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Goss et al.

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[54] **HYDRAULIC GUN SYSTEM**

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[52] **U.S. Cl.** **239/302,** 137/609, 239/445, 239/527

[51] **Int. Cl.** **B05b 1/16**

[58] **Field of Search** 239/302, 332, 396, 397, 239/443, 444, 445, 446, 447, 527; 137/609

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[57] **ABSTRACT**

A plurality of high pressure guns connected with a common fluid source for directing high pressure fluid outwardly wherein one gun can be shut down without effecting the operability of the remaining guns, each of the guns including a gun housing with a nozzle and exhaust line attached therewith, valve means in the gun housing for directing fluid through the nozzle or exhaust line and velocity reduction and flow restriction apparatus mounted in the exhaust line to exhaust fluid therefrom at reduced velocity while maintaining pressure at the fluid source.

7 Claims, 2 Drawing Figures

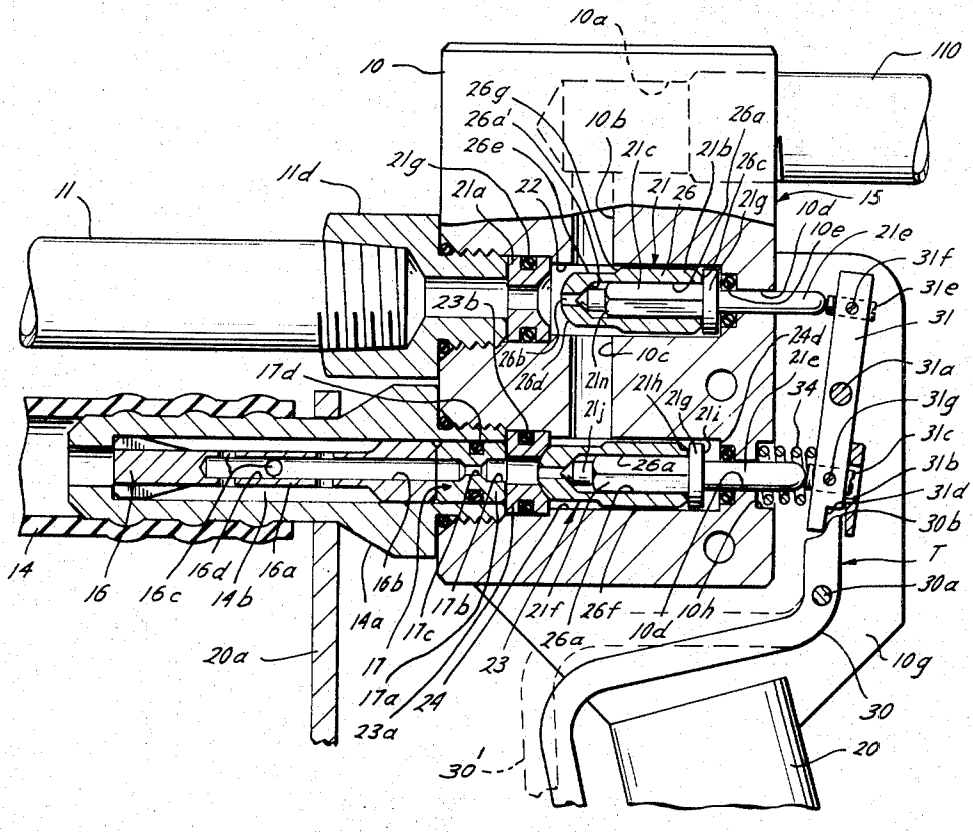


Fig. 1

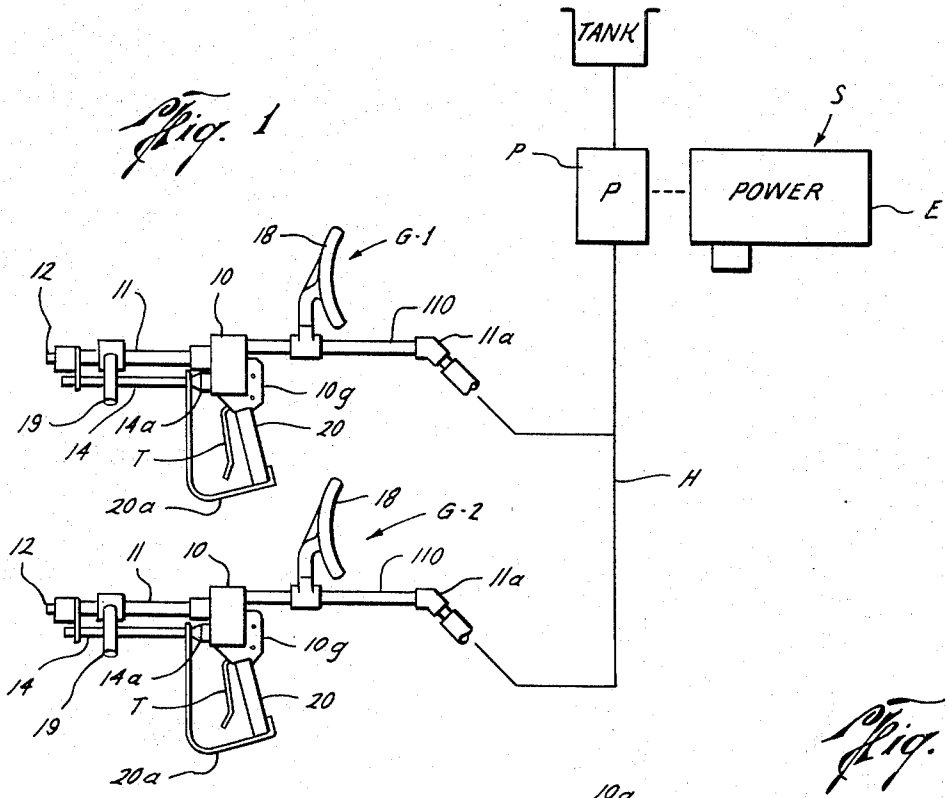
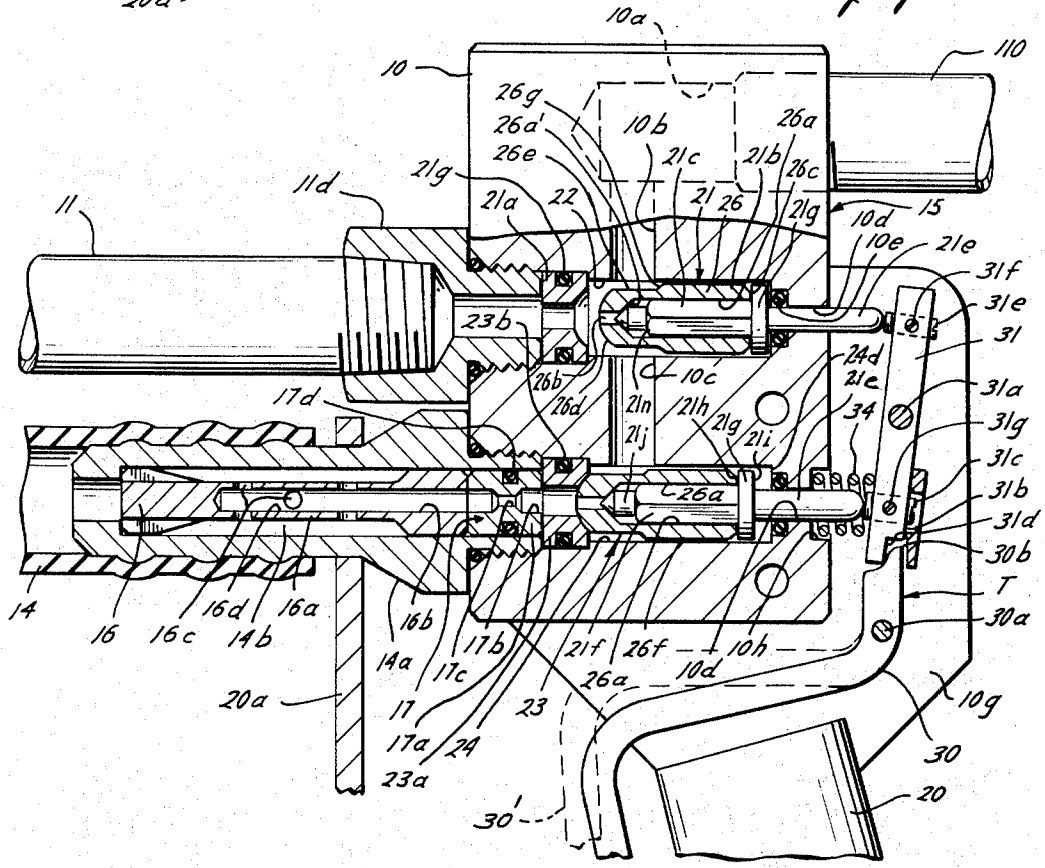

TANK
S
P
P
POWER
E
H
18
G-1
12
11
10
110
11a
10g
19
14a
20
14
T
20a
18
G-2
12
11
10
110
11a
10g
14
14a
T
20
19
20a

Fig. 2


10a
10
110
26g
26a'
10b
26a
26e
21c
21b
26c
21g
11d
21a
22
21
26
21g
15
10d
10e
21e
11
31f
31e
23b
31
24d
21e
10c
31a
26b
26d
21n
21h
21g
21i
34
31g
17d
21j
31c
26a
31b
31d
30b
T
30a
14
16
16c
16d
14b
16a
16b
14a
17b
17c
21f
26f
10h
10d
26a
10g
20a
17
23
30
17a
24
23a
30'
20

HYDRAULIC GUN SYSTEM

BACKGROUND OF THE INVENTION

The field of this invention is the operation of multiple high pressure guns.

It is frequently desirable to use a plurality of high pressure blasting guns that powered by the same hydraulic power system, which may be similar to the hydraulic power system disclosed in U.S. Pat. No. 3,335,962.

When using multiple guns, each operator of a gun encounters numerous occasions when he must shut the gun down temporarily. In the use of such multiple guns, the shutting down of one gun caused it to whip around dangerously if the full line pressure was maintained so as to operate the other guns, or alternatively, if the pressure at the shut down gun was reduced, the output pressure of the entire hydraulic power system was reduced below an effective range for the other guns. Under either alternative, the operation of multiple guns from a single power source was difficult, and usually impossible, from a practical standpoint.

SUMMARY OF THE INVENTION

The present invention relates to new and improved high pressure guns for use with a single hydraulic power source wherein one of the guns can be shut down without affecting the operation of the other guns. Each high pressure gun generally comprises a gun housing which includes a nozzle for directing fluid outwardly at a high pressure and an exhaust line for dumping fluids at a lower, safer pressure. Valve means are mounted within the gun housing for directing fluid flow through the nozzle or the exhaust line; and, velocity reduction and flow restriction means are mounted in the exhaust line to substantially maintain fluid pressure at the hydraulic power source while exhausting fluid through the exhaust line at a reduced velocity. In this manner, one or more of the plurality of such high pressure guns can be temporarily shut down while maintaining pressure in the line of the hydraulic power system so that the remaining guns are operable. The velocity reduction means of this invention reduces the velocity of the fluid flowing through the exhaust line such that the gun will not fly about if the operator should leave it unattended.

In one aspect of this invention, the valve means for the gun housing includes separate nozzle valve means and exhaust valve means for controlling the flow through the nozzle and exhaust line. The nozzle valve means and the exhaust valve means are operably connected to a trigger assembly that is continually urged to a released position wherein fluid is dumped through the exhaust line at reduced velocity while operating pressure from the hydraulic power source is maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially schematic view of the preferred embodiment of this invention wherein two high pressure guns are operated by a common hydraulic power system; and

FIG. 2 is a cross-sectional view of a high pressure gun housing with the valve means of this invention positioned to direct fluid outwardly at high pressure.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, the letter S generally designates a hydraulic power system that includes an engine E for driving a hydraulic pump P which provides hydraulic fluid at operating pressures to flexible hose H. Hydraulic guns generally designated as G1 and G2 are attached to the flexible hose H such that the hydraulic guns may be used to direct the hydraulic fluid outwardly at a very high pressure for purposes of scouring or cleaning objects. The hydraulic fluid provided by the common hydraulic pressure system is normally water at very high pressures, e.g., 5,000 to 10,000 p.s.i. and higher, which cleans when directed outwardly through the guns G1 and G2 at such high pressures.

The guns G1 and G2 are designed to be secured by the operators against their shoulders so that high pressure fluid can be safely directed toward the objects being cleaned. Each gun G1 and G2 basically includes a housing **10** having attached thereto a support conduit **110,** which is connected with the flexible hose H through coupling **11***a*. A nozzle line **11** is connected to the housing **10** and has mounted thereon a nozzle **12** which directs the fluid outwardly from the nozzle line **11** at a very high pressure. An exhaust line **14** is attached to the housing **10** by means of a coupling **14***a* to provide for the dumping of the hydraulic fluid outwardly at a safer, lower pressure whenever desired. A valve means generally designated as **15** (FIG. 2) is mounted in the housing **10** of each of the guns G1 and G2 for controlling the flow of hydraulic fluid through the nozzle line **11** and the exhaust line **14.**

A trigger assembly generally designated as T is operably connected to the valve means **15** and is movable between an actuated position wherein fluid is directed outwardly of the nozzle **12** and a released position (in phantom lines in FIG. 2) in which fluid is dumped through the exhaust line **14.** Velocity reduction means **16** and flow restriction means **17** are mounted within the housing **10** and exhaust line coupling **14***a* to reduce the velocity of the fluid dumped through the exhaust line **14** while maintaining operating pressure in the flexible hose H such that one gun such as G1 is operable even though another gun such as G2 is shut down.

Each of the guns G1 and G2 are provided with a shoulder brace **18** and a hand grip **19** such that the guns can be safely manipulated by the operators. A handle **20** and a support bracket **20***a*, which is attached with the exhaust line coupling **14***a*, is mounted into the housing **10** so that the trigger assembly T can be easily manipulated.

The valve means **15** includes a nozzle valve means generally designated as **21** mounted in the housing **10** within a bore **22** which is the fluid communication with the support conduit **110** by means of passages **10***a* and **10***b*. The bore **22** is in fluid communication with the nozzle line **11** through nozzle line coupling **11***d*. An exhaust valve means **23** is mounted in bore **24** of housing **10** below the nozzle valve means and is in fluid communication with bore **22** through passage **10***c*. The bore **24** of exhaust valve means **23** is in fluid communication with the exhaust line **14** through flow restriction means **17** and velocity reduction means **16.**

The nozzle valve means **21** and exhaust valve means **23** have substantially identical valve elements and thus

like numbers and letters will be used to describe like parts.

The nozzle valve means **21** includes a valve seat **21***a* mounted within bore **22** by nozzle line coupling **11***d* and having an O-ring seal **21***g* therewith. Similarly, the exhaust valve means **23** includes a valve seat **23***a* which is mounted in the bore **24** by the exhaust line coupling **14***a* and has an O-ring seal **23***b* mounted therewith. Cylindrical main valve elements **26** are slidably mounted within the bores **22** and **24** and pilot valves **21***c* are mounted for slidable movement within main valve elements **26** and housing bores **22** and **24.** For each of the valve means **21** and **23,** the pilot valve **21***c* includes a rod portion **21***e* that extends through housing openings **10***d*. An O-ring seal **10***e* mounted at each housing opening **10***d* sealingly engages the rod portion **21***e* of the pilot valves such that each pilot valve is mounted for slidable, sealable movement with respect to housing opening **10***d*. Each pilot valve **21***c* has a polygonal (four-sided) head **21***f* that is slidably mounted in bore **26***a* of main valve **26.** A pilot valve limit ring **21***g* separates the rod portion **21***e* and the head **21***f* and includes front shoulder **21***h* and rear shoulder **21***i*.

Bore **26***a* of each main valve **26** is cylindrical such that fluid can pass between polygonal pilot valve head **21***f* and bore **26***a*. An opening **26***b* in fluid communication with bore **26***a* is provided in each main valve **26.** Nose **21***j* for pilot valve **21***c* is adapted for insertion into opening **26***b* against bore front wall **26***a'*. The main valve **26** further includes a rear, annular face **26***c* and a front end portion designated as **26***d* adapted for seating against seats **21***a* and **23***a*. Each main valve **26** includes a by-pass portion **26***e* of reduced diameter that is joined to outside wall portion **26***f* by shoulder **26***g*. The diameter of outside wall portion **26***f* is less than the diameter of bores **22** and **24** so that fluid can pass therebetween.

Thus the valve elements **21***c* and **26** for the nozzle valve means **21** and for the exhaust valve means **23** are basically identical in structure and are movable between open and closed positions. The nozzle valve means **21** is illustrated in the open position and the exhaust valve means **23** is illustrated in the closed position. The nozzle valve means **21** is movable to the closed position of the exhaust valve means **23** and conversely, the exhaust valve means **23** is movable to the open position of the nozzle valve means **21.**

The trigger assembly T includes a trigger element **30** that is pivotally mounted on housing section **10***g* by means of pin **30***a*. The trigger element **30** is movable between an actuated position illustrated in solid lines in FIG. **2** and a released position illustrated in phantom lines in FIG. **2.**

The trigger assembly T further includes an actuator arm **31** that is pivotally mounted on housing section **10***g* by pin **31***a*. A tab **31***b* is formed integrally with or welded to the arm **31** so as to project downwardly behind the trigger element **30.** An adjustable contact screw **31***c* extends through the lower portion of the actuator arm **31** to contact the pivot valve rod portion **21***e*. A recess is provided between actuator arm surface **31***d* and the tab **31***b* for receiving end portion **30***b* of the trigger element **30.** An adjustable contact screw **31***e* extends through an upper portion of the arm **31** into engagement with rod portion **21***e* of the pilot valve **21***c*. The contact screw **31***e* is locked in place by a locking set screw **31***f*. Similarly, the contact screw **31***c* mounted in the lower portion of the actuator arm **31** is locked in position by a locking set screw **31***g*.

Whenever the trigger element **30** is moved by an operator to the actuated position, the actuator arm **31** is pivoted clockwise to cause the main valve element **26** for the exhaust valve means **23** to seat against seat **23***a* and pilot valve **21***c* to seat in main valve bore **26***a* thereby closing off flow into exhaust line **14.** The clockwise movement of the actuator arm **31** further allows the main valve element **26** and pilot valve **21***c* of the nozzle valve means **21** to be moved to the open position by fluid pressure.

Fluid pressure in bore **22** of the nozzle valve means **21** serves to continually urge the nozzle main valve **26** and the nozzle pilot valve **21***c* to the open position. Pressurized fluid constantly acts against front shoulder **21***h* and nose shoulder **21***n* and rear shoulder **21***m* of the pilot valve **21***c*. Since the area of nose shoulder **21***n* and front shoulder **21***h* is greater than the area of rear shoulder **21***i*, the pilot valve **21***c* is continually urged to the open position. Therefore, when the actuator arm **31** is rotated clockwise, the pilot valve **21***c* of the nozzle valve means **21** moves to the open position shown.

As pilot valve **21***c* is moved toward the open position, the nose **21***j* thereof is unseated from main valve end bore portion **26***a'*. The unseating of pilot valve nose **21***j* allows flow between the main valve outside surface **26***f* and bore **22,** into main valve bore **26***a* and outwardly through opening **26***b*. But, due to the reduced flow area between the main valve surface **26***f* and bore **22,** the fluid flowing therebetween is throttled to a lower pressure. The exertion of higher pressure fluid against outside shoulder **26***g* overcomes exertion of lower, throttled fluid pressure against main valve bore end **26***a'* and rear end **26***c* and causes main valve **26** to move toward pilot valve **26***c*. When main valve bore end wall **26***a'* is again seated against the nose **21***j* of the pilot valve, the pressurized fluid acting against unseated, exposed main valve front end portion **26***d* holds the main valve **26** and pilot valve **21***c* in the open position shown. In this manner the fluid flows through the nozzle valve means **21** and nozzle line **11** and outwardly through the nozzle **12** at a very high pressure.

The trigger element **30** is continually urged to rotate counter-clockwise by means of coil spring **34.** The coil spring **34** is mounted in a recess **10***h* in the housing **10** and extends into engagement with the lower portion of the actuator arm **31.** The coil spring **34** is positioned in the recess **10***h* such that pilot valve rod portion **21***e* of the exhaust valve **23** is free to slide within the bore **24.** When the trigger element **30** is rotated to the released position at **30'** and the acutator arm **31** rotates counter-clockwise, the set screw **31***e* moves the pilot valve **21***c* and main valve **26** of the nozzle valve means **21** to the closed position so that front end **26***d* is seated against seat **21***a*.

Even though the nozzle valve main element **26** is seated in the closed position, fluid by-passes reduced diameter portion **26***e* and thus fluid pressure continues within bore **24.** The movement of the lower end of arm **31** counter-clockwise allows the fluid pressure in bore **24** to move the pilot valve **21***c* and main valve **26** of the exhaust valve means to rear wall **24***a* of bore **24** thereby opening the bore **24** so that the fluid flows outwardly through exhaust line **14.** Fluid pressure in bore **24** acts to move the pilot valve **21***c* and main valve **26** of the ex-

haust valve means **23** to the open position just as the fluid pressure in bore **22** moves the elements **26** and **21***c* in nozzle valve means **21** to the open position. The diameter of the rod portion **21***e* of the pilot valve **21***c* for the exhaust valve means **23** is greater than the diameter of the pilot valve rod portion **21***e* of nozzle valve means **21.** Thus, fluid pressure acting in bores **22** and **24** results in a continued urging of actuator arm **31** in a counter-clockwise direction (of course, spring **34** also acts to urge arm **31** to a position wherein nozzle valve **21** is closed).

The flow restricting means **17** includes a flow restricting element **17***a* inserted into bore **14***b* of the exhaust line coupling element **14***a*. The flow restricting element **17***a* is seated against the valve seat **23***a* and is held in position by the velocity reduction means **16.** Element **17***a* is sealably mounted with respect to bore **14***b* and includes an O-ring seal **17***d*. The flow restricting element **17** has a bore **17***b* therein which is hydraulically equivalent to the nozzle **12.** The bore **17***b* includes an orifice portion **17***c* having a diameter substantially the same as the smallest diameter in the nozzle **12** so that the back pressure produced by the orifice portion **17***c* is substantially the same as the back pressure produced by the nozzle **12.**

The velocity reduction means **16** includes a tubular member **16***a* mounted in the bore **14***b* of the exhaust line coupling element **14***a*. The tubular element **16***a* includes a bore portion **16***b* that is in fluid communication with the bore **17***b* of the flow restricting element **17***a*. A plurality of radially directed holes **16***c* are provided in the wall **16***d* of the tubular member so that fluid passing through the bore **16***d* is directed radially outwardly against the wall of the bore **14***b* of the exhaust line coupling element **14***a*. The deflecting of the high pressure fluid radially outwardly against the bore **14***b* reduces the velocity of the fluid prior to the fluid passing outwardly into the nozzle **14.** In this manner, fluid flowing through the valve means **23** is passed outwardly through the nozzle line **14** at reduced pressure and velocity while the back pressure maintained in the flexible hole H is substantially the same as the back pressure produced by the nozzle **12.**

In the operation and use of the guns G1 and G2 of the preferred embodiment of this invention, the operator of each gun G1 or G2 moves the trigger element **30** to the actuated position (FIG. 2) whenever it is desired to direct the high pressure fluid outwardly through nozzle **12** in order to clean or scour an object. With the trigger element **30** in the actuated position, the actuator arm **31** holds the exhaust valve means **23** in the closed position against the urging of spring **34** and fluid pressure as heretofore described and the nozzle valve means **21** is allowed to move to the open position, thus directing the fluid outwardly of the nozzle line **11** and nozzle **12** at high pressure.

Whenever an operator releases the trigger element **30,** the urging of spring **34** moves the trigger element **30** to the released position (which can be designated at **30'** in FIG. 2). The pivoting of the actuator arm **31** by the trigger element **30** in a counterclockwise direction causes the actuator arm to close nozzle valve means **21** so that the fluid directed through the support conduit **110** bypasses the reduced portion **26***e* of the main valve element **26** for the nozzle valve means **21** and flows into the housing passage **10***c*. The pressure of the fluid in bore **24** causes the exhaust valve elements **26** and **21***c* in bore **24** to move to the open position so that the fluid flows through the flow restricting element **17***a*. The passing of the fluid through the flow restricting element **17***a* serves to maintain a back pressure on the fluid in the flexible hose H that is substantially the same as the back pressure caused by the nozzle **12** when the fluid is flowing outwardly through the nozzle line **11.** In this manner, one of the guns such as G1 can continue to operate even though the other gun G2 has been shut down by releasing the trigger element **30.**

The exhausting fluid flows through the open exhaust valve means **23,** through the flow restricting element **17***a* and into the bore **16***d* of the velocity reduction element **16***a*. The flow is then directed radially outwardly against the wall of bore **14***b* of the exhaust line coupling element **14***a* to reduce and dissipate the velocity thereof so that the fluid being dumped outwardly through the nozzle line **14** is dumped at a lower, safer pressure and velocity.

It should be understood that it is within the scope of this invention to use more than two of the hydraulic guns such as G1 and G2 with a common hydraulic power source S in such a manner that one or more of the guns may be shut down while leaving the remaining guns operable. Further, the guns G1 and G2 of the preferred embodiment of this invention may be used with any type of hydraulic power system which will provide hydraulic fluid under pressure. In the preferred embodiment of this invention, the guns G1 and G2 direct high pressure water toward an object for cleaning. It should be understood that it is within the scope of this invention to use such guns G1 and G2 to direct various other types of high pressure fluids outwardly for other purposes.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

We claim:

1. A plurality of high pressure guns for directing high pressure fluid from a common fluid source, wherein each high pressure gun comprises:

a gun housing including a nozzle means for directing fluid from said source outwardly at a high pressure and an exhaust means for dumping said fluid at a lower, safer pressure;

valve means mounted with said housing for controlling flow through said nozzle means and exhaust means; and

said exhaust means having velocity reduction means and flow restriction means mounted therewith to substantially maintain the operating pressure of said fluid source while exhausting fluid at reduced velocity.

2. The structure set forth in claim **1,** wherein:

said exhaust means includes a line in fluid communication with said valve means; and

said flow restriction means includes means positioned in said line for producing a back pressure at said fluid source substantially the same as the back pressure produced by the nozzle means whereby other high pressure guns remain operable while one of said high pressure guns is exhausting fluid.

3. The structure set forth in claim **1,** wherein:

said flow restriction means is an orificed member mounted with said exhaust means, said member having an orifice therein hydraulically equivalent to said nozzle means.

4. The structure set forth in claim **1,** wherein said velocity reduction means includes:

said exhaust means includes an exhaust line having a bore in fluid communication with said valve means; and

a tubular member having a passage and radial openings therein, said tubular member being mounted within said exhaust line whereby fluid being exhausted flows through said passage and radial openings and is deflected off the inside wall of said exhaust line bore whereby the velocity and pressure of the fluid being exhausted is substantially reduced.

5. The structure set forth in claim **1,** including:

nozzle valve means mounted with said housing for controlling flow through said nozzle means;

exhaust valve means mounted with said housing in fluid communication with said nozzle valve means for controlling flow through said exhaust means; and

releasable actuator means operatively connected with said nozzle valve means and said exhaust valve means for directing fluid through said nozzle means, and resilient means urging said actuator means to a released position wherein said fluid is exhausted through said exhaust valve means.

6. The structure set forth in claim **5,** wherein:

said nozzle valve means is movable between an open position in which said fluid is directed through said nozzle means and a bypass position in which said fluid is directed to said exhaust valve means.

7. The structure set forth in claim **5,** wherein: said exhaust valve means is movable between a dump position in which fluid flows through said exhaust means and a closed position wherein said exhaust means is closed to flow.

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