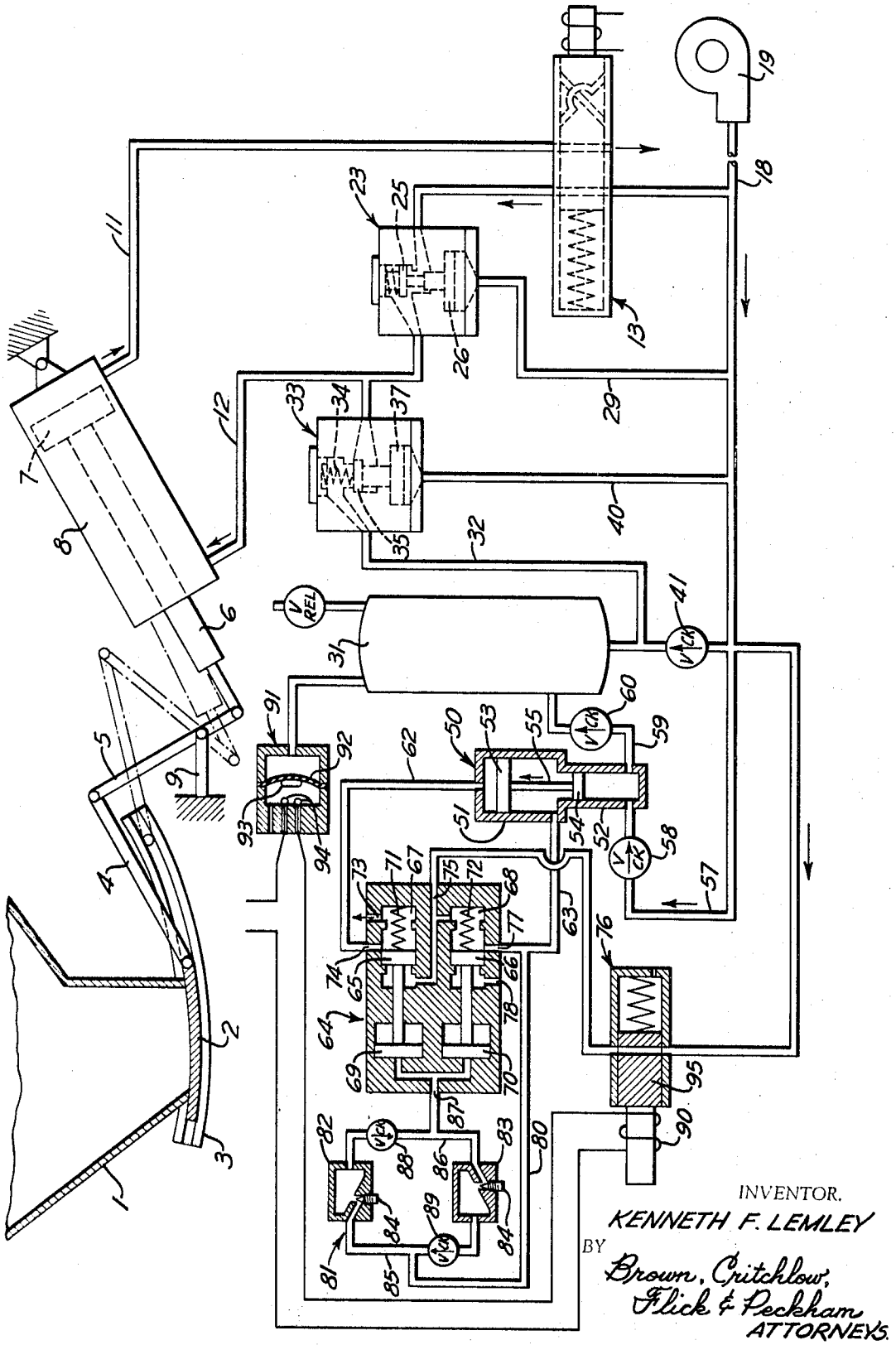
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HIGH PRESSURE FAIL-SAFE GATE-OPERATING APPARATUS

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# HIGH PRESSURE FAIL-SAFE GATE-OPERATING APPARATUS

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This invention relates to fluid pressure actuated gate-operating apparatus, and more particularly to such apparatus that will automaticaly close a gate if the fluid pressure fails.

Such fail-safe apparatus is shown and described in my Patent 3,225,544. In that patent, if the air pressure to the gate-operating cylinder fails, air under pressure in a reservoir immediately will be connected with the cylinder to close the gate. That system has proved to be very satisfactory, but when the gate-operating cylinder is quite large the compressed air tank or reservoir has to be made much larger than desired and occupies too much space. This is because the air in the reservoir is at the same relatively low pressure as that delivered by the compressor which normally operates the gate, and therefore there has to be a large volume of this compressed air stored in the reservoir to ensure closing of the gate.

It is among the objects of this invention to provide apparatus similar to that shown in my Patent 3,225,544, which can utilize a small compressed air reservoir for operating a large gate-operating cylinder, which requires no additional power except an insignificant amount of electricity for closing a valve, and which is entirely automatic.

In accordance with this invention, a reservoir contains compressed air that is used only for closing a gate in emergencies. There is a source of compressed air for keeping the reservoir charged. Likewise connected to the reservoir is a pressure intensifier that increases the air pressure in the reservoir above the pressure supplied by the source just mentioned. This intensifier includes a cylinder containing a piston for operating the intensifier. A pair of conduits are connected with the cylinder at opposite sides of the piston and with a reversing valve. The reversing valve is connected with the compressed air source for connecting it with the conduits alternately in order to reciprocate the piston. Means are provided for operating the reversing valve, preferably from the compressed air in the system.

The preferred embodiment of the invention is illustrated schematically in the single figure of the accompanying drawing.

Referring to the drawing, it includes a reproduction of all of FIG. 1 of the drawings in Patent 3,225,544. The reproduced parts also have been given the same numbers as in the patent, but some of them will be described more briefly herein. For a more detailed description, if desired, reference may be made to the patent. In the drawing of this aplication, the bottom outlet of a hopper or bin **1** is shown closed by a door or gate **2** that can slide in stationary tracks **3**. For reciprocating the gate in order to open and close it, one end of it is pivotally connected by a link **4** to the upper end of a lever **5**, the lower end of which is pivotally connected to the outer end of a piston rod **6** attached to a piston **7** in a fluid pressure cylinder **8**. The lever is pivotally connected to a suitable support **9**. It will be seen that when the piston is moved to the left-hand end of the cylinder the link and lever will pull the gate away from the bottom of the bin to open its outlet. When the piston is returned to the right-hand end of the cylinder, the gate will be closed.

For accomplishing these movements of the piston in the cylinder, a pipe **11** is connected to the right-hand end or gate-closed end of the cylinder, while another pipe **12** is connected to the opposite or gate-open end of the cylinder. These pipes may be flexible in whole or in part if desired. Both pipes terminate at control means for selectively connecting a source of compressed air with either of them and for connecting the other pipe with the atmosphere. Such means may include a conventional fluid pressure operated valve **13** having a solenoid-actuated pilot. As shown, the valve connects pipe **11** with the atmosphere and simultaneously connecting pipe **12** with a line **18** leading from a source of compressed air, such as a compressor **19**. When the control valve is reversed, it connects the compressor with pipe **11** and connects pipe **12** with the atmosphere. Thus, by operating this valve, air pressure can be delivered to either end of cylinder **8** in order to move the piston therein back and forth. The apparatus described thus far is satisfactory as long as the necessary air pressure is maintained in line **18**.

However, if while the gate is open, the air pressure in the system should happen to drop below the amount necessary to close the gate, thirty pounds per square inch absolute for example, emergency apparatus will come into operation automatically to move piston **7** towards the gate-closed end of the cylinder. Accordingly, pipe **12** is provided with a first valve **23** that normally is closed by a closure member **25**. However, the valve contains fluid pressure responsive means for opening it, which may be a plunger **26** slidably mounted in the bottom of the valve, which opens into the upper end of a tube **29** connected with compressed air line **18**. As soon as pressure in the line is built up to a predetermined point, it will force the plunger upward and thereby open the valve as shown so that compressed air can flow through pipe **12** to cylinder **8** when control valve **13** is in the position shown. When the control valve is reversed, air from the cylinder will escape through valve **23** and the control valve to the atmosphere. As long as the gate-operating apparatus is in use, and functioning properly, valve **23** will remain open.

Also connected with the compressed air line **18** is a reservoir **31**, which is charged with compressed air from the compressor. This reservoir is connected by a conduit **32** with pipe **12** between valve **23** and cylinder **8**. This conduit contains a second valve **33** that normally is held open by a coil spring **34** pressing the movable closure member **35** away from its seat. This valve likewise contains fluid pressure responsive means, which may be in the form of a plunger **37** in the bottom of the valve. The bottom of the valve is connected by a tube **40** to compressed air line **18**, so that while the compressor is operating, the air pressure against the bottom of plunger **37** will hold the plunger in its upper position and thereby close the valve. It will be seen that this valve will remain closed as long as the gate-operating apparatus is operating normally, so air cannot escape from reservoir **31** through conduit **32**. It cannot escape back through line **18** in case there is a break in the line, because there is a check valve **41** in the line close to the reservoir.

As explained above, during normal or proper operation of this apparatus, valve **23** is held open and valve **33** is held closed by the compressed air delivered by the compressor through line **18** and tubes **29** and **40**. However, in case there is a failure of pressure while the gate is open so that it cannot be closed in the normal way by compressed air flowing through valve **23**, the drop in pressure below a predetermined value will permit the valve **23** to close and valve **33** to open. The moment valve **23** is opened, compressed air in the reservoir is connected through conduit **32** and pipe **12** with the left-hand end of the operating cylinder to drive piston **7** toward the oppo-

site end of the cylinder and close the gate. After the difficulty that reduced the air pressure has been corrected so that the proper pressure can be built up in the system again, the air from the compressor will reopen valve **23**, close valve **33** and recharge the reservoir through check valve **41**. The reservoir is then ready to operate the piston again if another emergency should ever arise.

Obviously, the capacity of the reservoir should be great enough to provide sufficient air pressure to force the piston toward the gate-closed end of the cylinder and hold it there. To ensure having sufficient pressure for this purpose, and yet not provide a reservoir that is larger than it needs to be, the proper size for the reservoir can be determined in advance. It can be determined by multiplying the air pressure per square inch absolute in the charged reservoir by the volume of the reservoir, and dividing the product by the combined volume of the reservoir and cylinder. The result will be the air pressure per square inch absolute available for shifting the piston in its cylinder. In this way a reservoir can be selected that will provide the desired air pressure for operating the piston.

The apparatus described thus far is perfectly satisfactory for its intended purpose, but in installations where cylinder **8** becomes quite large, reservoir **31** also would have to be made much larger, except for this invention. Accordingly, it is a feature of this invention that regardless of the size of cylinder **8**, reservoir **31** can be maintained quite small. This is accomplished by providing the apparatus with means for greatly augmenting the air pressure in the reservoir, such as by an intensifier **50** which is formed from two aligned cylinders containing two pistons. The upper cylinder **51** is shown considerably larger than the lower one **52**, and therefore the upper piston **53** is much larger than the lower piston **54**. The two pistons are rigidly connected together by a rod **55**. The lower part of the small cylinder is supplied with compressed air through an extension **57** of compressed air line **18**. This pipe is provided with a check valve **58** that opens toward the intensifier. The same part of the intensifier is connected by a discharge pipe **59**, containing a check valve **60**, with the reservoir **31**.

To move the upper piston **53** up and down in its cylinder in order to reciprocate the lower piston and thereby force air under high pressure through pipe **59** into the reservoir, a conduit **62** is connected to the upper end of upper cylinder **51** and another conduit **63** is connected to the lower end of the cylinder. Both conduits lead to a reversing valve **64** of the bi-stable type, in which a pair of valve members **65** and **66** are movable back and forth in chambers **67** and **68** by pistons **69** and **70** and coil springs **71** and **72**. When the valve members are held in their left-hand positions by the springs, as shown, a passage **73** connects conduit **62** with the atmosphere by means of chamber **67** and a passage **74**. At the same time, an inlet passage **75** from line **18**, containing a normally open solenoid shutoff valve **76**, is connected through chamber **68** and a passage **77** with the lower conduit **63**.

With the valves in the positions shown, air under pressure from compressor **19** is entering the bottom of the large cylinder of the intensifier and thereby forcing the piston therein to rise. When the reversing valve **64** is reversed, the lower conduit **63** is connected with exhaust through chamber **68** and a passage **78**, and upper conduit **62** is connected with inlet passage **75** through chamber **67**, so that air pressure from line **18** will be applied to the top of the upper piston **53** to force it down in its cylinder. It will thus be seen that if the reversing valve is reversed periodically, the pistons in the intensifier will be reciprocated by air from the compressor and some air from the compressor will be increased in pressure by the intensifier and delivered to the reservoir. Consequently, the air in the reservoir can be maintained at a much higher pressure than the compressor can supply, so that in an emergency there will be a sufficient volume of compressed air to operate gate cylinder **8** even though the reservoir is relatively small as compared with the gate cylinder.

Another feature of this invention is that air from the compressor is used as the motive power for reversing the reversing valve **64**. For this purpose, the conduit **63** is connected by a branch pipe **80** to a pneumatic timer **81** that is connected to the left-hand end of the reversing valve. This timer permits air from the compressor to periodically move pistons **69** and **70** and valve members **65** and **66** in the reversing valve to the right against the resistance of the coil springs pressing against them, whereupon the pistons in the intensifier **50** will be driven downward until the timer allows the coil springs to return the valve member to the left-hand position.

The timer may be formed from two timing valves **82** and **83** connected in parallel. Each of these valves is provided with an orifice adjustable by a needle **84** to permit air to flow through the valve at a controlled slow rate. The two valves are connected at one end by a pipe **85** connected to branch pipe **80**, while their opposite ends are connected by a pipe **86** that in turn is connected with a passage **87** in the reversing valve leading to the two pistons therein. Between passage **87** and timing valve **82** there is a check valve **88**. Between the other timing valve and pipe **80** there is another check valve **89**. One of these check valves opens toward the reversing valve and the other one opens away from it.

It will be seen that while compressed air is entering the bottom of the large cylinder **51** of the intensifier, it also is flowing slowly through pipes **80** and **85** and timing valve **82** and into the adjacent end of the reversing valve. At about the time the pistons in the intensifier reach the tops of their cylinders, the air pressure against the pistons in the reversing valve becomes great enough to unbalance the valve members therein and shift them to the right, thereby connecting the compressor with the top of the intensifier and connecting the bottom of the large piston **53** with exhaust. Of course, at the same time the timer is connected with exhaust through pipe **80**. As the air pressure against the reversing valve pistons slowly discharges through timing valve **83** to exhaust, the intensifier pistons are being moved downward to increase the pressure of the air in reservoir **31**. At about the time they reach the lower ends of their cylinders, the air pressure in the reversing valve has been reduced to such a point that springs **71** and **72** can expand and quickly push valve members **65** and **66** back to their original positions, wherein the compressor again will be connected with conduit **63** and the timer, while the upper conduit **62** will be connected with exhaust. This automatic periodic reversal of the reversing valve therefore causes the intensifier to operate like a pump and increase the air pressure in the reservoir.

When the pressure in the reservoir reaches the desired level, provision is made for shutting off the intensifier. This may be done by connecting the solenoid coil **90** of the shutoff valve **76** with a normally-open fluid pressure switch **91** responsive to the air pressure in the reservoir. When that pressure rises to the desired value, it will move the diaphragm **92** in the pressure switch to the left and thereby cause a bridging bar **93** to span the electric contacts **94** so that the circuit to the shutoff valve will be closed. This will cause the valve member **95** in that valve to be moved to the right in order to shut off flow of compressed air to the upper cylinder **51** of the intensifier. Whenever the pressure in the reservoir drops, due to leakage or to use of the air therein, pressure switch **91** will open again and that will allow the shutoff valve to open so that the intensifier can start operating again to build the pressure in the reservoir back up to the desired level.

It will be observed that the intensifier is operated entirely automatically by the same compressor that charges the compressed air reservoir, and that the only additional

power required is the electricity used for closing shutoff valve 76, when the pressure in the reservoir is at its maximum.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In fail-safe gate-operating apparatus having a reservoir containing compressed air that is used only for closing a gate in emergencies, and a source of compressed air for charging the reservoir, of a pressure intensifier connected with said reservoir for increasing the air pressure in the reservoir above the pressure supplied by said source, said intensifier including a cylinder containing a piston for operating the intensifier, a pair of conduits connected with the cylinder at opposite sides of the piston, a reversing valve connected with said source for connecting it with said conduits alternately to reciprocate the piston, and means for operating the valve.

2. In fail-safe gate-operating apparatus according to claim 1, said valve connecting one conduit with the atmosphere when it connects the other with said source, and said valve-operating means including a spring urging the valve in one direction and an air line permanently connected with one of said conduits to employ the pressure from said source for moving the valve in the opposite direction.

3. In fail-safe gate-operating apparatus according to claim 2, said fluid pressure line containing a timer comprising an air passage provided with a restricted orifice and a check valve opening toward the reversing valve, and a second air passage provided with a restricted orifice and a check valve opening away from the reversing valve.

4. In fail-safe gate-operating apparatus according to claim 1, said intensifier receiving compressed air from said source, increasing its pressure and delivering it to the reservoir.

5. In fail-safe gate-operating apparatus according to claim 1, a normally-open valve connecting said source with said reversing valve, and means controlled by the pressure in said reservoir for closing said normally-open valve when that pressure rises to a predetermined value.

6. In fail-safe gate-operating apparatus according to claim 5, said normally-open valve being electrically operable, and said pressure-controlled means being a normally-open pressure switch electrically connected with said normally-open valve and closable by a predetermined pressure in said reservoir.

7. In fail-safe gate-operating apparatus according to claim 1, a conduit connecting said source with the intensifier for delivering compressed air thereto to be increased in pressure thereby and delivered to the reservoir,



a normally-open electrically operated valve connecting said source with said reversing valve, said pressure-controlled means being a normally-open pressure switch electrically connected with said normally-open valve and closable by a predetermined pressure in said reservoir, said reversing valve connecting one of said pair of conduits with the atmosphere when it connects the other with said source, and said valve-operating means including a spring urging the reversing valve in one direction and an air line permanently connected with one of said pair of conduits to employ the pressure from said source for moving the reversing valve in the opposite direction and containing a pneumatic timer.

8. Fail-safe gate-operating apparatus comprising a fluid pressure cylinder, a piston therein, a piston rod attached to the piston and extending out of one end of the cylinder for opening and closing a gate, pipes connected to the opposite ends of the cylinder, a source of compressed air, control means for selectively connecting said source with either of said pipes and connecting the other pipe with the atmosphere to move the piston from one end of the cylinder to the other, a normally closed first valve in the pipe that delivers compressed air to the end of the cylinder from which the piston moves to close the gate, said valve containing fluid pressure responsive means for opening it, means for delivering compressed air from said source to said pressure responsive means to hold the valve open during normal operation of the apparatus, a reservoir, a conduit connecting the reservoir with said valved pipe between said valve and cylinder, a normally-open second valve in said conduit provided with fluid pressure responsive means for closing it, means for delivering compressed air from said source to the pressure responsive means of the second valve to hold that valve closed during normal operation of the apparatus, a conduit connecting said source of compressed air with the reservoir, a check valve in said last-mentioned conduit permitting flow of air therethrough only toward the reservoir to charge it with compressed air, a pressure intensifier connected with said reservoir for increasing the air pressure in the reservoir above the pressure supplied by said source, said intensifier including a cylinder containing a piston for operating the intensifier, a pair of conduits connected with the cylinder at opposite sides of the piston, a reversing valve connected with said source for connecting it with said pair of conduits alternately to reciprocate the piston, and means for operating the reversing valve.

9. Fail-safe gate-operating apparatus according to claim 8, including a shut off valve normally connecting said source with said reversing valve, and means controlled by the pressure in said reservoir for closing said shut-off valve when that pressure reaches a predetermined maximum.

No references cited.

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