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[54] **GAS SUPPLY SYSTEM**

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[51] **Int. Cl.** **F17d 1/02**

[58] **Field of Search** 137/256, 608, 612.1, 119, 137/118, 169, 110, 170, 266, 263, 627, 568, 121; 222/6

[56] **References Cited**

UNITED STATES PATENTS

3,285,272	11/1966	Messenger	137/256
3,524,444	8/1970	Ellard	137/256 X
3,719,196	3/1973	McJones	137/256

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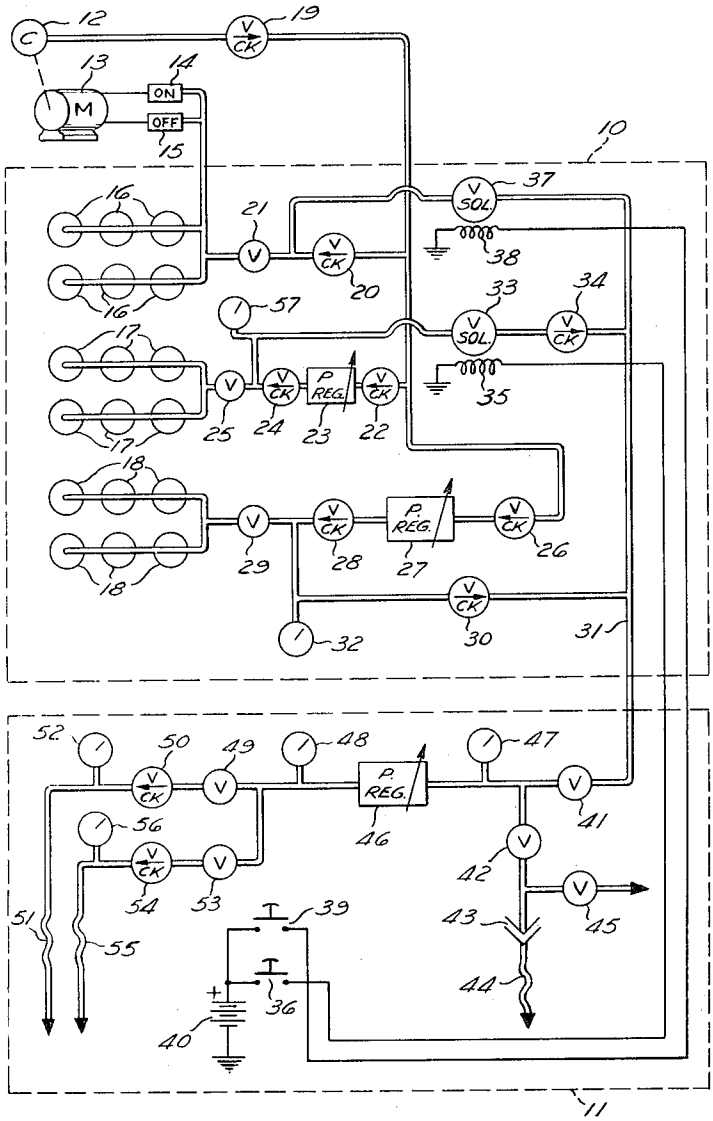
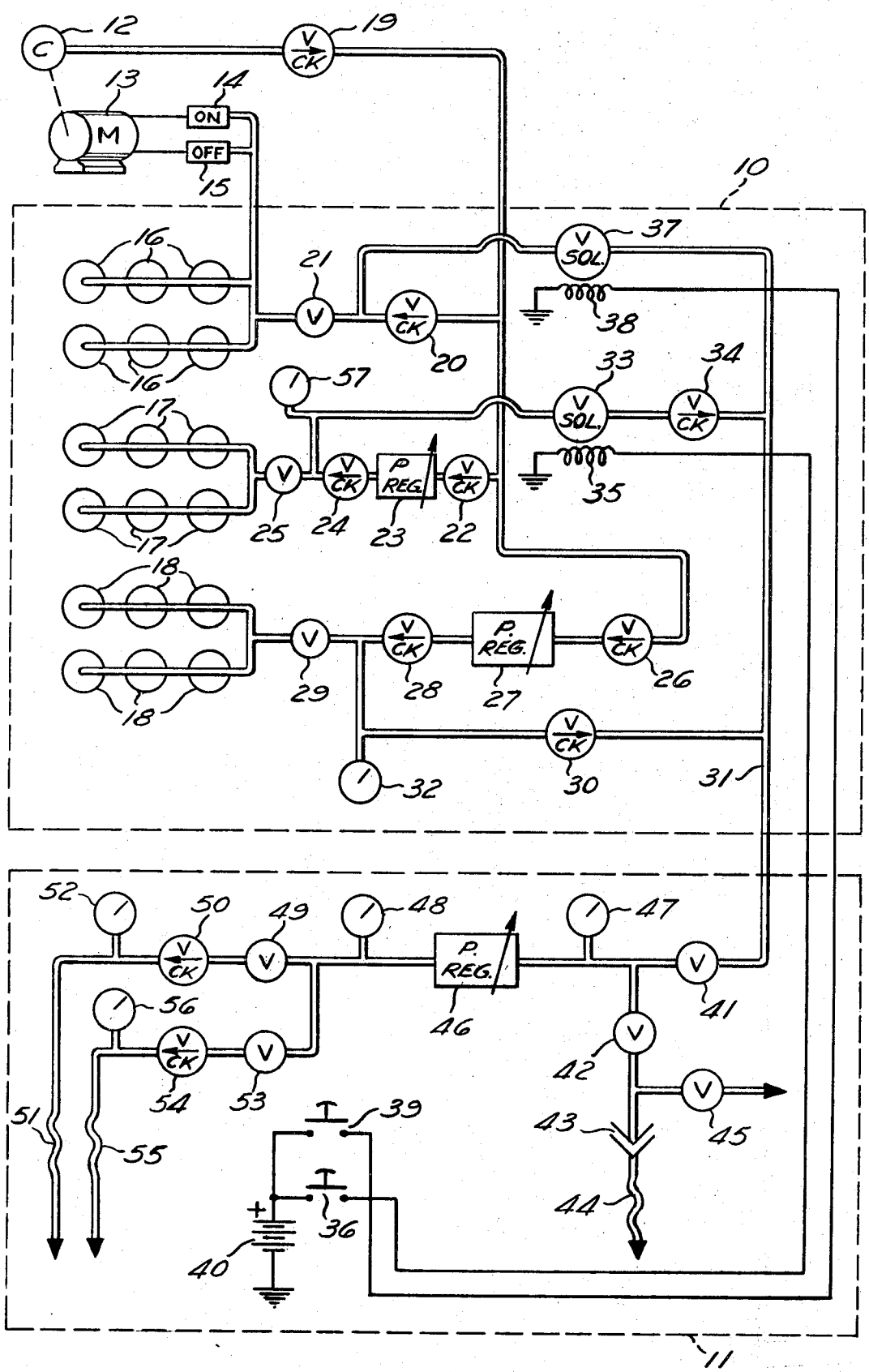
[57] **ABSTRACT**

A system for supplying gas, such as compressed air, from large capacity banks of storage containers having different pressure capacities. The gas is withdrawn first from the lowest pressure storage bank and only if necessary from a higher pressure bank. The storage banks are refilled automatically as necessary to bring the pressure of each up to rated capacity.

10 Claims, 1 Drawing Figure

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GAS SUPPLY SYSTEM

This invention relates to a system for supplying gas, such as compressed air, oxygen or natural gas, from relatively large capacity storage containers to smaller tanks.

A principal object of this invention is to provide a novel and improved gas supply system which is essentially automatic and therefore less subject to human error in its operation.

Another object of this invention is to provide a novel and improved gas supply system whose efficiency is enhanced by filling a tank first from lower pressure storage containers and then "topping off" from higher pressure containers, if necessary.

Another object of this invention is to provide a novel gas supply system of improved safety in which different capacity storage containers have their individual inputs pressure-regulated automatically and without the necessity of human supervision.

Further objects and advantages of this invention will be apparent from the following detailed description of a presently-preferred embodiment thereof, which is illustrated schematically in the single FIGURE of the accompanying drawing.

The single FIGURE of the drawing shows schemtically a system in accordance with the present invention for pressurizing different banks of containers with compressed air in a predetermined sequence, and for withdrawing compressed air from the container banks in the same sequence.

Referring to the drawing, the dashed line enclosure **10** contains the storage portion of the present system, and the dashed line enclosure **11** contains the utilization portion of the system. In this embodiment, the pressurized gas in the system is compressed air, supplied by an air compressor **12** driven by an electric motor **13** whose energization is controlled by "on" and "off" pressure switchs **14** and **15**, respectively.

Three banks of relatively large capacity storage containers are shown in the storage portion **10** of the system: a first bank of storage containers **16** having a maximum pressure of 3,600 pounds per squre inch; a second bank of storage containers **17** having a maximum pressure of 3,000 psi; and a third bank of storage containers **18** having a maximum pressure of 2,000 psi. It is to be understood that the number of banks of storage containers and their maximum pressures may differ from the particular example given.

The high pressure storage bank **16** is connected to the output of the air compressor **12** through two series-connected check valves **19** and **20** and a manual shut-off valve **21.** The check valve **20** and the shut-off valve **21** are individual to the high pressure bank of storage containers **16.** The check valve **19** is common to all three banks of storage containers **16, 17** and **18.**

The intermediate pressure bank **17** receives pressurized air from the air compressor **12** through check valves **19** and **22,** a manually adjustable pressure regulator **23,** check valve **24,** and a manual shut-off valve **25.** All of these are individual to the intermediate pressure bank, except the check valve **19.**

The lowest pressure bank of storage containers **18** receives pressurized air from the air compressor through check valve **19** and, in series, a check valve **26,** a manually adjustable pressure regulator **27,** a check valve **28,** and a shut-off valve **29,** all individual to this low pressure bank.

The "on" and "off" switches **14** and **15** for the compressor motor **13** are both pressure-operated switches that are connected to sense the air pressure in the high pressure storage bank **16.** Together they operate to keep the air compressor **12** on whenever the air pressure in the high pressure storage bamk **16** is below a predetermined value, and to turn off the compressor when the air pressure here reaches this value.

The three banks of storage containers **16, 17** and **18** are filled automatically from the air compressor **12** as follows:

In practice, the bank of storage containers **18** will have the lowest air pressure and these will be filled first, via check valve **26,** pressure regulator **27,** check valve **28,** and shut-off valve **29.**

When the air pressure in the containers **18** reaches the air pressure in the bank which is at the next higher pressure, then both banks of containers will be filled simultaneously. For example, the intermediate pressure containers **17** usually will be at this next higher pressure, and these containers will be filled now via check valve **22,** pressure regulator **23,** check valve **24** and shut-off valve **25** while the container bank **18** is continued to be filled.

When the pressure in both banks of containers **17** and **18** reaches the pressure in the high pressure bank **16,** all three banks of containers will be filled simultaneously.

Whenever the air pressure in the lower pressure bank **18** reaches the cut-off value determined by the setting of its pressure regulator **27,** the latter will close and thereby stop the filling of this container bank. The remaining container banks **17** and **16** will continue being pressurized simultaneously until the pressure in the container bank **17** reaches the cut-off value for which its pressure regulator **23** is set to close. Following this, the air compressor **12** continues to pressurize the container bank **16** until the maximum pressure for this bank is reached, at which time the cut-off switch **15** will turn off the compressor motor.

It is to be understood that there may be in the system any desired number of different banks of storage containers with different maximum pressures, as determined by individual pressure regulators.

The output from the lowest pressure storage container bank **18** is connected to the utilization portion of the system through the shut-off valve **29** and a check valve **30** leading to an output line **31.** A pressure gauge **32** senses the air pressure in the container bank **18.**

The output from the intermediate pressure storage container bank **17** is connected to the same output line **31** through the shut-off valve **25,** a solenoid valve **33** and a check valve **34.** The solenoid valve **33** is normally closed, and it is opened in response to the energization of its solenoid coil **35** by the closing of a manual switch **36** in the utilization portion **11** of the system. A pressure gauge **57** senses the air pressure in the container bank **17.**

The output from the highest pressure storage container bank **16** is connected to the output line **31** through the shut-off valve **21** and a normally closed solenoid valve **37,** which is opened in response to the energization of its solenoid coil **38** by the closing of a manual switch **39** in the utilization portion **11** of the system.

Both solenoid switches **36** and **39** are shown connected between the respective solenoid and a battery **40.** However, it is to be understood that any appropriate power source for the solenoids may be provided, as desired.

In the utilization portion of the system, the line **31** is connected through a shut-off valve **41** and a remote fill shut-off valve **42** to a quick-disconnect fitting **43** to which a fill hose **44** may be connected. The air pressure in hose **44** is unregulated. This hose may be connected to a remotely located utilization device, such as an air tank. A vent valve **45** is connected to the unregulated air line ahead of the quick-disconnect fitting **43** for venting this line to the atmosphere, when desired.

The output line **31** from the storage portion **10** of the system is connected through the shut-off valve **41** to a pressure regulator **46.** Air pressure gauges **47** and **48** are provided at the inlet and outlet sides of this pressure regulator. The outlet of the pressure regulator **46** is connected through a hose shut-off valve **49** and a check valve **50** to a fill hose **51,** which may be detachably connected to a tank to be filled. An air pressure gauge **52** reads the pressure in hose **51.**

The outlet of the pressure regulator **46** also is connected through a hose shut-off valve **53** and a check valve **54** to another fill hose **55,** which may be detachably connected to a second tank to be filled. An air pressure gauge **56** reads the air pressure in hose **55.**

Any additional number of fill hoses may be connected to the outlet of the pressure regulator **46** through similar individual shut-off valves and check valves.

The pressure regulator **46** is manually adjustable to limit the air pressure that may be applied to the fill hoses **51, 55.**

Operation

A tank to be filled is connected to a fill hose, **51,** for example, and the corresponding hose shut-off valve **49** is opened manually. Initially, the storage container bank **18** that is at the lowest pressure is connected to the fill hose **51** via shut-off valve **29,** check valve **30,** line **31,** shut-off valve **41,** pressure regulator **46,** hose shut-off valve **49,** and check valve **50.** The air pressure in the tank being filled is read at the pressure gauge **52.**

If the pressure in the storage container bank **18** is insufficient to fill the tank at the fill hose **51** to the desired final pressure, then the operator manually closes the solenoid switch **36,** thereby energizing the solenoid coil **35** and connecting the intermediate pressure storage container bank **17** to the fill hose **51** via the shut-off valve **25,** the now-open solenoid valve **33,** check valve **34,** line **31,** shut-off valve **41,** pressure regulator **46,** shut-off valve **49** and check valve **50.** In this manner, the intermediate pressure storage container bank **17** may be used to "top off" the tank that is being filled (i.e., to bring it up to the desired final pressure).

However, if the pressure in the intermediate pressure bank of storage containers **17** is insufficient to bring the tank being filled up to the desired final pressure, then the operator opens switch **36** and closes switch **39,** thereby energizing solenoid coil **38** and connecting the high pressure bank of storage containers **16** to the fill hose **51** via the shut-off valve **21,** the now-open solenoid valve **37,** line **31,** shut-off valve **41,** pressure regulator **46,** hose shut-off valve **49** and check valve **50.** In this manner, the high pressure storage container bank **16** may be used to "top off" the tank being filled, when necessary.

It is to be understood that the successively higher pressure storage container banks **17** and **16** are used only when necessary to bring the tank being filled up to the desired final pressure. The initial filling is from the lowest pressure bank of storage containers **18,** and in some cases the pressure here will be enough to bring the tank being filled up to the desired final pressure without the necessity of drawing any pressurized air from the higher pressure storage container banks. In this manner, the most efficient use is made of the banks of storage containers, with their different pressure capacities. Also, the lower pressure storage containers **18,** which provide the intial filling, need not be as heavily constructed and expensive as the higher pressure storage containers used for "topping off."

It is to be understood that two or more tanks may be filled at one time through the respective fill hose in the utilization portion of the system.

The refilling of the storage banks **16, 17** and **18** takes place whenever the pressure in the highest pressure bank **16** drops to a predetermined level effective to cause the "on" pressure switch **14** to turn on the motor for the air compressor **12.** This may happen while one or more tanks are being filled at the fill hoses **51, 55.**

When the air compressor is turned on, the banks of storage containers **16, 17** and **18** are re-filled as described in detail hereinbefore, with the lowest pressure bank being filled first.

If desired, a pressure relief valve (not shown) may be connected in each storage container bank to vent excess pressure to the atmosphere in case of a malfunction of the corresponding pressure regulator or a check valve or the compressor cut-off switch **15.**

The various check valves in the system prevent any undersired backflow among its different components.

It is to be understood that the invention is susceptible of embodiments differing from the particular arrangement disclosed. For example, the source of pressurized gas may be high pressure storage vessels instead of the air compressor shown. Also, if desired, certain of the banks of storage containers may be connected to have the same maximum gas pressure, instead of each having a different maximum pressure.

I claim:

1. In a gas supply system comprising:

a plurality of banks of storage containers;

and regulator means operatively associated individually with banks of said storage containers for limiting the respective gas pressures therein to different predetermined values;

the improvement which comprises:

means for connecting a pressurized gas source to said plurality of banks of storage containers to first add pressurized gas to the bank which is at the lowest pressure until its pressure becomes substantially equal to that of the next higher pressure bank, and thereafter in succession to each successively higher pressure bank simultaneously with said lowest pressure bank until each bank being filled reaches the gas pressure limit determined by its individual regulator means;

said gas supply system also comprising:

means for withdrawing pressurized gas first from the bank of storage containers which is at the lowest pressure;

and means operable thereafter for withdrawing pressurized gas from the higher pressure banks of storage containers in succession.

2. A gas supply system according to claim **1,** wherein said last-mentioned means comprises a respective normally closed, electrically operated valve connected to each higher pressure bank of storage containers, and a switch for opening said valve.

3. A gas supply system according to claim **1,** and further comprising check valve means connected to said banks of storage containers to:

a. pass pressurized gas from said source to said banks of storage containers; and

b. block return flow from the respective banks of storage containers to said source; and

c. block gas flow from any of said banks of storage containers to another bank.

4. A gas supply system according to claim **3,** wherein said means for withdrawing pressurized gas from each higher pressure bank of storage containers comprises a normally closed solenoid valve connected between the respective bank of storage containers and said check valve means, and a switch for opening said solenoid valve.

5. In a gas supply system comprising:

a plurality of banks of storage containers;

a pressurized gas source;

and individual regulator means for the banks of storage containers operatively connected individually to the latter to limit the gas pressure therein to different predetermined values;

the improvement which comprises:

means for connecting said source to said plurality of banks of storage containers to first add pressurized gas from said source to the bank which is at the lowest pressure and thereafter in succession to each successively higher pressure bank simultaneously with said lowest pressure bank until each bank being filled reaches the pressure limit set by its individual regulator means;

and check valve means operatively connected to each bank of storage containers to pass pressurized gas thereto from said source and to block return flow from the respective bank to said source and to block gas flow from any bank of storage containers to another bank;

said gas supply system also comprising:

means for filling a tank with pressurized gas first from the bank of storage containers which is at the lowest pressure and thereafter from one or more higher pressure banks of storage containers in succession when the gas pressure in said lowest pressure bank is insufficient to fill the tank to the desired pressure.

6. A gas supply system according to claim **5,** wherein said source is an air compressor, and the individual regulator means for the highest pressure bank of storage containers is a pressure switch operatively associated with said highest pressure bank and with said compressor to turn off said compressor when the gas pressure in said highest pressure bank reaches a predetermined value.

7. A gas supply system according to claim **5,** wherein said means for filling the tank comprises a fill hose, a check valve connected to said fill hose to pass pressurized gas thereto and block return flow from the fill hose, a pressure regulator connected between said banks of storage containers and said last-mentioned check valve, and a pressure gauge for sensing the gas pressure in said fill hose.

8. In a gas supply system:

different banks of individually pressure-regulated storage containers for storing gas at different pressures;

and means for connecting a pressurized gas source to said banks of storage containers to first add pressurized gas to the bank which is at the lowest pressure until its pressure is substantially equal to that of the next higher pressure bank, and thereafter to add pressurized gas to successively higher pressure banks simultaneously until each bank reaches a predetermined pressure.

9. A system according to claim **8,** and further comprising check valve means connected to said banks of storage containers to

a. pass pressurized gas from said source to said banks of storage containers; and

b. block return flow from the respective banks of storage containers to said source; and

c. block gas flow from any of said banks of storage containers to another bank.

10. In a gas supply system comrising:

a plurality of banks of storage containers which store gas at different pressures and which are all connected to a common outlet;

and means for withdrawing pressurized gas through said outlet first from the bank of storage containers which is at the lowest pressure and thereafter from a higher pressure bank of storage containers;

the improvement wherein:

said means for withdrawing pressurized gas comprises a respective normally closed, electrically operated valve connected between each higher pressure bank of storage containers and said outlet, and a switch for opening said electrically operated valve.

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