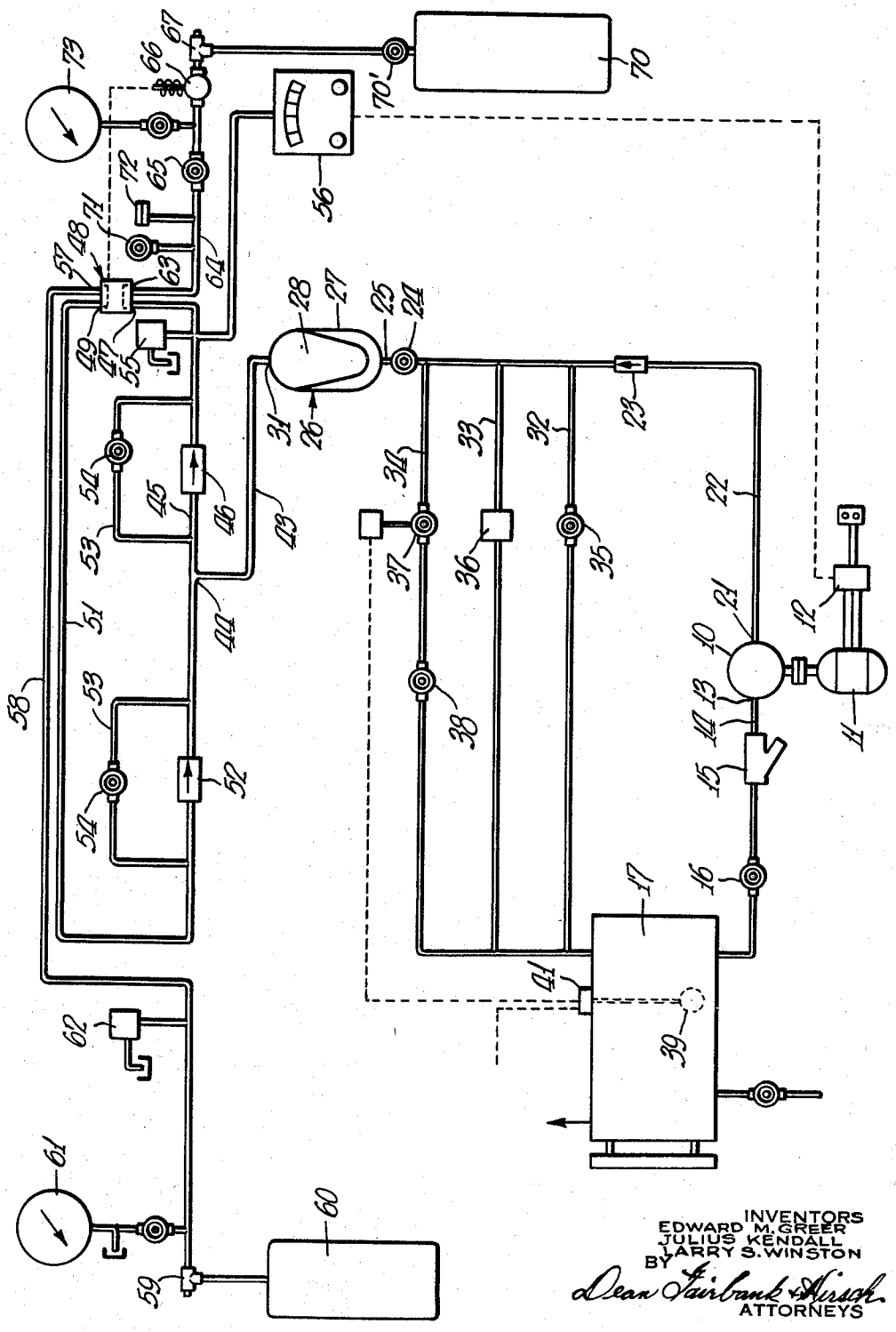
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GAS PRESSURE BOOSTER SYSTEM

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GAS PRESSURE BOOSTER SYSTEM

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This invention relates to the art of pressure booster systems, more particularly of the type for providing gas under relatively high pressure.

As conducive to an understanding of the invention, it is noted that certain equipment such as guided missiles, for example, requires very high pressure gas sources of large capacity, the highly compressed gases providing fuel as well as power for certain control elements.

Where high pressure units such as positive displacement piston-type pumps are used to compress the gas and where such equipment must be lubricated with oil, for example, the end product of compression requires elaborate drying and filtering to remove the contaminating oil. This operation is both difficult and costly at high pressures, say in the range of 6,000 p.s.i. Furthermore, compressors of capacity to supply large quantities of gas at 6,000 p.s.i., are extremely costly and in addition, since abundant lubrication cannot be used, costly overhaul of the compressors are required at frequent intervals.

Where the highly compressed gas is used as a fuel, i.e., oxygen, for example, if any oil should mix with such gas, due to the heat generated by compression of the gas, an explosion might occur with resultant destruction of equipment and possibility of injury.

It is accordingly among the objects of the invention to provide a relatively low cost gas pressure booster system that will supply large quantities of gas under high pressure, that is relatively simple in construction having a minimum number of mechanical moving parts and that is not likely to become out of order, that utilizes a relatively inexpensive pump that may be completely lubricated without possibility of the gas being compressed in the system becoming contaminated with such lubricant and which in the remote event of contamination of such gas will immediately cut off flow thereof prior to its entry into the chamber being charged.

According to the invention, a fluid transfer unit is provided having a movable partition between its oil and gas ports to prevent mixture of the fluids therein. The gas port is connected through a one-way valve to a gas supply and also through a second one-way valve to the chamber to be charged.

The gas from the supply and from the fluid transfer unit are compared by a suitable photo comparator unit which, in the event of contamination of the gas from the fluid transfer unit, will immediately close a valve in the line from the gas port to the chamber to be charged.

The liquid port is connected to a source of liquid under pressure including a reservoir and a pump and also through a normally closed valve back to said reservoir.

The normally closed valve is controlled by a switch having associated actuating means controlled by the level of the liquid in the reservoir so that the equipment will cycle successively to increase the pressure of the gas supplied to the chamber to be charged.

In the accompanying drawing in which is shown one of many possible embodiments of the several features of the invention, the single figure is a circuit diagram of the gas booster system.

Referring now to the drawings, the system comprises a high pressure hydraulic pump **10** which may be driven by a suitable electric motor **11** controlled by a starter **12**. The inlet port **13** of pump **11** is connected by line **14** through strainer **15** and manually operated valve **16** to a reservoir **17**. The outlet port **21** of pump **11** is connected by line **22** through one-way valve **23** and manually operated valve **24** to the liquid port **25** of a fluid transfer unit **26**. The fluid transfer unit **26** is desirably of the type put out by Greer Hydraulic, Inc. of New York and has a rigid shell or container **27** with a deformable partition or bladder **28** interposed between liquid port **25** and gas port **31**.

The portion of line **22** between one-way valve **23** and valve **24** is connected by lines **32**, **33** and **34** to the reservoir **17**. The line **32** has a manually operated valve **35**, the line **33** has a pressure operated relief valve **36** and the line **34** has in series a solenoid operated valve **37** and a manually operated valve **38**.

The valve **37** is electrically controlled by a suitable fluid height responsive float member **39** in the reservoir **17** which controls a float switch **41** so that the valve **37** will open and close based upon the quantity of fluid in reservoir **17**.

The gas port **31** of the fluid transfer unit **26**, is connected by line **43** to junction **44** which is connected by line **45** through one-way valve **46** to the port **47** of a photo compartor unit **48** of conventional type. The port **49** of unit **48** is connected by line **51** through one-way valve **52** to junction **44**. Each of the one-way valves **46** and **52** has a shunt line **53** with a manually operated valve **54**. A relief valve **55** is connected to line **45** as is a pressure controller **56** electrically connected to starter **12** and which may be set to control motor **12** at desired pressures.

The port **57** of the photo comparator unit **48** is connected by line **58** to the main gas inlet **59**, to which a cylinder **60** containing gas under pressure may be connected, a gauge **61** and a relief valve **62** being connected to line **58**. The port **63** of the photo comparator unit **48** is connected by line **64** through manually operated valve **65** and solenoid operated valve **66** to the gas outlet **67** to which the chamber **70** to be charged may be connected. The valve **66** is electrically controlled by the photo comparator unit **48** in the manner to be described. Desirably a manually operated valve **71**, a blow out disc **72** and a pressure gauge **73** are connected to line **64**.

To operate the unit, cylinder **60** charged with gas under pressure of say 3,000 p.s.i. is connected to gas inlet **59**. This gas will flow through line **58** into port **57** of photo comparator unit **48** and through port **49** thereof, which is internally connected to port **57**, through line **51**, one-way valve **52** to junction **44**. From junction **44** the gas will flow through line **43** into the gas port **31** of the fluid transfer unit **26** to cause the bladder **27** therein to expand and to charge with gas under such pressure of 3,000 p.s.i.

The valve **65** is then opened and gas will flow from junction **44**, through line **45**, one-way valve **46**, ports **47** and **63** of the photo comparator unit **48**, which are internally connected, line **64**, valve **65** and normally open solenoid valve **66**, through gas inlet **67** to charge chamber **70**.

Such gas will flow both from the supply cylinder **60** and the fluid transfer unit **26** and the gas in such system will stabilize at a pressure slightly less than that in the supply cylinder **60**.

At this time the motor **12** is energized and oil will be drawn from reservoir **17** and forced under pressure greater than that of the gas in cylinder **60**, through line **22**,

one-way valve 23 and open valve 24 into oil port 25 of the fluid transfer unit 26. As a result of such flow of oil the bladder 28 will be deformed compressing the gas therein and by reason of the one-way valve 52, which will restrain flow back into the supply cylinder 60, such gas will flow through one-way valve 46, ports 47, 63 of photo comparator unit 48, line 64, through valve 66 and outlet 67 into the chamber 70 to be charged, increasing the pressure therein.

When a predetermined quantity of oil has been forced into the fluid transfer unit 26, say 80 percent of its capacity to prevent injury to the bladder therein, as the level of the oil in reservoir 17 will drop, the float 39 will at such time actuate switch 41 to cause solenoid operated valve 37 to be actuated.

Opening of valve 37 will permit the oil from fluid transfer unit 26 to flow back to reservoir 17 and the bladder 28 to expand. By reason of the one-way valve 46, none of the gas from the chamber 70 will flow back into the charging system and the bladder 28 will again be charged with gas from cylinder 60.

Flow of oil from the fluid transfer unit 26 to the reservoir will cause the level of the liquid therein to again rise until the float 39 actuates switch 41 to energize solenoid operated valve 37 for closure thereof. When this occurs, the pump, which is continuously operating, will again force oil under pressure from reservoir 17 into the fluid transfer unit 26 to compress the gas in bladder 28 which now is again at substantially the same pressure as the gas in cylinder 60.

As oil is forced into fluid transfer unit 26, the gas in bladder 28 will again be compressed. As one-way valve 52 prevents flow of gas from unit 26 back to the cylinder 60, the gas from unit 26 can only flow toward outlet 67 and it will not flow until it has been compressed to an amount greater than that in the chamber 70.

Thus, with each repeated cycle of operation the pressure of the gas in the chamber 70 will rise and when it has reached a predetermined presure determined by the setting of controller unit 56, the starter 12 will be energized to shut off the motor 11 to stop the charging cycle.

At this time valve 65 can be closed as can a valve 70' connected directly to the chamber 70 and such chamber disconnected from outlet 67.

As the temperature of the gas is fairly high due to the high pressure involved, it is essential as a safety feature in the event of rupture of the bladder 28, to prevent mixture of the oil from the hydraulic portion of the system with the gas in the chamber 70 as an explosion might occur. This is accomplished by the photo comparator unit 48 and its associated solenoid operated valve 66. The photo comparator unit 48 by means of a photo cell, compares the gas flow from the chamber 60 with the gas flow from the fluid transfer unit 26. The supply gas flow is considered as a reference since this gas has been dried and filtered before delivery through line 58 to the port 57 of the photo comparator unit 48. An oil leak causing droplets of oil to enter the gas stream through line 43 into port 47 of the photo comparator unit 48 would cause a discrepancy in the color or density of the gas. This discrepancy is immediately detected by the photo comparator which energizes solenoid valve 66 to cut off flow of oil contaminated gas to the chamber being charged.

With the system above described, large quantities of gas under high pressure may be delivered. As the oil side of the system is separated from the gas side by the bladder 28, no contamination of the gas will occur under normal conditions. In the event of leakage of oil into the gas side of the system, which might occur in the remote contingency of the bladder failing, the photo comparator unit 48 will immediately cut off flow to the chamber 70. Thus no contamination will occur of the gas in such chamber and there is no likelihood of explosion.

The system is extremely flexible in operation as it can handle different types of gases without modification or component changes. It can be conveniently expanded to yield higher quantities of high pressure gases by adding an additional supply cylinder and additional fluid transfer units.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In a system of the type comprising a fluid transfer unit having a container with a pair of ports and a movable partition interposed between said ports, one of said ports defining a gas port and the other a liquid port, a reservoir for liquid, a pump, a line connecting the inlet of said pump to the reservoir, a line connecting the outlet of said pump to the liquid port of said fluid transfer unit for flow of liquid under pressure from said reservoir into said fluid transfer unit, a discharge line from said liquid port to said reservoir, a normally closed discharge valve in said line, a source of gas, a line connecting said source to the gas port of said fluid transfer unit, a one-way valve in said line permitting flow toward said fluid transfer unit, a gas outlet port, a line connecting said gas port of said fluid transfer unit to said gas outlet port, a oneway valve in said line permitting flow toward said gas outlet port; the combination therewith of means controlled by the quantity of liquid in said reservoir intermittently to actuate said discharge valve to correspondingly intermittently compress the gas in said fluid transfer unit, thereby to boost the pressure of the gas applied to said gas outlet port to a value above the pressure of the gas applied to said gas port of the fluid transfer unit.

2. The combination set forth in claim 1 in which said discharge valve is electrically controlled, the means controlled by the quantity of liquid in said reservoir to actuate said discharge valve comprises a float member in said reservoir, a switch controlled by said float member electrically connected to said discharge valve to actuate said valve to open the latter when the level of liquid in said reservoir falls to a predetermined amount and to actuate said valve to close the latter when the level of the liquid in said reservoir rises to a predetermined amount, whereby liquid under pressure will intermittently be forced into said fluid transfer unit, correspondingly intermittently to compress the gas therein.

3. The combination set forth in claim 1 in which a pressure relief valve is connected in parallel with said discharge valve.

4. The combination set forth in claim 1 in which a one-way valve is provided in the line between said pump and said liquid port permitting flow only into said liquid port.

5. The combination set forth in claim 1 in which a motor drives said pump, a starter unit controls said motor and means are provided in said line between the port of said fluid transfer unit and said gas outlet port to actuate said starter to shut off said motor when the pressure in said line has attained a predetermined value.

6. The combination set forth in claim 1 in which a photo comparator unit is provided which compares the flow of gas in the line between the source of gas and the one-way valve in said line, with the flow of gas in the line between the gas outlet port and the one-way valve in said line, a normally opened solenoid operated valve in the line between the gas outlet port and the one-way valve in said line and means to energize said sole-

noid operated valve when liquid flows through said last mentioned line.

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