hole where the pistol grip is attached to the tank. The RAR valve and conduit are then both welded to provide an airtight seal to their respective holes in the tank. In other embodiments the conduit hole in the tank may be in a location other than beneath the pistol grip.

[0079] The method then proceeds to step **807** for attachment of a nozzle assembly to the RAR valve. In various embodiments this is done by threading male threads of the nozzle proximal (rear) end into female threads provided just inside the distal (front) end of the RAR valve. In other embodiments the female threads may be configured within the nozzle while the RAR valve protrudes out of the tank with male threads to fit the nozzle. In yet other embodiments the nozzle may be affixed to the RAR valve by welding, gluing, compression fitting, or other such means of attachment. Upon attaching the nozzle to the RAR valve the method proceeds to block **809** to connect a handle to the tank.

[0080] In block **809** a handle is connected to the air tank. In various embodiments the handle is a pistol grip handle such as the pistol grip handle **107** depicted in FIGS. 1A-B. In some embodiments the handle may be connected either to the tank itself or to a connector attached to the conduit that extends from the RAR valve to the bottom of the tank. In other embodiments the handle may be connected directly to the tank, e.g., by an adhesive, or if the handle is metal, by welding. In various embodiments the conduit may be provided in multiple pieces, with one piece extending only a short distance out of the tank, e.g., less than 0.25 inch. In such embodiments the process of connecting the handle may involve connecting an extension of the conduit to the control valve **519** as shown in FIG. 5A. The portion of the conduit that extends out of the tank to the control valve **519** is reflected as dotted lines in FIG. 5A. Once the handle is connected to the tank in block **809**

the method proceeds to block **811**.

[0081] In block **811** a control cluster is connected to the air tank. The control cluster provides pneumatic communication to the inside of the tank for multiple devices (e.g., a pressure gauge, an inlet valve, and a relief valve) via a single access inlet in the tank. This avoids the need to drill multiple holes in the air tank for the various devices connected to it. Upon connecting the control cluster and completing block **811** the method proceeds to block **813**. In block **813** a carry handle is connected to the tank. For those embodiments with the control cluster mounted in the manner shown in FIG. **6A** the carry handle aids in protecting the control cluster from damage when the tire seater is set upside down on a planar surface table that coincides with the clearance line **661** of FIG. **6A**. The carry handle also serves as a convenient hand-hold for carrying the pneumatic tire seater and for hanging it up on a wall.

[0082] Upon completing the assembly of the pneumatic tire seater with connection of the carry handle in block **813** the method proceeds to block **815** where the tank is filled with pressurized air. The amount of air to be pumped into the tank—as determined by the reading on the pressure gauge—is determined by the type and size of tire being seated. Larger tires contain a larger volume of air, and thus require a high pressure in the air tank to seat them. A typical pressure used to fill car and truck tires may be within the range of 100 psi to 150 psi. In other instances the tank may be filled to higher pressures or lower pressures, depending upon the specifics of the tire to be seated. Upon filling the tank in block **815** the method proceeds to block **817** to seat a tire using the device.

[0083] In block **817** the user points the nozzle into the gap between the tire to be mounted and the wheel. It was discovered by the present inventors that the device works best with the nozzle an inch or so away from the gap, rather than placing the nozzle directly within the gap. For this reason some models of the bead seater are provided without the tab **777** mounted between the arms of the “Y” shaped nozzle outlet as shown in FIGS. **7A-C**. In such embodiments there is typically no tab **777** and nothing between the “Y” shaped outlet arms of the nozzle to impede flow of the air into the gap between the tire and the wheel. Upon directing the nozzle into the gap between the tire and the wheel the method proceeds to block **819**.

[0084] In block **819** the user manipulates a valve control mechanism—e.g., the valve control mechanism **517** shown in FIG. **5A**—to open the RAR valve. In the embodiment depicted in FIGS. **5A-B** this is done by pressing the valve control mechanism **517** mechanism which is a button in the implementation depicted in the figure. In other embodiments the valve control mechanism **517** may be a trigger, a twist valve, a valve lever, a switch, an electronic control in communication with a valve, or other such valve control mechanisms as are known by those of ordinary skill in the art. Upon opening the valve in block **819**, the method proceeds to block **821** to direct the blast of air in between the tire and rim, thus seating the tire. Once the tire is seated the method proceeds to block **823** and ends.

[0085] Various activities may be included or excluded as described above, or performed in a different order as would be known by one of ordinary skill in the art, while still remaining within the scope of at least one of the various embodiments. For example, the carry handle may (and generally is) connected to the tank (block **813**) before connecting the control cluster to the tank (block **811**). Further, blocks **805** to **813** may be implemented in various different orders. The descriptions contained in this disclosure are written in terms of an RAR valve used as part of a pneumatic tire seater tire mounting device. However, the RAR valve may be used in other types of devices or for other purposes.

[0086] For the sake of brevity within this disclosure the RAR valve cylinder **310**, piston **314** and various other components are referred to herein and depicted as being circular in cross-section, e.g., as shown in FIG. **3A**. However, in practice the cylinder **310**, piston **314** and various other components may have a cross-section other than round—that is, they may be any number of shapes or sizes aside from having a round cross-section. For example, the various components may be implemented with cross-sections that are round, oval, oblong, square, triangular, rectangular

(slotted), pentagonal, hexagonal, with rounded corners, with square, triangular or other sharp corners, a non-symmetrical shape, or other like shapes as are known to those of ordinary skill in the art. In the discussion above the RAR valve and conduit are said to be affixed to the tank by welding the parts to the tank walls. In practice, however, the various parts may be affixed to each other by any of several different fastening means, including for example, by gluing or use of other adhesives, by taping, by compression fitting, by using threaded connections, or other such means of affixing components as are known to those of ordinary skill in the art.

[0087] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes,” and/or “including” used in this specification specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The term “plurality”, as used herein and in the claims, means two or more of a named element. It should not, however, be interpreted to necessarily refer to every instance of the named element in the entire device. Particularly, if there is a reference to “each” element of a “plurality” of elements. There may be additional elements in the entire device that are not included in the “plurality” and are not, therefore, referred to by “each.”

[0088] The word “substantially” (e.g., substantially vertical or substantially one foot) as used herein in the specification and claims is meant to mean plus or minus as much as 2%. For example, substantially one foot as used herein means any length within the range of 1 foot $\pm$ 0.02 foot. Similarly, an angle of 10 degrees as used herein means any angle within the range of 10 degrees $\pm$ 0.2 degree. The word “approximately” as used herein means the same as the word “substantially.” The phrase “slightly less than” as used herein, is defined to mean at least 98.5% of. For example, an outside diameter of the piston that is slightly less than the cylinder's inside diameter means that the piston's diameter is at least 98.5% of the cylinder's inside diameter. The phrase “back and forth” as used herein describing the motion of a first part relative to a second part means that the first part moves one way (e.g., distal direction) relative to the second part, and then moves the other way (e.g., proximal direction) relative to the second part. For example, a piston that moves back and forth within a cylinder moves towards a distal end of the cylinder, then changes direction to move toward a proximal direction of the cylinder.

[0089] Two components that are in “pneumatic communication” with each other, as this phrase is used herein, means that air (e.g., pressurized air or gas) passes between the two components. The phrase “pneumatically connected” means the same as “in pneumatic communication.” More than two components can be “in pneumatic communication” (or be pneumatically connected). For example, the pressure gauge **655**, the inlet valve **657** and the relief valve **659** are each in pneumatic communication (or in other words, are pneumatically connected) with the interior of the air tank **601** via the three-way air manifold of the control cluster **609** as shown in FIGS. **6A-B**. This means that high pressure air within the air tank passes through the three-way air manifold of the control cluster **609** to each of the pressure gauge **655**, the inlet valve **657** and the relief valve **659**. Two different types of pneumatic communication are disclosed herein for the various embodiments, namely: “unconstrained pneumatic communication”, and “constrained pneumatic communication.” Typically, in the open position the RAR valve of pneumatic tire seater disclosed herein (e.g., embodiment **110** of FIG. **1A**) provides unconstrained pneumatic communication between the interior of the tank and the outside atmosphere.

[0090] Unconstrained pneumatic communication: Two pneumatically connected components that pass air between each other in a relatively unrestrained manner are said to be in “unconstrained pneumatic communication.” For the purposes of defining this term (at standard atmospheric temperature and pressure (STP)), a 0.25 inch long hole with a diameter of at least 0.5 inch between

two components provides “unconstrained pneumatic communication” of air or other gas between the two components. For example, a pressurized air tank connected to a nozzle with a gas valve that opens to a 0.5 inch round hole that is 0.25 inch long (between the tank and the nozzle) provides unconstrained pneumatic communication between the tank and the nozzle. Moreover, a hole of any cross-section shape or length that provides the same air flow as 0.25 inch long round hole with a diameter of at least 0.5 inch also provides unconstrained pneumatic communication of air or other gases.

[0091] Constrained pneumatic communication: Two pneumatically connected components that pass air between each other in a relatively restricted manner are said to be in “constrained pneumatic communication.” For the purposes of defining this term (at STP), a 0.25 inch long hole between two components with a diameter of less than 0.5 inch provides “constrained pneumatic communication” between the two components. For example, a pressurized air tank connected to a control chamber by a 0.25 inch long round passageway that is slightly less than 0.5 inch in diameter provides constrained pneumatic communication between the tank and the control chamber. Moreover, a hole of any cross-section shape or length that provides the same air flow as 0.25 inch long round hole with a diameter of less than 0.5 inch also provides constrained pneumatic communication of air or other gases.

[0092] A “two-state open/close gas valve”, as this phrase is used herein, has an open state and a closed state. The “two-state open/close gas valve” holding a pressurized tank of gas (e.g., air) remains in a closed state until its valve switch component is actuated, and moves rapidly to an open state in response to the valve switch component being actuated (i.e., here “rapidly” means in 250 ms or less). The “two-state open/close gas valve” holding back pressurized gas cannot be set at an intermediate opened state between the open state and the closed state, and is only in a partially opened state as is rapidly (i.e., in 250 ms or less) moves from the open state to the closed state. The “two-state open/close gas valve” opens at the same rate independent of how fast the user manipulates the valve switch component. That is, pulling the trigger (valve switch component) faster does not make the valve open any faster. In response to a user actuating the valve switch component the two-state open/close gas valve rapidly changes states from the closed state to the open state allowing the pressurized gas to pass through the valve.

[0093] Some components disclosed herein are connected together in unconstrained pneumatic communication so that air can flow freely between them. For example, the RAR valve of various embodiments is in unconstrained pneumatic communication with the air storage tank. Other components disclosed herein are connected together in constrained pneumatic communication so that air flows between them in a restricted manner. For example, in various embodiments the RAR valve is constructed so that the control chamber (area behind the piston) is in constrained pneumatic communication with the air storage tank. Yet other components may be connected in either manner, in accordance with various embodiments. For example, depending upon the particularities of a given implementation the conduit between the control chamber and the control valve (e.g., conduit **304** of FIGS. 5A-B) may provide either constrained or unconstrained pneumatic communication between the control chamber and the atmosphere outside the air tank. Such components that may be designed either way are simply said to be in “pneumatic communication” (or said to be “pneumatically connected”) without specifying the relationship to be either constrained or unconstrained.

[0094] The term “pressurized air” means air that has been compressed to have a pressure of greater than atmospheric pressure (or similarly for “pressurized gas”). In regards to the term “pressurized air” it is understood that upon releasing the pressurized air from the air tank, the pressure of that air drops considerably—although it is still pressurized above atmospheric pressure upon being received within a seated tire. To simplify the explanation herein, the pressurized air released from the air tank will still be called pressurized air even when it has been released from the tank and blown from the nozzle, so as to distinguish it from all other air or gases within the atmosphere

outside of the air tank. In regards to the term “airtight seal” it is understood that, given enough time, nearly any tank with a valve that is filled with pressurized gas will eventually leak out at least some of the pressurized gas. The term “airtight seal” as used herein is defined to mean that no more than 1 liter of a gas contained within the receptacle at 100 psi will leak past the airtight seal within a 30 minute period. The phrase “affixed in an airtight manner” is defined to mean being affixed with an airtight seal. For example, an RAR valve that is affixed in an airtight manner to an air tank won't leak at the seam where the two components are affixed at a rate of more than 1 liter of the gas contained in the receptacle at 100 psi within a 30 minute period. The term “substantially airtight seal” as used herein is defined to mean that no more than 1 liter of a gas (e.g., air) contained within the receptacle (e.g., air tank **101**) at 100 psi will leak past the airtight seal within a 10 minute period. The phrase “affixed in a substantially airtight manner” is defined to mean being affixed with a substantially airtight seal. The piston **314** configured with a distal O-ring **318** as shown in FIG. **3A** forms an airtight seal against the slotted lock collar **320** with the RAR valve in the closed position. In various embodiments, so long as the surface of the components are not worn, damaged, or soiled with impurities the RAR valve in a closed position will typically maintain an airtight seal for at least several hours.

[0095] Air tanks, such as tank **102** and tank **101** shown in FIG. **1A**, must be certified to be safe at a given pressure. The term “certified” as used herein means that the tank has been CE certified (Conformité Européenne)—or certified by an authorized governmental agency in another country—for inflation to a given pressure. For example, a tank may be certified for pressures up to 300 psi—meaning that it is certified by CE or other government's agency for inflation up to 300 psi. The phrase “certified at no less than 300 psi” means that the certification by CE or another governmental agency is at least 300 psi, and may be certified at a pressure higher than 300 psi (e.g., may be 350 psi, 400 psi, 850 psi, etc.).

[0096] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements, if any, in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. This disclosure of the various embodiments has been presented for purposes of illustration and description, and is not intended to be exhaustive in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and gist of the invention. The various embodiments included herein were chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated. The description of the various embodiments provided above is illustrative in nature inasmuch as it is not intended to limit the invention, its application, or uses. Thus, variations that do not depart from the intents or purposes of the invention are encompassed by the various embodiments of the present invention. Such variations are not to be regarded as a departure from the intended scope of the present invention.

## Claims

1. A pneumatic tire seater for seating a tire on a wheel, the pneumatic tire seater comprising: an air tank configured to hold pressurized air in an interior of the air tank; a gas valve in unconstrained pneumatic communication with the interior of the air tank, the gas valve being configured with an endcap at a proximal end of the gas valve; a piston included as part of the gas valve, the piston being configured to slide back and forth within a cylinder of the gas valve, wherein a distal end of the piston is configured to be seated in a closed position against a portion of the gas valve to prevent the pressurized air from escaping from the air tank; a control chamber formed within the cylinder between the endcap of the gas valve and a proximal end of the piston; and a control valve pneumatically connected between the control chamber and atmosphere outside the air tank;

wherein the gas valve opens in response to the control valve being actuated.

2. The pneumatic tire seater of claim 1, wherein, in response to being opened the gas valve releases the pressurized air from the air tank in a burst sufficient to seat the tire on a rim of the wheel.

3. The pneumatic tire seater of claim 2, wherein the gas valve is a two-state open/close gas valve, the pneumatic tire seater further comprising: one or more control gas passageways including a gap between the piston and an interior wall of the cylinder that allow some of the pressurized air to bleed past the piston into the control chamber.

4. The pneumatic tire seater of claim 3, wherein the one or more control gas passageways includes one or more control gas holes configured in the piston to provide constrained pneumatic communication between the control chamber and the pressurized air in the air tank.

5. The pneumatic tire seater of claim 4, wherein the air tank has an inside diameter of no greater than 6 inches, the pneumatic tire seater further comprising: an O-ring trough provided around a circumference of the piston; wherein the one or more control gas holes run in an axial direction between the O-ring trough and the proximal end of the piston.

6. The pneumatic tire seater of claim 1, further comprising: a control valve inlet configured as part of the control valve; a control valve outlet that opens to the atmosphere outside the air tank; and a conduit pneumatically connecting the control chamber to the control valve inlet.

7. The pneumatic tire seater of claim 6, wherein the air tank can hold a pressure of at least 300 psi; and wherein opening the control valve results in the control chamber becoming pneumatically connected to the atmosphere via the conduit.

8. The pneumatic tire seater of claim 1, wherein the gas valve has a valve/tank ratio equal or greater than 40% as measured using an inside diameter of the cylinder and an outside tank diameter of the air tank.

9. The pneumatic tire seater of claim 1, further comprising: a nozzle connected to a distal end of the gas valve, said nozzle comprising a distal end with one or more nozzle outlet holes configured to direct the pressurized air into a gap between the tire and the rim; and a flexible sealing component included as part of the gas valve and being configured to removably seat on a portion of the gas valve in an airtight manner.

10. The pneumatic tire seater of claim 9, further comprising: a nozzle outlet section configured as part of the nozzle and being in unconstrained pneumatic communication with the gas valve, the nozzle outlet section comprising first and second nozzle arms, the first nozzle arm comprising a first nozzle outlet hole and the second nozzle arm comprising a second nozzle outlet hole; and a vent configured as part of the nozzle outlet section configured to span a throat of the nozzle outlet section between the first nozzle outlet hole and the second nozzle outlet hole.

11. The pneumatic tire seater of claim 10, wherein the vent and the first and the second nozzle outlet holes are characterized by a nozzle outlet-vent ratio of 1.0 or greater; and wherein the air tank is cylindrical with rounded ends and has an outside tank diameter of between 3.75 and 6.5 inches

12. The pneumatic tire seater of claim 1, further comprising: a control cluster comprising at least two devices, the control cluster being pneumatically connected to the interior of the air tank; wherein the at least two devices are selected from the group consisting of a pressure gauge, an inlet valve and a relief valve.

13. The pneumatic tire seater of claim 1, wherein the gas valve has an opening time of no greater than 150 ms, the pneumatic tire seater further comprising: a compression spring positioned within the cylinder between the endcap and the proximal end of the piston; and a cushion positioned within the cylinder between the endcap and the proximal end of the piston.

14. The pneumatic tire seater of claim 1, further comprising: a lock collar configured to be removably affixed inside the distal end of the gas valve.

15. A method of constructing pneumatic tire seater for seating a tire on a wheel, the method comprising: holding pressurized air in an interior of an air tank; connecting a gas valve in

unconstrained pneumatic communication with the interior of the air tank; providing the gas valve with an endcap at a proximal end of the gas valve; configuring a piston to slide back and forth within a cylinder of the gas valve, wherein a distal end of the piston is configured to be seated in a closed position against a portion of the gas valve to prevent the pressurized air from escaping from the air tank; forming a control chamber within the cylinder between the endcap of the gas valve and a proximal end of the piston; and pneumatically connecting a control valve between the control chamber and atmosphere outside the air tank; and opening the gas valve in response to the control valve being actuated; wherein the gas valve has an opening time of no greater than 150 ms.

**16.** The method of claim 15, further comprising: releasing the pressurized air from the air tank in a burst sufficient to seat the tire on a rim of the wheel in response to opening the gas valve.

**17.** The method of claim 16, wherein the gas valve is a two-state open/close gas valve, the method further comprising: providing one or more control gas passageways including a gap between the piston and an interior wall of the cylinder that allow some of the pressurized air to bleed past the piston into the control chamber; wherein the one or more control gas passageways includes one or more control gas holes configured in the piston to provide constrained pneumatic communication between the control chamber and the pressurized air in the air tank.

**18.** The method of claim 17, wherein the air tank has an inside diameter of no greater than 6 inches, the pneumatic tire seater further comprising: forming an O-ring trough around a circumference of the piston; wherein the one or more control gas holes run in an axial direction between the O-ring trough and the proximal end of the piston.

**19.** The method of claim 1, wherein the air tank can hold a pressure of at least 300 psi, the method further comprising: configuring a control valve inlet as part of the control valve; connecting a control valve outlet that opens to the atmosphere outside the air tank; and pneumatically connecting a conduit between the control chamber and the control valve inlet.

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