May 14, 1963 R. W. MOORE 3,089,285

ABRASIVE BLASTING APPARATUS

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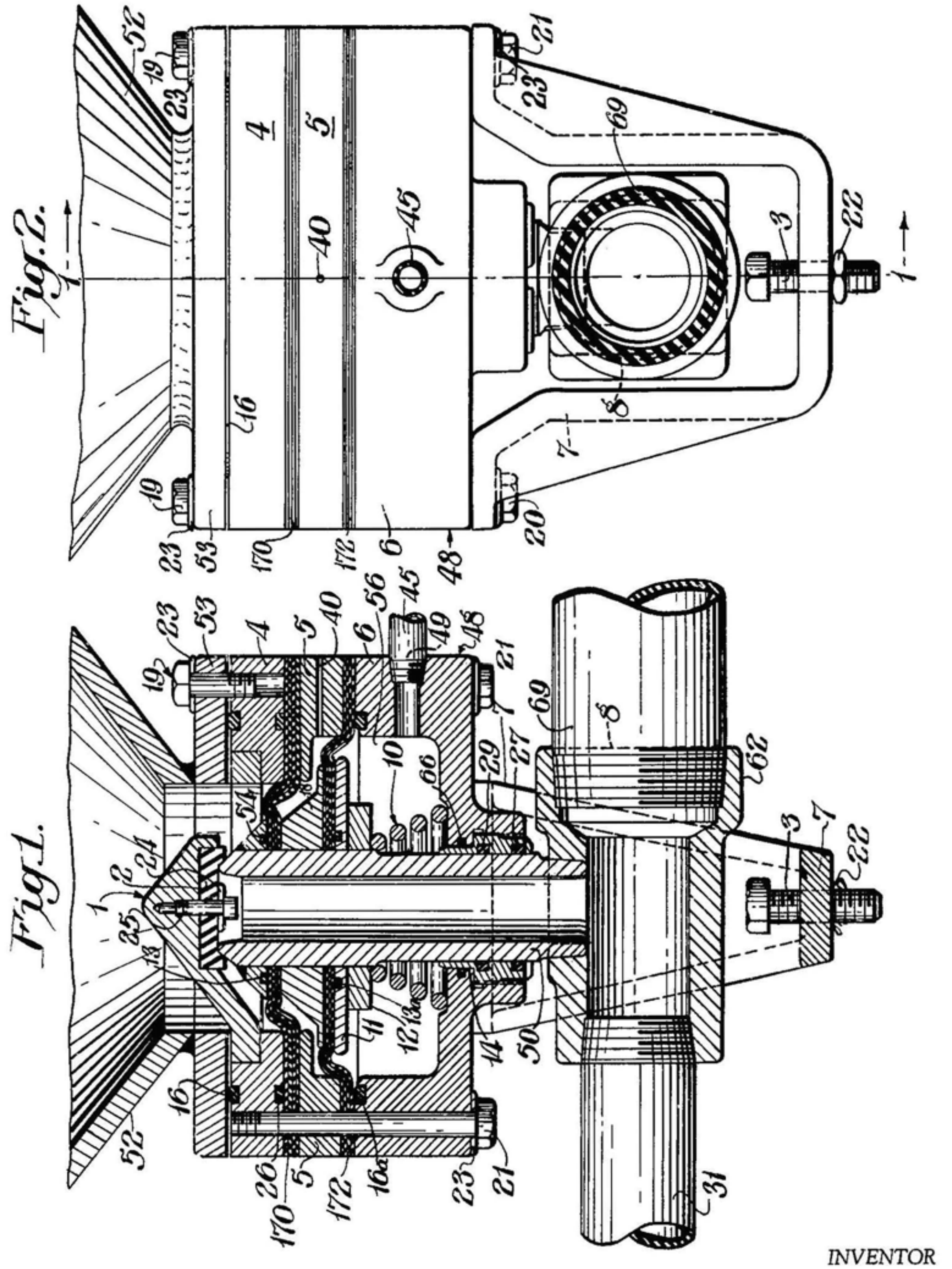

INVENTOR

RALPH W. MOORE

BY Connolly and Hutz

ATTORNEYS

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Fig. 4.

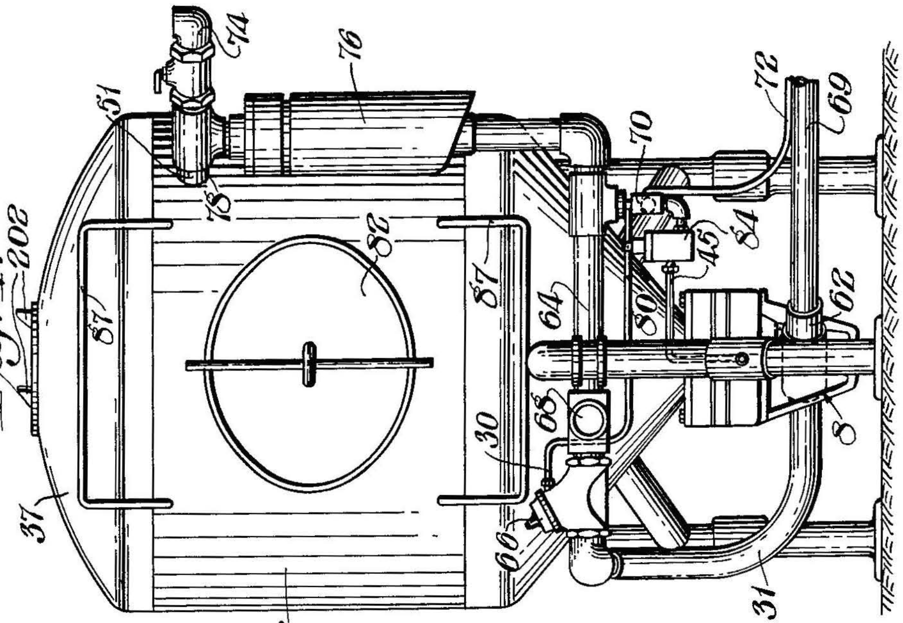
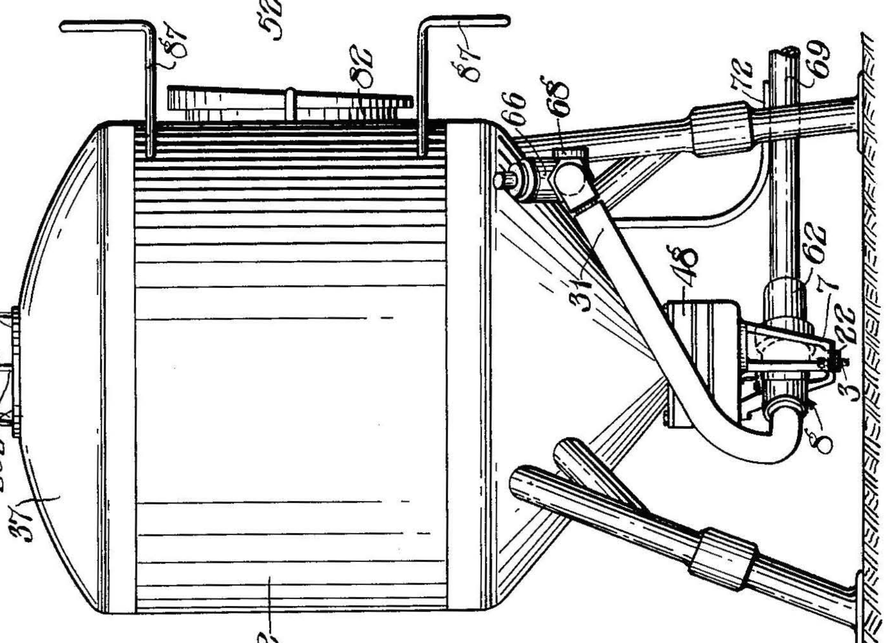


Fig. 3.



INVENTOR

RALPH W. MOORE

BY Connolly and Hutz

ATTORNEYS

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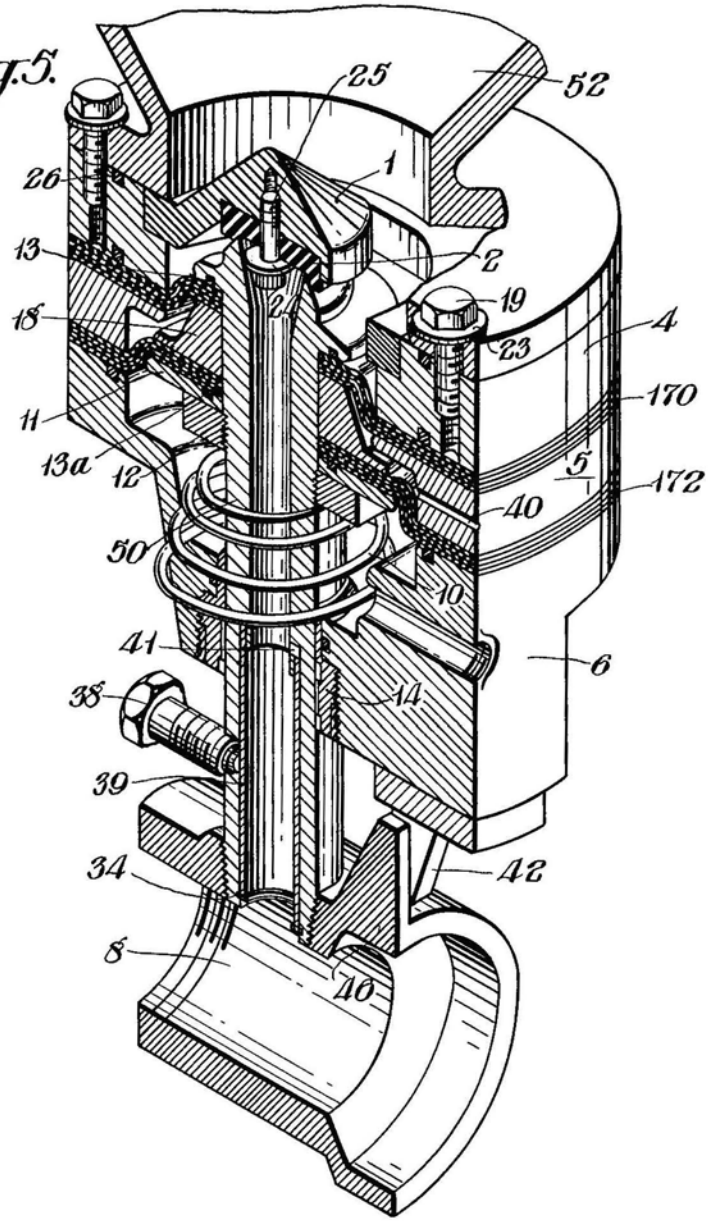
Fig. 5.



INVENTOR
Ralph W. Moore

BY Connolly and Hutz
ATTORNEYS

Fig. 5A.

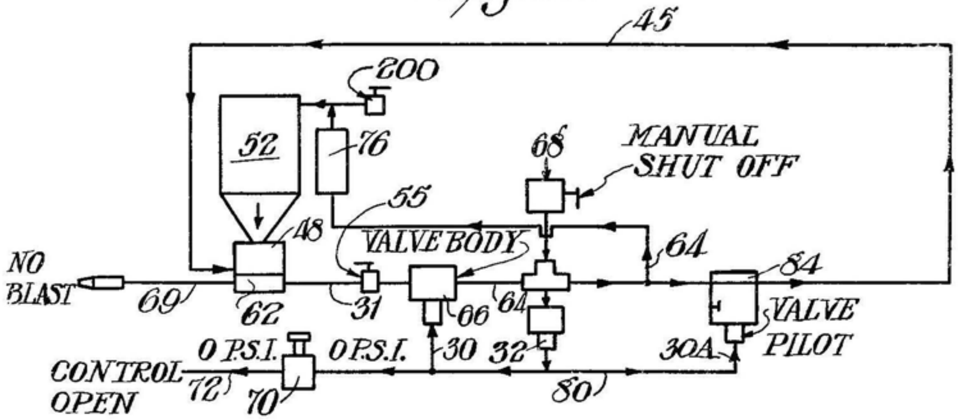
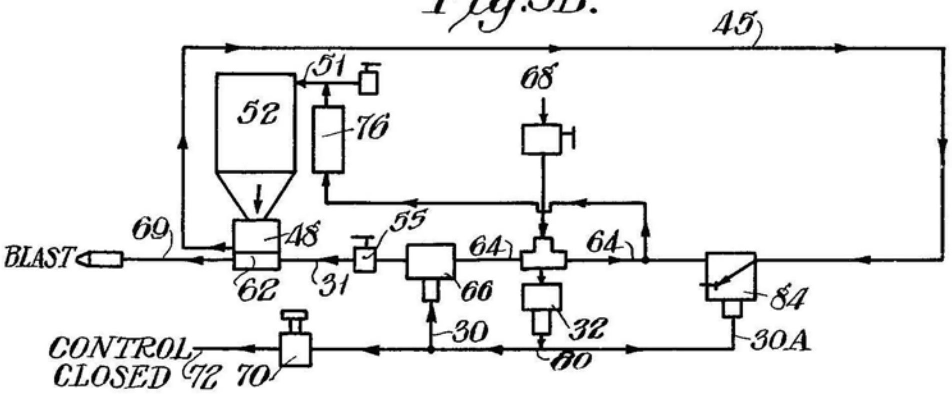


Fig. 5B.



INVENTOR
RALPH W. MOORE
BY Connolly and Hutz
ATTORNEYS

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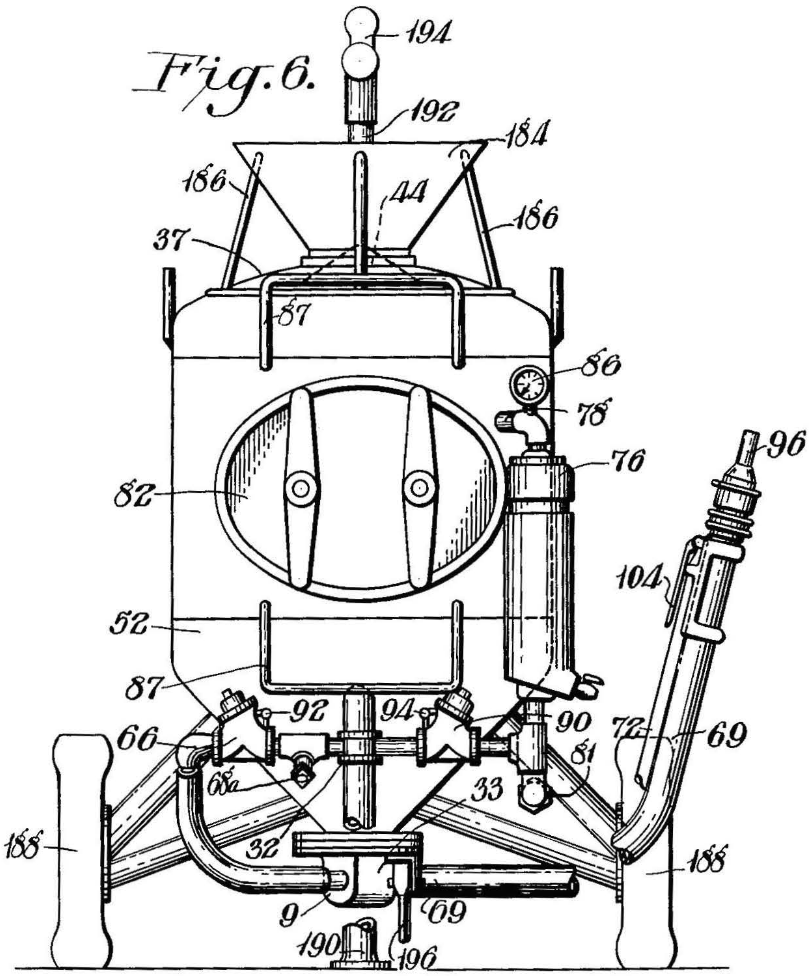
Fig. 6.



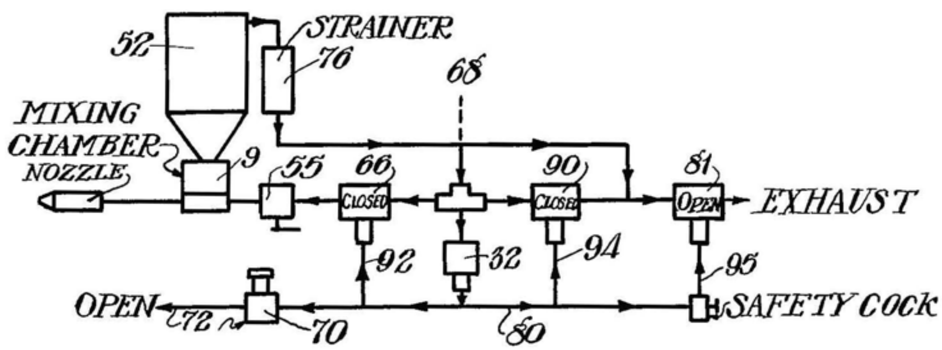
INVENTOR

Ralph W. Moore

BY Connolly and Hutz

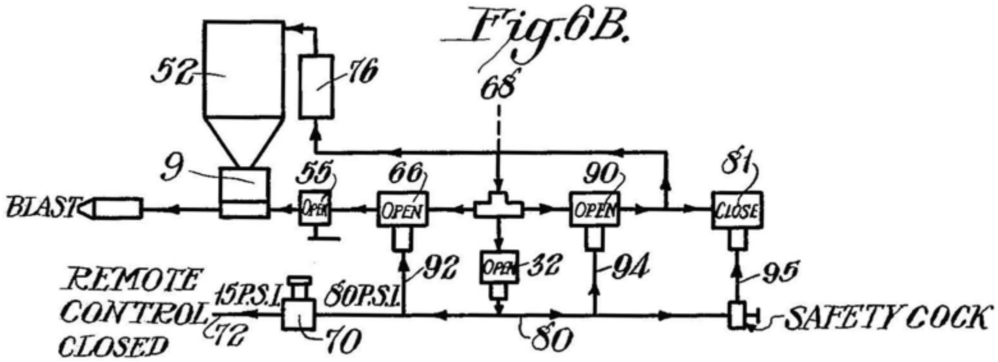
ATTORNEYS

Fig. 6A.



CONTROL OPEN OR SAFETY COCK OPEN - BLAST OFF

Fig. 6B.



CONTROL CLOSED-BLAST ON

INVENTOR
RALPH W. MOORE
BY Connolly and Hutz
ATTORNEYS

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Fig. 7.

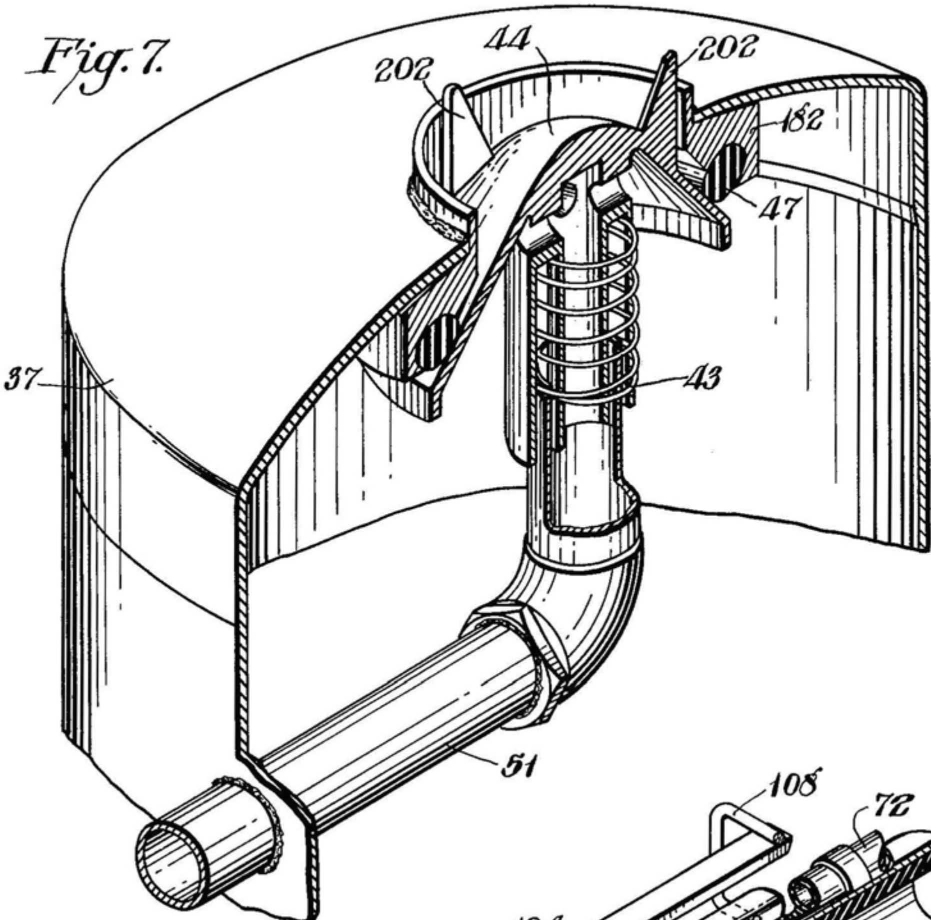
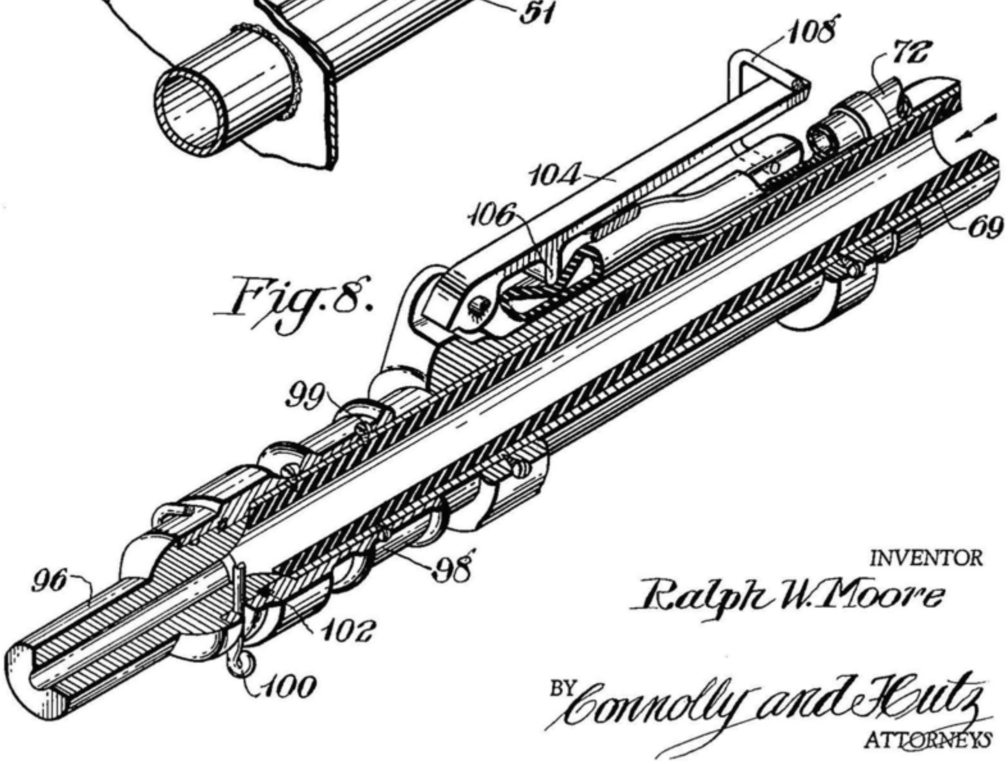


Fig. 8.



INVENTOR
Ralph W. Moore

BY Connolly and Hutz
ATTORNEYS

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3,089,285

ABRASIVE BLASTING APPARATUS

Ralph W. Moore, Hagerstown, Md., assignor to Pangborn Corporation, Hagerstown, Md., a corporation of Maryland

Filed Apr. 19, 1962, Ser. No. 188,744
6 Claims. (Cl. 51—8)

The present invention relates to the blasting of work pieces with abrasive particles carried by a stream of fluid, and more specifically, to apparatus for supplying and cutting off the flow of abrasive particles.

In the abrasive cleaning field, particularly the pressure blasting art, the maintenance of a shutoff or regulatory valving system is often found to be a source of considerable inconvenience and expense, and very few arrangements have been found which work consistently or well. Because of the nature of a stream of moving abrasive or blastant particles, the life of the usual regulating valve is generally very short. This is due to the fact that a moving abrasive tends to cut and scour the parts or to sift into and across valve seats and fittings causing added wear.

Various devices and techniques have been employed to lengthen the life and increase the reliability of abrasive regulatory devices. To date, however, the results have not been completely successful.

It is an object of the present invention to provide a wear-resistant, reliable system for supplying and controlling the flow of a stream of abrasive particles being fed under pressure.

The above and other objects are accomplished in accordance with the present invention by a supply apparatus that includes a valve structure having a valve seat positioned above a generally horizontally moving incoming abrasive stream and a vertically positioned and vertically movable hollow valve piston or tubular valving element, the interior of which also provides a discharge path for the incoming stream of abrasive material.

This valve arrangement is, in turn, activated by a dead man control conveniently located in the handle or nozzle of the blasting apparatus.

A better understanding of the invention will be gained by referring to the appended drawings wherein:

FIG. 1 is a vertical cross-section of a valving arrangement of the present invention shown in closed position;

FIG. 2 is a side view of the arrangement of FIG. 1;

FIG. 3 is a front view of the apparatus showing the valving device of FIGS. 1 and 2 in perspective and attached to a pressurized abrasive supply tank;

FIG. 4 is a side view of the apparatus showing the valving device in perspective with the abrasive pressure tank of FIG. 3;

FIG. 5 is a cut-away perspective of a modified valving device according to the present invention;

FIG. 5A is a schematic view of a pressure holding regulatory system of the type employed in FIGS. 1–4 in off position;

FIG. 5B is a schematic view of the pressure holding system of FIG. 5A in on position;

FIG. 6 is a front view of a modification of the apparatus of FIGS. 3 and 4;

FIG. 6A is a schematic representation of a pressure venting regulated blast system of the type illustrated in FIG. 6 in off position;

FIG. 6B is a schematic representation of the pressure venting system of FIG. 6A in on position;

FIG. 7 is a broken away perspective of the upper portion of the apparatus of FIGS. 3, 4 and 6; and

FIG. 8 is a cut-away perspective of a nozzle and dead man control for the regulatory system.

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The supply structure of FIGS. 1 and 2 comprises a pressurized tank, the lower portion of which is shown at 52, in sealed attachment as by welded-on flange 53 and O-ring 16, to the body of valving device 48 with a set of cap screws 19 and washers 23. The valving device 48 has a top plate 4, an intermediate ring 5, a lower cup 6, and a U-shaped bracket 7, held together by bolts 20 and 21. In the space between the arms of bracket 7 there is a mixing T 8 that includes a horizontal tube 62 and a vertical tube or stem 50, which is vertically slidable with respect to the floor of cup 6. A gland nut 14, containing scraper ring 29 and cylindrical guide 27, is pressed or threaded into the floor of cups 6, and provides a seal against the movable stem. The gland nut is, in turn, sealed against the cup floor by an O-ring 66 or similar gasket. A screw 3 adjustably threaded in the web of bracket 7 and locked in place by a nut 22, provides a stop for the downward travel of the mixing T. Flexible diaphragms 170 and 172 connected between stem 50 and the outer walls of the valving device seal the upper portion of its hollow interior. A head 54 and spacers 18 and 11 are clamped to the central portions of the diaphragms by nut 12 and secured to the stem 50. The outer portions of the diaphragms are clamped between the plate 4 and ring 5, and between ring 5 and cup 6 respectively. Inner O-rings 13 and 13A and outer O-rings 16 and 16A also help seal the diaphragm in place.

Mixing T 8 and vertical stem 50 are biased upwardly by compression spring 10 against a fixed valve seat 2 secured to valve cap 1 by screw 25 and washer 24. The spring is shown as disposed between clamp nut 12 and the floor of cup 6 in a chamber 56 in the lower portion of the interior of the valving device 48, although the spring can be external of the chamber, if desired. A control port 49 in the side wall of cup 6 enables the connection of a control line for fluid that can be introduced into or released from chamber 56 to effect operation of the valve. The horizontal tube 62 of the mixing T 8 can then be connected to a line that discharges a stream of fluid, so as to cause the stream to entrain the particles that are delivered from tank 52 through the valving device. An external breathing port 40 can also be provided for the space between the two diaphragms, but this is not essential.

Operation of the valving device of FIGS. 1 and 2 is effected by connecting an abrasive reservoir or tank 52 and the tube 62 to the same source of pressurized fluid, e.g. compressed air. An arrangement such as illustrated in FIGS. 3, 4, 5A and 5B is suitable for this purpose.

In FIGS. 3 and 4, abrasive tank 52 is shown with head 37 and filler valve guides 202. Pressurized air is obtained through receiving coupling 68 and passes into the tank through manifold 64, moisture and abrasive trap 76, tank connector T 78 and line 51. Also shown in FIGS. 3 and 4 is an externally mounted hose rack 87 for securing hose 69.

The arrangement illustrated in FIGS. 3, 4, 5A and 5B comprises a pressure tank 52 operating independently of the control of the pressure blasting stream. Main valve 66 controls the flow of the pressurized air from manifold 64 to line 31, horizontal mixing T 62 and into the blast discharge line 69. Manifold 64 also separately supplies air through filter restrictor 32, line 80 and pressure reducer 70 to remote control line 72. At the same time, pressurized air is connected through 3-way control valve 84 and line 45 to valving device 48 to maintain stem 50 (ref. FIG. 1) in seated position against valve seat 2 against the pressure of tank 52. Extension control line 30 controls the operation of valve 66 which is biased in a closed position and opens in response to an increase in pressure in line 80 obtained by blockage of remote control line 72.

When the device is to be turned on (ref. FIG. 5B) control line 72 is blocked, allowing pressure to build up in lines 80, 30 and 30A, tripping 3-way valve 84 to vent line 45 to the atmosphere and opening valve 66. As a result, the pressure in pressurized tank 52 acts on diaphragm 170 (ref. FIG. 1), opening valve 48, while full pressure is simultaneously flowing through line 31 into mixing T 8. At T 8 the vehicle and abrasive are admixed and proceed to the nozzle. If desired, a manually operated choke relief valve 55 can be inserted between valve 66 and valving device 48 so that substantially full pressure may be supplied from manifold 64 to tank 52 for the purpose of clearing any blockage in the valving device. If desired, it is also found convenient to install such a choke on a by-pass of valve 66 to allow lines 31 and 69 and the attached nozzle to be blown out with full pressure while valve 48 is in closed position.

When the operator wishes to shut off the flow of abrasive, he unblocks control line 72 causing the pressure within lines 80 and extensions 30 and 30A to drop. The reduced pressure activates 3-way valve 84 to direct pressurized air from manifold 64 through line 45 to the abrasive valve 48 to effect a seating of element 50, and also to effect a closing of valve 66 through line 30.

As employed in the present invention, the control fluid for activating valve 48 may be either a liquid or gas, and should be inert to the valve and conduit components under normal operating conditions. Air is preferred although other relatively inert gases can be used, and even water is useful, particularly where it is also the blastant propellant fluid.

In FIGS. 3 and 4 there is shown an inspection door 82 which provides access to the interior of tank 52, and a normally closed vent 74 which enables a venting of tank 52 when desired.

In FIG. 5 is shown a useful modification of the abrasive valving device of FIG. 1 in which a resilient lining or metering tube 39 is introduced into the bottom of vertical stem 50 and held in place by means of spacer 41 and retaining ring 34.

The liner is used in conjunction with an adjusting screw 38 threaded through the side of the vertical stem 50 and adapted for restricting or closing said tube. Such an arrangement is particularly useful in fine control of the rate of abrasive particle outflow into the blasting fluid, when the apparatus is in use.

A further modification includes the use of an outside guide 42 or pair of such guides in the form of two spurs in parallel arrangement and extending downwardly from the bottom of the lower cup 6 and contacting a corresponding member 46 extending upwards from the mixing T 8. By such an arrangement the mixing T can be prevented from rotating and causing extra wear on valve seat 2 while the valve is in closed position.

In both FIGS. 1 and 5 the valve seat 2 is made of tough resilient material such as vulcanized rubber (natural, chloroprene, butyl, GR–S, etc.) or plastic (polyethylene, Teflon, polyvinylchloride, etc.) or similar material which is capable of forming a good pressure seal with valving tube 50, and is resistant to wear. The seat can be perfectly flat where it is engaged by the top of stem 50, or it can be recessed 1/16 to 1/2 inch to further reduce erosion by the flowing stream of particles.

The diaphragms can also be made of the above tough materials, and can be further laminated with a textile layer.

In FIGS. 6, 6A and 6B is illustrated a modified device having a control system in which two 2-way pilot-operated valves 66 and 90 are closed when the device is not being used and valve 81 is biased in open position. This arrangement allows tank 52 to vent to the outside through exhaust valve 81.

When blasting is to be resumed, line 72 is blocked, building up pressure in control lines 80, and extensions 92, 94 and 95, which cause valves 66 and 90 to open and 2-way pilot valve 81 to close. Compressed air then flows into tank 52 and also through abrasive mixing chamber 9 to line 69.

The abrasive mixing chamber 9 as shown, has a quick release clamp 196 (FIG. 6) which may conveniently be of the type disclosed in FIG. 3 of applicant's copending application, Serial No. 146,144, filed October 19, 1961.

In FIG. 6 is illustrated a portable device having wheels 188, a supporting foot 190 together with a tow bar 192 and hitch 194. Also shown is an attached funnel 184 having supports 186.

FIG. 7 shows a suitable safety-fill arrangement for tank 52.

Cone-shaped valve 44 held on counter-balancing spring 43 is slidably connected to the end of filler line 51 and cooperates with a valve seat 182 around the inside of the fill opening at the top of the tank. When air is introduced into the tank through line 51, the pressure of the introduced air pushes valve 44 up against the seat 182. An abrasive-resistant sealing ring insert 47 can be provided for a better seal. Upon venting the gas from tank 52, valve 44 automatically opens to permit recharging with an abrasive. Guides 202 on valve 44 are helpful in engaging the walls of the filler opening to appropriately align and insert the valve. Both the valve and the seat or ring can be made of rubber, plastic or similar wear-resistant material.

In FIG. 8 is shown a suitable nozzle and nozzle control arrangement for use in the present invention. The nozzle comprises a hardened abrasive-resistant end member 96 made of material such as tungsten carbide or boron carbide attached and sealed to a supporting nozzle holder 98 by spring clip 100 and O-ring 102. The nozzle holder is, in turn, attached to the end of hose 69 by means of screws 99 or other convenient attaching ararngement. Also shown is control handle 104, pivoted at one end to nozzle holder 98 and possessing a spur 106. Control hose 72 is so arranged with respect to the nozzle that when the handle is squeezed against the holder, the spur 106 squeezes the hose sufficiently to effectively close it. A conveniently mounted retaining clip 108 is shown for locking the handle in operating position. Further details of a suitable arrangement of this type are shown in U.S. Patent 2,753,664 granted July 10, 1956.

As already illustrated in FIG. 1, it is preferred to employ a lower diaphragm 172 with a larger effective area exposed in chamber 56 than the corresponding area of diaphragm 170 exposed to tank pressure in the upper portion of the valve assembly. This arrangement enables valve 48 to be closed by a somewhat lower pressure in chamber 56 than that employed in tank 52, even if biasing spring 10 should break. The use of double diaphragms also provides an extra measure of protection since it is not likely that both diaphragms and spring 10 will fail at the same time. Failure of the upper diaphragm 170 will cause the pressure in the supply tank 52 to bleed through the failed diaphragm into the space between the two diaphragms and out through port 40, and by the sound of the resulting escaping stream of air, warn of the failure. Failure of the lower diaphragm 172 will open chamber 56 to the vent 40 and also give the above warning, which will sound differently if the control pressure employed is different from the supply tank pressure. Failure of the lower diaphragm will reduce the effectiveness with which the valve 48 is closed, or make it impossible to completely close the valve without the aid of spring 10.

The vent 40 can have a relatively small cross-sectional width. It can, for example, be made so narrow that the individual abrasive particles will not be able to enter it, so that failure of the upper diaphragm will not cause abrasive to be projected out through the vent along with the escaping fluid. However, even if the vent has a width of ¼ to ⅜ of an inch, it will not discharge tremendous amounts of the abrasive in the event the upper diaphragm breaks, though the abrasive particles are as small as 50 mils in thickness. The abrasive particles have a tendency to jam and bridge over an opening that is so small.

Vent **40** can also be fitted wtih a discharge tube projecting from its outer end and leading to a container which will catch escaping particles and keep them from being scattered all over the floor. The sound of the escaping fluid as it emerges with these particles can then be used as diaphragm-failure warning without the inconvenience of spilled abrasive particles.

Warning of diaphragm rupture can also be made more positive as by connecting vent **40** to a pressure-responsive switch not shown to shut off the main air supply line when the pressure in the vent exceeds the maximum developed in ordinary operation.

As a safety measure, it is preferred to have the element **50** of FIGS. 1 and 5 mechanically spring-biased toward closed position as by spring **10**, so that the valve will remain closed when the pressure in storage tank **52** is discharged, or the device disconnected from a compressed air source. Such an arrangement is useful in preventing undesired escape of particles from the tank.

Instead of having a superatmospheric control pressure applied to the lower diaphragm for closing the valve, a subatmospheric pressure can also be used. For this purpose, a partition can be inserted between the two diaphragms, below the vent **40**, for example, and the space between the partition and the lower diaphragm connected to a source of suction. This partition can also be used as a guide for the vertical movements of the valve **T** instead of having the cup **6** perform this function. The source of suction can be a venturi operated by the compressed air used in the blasting.

The valve construction of the above type, that is with a generally horizontally moving incoming abrasive stream that passes below the valve seat and enters a vertically positioned and a vertically movable hollow valve piston which can be engaged with that seat, shows an unusually long life in service. Even such highly abrasive materials as sand and the like, will not wear out the valve as rapidly as it will other types of valves.

Since it is obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited to said details except as set forth in the appended claims.

What is claimed:

1. A pressure-responsive mixing device for controlling the flow of a stream of particles from a supply tank, said device including a flow conduit, a tubular member having its upper portion projecting into the conduit and providing a discharge path for the conduit, a rubber valve seat in said conduit above the upper portion of the tubular member, a spring for upwardly biasing the tubular member against the valve seat, two spaced pressure-responsive diaphragms holding the tubular member in place, and a pressure applying connection for causing changes in pressure to raise and lower the tubular member against and away from the valve seat, one of said diaphragms having one face exposed to the conduit while the second diaphragm has the opposite face exposed to the pressure-applying connection, the total moving area of the second diaphragm being greater than the corresponding area of the other diaphragm, the upper portion of the tubular member forming a valve closure with said seat.

2. The combination of claim 1 in which the lower part of said tubular member is equipped with a resilient lining and means for restricting said lining.

3. The pressure-responsive mixing device according to claim 1 wherein a fluid carrying line is connected with said supply tank to produce a pressure in said tank, a fluid supply manifold is directly connected to one end of said pressure line, a fluid blast line is connected with the other end of said manifold and with said tubular member for picking up and propelling the particles discharged through said tubular member supported by said pressure-responsive diaphragms, a normally closed valve is interposed between said manifold and said blast line, a remote control fluid line is connected at one end with said normally closed valve and discharges into the atmosphere at the other end, an auxiliary connection leads from said manifold to said remote control line, and a valve is installed at the discharge end of said remote control fluid line for closing off said remote control line to build up back pressure within said remote control line when fluid is provided thereto from said manifold to open said valve connecting said manifold and blast line.

4. The pressure-responsive mixing device according to claim 3 wherein a three-way valve is connected with said manifold, said remote control line, and said pressure applying connection for said pressure-responsive diaphragms.

5. The pressure-responsive mixing device according to claim 4 wherein a choke relief valve is inserted between said normally closed valve and said pressure applying connection.

6. The pressure-responsive mixing device according to claim 3 wherein a choke for the blast line is installed in a by-pass line of said normally closed valve.

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