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HYDRAULIC POWER SUPPLY

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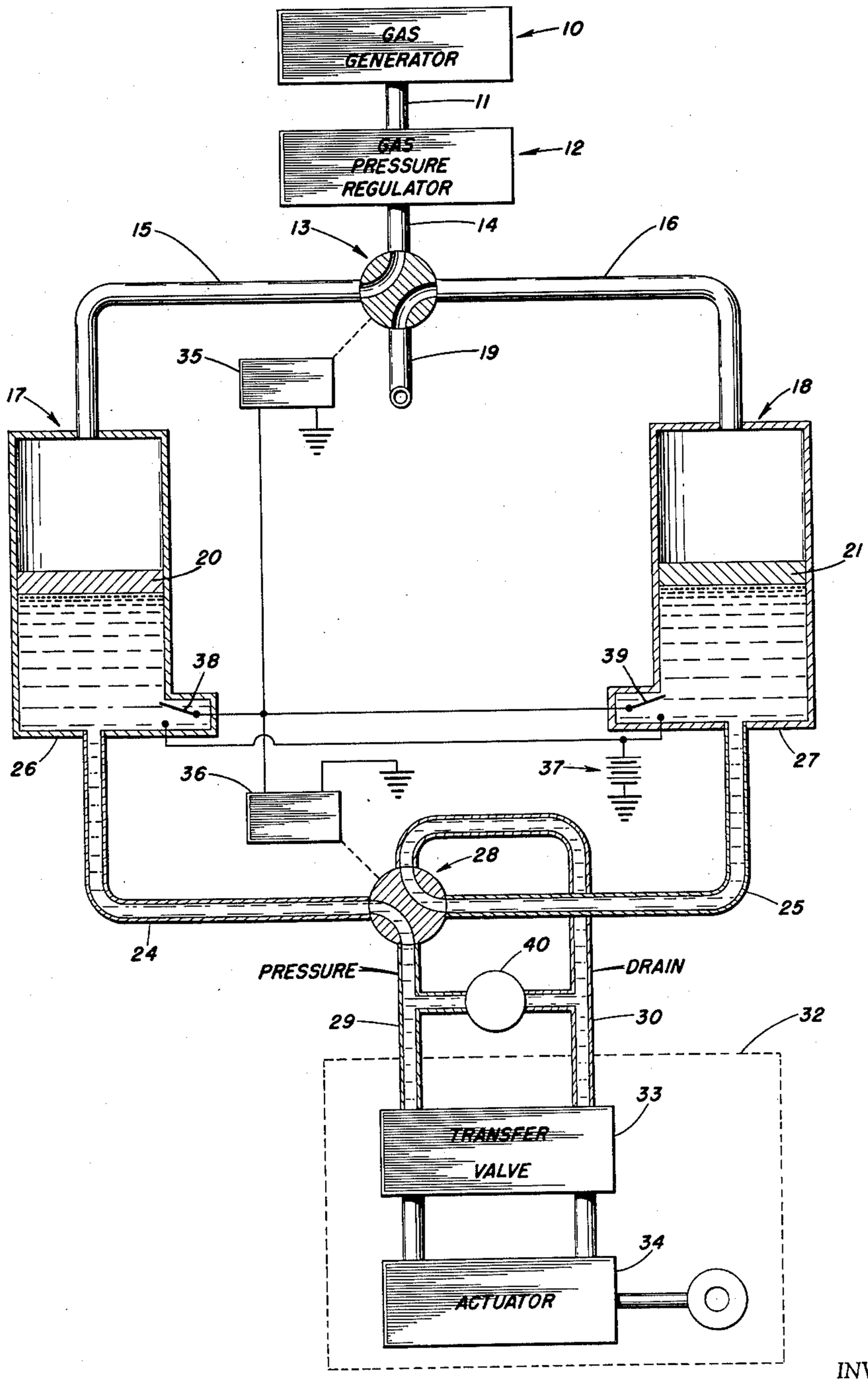

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HYDRAULIC POWER SUPPLY

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The present invention relates generally to hydraulic power supply systems and more particularly to a missile hydraulic power supply.

Desirable features for components of guided missiles are simplicity, lightness, strength and reliability. Hydraulic systems now in use include turbopump components which contain a multiplicity of parts and are, therefore, complicated and relatively heavy.

The principal object of the present invention, therefore, is to provide a missile power supply wherein complicated and physically heavy parts, such as turbo-generators, are eliminated.

Another object of the invention is to provide an apparatus which will supply a constant flow of high pressure fluid to a hydraulic servo system or a hydraulically driven electrical generator.

Another object of the invention resides in the provision of a power supply for the purpose set forth that will be simple in construction and highly efficient in use.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing.

The single FIGURE of the drawing is a block diagram showing the improved missile power supply.

Briefly, the power supply according to the invention includes as a hydraulic pressure generating mechanism either a piston or diaphragm within a cylinder against which gas under pressure is applied displacing the piston or diaphragm and causing delivery of hydraulic pressure fluid. The gas under pressure may be supplied from a solid or liquid propellant gas generator of generally known construction, from a rocket chamber, or from a missile exhaust nozzle. More specifically, the pistons or diaphragms within the cylinders separate the activating gas from the hydraulic fluid and serve to transfer energy from the gas to the fluid without contamination of the fluid. Because of limited displacement in a single cylinder, a pair of cylinders are utilized in an alternating cycle which permits one cylinder to deliver pressure fluid and diminish the volume of fluid contained therein while the other cylinder acts as a sump and recharges itself with fluid. When the one cylinder reaches its displacement limit, means operate to interchange the other cylinder with the one, thereby insuring a continuous flow of fluid.

With reference to the drawing, the invention comprises a gas generator **10** which supplies hot gas under pressure. A supply line **11** connects the gas generator **10** to a high temperature gas pressure regulator **12**. A solenoid actuated four-way gas switching valve **13** is connected to the gas pressure regulator **12** by supply line **14**.

The valve **13** directs the supply of gas under pressure from the pressure regulator **12** alternately through conduit **15** or **16** to cylinder **17** or **18**. The conduit **15** or **16** not connected to conduit **14** is connected by the valve **13** to a vent **19**.

The fluid pressure generating cylinders **17** and **18** include displaceable pistons **20** and **21** which transfer the energy of the gas to the fluid. Instead of pistons, standard metallic diaphragms, not shown, may be used. Within cylinders **17** and **18**, the pistons **20** and **21**, respectively, separate power producing hydraulic fluid or liquid in said cylinders below said pistons from the applied gaseous medium above said pistons. When the load demands flow of pressure fluid, gas pressure in the particular cylinder **17** or **18** which is at the time connected to conduit **14** causes displacement of piston **20** or **21** forcing fluid from the cylinder to be delivered to the load and reducing the volume of fluid contained therein. At the same time, the cylinder **17** or **18** connected to vent **19** receives fluid returned from the load, in a manner shortly to be described. Conduits **24** and **25** are connected from the lower or outlet ends **26** and **27** of the cylinders **17** and **18** to two opposite lines of a four-way solenoid operated hydraulic fluid switching valve **28**. The two remaining lines **29** and **30** of valve **28** serve as fluid pressure and return lines, respectively. Valve **28** is synchronized with valve **13** so that whenever valve **13** is positioned to deliver gas pressure to cylinder **17**, valve **28** connects conduit **24** to the load pressure line **29** and conduit **25** to load drain line **30**. The load **32** may comprise a conventional hydraulic transfer valve **33** and actuator **34** or any other hydraulically operated device, such as a fluid motor.

The positions of valves **13** and **28** are controlled by solenoids **35** and **36**, respectively. The solenoids are of the rotary form, such as described in U.S. Patent No. 2,539,090 to George N. Leland, which convert a momentary electrical impulse into rotary movements. In this case, a rotation of 90° is provided for each impulse supplied. As will be readily understood from the schematic representation of the valves, it is unnecessary to change the direction of rotation in order to interchange passages between the four valve lines. Rotation in a single direction, as supplied by the solenoids, is therefore satisfactory.

Solenoids **35** and **36** are simultaneously energized by means of a circuit including a battery **37** and switches **38** and **39**, the closure of either of which will supply an operating impulse. When one of the pistons finishes its pressure stroke in its cylinder, say cylinder **17**, piston **20** contacts switch **38** thereby closing the circuit through solenoids **35** and **36** hence reversing valves **13** and **28** and substituting cylinder **18** for cylinder **17** as the pressure fluid source.

A hydraulic by-pass or pressure regulator **40** may be connected between the fluid pressure and return lines **29** and **30**, if desired, for the purpose of eliminating excessive fluid pressure build-up.

Summarizing, the operation of the invention is as follows. In the position in which piston **20** is shown in the drawing, gas is conducted from the generator **10** through supply line **11**, regulator **12**, supply line **14**, gas switching valve **13**, conduit **15** to cylinder **17** and exerts pressure on the piston **20** forcing the piston downward. The piston **20** acts on the hydraulic fluid beneath it and drives fluid under pressure through conduit **24** to the fluid switching valve **28**. Fluid under pressure is then transferred by valve **28** through pressure line **29** to the load **32**. Drain fluid from the load returns by line **30**, valve **28** and conduit **25** to cylinder **18** to move piston **21** upwardly, driving gas not under pressure through conduit **16** to valve **13**, to be vented to the atmosphere through vent **19**.

When the piston **20** of cylinder **17** reaches the end of a pressure stroke, the switch **38** is closed and the valves **13** and **28** reverse their position. The gas switching valve **13** then diverts the gas from generator **10** through conduit **16** to cylinder **18** to act on piston **21**, and permits gas from the cylinder **17** to escape through vent **19**. Similarly, the fluid switching valve **28** transfers the fluid under pressure from cylinder **18** to pressure line **29** and transfers the drain fluid from the return line **30** through conduit **24** to cylinder **17**. Thus the operation of piston **21** is the

same as piston 20. Closure of switch 39 by the piston 21 will cause the valves 13 and 28 to operate as first described.

It will be understood, of course, that gas regulator 12 and valve 13 can be protected from the effects of gas at excessive temperatures by cooling supply lines 11 and 14 in any convenient manner.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A hydraulic power supply for a guided missile, comprising a source of gas under pressure, an electrically operated gas switching valve connected to said source, at least a pair of fluid pressure generating cylinders connected to said gas switching valve, said gas switching valve supplying alternately gas under pressure from said source to one of said cylinders and exhausting alternately gas from the other of said cylinders as the switching valve is operated, said one cylinder receiving gas under pressure being arranged to discharge fluid, said other cylinder exhausting gas being arranged to receive fluid, a disc-shaped displacement piston dividing each of said cylinders into a pair of expansible chambers and slidably disposed therein, the first of said chambers being supplied with gas, the second of said chambers containing fluid, said disc-shaped displacement pistons being subjected alternately to gas under pressure in said first chamber for pressurizing the fluid in said second chamber, a gas switching circuit, a switch included in said circuit and disposed within said first chamber and actuated by the disc-shaped piston therein, a solenoid included in said gas switching circuit for operating said gas switching valve as the switch in said first chamber is actuated by the disc-shaped piston therein, an electrically operated fluid switching valve having a pair of conduits respectively connected to said second chambers of said cylinders, a load pressure line connected to said fluid switching valve, a load drain line connected to said fluid switching valve, said fluid switching valve being arranged to interchange connections from said conduits from said second chambers of said cylinders with said load pressure line and said load drain line so as to maintain said load pressure line connected to the one of said second chambers delivering pressure fluid as the fluid switching valve is operated, a fluid switch circuit, an additional switch included in said fluid switching circuit and disposed within said second chamber and actuated by the disc-shaped piston therein, and an additional solenoid included in said fluid switching circuit for operating the fluid switching valve as the additional switch is actuated by the disc-shaped piston in the second chamber.

2. A hydraulic power supply for a guided missile, comprising a source of gas under pressure, a gas pressure regulator connected to said source, an electrically operated gas switching valve connected to said pressure regulator, at least a pair of fluid pressure generating cylinders connected to said gas switching valve, said gas switching valve supplying gas under constant pressure from said gas pressure regulator to one or the other of said cylinders, the one of said cylinders receiving gas under pressure being arranged to discharge fluid, a disc-shaped displacement piston within each of said cylinders, a quantity of fluid contained by said cylinders and separated from the gas within said cylinders by said disc-shaped displacement pistons, said pistons being displaceable by gas under pressure for discharging fluid under pressure from said cylinders, an electrically operated fluid switching valve having conduits connected to each of said cylinders, a load, a pressure supply line connected from said fluid switching valve to said load, a drain line connected from said load to said fluid switching valve, an electrical switch disposed within each cylinder of said pair of cylinders engageable with and actuated by said pistons, means responsive to an electrical impulse connected to the switch in each cylinder and operated as the switch in each cylinder is actuated by the disc-shaped displacement piston therein for reversing the position of said gas switching valve and said fluid switching valve in synchronism whereby pressure fluid will be continuously maintained in said load supply line, and circuit means including a battery connecting the switch in each cylinder and the means responsive to said electrical impulse for supplying said impulse thereto.

3. A hydraulic power supply for a guided missile, comprising a source of gas under pressure, a gas pressure regulator connected to said source, an electrically operated gas switching valve connected to said regulator, at least a pair of liquid pressure generating cylinders connected to said gas switching valve, said gas switching valve supplying alternately gas under constant pressure from said gas pressure regulator to one of said cylinders and exhausting alternately gas from the other of said cylinders, said one cylinder receiving gas under pressure being arranged to discharge liquid, said other cylinder exhausting gas being arranged to receive liquid, disc piston means dividing each of said cylinders into a pair of expansible chambers, the first of said chambers being supplied with gas, the second of said chambers containing liquid, said disc piston means being subjected alternately to gas under pressure in said first chamber for pressurizing the liquid in said second chamber, a conduit connected to each of said second chambers, an electrically operated liquid switching valve connected to said conduits, a load, a pressure supply line connected from said liquid switching valve to said load, a drain line connected from said load to said liquid switching valve, switch means controlled by said disc piston means in each cylinder, solenoid means operated as the switch means are actuated to a closed position by said disc piston means for reversing the position of said gas switching valve and said liquid switching valve in synchronism whereby pressure liquid will be continuously maintained in said load supply line, and circuit means including battery means connecting the switch means and solenoid means for supplying operating energy to the solenoid as the switch means are actuated to said closed position.

4. A hydraulic power supply for a guided missile, comprising a source of gas under pressure, a gas pressure regulator connected to said source, a gas switching valve connected to said regulator, at least a pair of liquid pressure generating cylinders connected to said gas switching valve, said gas switching valve supplying gas under constant pressure from gas pressure regulator to one of said cylinders, said other cylinder exhausting gas being arranged to receive liquid, a disc piston slidably disposed within each of said cylinders, a quantity of liquid contained by said cylinders and separated from the gas within said cylinders by said pistons, said disc pistons being displaceable by gas under pressure for discharging liquid under pressure from said cylinders, a conduit connected to each of said cylinders, a liquid switching valve connected alternately to each of said cylinders through said conduit, a load, a pressure supply line connected from said liquid switching valve to said load, a drain line connected from said load to said liquid switching valve, a liquid pressure regulator connected between said supply line and said drain line, and switch means disposed within each cylinder of said pair of cylinders and actuated alternately by each of said disc pistons to a closed position, solenoid means including circuit means connected to said switch for reversing the position of said gas switching valve and said liquid switching valve in synchronism whereby pressure liquid will be continuously maintained in said load supply line, as the switch means are actuated to said closed position.

5. A hydraulic power suply for a guided missile, comprising a source of gas under pressure, an electrically operated gas switching valve connected to said source, at least a pair of fluid pressure generating cylinders connected to said electrically operated gas switching valve, said electri-

cally operated gas switching valve supplying alternately gas under pressure from said source to one of said cylinders and exhausting alternately gas from the other of said cylinders, said one cylinder receiving gas under pressure being arranged to discharge fluid, said other cylinder exhausting gas being arranged to receive fluid, disc piston means dividing each of said cylinders into a pair of expansible chambers and slidably disposed therein, the first of said chambers being supplied with gas, the second of said chambers containing fluid, said disc piston means being subjected alternately to gas under pressure in said first chamber for pressurizing the fluid in said second chamber, an electrically operated fluid switching valve connected to said second chambers of said cylinders, a load, a pressure supply line connected from said fluid switching valve to said load, a drain line connected from said load to said fluid switching valve, electrical means connected between said valves and said second chambers,

said switch means actuated alternately to a closed position by each of said disc piston means, electrical impulse responsive means operated as the switch means are moved to said closed position for reversing the position of said gas switching valve and said fluid switching valve in synchronism whereby pressure fluid will be continuously maintained in said load supply line, and circuit means including a battery connecting said switch means and the electrical impulse responsive means for suplying an electrical impulse thereto as the switch means moves to said closed position.

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