United States Patent

Blatt

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[54] PRESSURE SAFETY RELEASE INDUSTRIAL AIR EXHAUST SILENCER

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[51] **Int. Cl.**.....**F01n 1/10,** F01n 1/20, F01n 3/00

[58] **Field of Search**.....181/36–38, 36 A, 181/45, 47, 47 A, 64 B, 65, 72

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[57] **ABSTRACT**

An air exhaust silencer comprises a barrel which has a piston head, the barrel is contained for reciprocation within a cylinder and is normally retained in the cylinder in an inwardly retracted position so as to permit air exhaust through the silencer structure supported within the barrel and which embodies a pair of gas permeable frequency distorters adapted to muffle the noise of the exhaust air to below a predetermined maximum noise level; the barrel containing cylinder of the silencer is provided with a plurality of relief ports which are in open communication with a normally closed off relief chamber in front of the piston head; regulated fluid pressure retaining means are employed to normally retain the barrel in the retracted position; upon build-up of back pressure in the silencer assembly, due to clogging of the gas permeable members of the silencer, the increased air pressure through the silencer becomes sufficient to move the barrel of the silencer out of the cylinder overcoming the magnitude of the fluid pressure retaining means to establish communication between the relief chamber and the inlet port of the silencer to thereby permit air pressure to bypass said clogged gas permeable members of the silencer for direct passage to the atmosphere.

7 Claims, 3 Drawing Figures

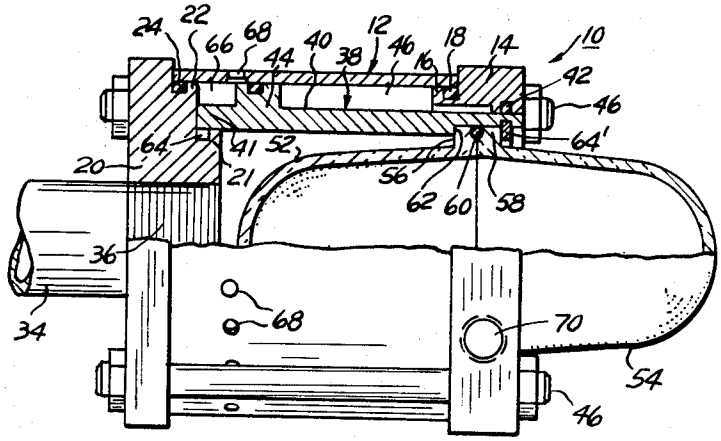


FIG. 1

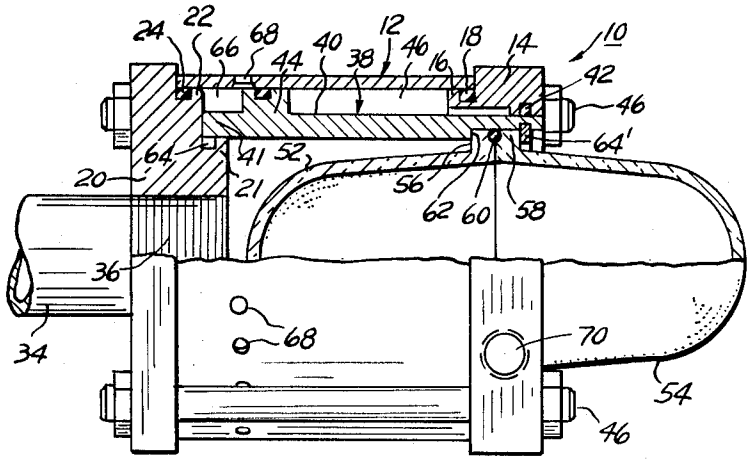


FIG. 2

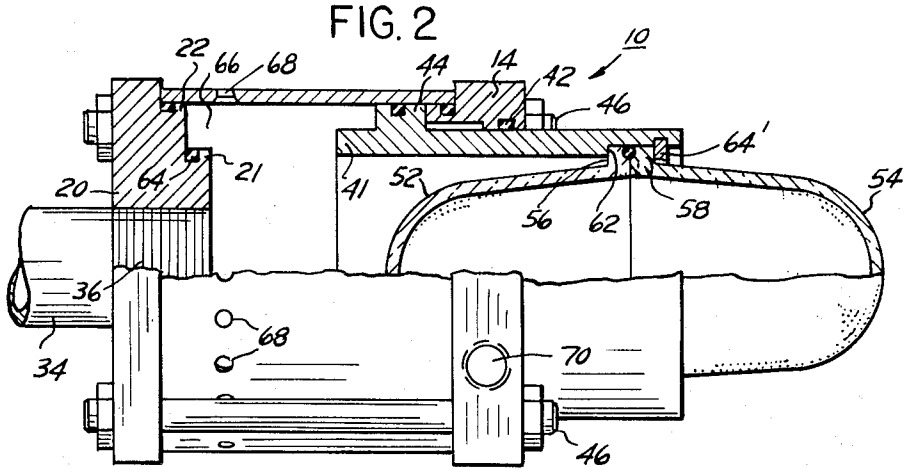
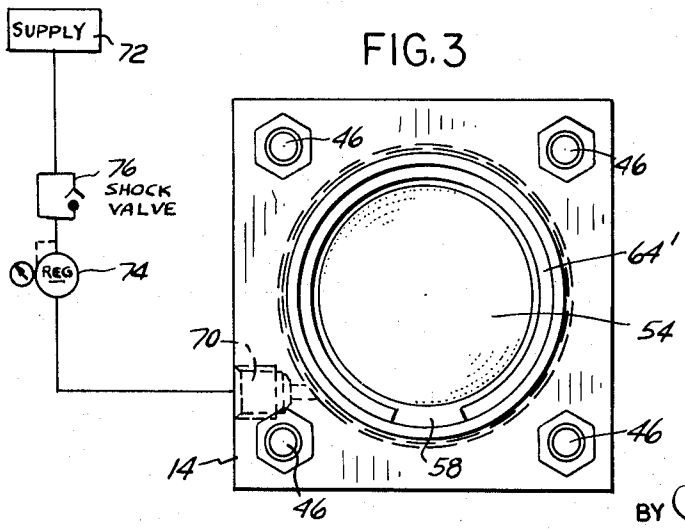


FIG. 3



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PRESSURE SAFETY RELEASE INDUSTRIAL AIR EXHAUST SILENCER

REFERENCE TO RELATED APPLICATIONS

The present application relates in part to the air exhaust silencer structure disclosed in applicants co-pending application, Ser. No. 91,125, filed Nov. 19, 1970, now U.S. Pat. No. 3,612,214, issued Oct. 12, 1971, for "Pressure Release Safety Industrial Air Exhaust Silencer" and comprises a further improvement thereof.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to mufflers or silencer structures and more in particular to an air exhaust silencer of the type disclosed in applicant's afore mentioned co-Pending application, Ser. No. 91,125.

As described in detail in the above referred to copending application, these types of silencers are incorporated in industrial applications for air valve outlets or venturis on air operated tools, pneumatic presses and the like.

The silencer of the present invention, and as described in the afore mentioned co-pending application, has a barrel type housing providing an inlet for attachment to a respective air exhaust. The housing contains one or more frequency distorters made of porous material, such as sintered bronze, ceramic or the like, and in certain applications may also include a frequency modulator of foam material disposed between two adjacent frequency distorters.

It is evident that with the type of porous material used for the frequency distorting and frequency modulating members of the silencer, if the air exhaust lines to which the silencer is attached carry any foreign material, such as debris, scale, hard grease, etc. the foreign material conveyed by the stream of air will be carried into the silencer and eventually clog the porous frequency distortion members, which act as a filter letting only air through at a certain flow rate, the foreign material carried by the air flow being caused to adhere to the surface of the porous frequency distortion members. Clogging of the porous members through which the exhaust air is caused to pass, of course, considerably decreases the flow efficiency through the silencer and creates a back pressure.

In most ordinary applications, this will present no great problem other than the possible slow-down of the operating equipment to which the silencer is attached. However, in some particular applications, such as in clutch or brake valve applications for a pneumatic press, clogging of the porous members in the silencer will eventually cause the valve to malfunction and, thus, the brake or clutch of the press cannot be operated properly, with the result that the press ram would automatically continue to reciprocate without the usual intermittent stop and start requirement of the ram. This, of course, creates a considerable safety hazard and may also result in costly damage to the machinery.

In view of the foregoing, the present invention provides an improved, pressure release, safety mechanism for this type of silencer which is effective to maintain a constant flow rate from the exhaust through the silencer or directly to the atmosphere. Thus, in the event that the porous members of the silencers should become severely clogged, the increased air flow pressure through the silencer is effective to actuate the safety release mechanism, causing the air flow to be directly diverted to the atmosphere by bypassing the clogged porous frequency distortion members of the silencer, until such time at which the clogged porous members will have been cleaned or replaced.

In the afore mentioned co-pending application the barrel of the silencer assembly, which carries the frequency distortion member, is maintained in retracted position within an outer cylinder surrounding the barrel by mechanical means such as shear pins or expansion springs which would give way when subjected to a certain pressure magnitude.

Although these arrangements in the prior application are sufficiently effective for most applications to exhausts of valve

operated brake or clutch release mechanisms of a particular machinery, it has been found that in certain instances an increased versatility of pressure release adjustment will be required to accommodate varying operating fluid pressures. In other words, in the prior arrangements of applicant's co-pending application the shear pin strength or, respectively, the compression force of the biasing spring can only be designed at a fixed pressure magnitude to be operable.

Accordingly, applicant's present application provides for a variable adjustment of the normal operating retaining force to normally close off the pressure relief ports to the atmosphere. This is accomplished by the provision of a regulated fluid pressure system acting on the barrel of the silencer in such way as to normally retain the barrel of the silencer in the retracted position within the cylinder housing and which pressure can be regulated by means of a manual pressure regulator incorporated in the fluid system. Thus, the retaining pressure acting on the barrel of the silencer can be adjusted to accommodate various operating conditions of the machinery or respectively accommodate varying operating fluid pressures of, for instance, valve mechanisms for operation of brake or clutch release means of a machinery such as found in heavy presses and the like. The fluid pressure magnitudes for these valve mechanisms are usually designed to be operable between a minimum and a maximum pressure magnitude within which the brake or clutch release mechanisms are effectively operable.

Accordingly, the present improved silencer pressure relief mechanism incoporates adjustable features to accommodate a wide range of operating pressures for fluid pressure operated mechanisms as above described without the need of any physical or structural alterations in the silencer structure itself.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a preferred embodiment of the invention in which:

FIG. 1 is a longitudinal cross-section through the improved embodiment utilizing regulated fluid pressure to normally maintain the silencer in operating condition;

FIG. 2 illustrates the arrangement of FIG. 1 in the extended position for bleeding off air pressure directly to the atmosphere; and

FIG. 3 is a front end view of the device including a diagram of the regulated fluid pressure system.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the drawings, the improved embodiment of the combined silencer and pressure relief assembly, generally indicated at **10**, is composed of a cylindrical housing **12** closed by an outer end cap **14** having a pilot section **16** extending into said housing **12** and which provides the seat for a seal ring **18**. The other end of the cylindrical housing **12** is closed by a port cap **20** similarly provided with a pilot portion **22** which extends into the housing **12** providing a seat for a similar seal ring **24**. The two end caps **20** and **14** are tied together by a plurality of tie rods **46**, as is customary in cylinder designs of this kind.

The cylinder **12** is attached to the air exhaust pipe **34** of the particular device or tool to which the silencer structure is applied, by means of a threaded bore **36** in end cap **20**, which provides the inlet into the silencer structure.

The cylindrical housing **12** is adapted to receive a silencer assembly **38** composed of a cylindrical barrel **40** which outer end is supported in sliding engagement with the internal surface of the outer end cap **14**. The inner radial surface of the outer end cap **14** is provided with a seal assembly **42** for sealing engagement around the barrel **40**.

The inner end of the barrel member **40** carries a piston head **44** adapted for reciprocation within the cylinder **12**.

It will be noted that the outer diameter of the barrel member **40** is of substantially smaller dimension than the inner diameter of the cylinder **12** to thereby provide a radial chamber **46** between the barrel **40** and cylinder **12**.

The outer end of the barrel **40** of the silencer assembly **38** retains a pair of frequency distorter members **52** and **54**, respectively, of identical construction and assembled in back-to-back relationship. The frequency distorter members **52** and **54** are of axially extending dome shaped configuration such that the member **52** extends through the barrel **40** forwardly towards the inlet **36** and the other member **54** extends axially outwardly of both the barrel **40** and cylinder **12**. Each of the frequency distorter member **52** and **54** is provided with an opposed radial flange **56** and **58**, respectively, which are disposed in abutting relationship and retain a sealing member **60** in between them. In order to retain the members **52** and **54** in position, the flange **56** of the member **52** abuts against an inner shoulder **62** within the barrel **40** and the other flange **58** of the other member **54** is clamped against flange **56** by means of a lock ring **64'**.

As more fully in detail described, in co-pending application Ser. No. 81,051, filed Oct. 15, 1970, shaped frequency distorter members **52** and **54** are made of a porous material such, as for instance, sintered bronze, ceramic or the like, having a predetermined density which varies with the particular application of the silencer assembly. Alternately, the density of the porous material of the frequency distorter member **52** may be different from that of the other frequency distorter member **54** to thereby obtain sequential noise reduction of the exhaust air passing through the silencer assembly **38**.

In certain applications, and particularly in applications where different noises at different frequencies must be absorbed by the silencer and additional noise reduction baffle member of porous nature may be provided and which would be located between the dome shaped frequency distorter members **52** and **54** as disclosed in the above mentioned co-pending application. This baffle member, which appropriately can be called a frequency modulator, is made of a foamed urethane or any similar porous material.

In accordance with the present invention, the front end **41** of the barrel member **40** of the silencer **38** is seated on an axially inwardly extended hub portion **21** of the end cap **20** which is provided with a seal assembly **64** for sealing engagement against the barrel member **40**. The piston **44**, which may be integrally formed as a radial flange on the barrel member **40**, is located a predetermined distance rearwardly of the front end **41** of the barrel member **40**. Thus, in the normal operating position of the silencer assembly **38**, as shown in FIG. **1**, a second radial chamber **66** is formed between the end cap **20** and the piston **44** of the barrel member **40**. The second radial chamber **66** under normal operating conditions shown in FIG. **1**, is normally closed off from the inlet **36** of the silencer assembly by means of sealing engagement of the front end **41** of the barrel member **40** on the axial hub portion **21** of the end cap **20**. The cylindrical housing **12** is provided with a plurality of relief ports **68** circumferentially arranged around the housing. The relief ports **68** are in constant communication with the second radial chamber **66** for connection of the chamber **66** with the atmosphere. Thus, the second radial chamber **66**, in front of the barrel piston **44**, defines an air exhaust relief chamber normally closed off against the interior of the silencer **38**.

As further contemplated in the present improved safety exhaust device, the radial chamber **46** between the rear end of the barrel piston **44** and end cap **14** is connected by means of an inlet **70** provided in the end cap **14** to a source of fluid under pressure, indicated at **72** in FIG. **3**. The fluid pressure maintained in the radial chamber **46** to normally maintain the barrel assembly **40** of the silencer **38** in retracted position within the cylindrical housing **12**, is adapted to be manually regulated by a regulator **74** installed between the source **72** and the fluid inlet **70**. Additionally, as is common practice, a one-way check valve is provided between the source **72** and the regulator **74**, said check valve being shown at **76**.

Thus, in accordance with the present invention, the fluid pressure within the radial chamber **46** of the assembly **10** acting against the barrel piston **44** is adapted to be accurately adjustable by means of the manual regulator **74** relative to the exhaust pipe **34** of the device to which the assembly **10** is attached, which may vary under certain operating conditions.

The pressure within the radial chamber **46** of assembly **10** acting on the cross sectional piston area of **44**, may be adjusted to maintain the silencer assembly **38** in a retracted position within the cylindrical housing **12** with **41** in contact with seal **64** so to permit the air to exhaust through the hemispherical silencing elements **52** and **54**.

If the pressure in **46** were to be increased proportionally a greater percentage of clogging could be tolerated, still permitting the air to exhaust through the silencing elements. Should these hemispherical frequency distorting members become clogged to such an extent that an increase in back pressure at the inertial exhaust instant would be great enough to upset the differential maintained in radial chamber **46**, silencing assembly **38** would move outward within housing **12**, removing end **41** of barrel **40** from its sealing position on the axial housing portion **21**, and allowing the excess pressure to exhaust through chamber **66** and relief ports **68**.

When the inlet pressure at **36**, at the cracking inertial exhaust instant, would be bled off to atmosphere lowering the back pressure acting on hemispherical element **52** to less than the pressure on piston **44** within chamber **46**, the exhaust silencer assembly **38** would reseat itself on seal **64** in rest position for another exhaust cycle and will continue to relieve any back pressure and reseat itself until the porous members of the hemispherical exhaust chambers are cleaned by removing the cogging debris.

The direct bleed-off exhaust air from the exhaust pipe **34** to the atmosphere through ports **68**, causes a considerable increase in noise level of the assembly **10** to thereby signal to the operator of the machine, or other device to which the silencer is attached, that the noise level reduction members of the silencer need to be cleaned from contaminants or, respectively, need to be replaced.

It will be apparent that the present improved safety pressure release mechanism is able to be positively controlled at adjustable pressure differentials in accordance with required minimum safe operating pressures of the air operated device or machinery, (such as for instance a clutch or brake mechanism of a press), to which the silencer is attached.

Furthermore, by location of the release ports **68** as close as possible to the inlet port **36**, a more effective, fast acting and immediately responsive pressure release is accomplished to positively prevent any damage to the air operated mechanism to which the present improved device is attached.

Similarly, back pressure created by clogged conditions of the porous noise reducing members **52–54**, is substantially reduced to a safe minimum at such level as not to affect the safe operation of the clutch or brake mechanism or similar mechanism to which the silencer device **10** is attached.

Although the present invention has been shown and, described in connection with a silencer structure incorporating a pair of dome shaped noise reducing or frequency distortion members, the safety pressure relief mechanism of the present invention is similarly applicable to silencer structures of the kind as for instance disclosed in applicant's co-pending prior application Ser. No. 81,051, supra.

It will be obvious to a person skilled in the art to which the present invention pertains that various changes in arrangement and detail may be asserted to without departing from the spirit and essential characteristic of the invention as defined in the appended claims.

I claim:

1. In combination with an air exhaust silencer assembly comprising a barrel having at least one gas permeable member disposed therein made of a porous material to permit the passage of air therethrough, the improvement comprising: a pressure release mechanism including a cylinder having an open end; a closure plate including an air inlet port at the other end of said cylinder for attachment to an air exhaust; said barrel of said silencer extending through said open end into said cylinder and being provided with a piston head ad-

jacent its inner end for sliding engagement within said cylinder; said cylinder being provided with at least one relief port in open communication with a pressure release chamber formed between said piston head and said closure plate normally closed off towards said inlet port; fluid pressure means to normally retain said barrel within said cylinder under normal operating conditions of said silencer; said fluid pressure means being of a magnitude to yield at a predetermined magnitude of pressure build-up within said silencer assembly to permit said barrel to be moved outwardly to said cylinder by increased pressure on said piston to thereby expose said release chamber for communication with said inlet port to bleed off excess air pressure directly to the atmosphere; and means to regulate fluid pressure in predetermined relationship with normal operating exhaust pressure through said silencer.

2. In the silencer assembly as defined in claim 1, said cylinder having an end cap for reciprocable extension of said barrel therethrough; said barrel being of smaller diameter than the internal diameter of said cylinder to form a radial chamber between said barrel and said cylinder and between said piston head on said barrel and said end cap of said cylinder; said radial pressure chamber being connected to a source of fluid under pressure and said regulating means defining a manually operable fluid pressure regulator between said radial pressure chamber and said source of fluid under pressure to thereby maintain said barrel in a retracted position within said cylinder at adjustable pressures to normally close off said pressure release chamber to said inlet port during normal exhaust operating conditions through said silencer assembly.

3. In the silencer assembly as defined in claim 2, said air inlet closure plate being provided with an axially inwardly extending seat portion being adapted to receive the front end of said barrel within said cylinder; and said piston head on said barrel being located a distance inwardly from said front end to thereby form a second radial chamber between said piston head and said front closure plate defining said pressure release chamber.

4. In the silencer assembly as defined in claim 3, said cylinder being provided with a plurality of radially spaced relief ports in open communication with said pressure release chamber.

5. In the silencer assembly as defined in claim 3, said axially inwardly extending portion of said air inlet closure plate being provided with a radial seal assembly sealingly engaging the internal surface of the front end of said barrel to prevent air leakage from said inlet into said release chamber under normal operating conditions of said silencer assembly.

6. In combination with a fluid pressure operated valve mechanism for a clutch or brake device of a machine operable at a predetermined fluid pressure; said fluid pressure operable valve mechanism having an air exhaust, a silencer assembly attached to said air exhaust to muffle the noise created by the exhausting air; said silencer assembly comprising a cylinder, noise level reduction means within said cylinder defining a barrel head and a piston head supported for reciprocating movement within said cylinder in coaxial relationship therewith; said noise reduction means including a first pressure chamber; a second pressure chamber between said barrel and the interior of said cylinder at the rear of said piston head; means to regulate the pressure in the second pressure chamber to maintain said barrel in retracted position within said cylinder under normal air exhaust conditions through said noise reduction means; said barrel being adapted to be moved outwardly of said cylinder at a predetermined fluid pressure differential between said first and said second chamber; said cylinder being provided with a fluid pressure relief means forwardly of said piston head of said barrel effective upon movement of said barrel outwardly of said cylinder to bleed off excess air pressure from said exhaust directly to the atmosphere.

7. A pressure relief mechanism for an exhaust silencer adapted to be connected to an exhaust port of an air operated device in which the said silencer comprises: a cylindrical barrel having at least one gas permeable member disposed therein for passage of air therethrough from said exhaust at predetermined pressure magnitude and flow rate; the gas permeable member being adapted to reduce the exhaust noise of air flow through the silencer; said safety pressure relief mechanism comprising: a cylindrical housing adapted to surround said barrel; said cylindrical housing at one end having a cap member defining an air inlet co-axially aligned with said exhaust of said device; the other end of said cylindrical housing being provided with an end wall having an aperture for reciprocable extension and sliding support of said barrel therethrough; the inner end of said barrel being provided with a piston head; said cylinder being provided with at least one relief port normally not in communication with said inlet; fluid pressure means to normally releasably retain said barrel in retracted position within said cylinder; said fluid pressure retaining means being operable at a preselected magnitude of excess pressure within said barrel to be overcome to permit said barrel to be moved out of said cylinder due to the increased fluid pressure within said barrel; and said fluid pressure retaining means being manually adjustable to accommodate a variety of operable fluid pressure magnitudes.

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