

ABSTRACT

Portable, pneumatically **operable** tool systems and **compressors** for providing **pneumatic** power therefor. In at least one embodiment, compressors capable of producing clean, dry compressed **air/gas** (e.g., either in naturally occurring atmospheric **nitrogen/oxygen** ratios or as purified nitrogen or in alternative ratios therebetween) employing atmospheric air as a starting material, for use by portable pneumatic tools systems. In certain additional **embodiments**, methods of compressing **and/or** purifying atmospheric air and of **its use** in portable pneumatic tool **systems**.

ORIGINAL

I claim:

1. A system for manufacturing and providing compressed air/gas to a portable, pneumatic, power supply system comprising:
 - a) a compressor comprising:
 - a motor **operably** connected to a flywheel and capable of rotating said flywheel;
 - a linearly actuated pump having a first end and a second end, said first end **pivotally** connected to said flywheel at a pump **mount** location and said second end **pivotally** connected to a frame member, said pump **including** a piston which is linearly actuated when said flywheel is caused to rotate;
 - a counterweight connected to said flywheel at a location on said flywheel **generally opposite** said pump mount location, said counterweight being so located such that when said flywheel is caused to rotate, said counterweight imparts a **momentum** to said flywheel;
 - said linearly actuated pump including an air/gas pump input **capable** of receiving air/gas at atmospheric pressure and an air/gas pump output capable of **outputting** air/gas which is pressurized by said linearly actuated pump when said piston is linearly actuated;
 - and
 - b) a portable, pneumatic, power supply system comprising:
 - a portable air/gas reservoir;
 - a pressure regulator in air/gas flow communication with said portable **air/gas reservoir**, said pressure regulator including an air/gas pressure adjustment mechanism capable of adjusting pressure of **air/gas** outflow **therefrom**;
 - a power supply air/gas outlet including a coupler mechanism for connecting said power supply air/gas outlet to a pneumatically operable tool; and

wherein said air/gas pressure adjustment mechanism is capable of operating to deliver a plurality of selected air/gas pressures which **correspond** to pressures useful for operating a plurality of pneumatic tools; and

wherein said compressor is capable of **manufacturing** compressed **air/gas** for filling said portable air/gas reservoir with compressed air/gas; and

wherein said **air/gas** pump output is selectively **gas-flow connectable** and **disconnectable** to and **from** said portable, **pneumatic**, power supply system for filling said portable air/gas reservoir with compressed air/gas.

2. The **system** according to claim 1 wherein said portable air/gas reservoir contains **air/gas** compressed to a high initial pressure,

wherein said pressure regulator is connected to said portable **air/gas** reservoir such that compressed air/gas which exits said portable air/gas reservoir is delivered to said pressure regulator and wherein said pressure regulator is capable of receiving said compressed air/gas and thereafter delivering said air/gas to said interconnect at a reduced pressure relative to said high **initial pressure** as contained in said portable air/gas reservoir.

3. The system according to claim 2 wherein said air/gas pressure adjustment mechanism is capable of adjusting said air/gas flow output pressure in substantially **continuously variable** increments between at least an intermediate output pressure and a substantially zero output pressure.

4. The system according to claim 2 wherein said air/gas pressure adjustment mechanism is capable of effecting regulation of air/gas flow output **pressure** from said pressure regulator; said air/gas pressure **adjustment** mechanism being selectively capable of adjusting said air/gas flow output pressure within a substantially continuously variable range between said high initial pressure as contained in said portable air/gas reservoir and a substantially zero output pressure.

5. The system according to claim 3 farther including an interconnect attached to and providing air/gas flow communication between said pressure regulator and a power supply air/gas **outlet** wherein said air/gas flow output pressure, during system **operation**, is delivered to said interconnect for delivery for end pneumatic use.

6. The system according to claim 5 wherein said interconnect comprises a flexible **conduit**, said flexible conduit having a quick **connect-disconnect** coupler attached proximal one end thereof capable of connecting and disconnecting to a pneumatically operable device.

7. The system according to claim 6 wherein said pressure regulator is so constructed **such that** said **air/gas** flow output pressure is regulated by said pressure regulator in a single stage regulation step comprising:

receiving air/gas flow at said high initial pressure and thereafter delivering said air/gas flow at **reduced** pressures relative to said initial high **pressure**, said reduced pressures being selectable from within a range of air/gas pressures suitable for operating a plurality of pneumatic tools.

8. The system according to claim 6 wherein said pressure regulator is a dual stage regulator and said air/gas flow output pressure is regulated by said pressure regulator in a dual stage regulation comprising:

receiving air/gas flow at said high initial pressure;

reducing said high **initial** pressure of said air/gas flow to an intermediate pressure at a first stage;

reducing said intermediate pressure of said air/gas flow to a working pressure at a second stage, said working pressure being selected from within a range of pressures suitable for operating a plurality of pneumatic tools.

9. The system according to claim 8 wherein said working pressure is selected from between approximately a value greater than 0 and a value equal to or less than 500 psi.

10. The system according to claim 7 or 8 ~~further~~including:
a plurality of pneumatically operable tools having universal connectors; and
wherein said quick ~~connect-disconnect~~ coupler of said conduit is capable of being
selectively, alternately connected to said plurality of ~~pneumatically~~ operable tools such
~~that~~, when ~~connected~~, said tools are in air/gas flow communication with said pressure
regulator via said conduit,
11. The system according to claim ~~10~~ wherein said system is so configured so as to be
capable of providing a workable output pressure to operate a plurality of pneumatic tools,
including at least: a nail gun, an air wrench, a paint sprayer, an inflator, a stapler, a micro
pinner, ~~a pin tacker~~, and a drill.
12. The system according to claim 7 or 8 wherein said pressure ~~regulator~~ further
includes an air/gas flow input which is so constructed so as to be ~~capable~~ of being
communicably connected to said compressor so that said high pressure compressor can
replenish gas pressure to said portable gas reservoir.
13. The ~~system~~ according to claim 1 wherein said ~~portable~~ air/gas reservoir has a rated
pressure of at least 3000 psi and weighs less than approximately 10 ~~lbs~~.
14. The system according to claim ~~1~~ wherein said portable air/gas reservoir has a rated
pressure of at least 5000 psi and weighs less than 50 ~~lbs~~.
15. The system according to claim 2 wherein said portable air/gas reservoir is configured
to be attached to a user-wearable belt.
16. The system according to claim 2 wherein said portable air/gas reservoir is configured
to be attached to a ~~user-wearable~~ back harness.

17. The system according to claim 8 wherein said intermediate pressure is selected from between **approximately 800-4500** psi and said working pressure is less than or equal to approximately 500 psi,

18. A system for manufacturing and providing compressed air/gas to a portable, pneumatic, power supply system **comprising**:

a) a compressor comprising:

a motor **operably** connected to a flywheel and capable of rotating said flywheel;

a linearly actuated pump having a first end and a second end, said first end **pivotally** connected to said flywheel at a pump mount location and **said second** end pivotally connected to a frame member, said pump including a piston which is linearly actuated when said flywheel is caused to rotate;

a **counterweight** connected to said flywheel at a location on said flywheel **generally** opposite **said** pump mount location, said counterweight being so located such that when said flywheel is caused to rotate, said counterweight imparts a momentum to said flywheel;

said linearly actuated pump including an air/gas pump input for receiving **air/gas** at atmospheric pressure and an air/gas pump output for **outputting air/gas** which is **pressurized** by **said** linearly actuated pump when said piston is linearly **actuated**; and

b) a **portable**, pneumatic, power supply system comprising:

a portable air/gas reservoir containing air/gas compressed to a high initial pressure;

a **pressure** regulator in air/gas flow **communication** with said portable air/gas reservoir, said pressure regulator including an air/gas pressure **adjustment** mechanism capable of adjusting pressure of air/gas outflow therefrom, said pressure regulator being so connected to said portable air/gas reservoir such that compressed air/gas which exits said portable air/gas reservoir is delivered to said **pressure** regulator;

an **interconnect attached** to and providing air/gas flow communication between said pressure regulator and an air/gas outlet, said interconnect comprising a flexible **conduit** and said air/gas outlet comprising a quick **connect-disconnect** coupler attached proximal one end of said flexible conduit;

wherein said air/gas pressure adjustment **mechanism** is capable of operating to deliver a plurality of selected air/gas pressures which correspond to pressures useful for a plurality of **pneumatic** end uses;

wherein said pressure regulator is capable of receiving said compressed air/gas and thereafter **delivering** said air/gas to said interconnect at a reduced pressure relative to said high initial pressure as contained in said portable air/gas reservoir; and

wherein said pressure regulator is a **dual** stage **regulator** and said air/gas flow output **pressure** is regulated by said pressure regulator in a dual stage regulation comprising:

receiving air/gas flow at said high initial pressure;

reducing said high initial pressure of said air/gas flow to **an** intermediate **pressure** at a first stage;

reducing said intermediate **pressure** of **said** air/gas flow to a working **pressure** at a second stage, said working pressure being selected from within a range of pressures suitable for operating a plurality of pneumatically operable tools; and

wherein said compressor is capable of manufacturing compressed air/gas for filling said portable air/gas reservoir with compressed air/gas; and

wherein said air/gas pump output is selectively gas-flow **connectable** and disconnectable to and from said portable, pneumatic, power supply system for **filling** said portable air/gas reservoir with compressed air/gas.

19. The system according to claim 19 wherein said working pressure is selected from between approximately a value greater than 0 and a value equal to or less than 500 psi.

20. The system according to claim 19 further including:

a **plurality** of pneumatically operable tools having universal connectors; and
wherein said quick **connect-disconnect** coupler of said conduit is capable of being

selectively, alternately connected to said plurality of pneumatically operable tools such that, when connected, said tools are in air/gas flow communication with said pressure regulator via said conduit.

21. The system according to claim 21 wherein said system is so configured so as to be capable of providing a workable output pressure to operate a plurality of pneumatic tools, **including** at least; a nail **gun**, an air **wrench**, a paint **sprayer**, an **inflator**, a stapler, a micro pinner, a pin **tacker**, and a drill.

22. The system according to claim 19 wherein said pressure regulator further includes an air/gas flow input which is so constructed so as to be capable of being **communicably** connected to said compressor so that said compressor can replenish air/gas pressure to said portable air/gas reservoir.

23. The system according to claim 1 or 19 wherein said portable air/gas reservoir is constructed, at least in part, from a material selected from the group consisting of; **steel**, **aluminum**, and carbon fiber,

24. The **system** according to claim 1 or 19 wherein said linearly actuated **pump** comprises a shell housing and a linearly extendable and retractable **piston**, said piston being linearly translatable to effect a **pressurization** of **air/gas**.

25. The system according to claim 25 **wherein, during** operation, said flywheel has a **rotational** direction which causes alternating push **and** pull strokes of said piston and wherein said counterweight is connected to said flywheel in such a location generally opposite **said** pump mount location such that when said flywheel is rotating to cause a push **stroke** of said piston, said counterweight is located such that gravity acts on said counterweight in **a** direction which is generally **co-directional** with **said** rotational direction of said flywheel; and

when said flywheel is rotating to cause a pull stroke of **said piston**, said **counterweight** is located such that gravity acts on said counterweight in a direction which is generally opposite said rotational direction of said flywheel.

26. The **system** according to claim 26 further wherein during a push stroke of said piston, said counterweight assists in effecting a completion of said push stroke and during a pull **stroke** of said piston, said **counterweight** adds resistance to effecting a completion of **said pull** stroke,

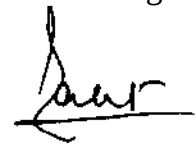
27. The system **according** to claim 27 wherein said position and location of counterweight causes said counterweight, during directional motion of said flywheel, to **alternately** assist and resist push and **pull** strokes of said piston thereby to effect a generally consistent **rotational** velocity of said flywheel during compressor **operation**.

28. The system according to claim **28** wherein said compressor is capable of pressuring air up to a pressure of at least approximately 6000 **psi**.

29. The system according to **claim** 28 wherein said **linearly actuated** pump includes a coolant fluid path through which a coolant can be transmitted thereby to temperature regulate said linearly actuated pump during operation.

30. The **system** according to claim 30 wherein said coolant fluid path is a fluid passageway located internal to said shell housing in proximity to said linearly extendable **and** retractable piston.

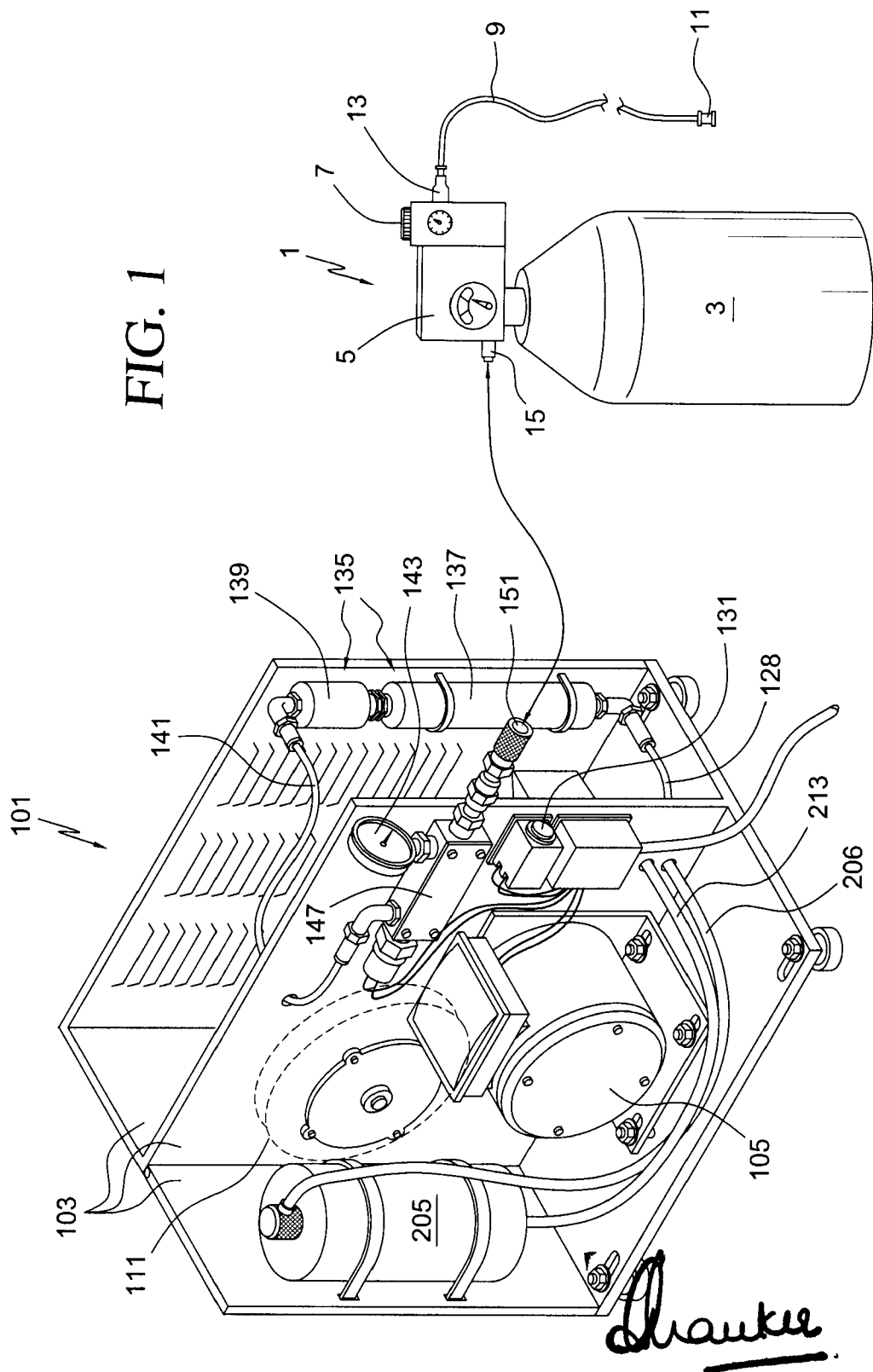
31. The system according to claim **31** further including a coolant reservoir in fluid communication with said coolant fluid path and a coolant pump for transmitting coolant from said coolant reservoir and through said coolant fluid path.


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Dated Ms 04th day of August 2006

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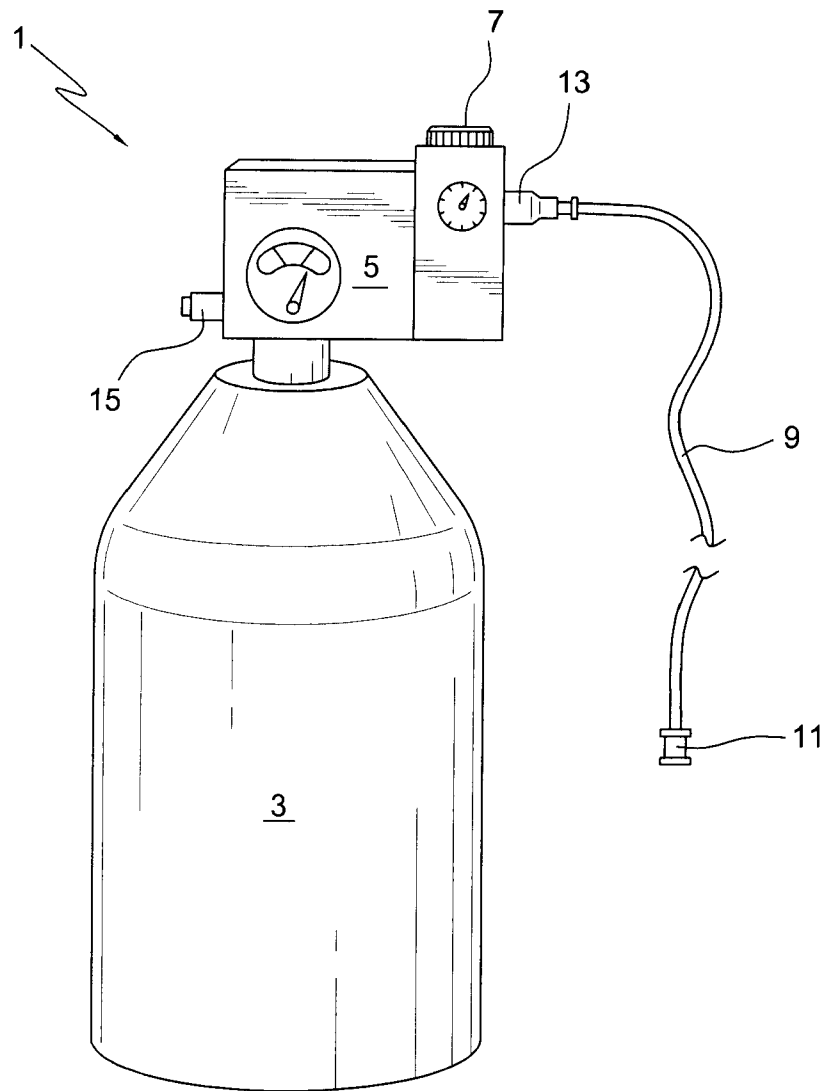


FIG. 2

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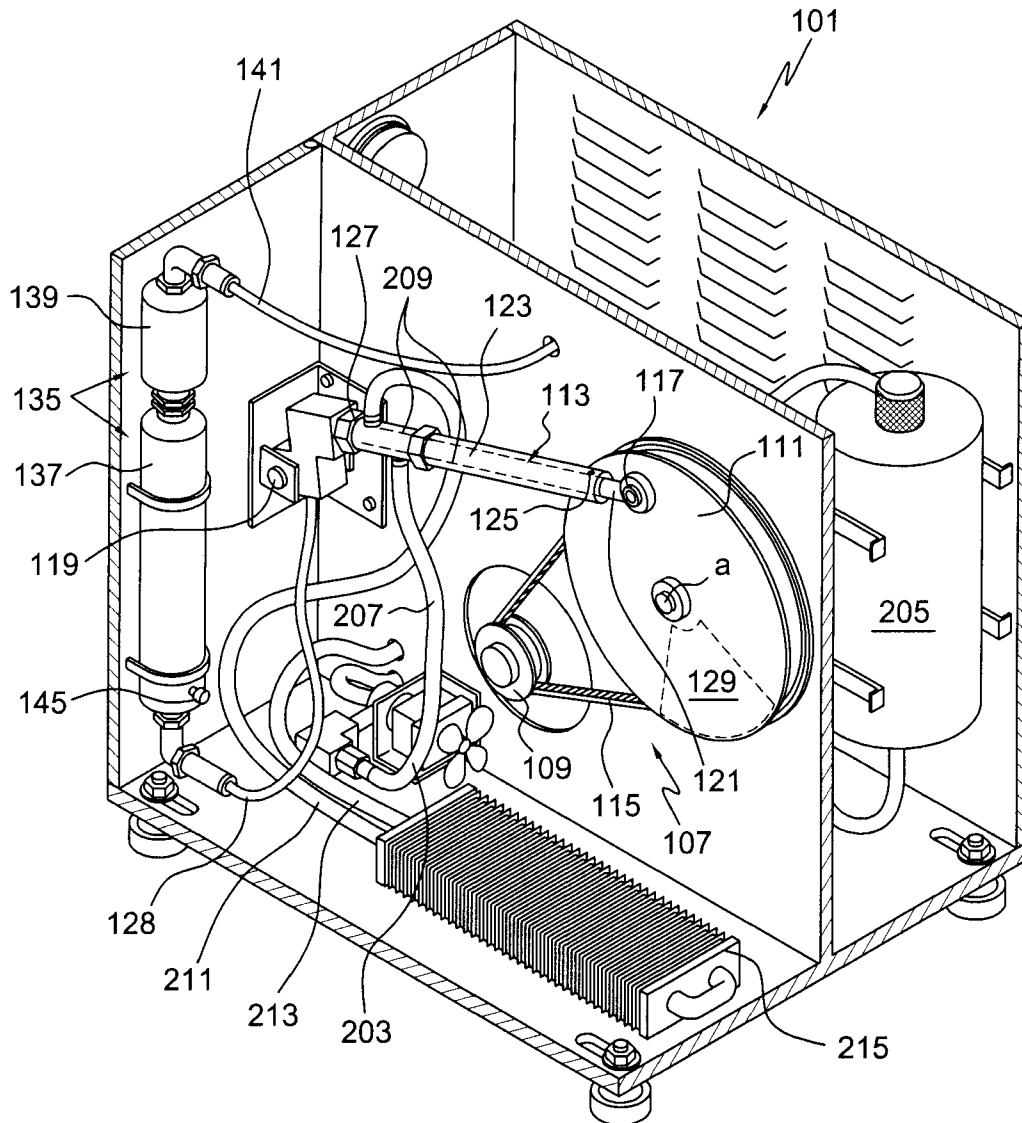


FIG. 3

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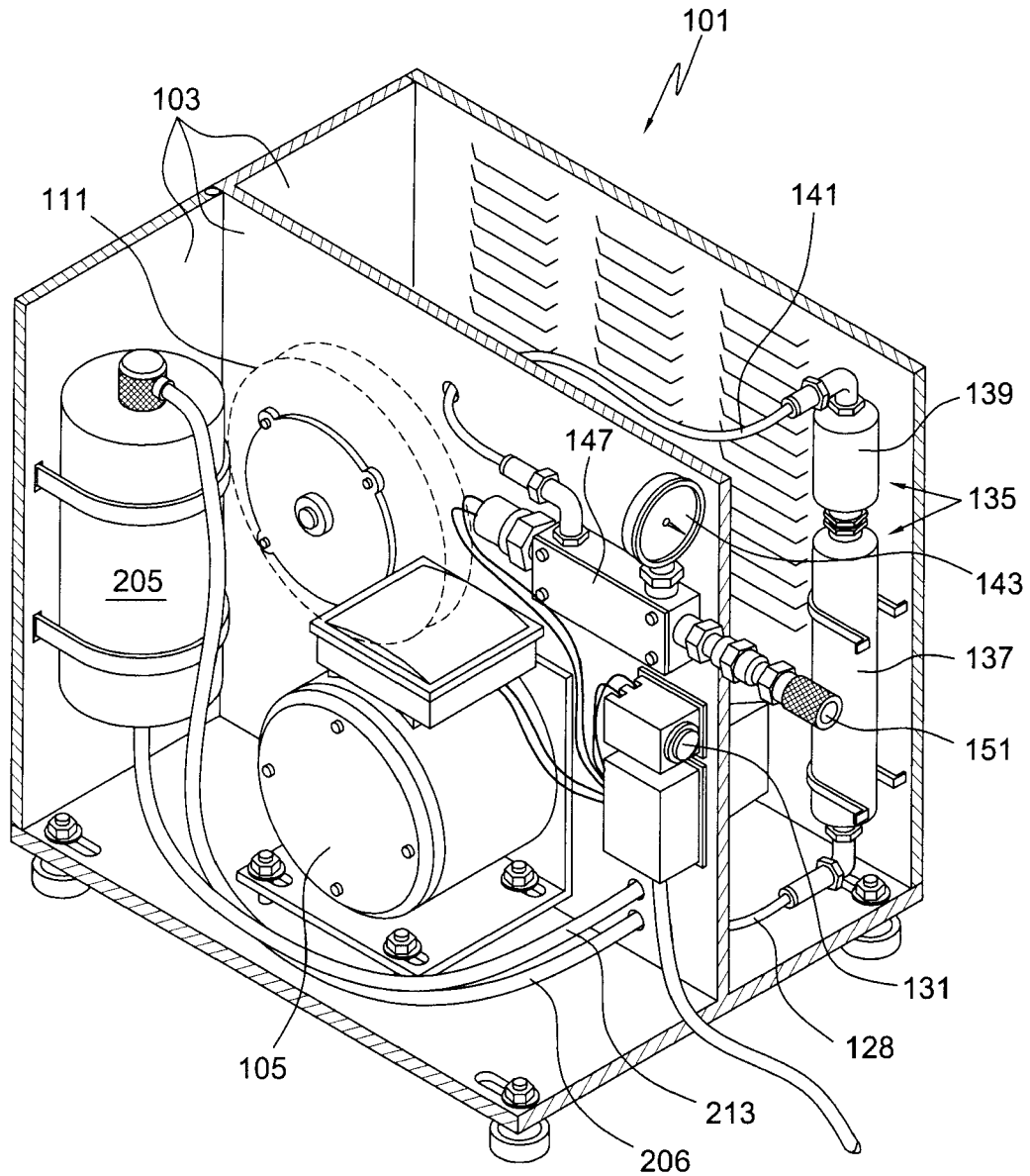
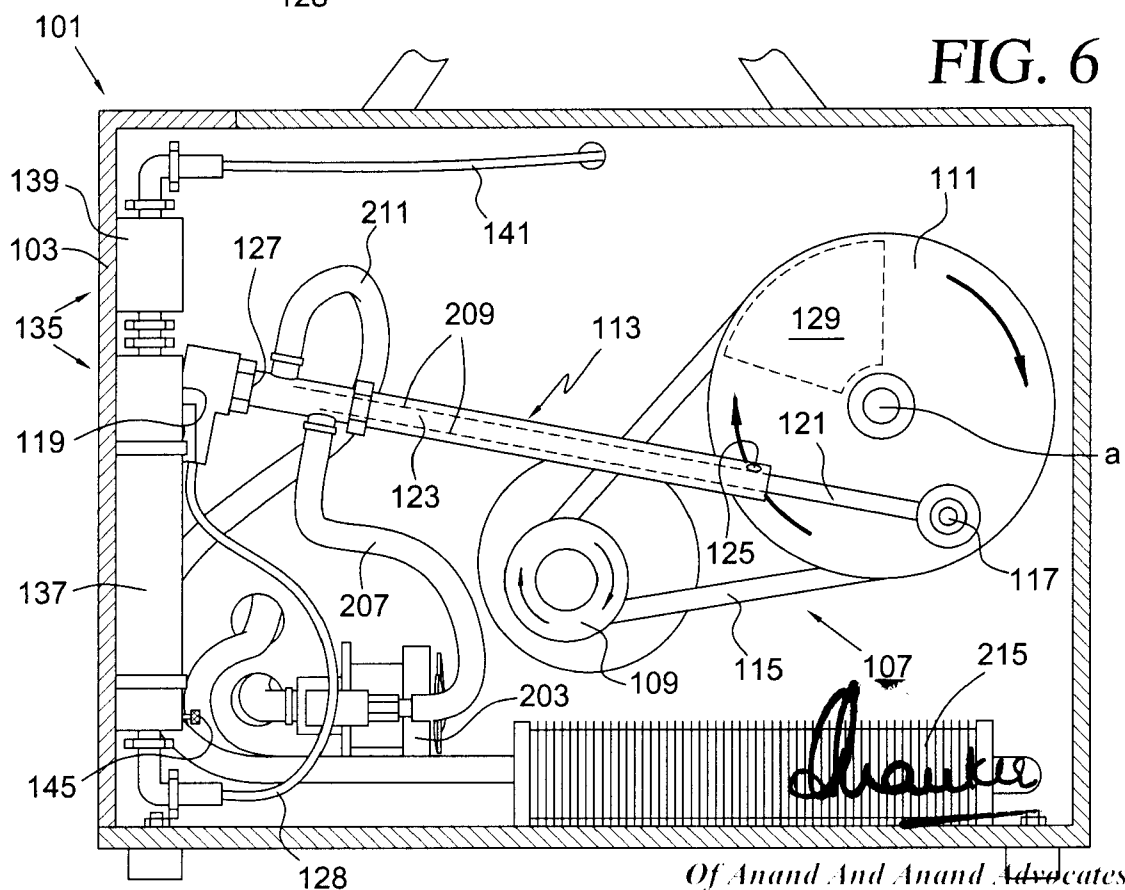
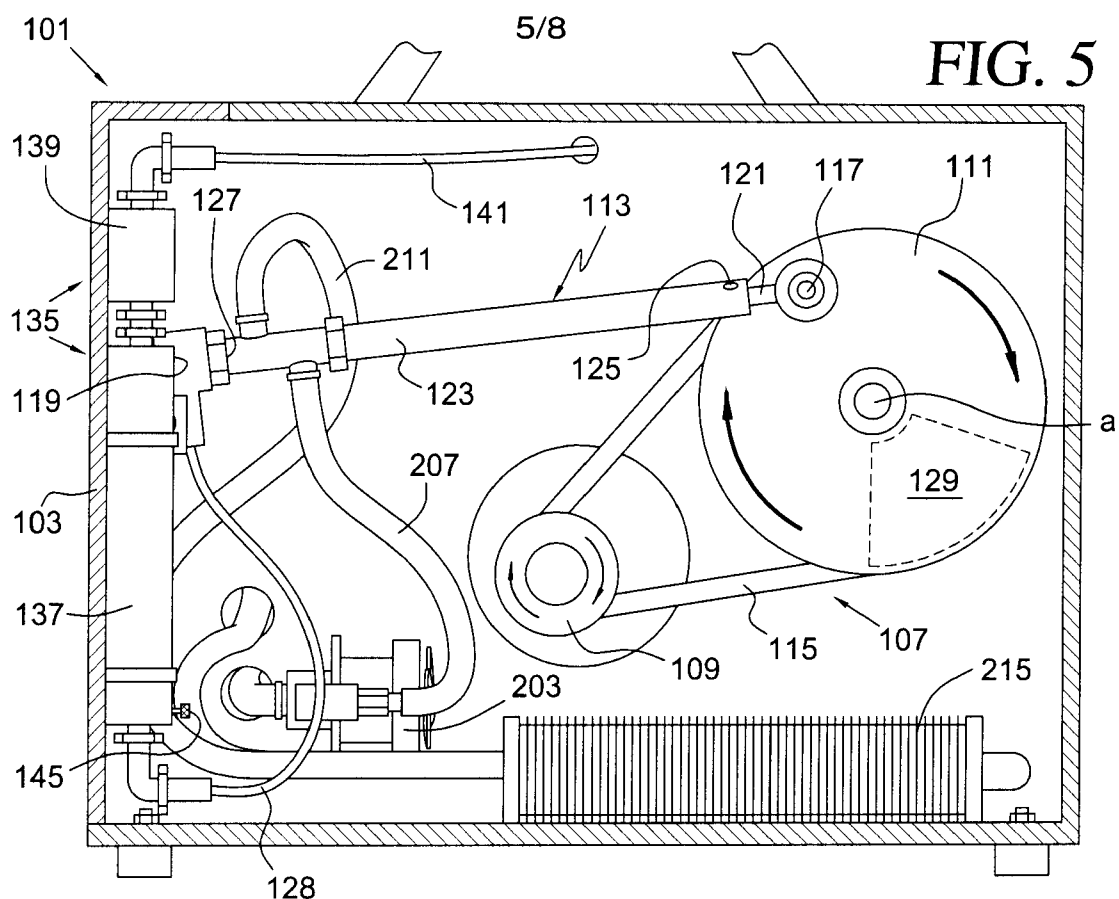


FIG. 4

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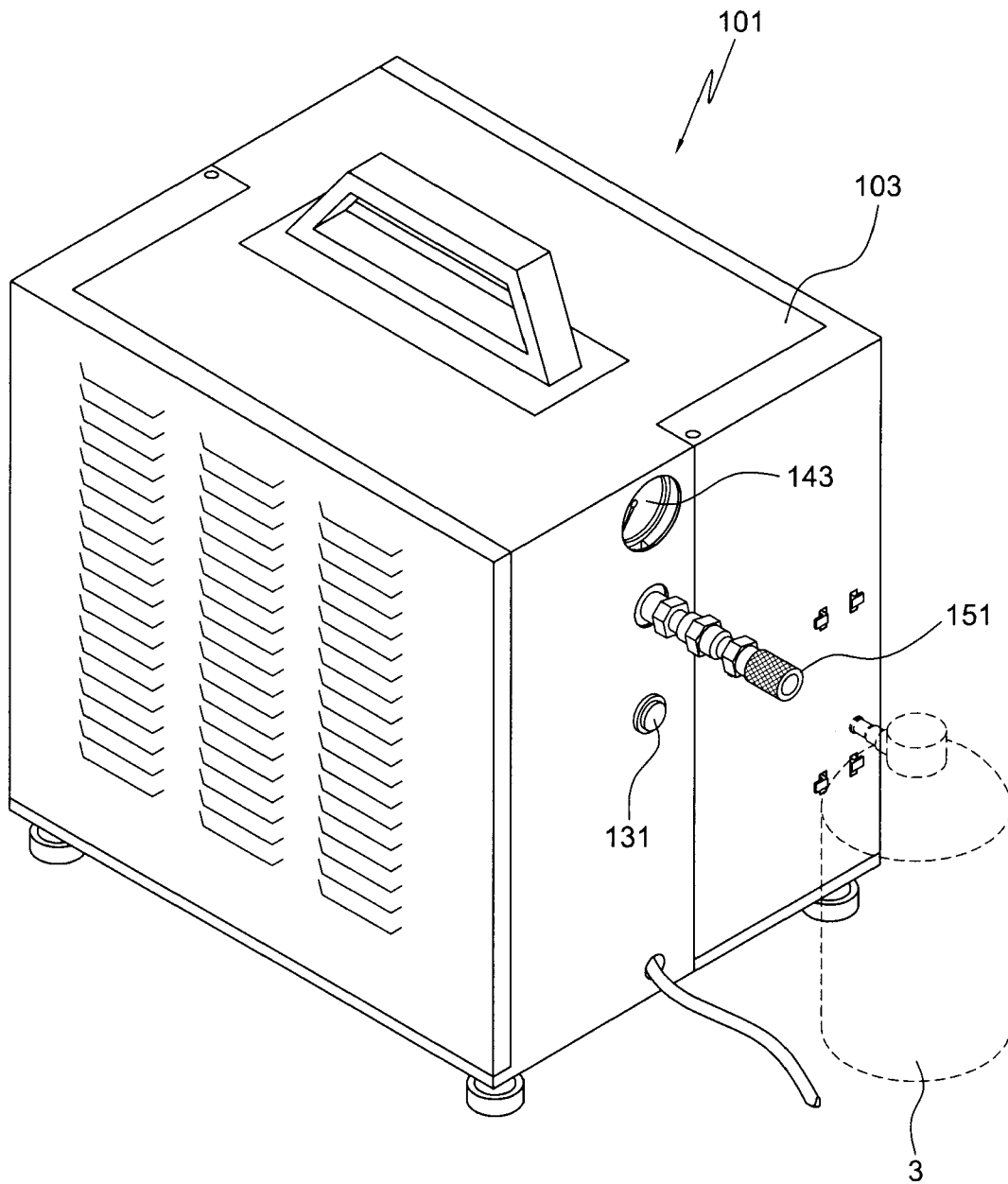
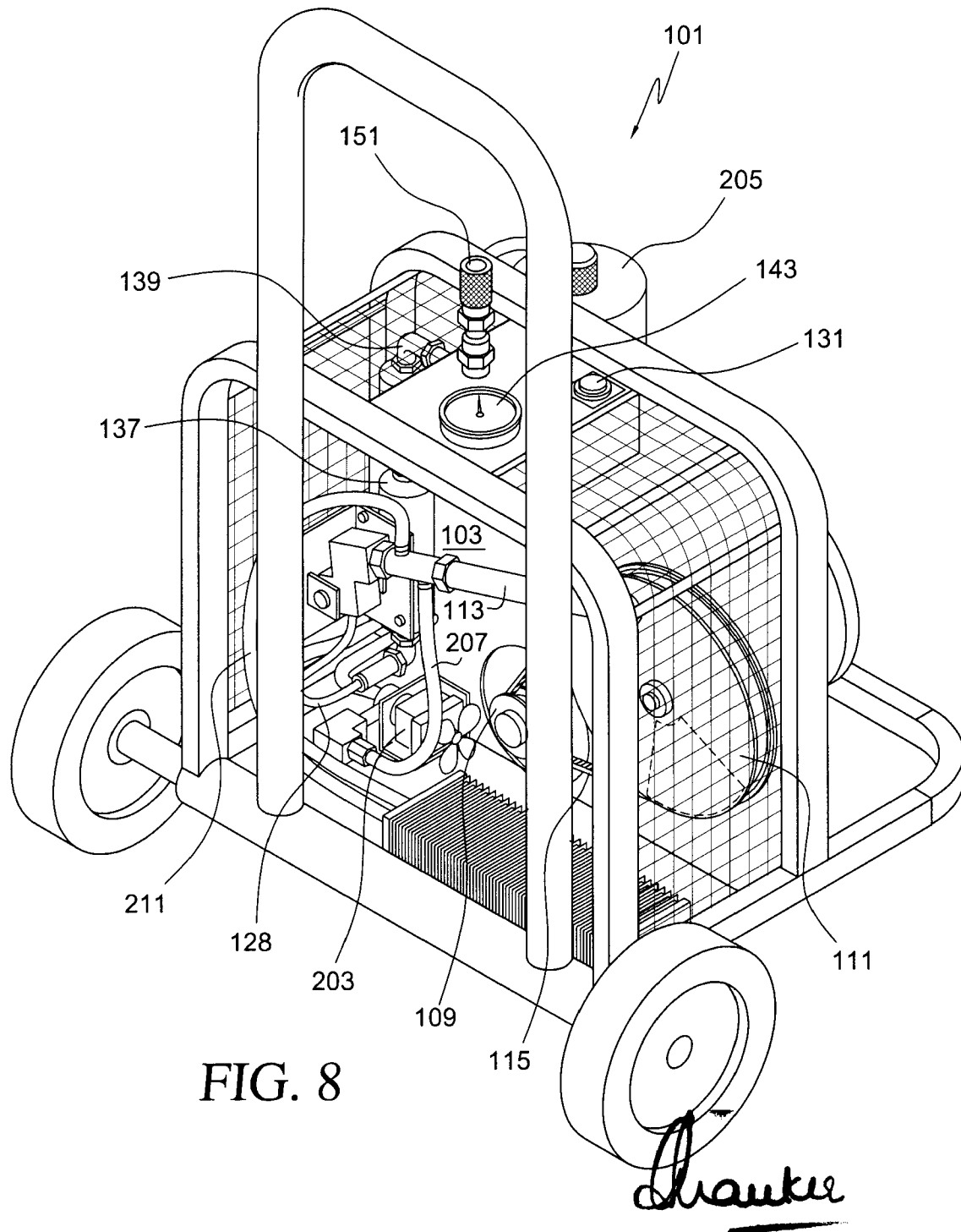


FIG. 7

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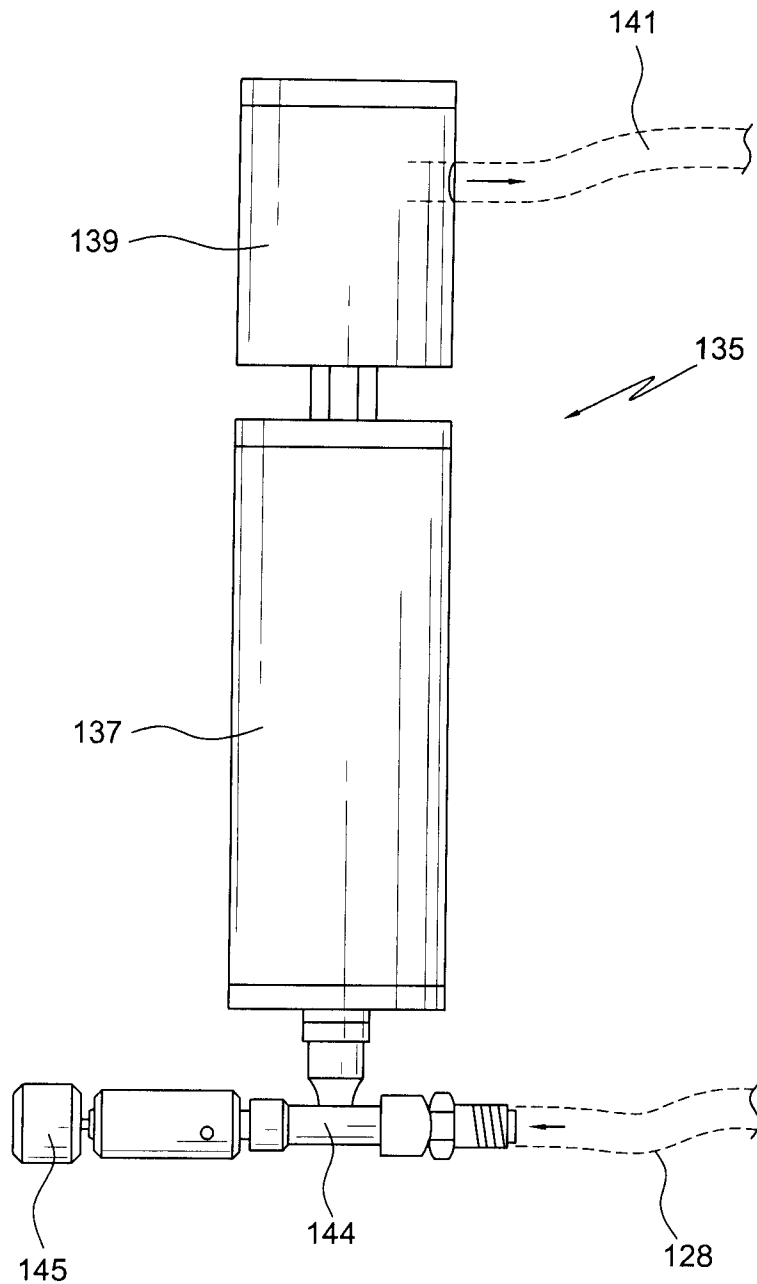


FIG. 9

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PORTABLE PNEUMATIC **POWER** SUPPLY AND COMPRESSOR **SYSTEMS** AND
METHODS THEREOF
RELATED **APPLICATION** DATA

This application **claims** the **benefit** of priority of United States Provisional Patent Application No. **60/780,236**, entitled GAS COMPRESSOR and **co-invented** herewith and hereby incorporates such application, in **its** entirety, by reference. United States Patent No. **6,932,128**, entitled APPARATUS AND METHOD FOR USING A LIGHTWEIGHT PORTABLE **AIR/GAS** POWER SUPPLY and co-invented **herewith**, is further incorporated in its entirety by reference.

FIELD OF INVENTION

This invention relates to portable, pneumatic power supply systems and compressors for providing pneumatic power therefor. **In** at least one **embodiment**, this invention relates to **compressors** capable of producing clean, dry compressed air/gas (**e.g.**, either in naturally occurring atmospheric **nitrogen/oxygen** ratios or as purified nitrogen or in alternative ratios therebetween) employing **atmospheric** air as a starting **material**, **for** use by portable pneumatic power supply systems (**e.g.**, for powering pneumatically operable tools). In certain **additional** embodiments, this invention relates to methods of compressing **and/or** purifying atmospheric air and to its use in portable pneumatic power supply and/or tool systems.

BACKGROUND OF THE INVENTION

A tremendous variety of tools types and the like have been developed over the centuries to address the many numbers of construction and manufacturing arts which have **evolved** during **civilization's** technological progress through modern times. For example, in a single industry such as the **construction industry**, dozens of different tools **types** may be used on a single **construction** site. In particular, the number of such tool types which are used has increased due to **the** various specialties and sub-specialties of carpentry and other construction techniques which continue to develop as modern buildings become more complex.

Throughout the **modern** evolution of tools, substantial efforts have been made to automate **tool** operation, principally, to improve job efficiencies by improving tool operation speeds and by reducing fatigue of tool operators. In recent decades, such

automation **efforts** have **typically** involved the **development** or innovation of compressor powered pneumatic tools or tools powered by electricity. In this regard, due to their improved efficiencies, the use of automated **tools** has become **so** commonplace that one would be hard-pressed to not find a **pneumatic** nail gun or an electrically powered drill at a typical construction job site. Nevertheless, conventional pneumatic or electrically operable tools **suffer** various **disadvantages** or drawbacks.

For **example**, pneumatic or electrically powered tools which are directly connected to a compressor via a hose or to an electrical outlet via a power cord are limited in their portability or mobility due to their attachment to their respective power sources (**e.g.**, their portability is limited to the length of the hose or cord and/or they may be difficult or unsafe to carry up a ladder for example). Moreover, the longer the cord or hose, the greater the overall weight as well as the chance that such hose or cord will become entangled or otherwise act as a safety hazard (**e.g.**, as a tripping hazard). Although battery operated tools address some of these disadvantages, such tools are burdened by their own drawbacks such as their increased weight and **reliance** on the finite charge of a battery (**and**, after battery depletion, one must wait for the battery to be recharged or have additional batteries available, for example).

The present inventor has addressed the aforementioned problems and drawbacks in his U.S. Patent No. **6,932,128**, entitled APPARATUS AND METHOD FOR USING A LIGHTWEIGHT PORTABLE **AIR/GAS** POWER SUPPLY. The present invention is intended to further improve on the apparatus and methods disclosed therein.

In addition to the aforementioned problems related to portability and mobility of pneumatic tools such as discussed above, such **tools'** reliance on the use of conventional air compressors for providing pneumatic air "**power**" further **compounds** their drawbacks. **In** this regard, known compressors are generally bulky and heavy and exhibit other related drawbacks. More specifically, known air compressors are too large and unwieldy to safely use in many work **environments** (**e.g.**, on a **rooftop** in a construction project). Moreover, known compressors are noisy, complicated in mechanical **structure** and/or expensive to maintain or manufacture, or cannot safely **pressurize** air/gas past certain threshold "**psi's**". Certain other known compressor types **utilize** fossil fuels for power, require the use of oil (for lubrication), **and/or** employ **disposable** filters. In this **regard**,

such known air/gas compressor types are **environmentally unsound** as they either **produce** significant pollution or they rely on **finite** natural resources for **fuel**, or both.

In view of the above, it is apparent that **there** exists a need in the art for methods **and/or** apparatus **and/or** systems which overcome or, at **least**, ameliorate one or more of the above or other **drawbacks**. **It** is a purpose of this invention to fulfill this **need, as well** as other needs in the art which will become apparent to the skilled artisan once given the above disclosure.

SUMMARY OF THE INVENTION

Generally speaking, this invention fulfills the **above-described** needs in the art by providing a portable, **lightweight** system for generating compressed air/gas power **and/or** for **functionally** and **portably** storing such air/gas power for use in portable pneumatic tool operation.

In at least one **embodiment**, this invention provides:

a **system** for manufacturing and providing compressed air/gas to a portable, pneumatic, power supply **system** comprising:

a) a compressor comprising:

a motor operably connected to a flywheel and capable of rotating the flywheel;

a linearly actuated pump having a **first** end and a second **end**, the first end pivotally connected to the flywheel at a pump mount location and the second end **pivotally** connected to a frame member, the pump including a piston which is linearly actuated when the flywheel is caused to rotate;

a counterweight connected to the flywheel at a location on the flywheel generally opposite the pump mount **location**, the counterweight being so located such **that** when the flywheel is caused to rotate, the counterweight imparts a momentum to the flywheel;

the linearly actuated pump **including** an air/gas pump input capable of receiving air/gas at atmospheric pressure and an air/gas pump output capable of **outputting** air/gas which is **pressurized** by the linearly actuated pump when the piston is linearly actuated; and

b) a portable, pneumatic, power supply system comprising:

a portable air/gas reservoir;

a pressure regulator in **air/gas** flow communication with the **portable air/gas** reservoir, the pressure regulator including an air/gas pressure **adjustment** mechanism capable of adjusting pressure of air/gas outflow **therefrom**;

a power supply air/gas outlet including a coupler **mechanism** for connecting the power supply air/gas **outlet** to a pneumatically operable tool; and

wherein the air/gas pressure adjustment mechanism is capable of operating to deliver a plurality of selected air/gas pressures which correspond to pressures useful for operating a plurality of pneumatic tools; and

wherein the compressor is capable of **manufacturing** compressed air/gas for filling the **portable** air/gas reservoir with **compressed** air/gas; and

wherein the air/gas **pump** output is selectively gas-flow **connectable** and disconnectable to and from the portable, pneumatic, power supply system for filling the portable air/gas reservoir with compressed air/gas,

In an alternative **embodiment**, this invention provides:

a system for manufacturing and providing compressed air/gas to a **portable**, pneumatic, power supply system comprising:

a) a compressor comprising:

a motor **operably connected** to a flywheel and capable of rotating the flywheel;

a linearly actuated pump having a first end and a second **end**, the first end pivotally connected to the flywheel at a pump mount location and the second end **pivotally** connected to a frame member, the pump including a piston which is linearly actuated when the flywheel is caused to rotate;

a counterweight connected to the flywheel at a location on the flywheel generally opposite the pump mount location, the counterweight being so located such that when the flywheel is **caused** to rotate, the counterweight **imparts** a momentum to the flywheel;

the linearly actuated **pump** including an **air/gas** pump input for receiving air/gas at atmospheric pressure and an air/gas pump **output** for **outputting** air/gas which is pressurized by the linearly actuated pump when the piston is linearly actuated; and

b) a **portable**, pneumatic, power supply system comprising:

a portable air/gas reservoir containing air/gas **compressed** to a high initial pressure;

a pressure regulator **in** air/gas flow communication with the **portable** air/gas **reservoir**, the pressure regulator including an air/gas pressure adjustment mechanism capable of adjusting pressure of air/gas outflow **therefrom**, the pressure regulator being so connected to the portable air/gas reservoir such that compressed **air/gas** which exits the portable air/gas reservoir is delivered to the pressure regulator;

an interconnect attached to and providing air/gas flow communication between the pressure regulator and an air/gas **outlet**, the interconnect comprising a flexible conduit and the air/gas outlet comprising a quick **connect-disconnect** coupler attached proximal one end of the flexible conduit;

wherein the **air/gas** pressure adjustment **mechanism** is capable of operating to deliver a plurality of selected air/gas pressures which correspond to pressures useful for a plurality of pneumatic end uses;

wherein the pressure regulator **is** capable of receiving said compressed air/gas and thereafter delivering said air/gas to said interconnect at a reduced pressure relative to said high initial pressure as contained in said portable air/gas **reservoir**; and

wherein said pressure regulator is a dual stage regulator and said air/gas flow output pressure is regulated by said pressure **regulator** in a dual stage regulation comprising:

receiving **air/gas** flow at said high initial pressure;

reducing said high initial pressure of said air/gas flow to an intermediate pressure at a first stage;

reducing said intermediate pressure of said air/gas flow to a working pressure at a second stage, said working pressure being selected from within a range of pressures suitable for operating a plurality of pneumatically operable tools; and

wherein said compressor is capable of manufacturing compressed air/gas for filling said portable air/gas reservoir with compressed air/gas; and

wherein said air/gas pump output is selectively gas-flow **connectable** and **disconnectable** to and from said portable, **pneumatic**, power supply system for filling said

portable air/gas reservoir with compressed air/gas.

In certain embodiments, the linearly actuated pump comprises a shell housing and a **linearly** extendable and retractable **piston**, the piston being linearly translatable to effect **a pressurization of** air/gas.

In certain additional embodiments, the flywheel which is **employed**, during operation, has a rotational direction which causes alternating push and pull strokes of the piston and **wherein** the counterweight is connected to the flywheel in such a location generally **opposite** the **pump** mount location such that when the flywheel is rotating to cause a push stroke of the piston, the counterweight is located such that gravity acts on the counterweight in a direction which is generally co-directional with the rotational **direction** of the flywheel; and

when the flywheel is rotating to cause a pull stroke of the piston, the counterweight is located such that gravity acts on the counterweight in a direction which is generally opposite the rotational direction of the flywheel.

In certain preferred embodiments, during a push stroke of the **piston**, the counterweight **assists** in effecting a completion of the push stroke and during a pull stroke of the piston, the counterweight adds resistance to effecting a completion of the **pull** stroke.

In yet additional preferred embodiments, the position and location of counterweight causes the counterweight, during directional motion of the flywheel, to alternately assist and resist push and pull strokes of the piston thereby to effect a generally consistent rotational velocity of the flywheel during compressor operation.

In some embodiments, the system is provided with a linearly actuated pump which includes a coolant fluid path through which a coolant can be transmitted thereby to temperature regulate the linearly actuated pump during operation. In at least one of such embodiments, the coolant **fluid** path is a fluid passageway located internal to the shell housing in proximity to the linearly extendable and retractable piston. In at least one preferred embodiment, the system further includes a coolant reservoir in fluid **communication** with the coolant fluid path and a coolant pump for transmitting coolant from the coolant reservoir and through the coolant fluid path

In at least one embodiment, it is an object to provide a system for powering

pneumatic tools which is lightweight **and/or compact** in configuration **and/or** which has an adjustable output pressure (e.g., so that a wide variety of tool types can be operated).

In at least one preferred embodiment, a system ~~for~~ powering pneumatic tools is provided which is capable ~~of~~ providing continuously variable output pressures (e.g., so that output pressures can be **optimized** for **specific** tool types).

In certain preferred **embodiments**, **output** pressures can be manually adjusted between very low and very high pressures, for example, between 5 psi and 6000 **psi**.

In at least one embodiment, a system is provided which is capable ~~of~~ **portably** powering air **wrenches**, pin **tackers**, micro pinners, brad **nailers**, roof nailers, framing **nailers**, inflation devices (e.g., for tire inflation), drills, **and/or** screwdrivers. In at least one such **embodiment**, such system is provided with a connector which is **universally** functionally **connectable** to all or at least a plurality of tool types.

In at least one embodiment, it is an object to provide a compact **and/or** lightweight **and/or** portable **and/or** mechanically non-complex compressor which ~~is~~ capable of pressuring air/gas. In a preferred embodiment of such a compressor, such compressor is capable of filling an air storage reservoir to pressures selected between 0 and 5000 psi. In an alternative preferred **embodiment**, such compressor is capable of filling an air storage reservoir to pressures selected from between 0 and **10,000** psi or more.

In at least one preferred embodiment, the tool systems **and/or** compressors described herein are capable of increasing work productivity **and/or** reducing labor costs.

This invention will now be described with respect to certain embodiments thereof as illustrated in the following drawings wherein:

IN THE DRAWINGS

FIG. 1 is a **three-dimensional** perspective view of one embodiment of a system **for** manufacturing and providing compressed air/gas to a portable, pneumatic, power supply system according to the subject invention.

FIG. 2 is a three-dimensional perspective view of one embodiment of a portable, pneumatic, power supply system according to the subject invention.

FIG. 3 is a three-dimensional, perspective view of one embodiment of a **compressor** according to the subject invention.

FIG. 4 is an alternative, **three-dimensional**, perspective view of the embodiment

of the compressor illustrated in FIG. 1.

FIG. 5 is a two-dimensional, diagrammatic view of one embodiment of a compressor according to the subject invention.

FIG. 6 is an alternative, two-dimensional, diagrammatic view of the embodiment of the compressor illustrated in FIG. 3.

FIG. 7 is a three-dimensional, perspective view of one embodiment of a compressor according to the subject invention shown housed in a free-standing portable casing and with a separate air/gas **vessel** to be filled by the compressor.

FIG. 8 is a **three-dimensional**, perspective view of one embodiment of a compressor according to the subject invention shown housed in a **free-standing**, portable, wheeled cart.

FIG. 9 is two-dimensional, diagrammatic view of one embodiment of a filtration system according to the subject invention useful in connection with the herein described compressors,

DETAILED DESCRIPTION OF CERTAIN EMBODIMENTS

Definitions

Fluid: The term "fluid" as is used herein in the **specification** and claims is intended to retain its accepted art and/or scientific definition. In this regard, the term "fluid" includes gases within its scope (in addition to **liquids**) and, therefore, a component described as being in fluid communication (or in fluid **connection**), **is**, in some circumstances, in gas-flow communication (or in gas-flow connection).

Air/gas: The term "air/gas" as used herein in the specification and claims is defined as a fluid in a gaseous state having neither independent shape nor volume. As non-limiting examples, the term "air/gas" includes within its scope atmospheric air, purified atmospheric air, purified **nitrogen**, various ratios of mixtures of nitrogen and oxygen and other such fluids in the gaseous state not otherwise specifically described herein,

For a more complete understanding of the present invention and advantages thereof, reference **is** now made to the following description of various illustrative and non-limiting embodiments thereof, taken in conjunction with the accompanying drawings in which like reference numbers indicate like features

Referring **now** initially to Figs. 1-2, an exemplar embodiment of the **compressor** and pneumatic power supply system according to the invention is illustrated therein. Generally speaking, pneumatic power supply **system** 1 (illustrated more clearly in Fig. 2) comprises a vessel 3 for storing **pressurized** air/gas, a regulator 5 for delivering usable air/gas pressures to **an** air/gas **output** (e.g., for operating or powering tools), and an output air/gas pressure adjustment mechanism 7 for allowing system **operators** to manually select desired output pressures (e.g., to tailor the output pressures for specific tool types requiring different operating pressures). Also shown in such figure is a flexible conduit or interconnect (hereinafter "conduit") 9 for connecting or transmitting compressed **air/gas** power from regulator 5 of power supply vessel 3 to a pneumatically operable tool (e.g., via a quick **connect/disconnect** coupler 11) as shown (or for another end use such as for inflating a tire, for **example**).

More specifically, **vessel** 3 is a high **pressure** air/gas reservoir which is configured to contain or store pressurized air/gas at pressures ranging **typically** from approximately zero to 6000 pounds per square inch or "**psi**" (higher capacity vessels are certainly contemplated, however). Attached to the opening in the neck of vessel 3 **is** a uniquely designed regulator 5 (e.g., attached to the **vessel** or bottle by mating screw threads). **Regulator** 5 is provided for accepting the high initial air/gas pressure from vessel 3 and releasing it at a comparatively low working or output air/gas pressure (e.g., typically between 0 and 125 psi). **Although** the reduction of pressure to a working air/gas pressure can occur in a single stage, in some **embodiments**, regulator 5 is **constructed** as a two stage regulator. In such a two stage **embodiment**, in a first **step**, the regulator converts the high initial pressure of stored air/gas in vessel 3 to an intermediate pressure at a first stage **and**, in a second step, converts or releases the air/gas at a further reduced pressure or working pressure at a second stage (e.g., the working pressure being selected from within a range of pressures suitable for operating a plurality of pneumatic **tools**). In preferred embodiments, whether employing a regulator of a single or dual stage type, an output pressure adjustment **mechanism** 7 is provided for tuning the output air/gas pressure to a pressure which is usable by the particular tool type to be used. For **example**, in at least one embodiment, adjustment mechanism 7 comprises a manually operated dial (e.g., displaying visual output pressure indicia) which can be turned or **dialed** to release a

specific **desired** output air/gas **pressure** (e.g., 125 psi for a pneumatic nail gun, or higher **psi's** for an impact wrench or other more demanding **tools**). Moreover, in **certain** preferred **embodiments**, **regulator** 5 includes a fill port 15 via **which** air/gas vessel 3 can be filled/replenished with **pressurized** air/gas.

In order to facilitate convenient or **ergonomic** transmission of working gas pressures from **pneumatic** power **supply** system 1 to pneumatic **tools**, a flexible conduit 9 comprised of a length of high pressure tubing is provided. In preferred **embodiments**, such conduit 9 includes connectors at its opposite ends for connecting to air/gas output port 13 (of regulator 5) and to a pneumatic tool or other device at its opposite **end**, respectively. In preferred embodiments, at least **one** connector of conduit 9 is a universal fit or **quick-connect/disconnect-type** which is **connectable** to a wide range of pneumatic tool types. Alternatively, proprietary **connector-types** may be employed as such connector-types are developed or become well-known and **used** as the use of the herein-described system becomes **more prolific**.

Although various mechanism **and/or methods** for carrying or transporting system 1 are **contemplated**, in certain example embodiments, air/gas supply vessel 3 is carried by **back** or hip mounted systems (e.g., such a carried by shoulder straps or clipped to a belt). Such mechanisms or methods **should** not, of course, be **construed** as limiting the scope of the subject **invention**.

Turning now to Figs. 3-4, an example embodiment of a **unique, portable** air/gas **compressor** **according** to the subject invention is depicted as compressor 101. In this regard, as illustrated, compressor 101 generally comprises a frame 103 **housing** a motor 105 and drive assembly 107 which operates a piston driven pump 113 for compressing air inspired or input into the compressor system (e.g., from the surrounding atmosphere). More specifically, in the embodiment which is **illustrated**, motor 105, when operated, drives a small pulley 109 (e.g., approximately 2 inches in diameter) **which**, in turn, drives flywheel 111 (e.g., **approximately** 10 inches in diameter) which is connected to pulley 109 by a drive belt 115. **Furthermore**, as illustrated in the figure, linearly actuated pump 113 is connected at its first end, via a conventional pivot type connection, to a shaft 117 extending from a lateral surface of flywheel 111 located at a select distance from the center or **rotational** axis of the flywheel (e.g., **here**, where employing a 10 inch diameter

flywheel, shaft 117 is located approximately 3,0 inches from the axis/center thereof). At its second **end**, pump 113 is **connected, also** via pivot type (or rocker type) **connection**, to mount member 119 (e.g., immovably attached to frame 103). Assembled as such, as flywheel 111 is **rotationally** driven (by operation of motor 105 powering drive assembly 107), piston 121 of pump 113 is caused to alternate between generally linear push and pull strokes to effect a **pressurization** of air (i.e., in a compression chamber in pump 113, not shown). More specifically, in a "**pull stroke**", piston 121 is withdrawn from shell housing 123 (of pump 113) upon which air is inspired into the compression cavity of the pump (e.g., at air/gas input 125). Conversely, in a "push stroke", piston 121 is driven into shell housing 123 upon which air is pressurized in the compression cavity and **thereafter** expired via air/gas output 127 (e.g., for subsequent transmission to a filtration system).

Although the embodiment described above employs drive belt trained about a pair of unequally **sized** "pulleys" (i.e., including flywheel 111) as a pump "**drive**" (the size relationship of the pulleys thus being in an approximately 1:5 ratio so that pump 113, at full operational **speed**, operates at or within its approximate optimized parameters i.e., at or below 1350-1400 pump **cycles** per **minute**, and preferably at or below 1380-1385 pump cycles per minute), alternative embodiments by which pump 113 is differently or alternatively driven are, of course, contemplated. In one such envisioned **embodiment**, motor 105 directly drives flywheel 111 without a separate **pulley** or drive belt being employed. In **particular**, such an embodiment is **simpler** in construction and reduces the overall number of working parts (however, due to the potential mechanical advantage **lost**, a larger or more robust motor or different pump type may need be employed).

Through diligent experimentation with various iterations of the above described compressor system, in addition to having evolved a uniquely compact and portable compressor which utilizes a simple construction and few mechanical parts, Applicant has discovered that particularly advantageous compressor performance can be achieved through the use of one or more **structural** variations of a heretofore unknown **flywheel** structure employing a specifically located **and/or** sized counterweight. In this **regard**, in preferred embodiments of the subject invention, a flywheel utilizing such a counterweight 129 is employed in the subject inventive **compressor(s)**.

Specifically, as can be seen most clearly in Figs, 5 and 6, in such preferred (albeit

optional) embodiments, a counterweight **129** (shown in “phantom” or dotted lines) is integrated into flywheel **111** such as by molding, casting, **machining**, or other conventional tooling methods or mechanisms (alternatively, counterweight **129** can be affixed to flywheel **111** as an separately manufactured part). More particularly, in the most efficacious embodiments, counterweight **129** (e.g., a 10.3 oz. counterweight as illustrated, or, more generally, a counterweight **sized** between approximately 6 and **16** oz. or between approximately 10-20 % of the flywheel's mass) is located **directly** opposite the flywheel mount location of pump **113** i.e., opposite shaft **117** on the other or opposite side of rotational axis "a" of the flywheel,

Still more specifically, counterweight **129** is located as described so that it provides a counterbalance to the force or resistance imparted by pump **113** on the flywheel as push and pull strokes of pump **113** are effected by the directional rotation of the flywheel (thought of differently, counterweight **129**, in **part**, adds momentum to the flywheel to propel its rotation against the resistance of a push stroke of piston **121** into pump **113**). In this regard, during a push stroke of piston **121**, as the piston is being driven into the compression cavity to compress air/gas, the resistance of the air/gas being compressed impedes the stroke of the piston and thus the rotation of flywheel **111** (thus tending to decrease the rotational speed of the flywheel). Conversely, during a pull stroke of piston **121**, the lack of air compression related **resistance** results in a piston stroke which is relatively unimpeded. **As** a result, as compared to during a push stroke, the rotational speed of flywheel **111** tends to increase. **Nonetheless**, alternating changes in rotational velocity of the flywheel are generally not desired and contribute to rapid part wear and mechanical breakdown and thus limit the upper operational speed of the pump (and thus the upper limit **pressurization** capabilities of the compressor).

Therefore, by locating counterweight **129** as shown in Figs. 5 and 6 (e.g., relative to the mounting location of pump **113**), during a push stroke, counterweight **129** is located such that gravity acts on the counterweight in a direction which is generally co-directional with the rotational direction of the flywheel (i.e., clockwise as shown in the figure). In this **manner**, the gravitational force on the counterweight aids in completion of the push stroke thereby **minimizing** or eliminating any decrease in rotational velocity which would otherwise occur. Conversely, during a pull stroke (the end of which is

illustrated in Fig. 6), counterweight 129 is located so that gravity acts on the counterweight in a direction which is generally opposite the rotational direction of the flywheel. In sum, the position and location of counterweight 129 causes the **counterweight**, during directional motion of flywheel 111, to alternately assist and resist push and **pull** strokes of the piston thereby to effect a generally consistent rotational velocity of flywheel 111 during compressor 101 operation. In such manner, the aforementioned drawbacks related to mechanical reliability **and/or** upper **limit** operational speeds are **substantially** eliminated or at least ameliorated. As a result, at least one prototype of a compressor such as described herein has produced end pressures as high as approximately 5000 psi (and still higher pressures, **e.g.**, above 6000 psi, **or, possibly**, even above 10,000 psi, are expected to be achieved through further optimization and/or **experimentation**).

Although, as described herein, the use of a **counterweight**, such as 129, offers or enables distinct and significant advantages to compressor performance or operation, alternative embodiments by which similar advantages are achieved are contemplated. For **example**, instead of using a counterweight on flywheel 111, a flywheel with increased mass as compared to a conventional flywheel could be utilized. In such manner, the increased momentum achieved by the use of a high mass flywheel should, in **theory**, substantially overcome the resistance of piston 121 as it compresses the air/gas (moreover, the lack of resistance **during** a "pull stroke" would not be **comparatively** sufficient, relative to the high mass flywheel, to impart **significant** increased rotational velocity). In **sum**, such a sufficiently massed flywheel should not experience **significant/detrimental** changes in velocity due to resistance and **non-resistance** of piston 121 during push and pull strokes, respectively.

In addition to the above described advantages, certain embodiments of compressor 101 employ filtration systems comprising one or more filter types such as for drying and/or cleaning air/gas (or, in certain embodiments employing so-called molecular **sieves**, isolating one gas molecule type from another). Referring now again to Figs. 3-6, and most particularly to Fig. 9, one **embodiment** of such a filtration system is illustrated therein.

As is detailed **most** clearly in Fig. 9, filtration system 135 generally comprises a

filter column constructed from a combination of a **desiccant** filter 137 and a **coalescent filter** 139. More specifically, desiccant filter 137 is in fluid communication (i.e., gas-flow communication) with air/gas pump output 127 via a valve 144 connected to air/gas pump output line 128 (e.g., conventional high pressure **tubing**). Moreover, coalescent filter 139 is connected physically and fluidly (**i.e.**, in gas-flow communication) in series with desiccant filter 137. Coalescent filter 139, in turn, is physically and fluidly connected to one end of **air/gas** output line 141 **which** is connected at its other end to manifold 147 (which includes a fill port 151 for connecting to and filling/pressurizing an **air/gas** vessel 3).

In exemplar embodiments of filtration system 135, the entire filter system is generally hermetically **sealed** but permits air/gas flow through its connections to line 128 and **line 141** and selectively via vent port 145 as desired (as will be described in the text which **follows**). Thus, when compressor 101 is operated to manufacture **pressurized** air/gas, such air/gas is flowed through both desiccant filter 137 and coalescent 139 at generally full system pressures. In such manner, condensation (**e.g.**, water condensation) **and/or particulate** matter is filtered from the **air/gas** flowed through the filter system (e.g., thus **resulting** in clean, dry **air/** gas).

In an example operation to fill an air/gas vessel, **then**, a vessel 3 is first connected to fill port 151 via a conventional or proprietary valve type connection (e.g., at fill port 15, see Fig. 1). **Then**, compressor 101 is powered on (**e.g.**, by operation of **on/off** switch 131) and air/gas is inspired and **compressed** as compressor 101's systems operate pump 113 as described above. As compressor 101 compresses or pressurizes inspired air/gas, the compressed air/gas flows **from** pump 113 through air/gas outlet 127. Then, in embodiments of the compressor which employ filtration system 135, the compressed or pressurized air/gas is caused to first flow through desiccant filter 137 which removes moisture from the compressed **air/gas**, and, afterwards, through coalescent filter 139 which removes certain types of **particulates**.

In certain particularly preferred **embodiments**, compressor 101 additionally includes an **auto-shut-off** switch (not shown) which functions to shut down compressor 101 upon detection of a pre-selected pressurization or fill pressure. During a fill operation in embodiments which employ such **auto-shut off** features, then, **as** compressed air/gas

fills vessel 3, pressure gauge 143 (see Fig. 4) monitors the pressure of the air/gas being provided and automatically turns off compressor 101 (e.g., by switch relay) once the desired air/gas pressure is reached (e.g., which has **been pre-selected** by a compressor operator utilizing a pressure selection switch or dial, not illustrated). In this way, compressor 101 is **able** to automatically provide desired fill pressures (e.g., commensurate with storage **and/or** safety limits of particular air/gas storage vessels) without requiring that a pressure gauge be actively or **constantly** monitored. Non-automated embodiments, nonetheless, are certainly contemplated.

In certain preferred embodiments, after a desired fill pressure is achieved, compressor 101 is shut down either automatically as described immediately above, or manually by operation of switch 131. **Thereafter**, before disconnecting vessel 3 from fill port 151, **vent** port 145 (e.g., operated by thumbscrew or similar mechanical mechanism) is opened and residual pressurized air/gas purges from the vent port and simultaneously causes the **desiccant** and **coalescent filters** to purge **collected/filtered** condensation and **particulate** matter, respectively.

In still further alternative embodiments, it has been **determined** through certain additional innovation and experimentation, that employing a cooling system to cool pump 113 during compressor operation substantially improves the performance of compressors such as those described herein principally by reducing wear rates of internal pump parts. Thus, as an optional feature in certain compressors such as illustrated as preferred embodiments in Figs. 3-6, a coolant system 201 for cooling pump 113 during operation is provided.

As illustrated in various views in Figs. 3-6, coolant system 201 generally includes a coolant reservoir 205 storing a liquid or gaseous coolant of conventional composition (e.g., an “**anti-freeze**” type liquid), a pump 203 (e.g., a conventional water pump) for pumping coolant from the reservoir and through the coolant system, and a radiator 215 for removing **absorbed/adsorbed** heat from the coolant **fluid/gas** prior to returning the coolant to coolant reservoir 205 by **return** path 213.

More specifically, and in example operation of system 201 during compressor operation, as pump 203 is **actuated**, coolant fluid (or gas) is first drawn from reservoir 205 into and through internal conduits of pump 203 and then, afterwards, flowed into

pump 113 via coolant ingress line 207. As coolant enters pump 113, it circulates within shell housing 123 along the length of and proximal piston 121 (e.g., via a conduit **circumferentially** surrounding piston 121) thereby **absorbing/adsorbing** heat generated by the piston during pump 113 operation. After **circulating** within the internal components of pump 113, the coolant is then caused to exit or flow from pump 113 (by continued operation of pump 203) via coolant egress line 211 whereby it is transmitted to radiator 215 (e.g., **ofconventional** radiator construction). After passing through radiator 215 where heat "carried" by the coolant is **substantially** removed or reduced (e.g., actively or **passively**), the coolant is returned to **reservoir** 205 via coolant return path 213 (e.g., for **recirculation** through the coolant system). Alternative methods and mechanisms for cooling pump 113 during operation are, of course, envisioned.

Compressor 101 is believed to be particularly advantageous when used in combination with portable pneumatic power systems such as described herein (or as described in my United States Patent No. 6,932,128), i.e., because when used with such described systems, the combined compressor/power supply system far surpasses conventional **direct-compressor-driven** pneumatic tool systems known in the art. **Nevertheless**, compressor 101 is capable of producing clean, dry compressed air/gas for many other end uses. Moreover, compressors such as described herein exhibit significant performance improvements over known compressors, **In this regard**, compressor 101 is capable of filling large air/gas supply vessels with high air/gas pressures all the while having a heretofore unknown compact and simple structural design. **In particular**, compressor 101's compact and lightweight structure allows it to be uniquely portable for a compressor with such high performance compression capabilities. Furthermore, certain embodiments of compressor 101, relative to known compressors, are remarkably simply in structural design. **In this regard**, in preferred embodiments, compressor 101 utilizes a single drive belt 115 to minimize maintenance and extend longevity, does not require the changing and discarding of oil, does not require gas, oil, or filters, **and/or** generally uses no **parts** which are vulnerable to rusting or degradation, Certain additional embodiments (**alternatively**, or in combination with the **immediately** previously described improvements), exhibit low operational noise levels (typically about 55 dBA or less), are virtually maintenance-free, operate on standard **power/electrical** sources (e.g., **110-volt**

electrical power), do not emit toxic fumes or exhaust, ~~and/or~~ are self-cleaning (e.g., because moisture and dust **particles** are purged from the system at the conclusion of each use such as described above).

Once given the **above**, non-limiting **disclosure**, many other features, modifications, and improvements will become apparent to the skilled artisan. Such other features, modifications, and **improvements** are therefore considered to be part of this **invention**, the scope of which is to be determined by the following claims: