June 10, 1952 S. J. GIBEL 2,600,236

MUFFLER WITH A PLURALITY OF PASSAGES

Filed Nov. 16, 1948 2 SHEETS—SHEET 1

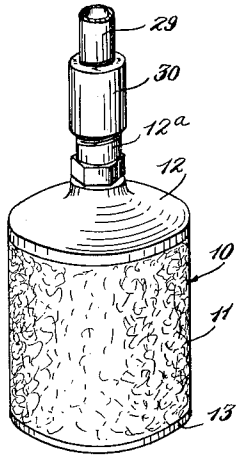

FIG. 1

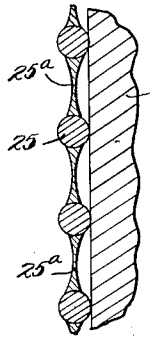

FIG. 9

FIG. 2

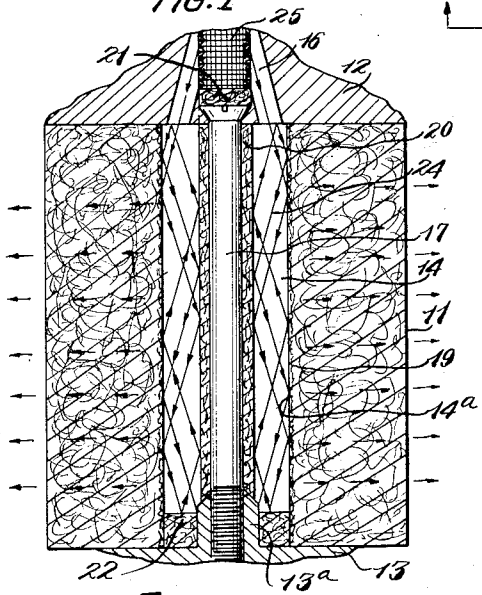

FIG. 4

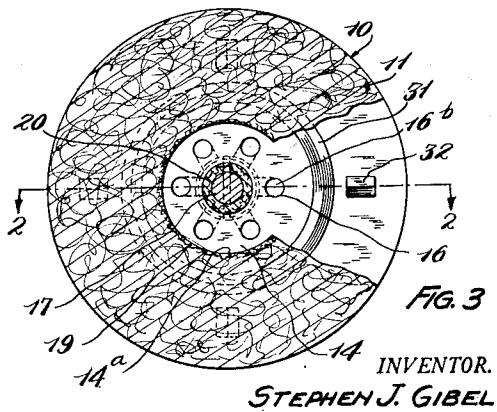

FIG. 3

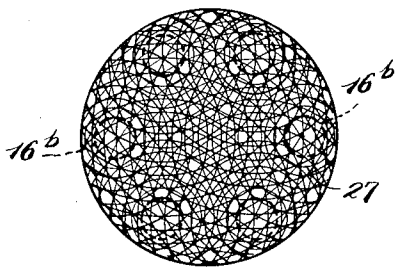

FIG. 5

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MUFFLER WITH A PLURALITY OF PASSAGES

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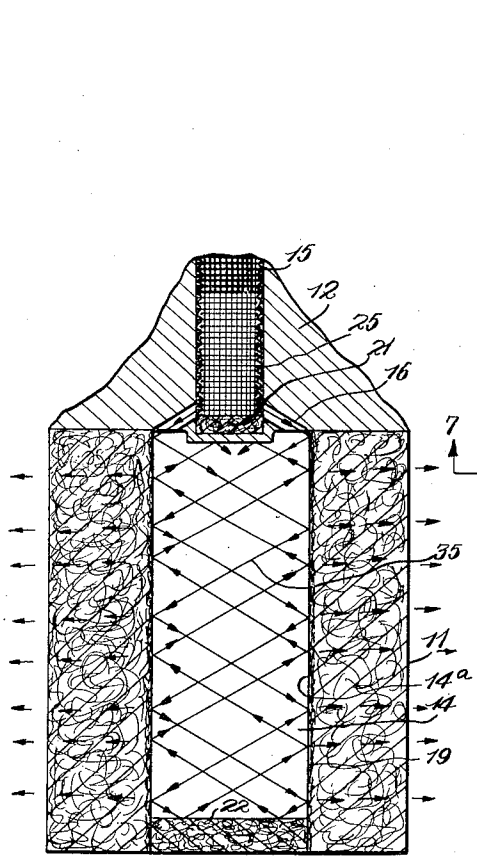

FIG. 8

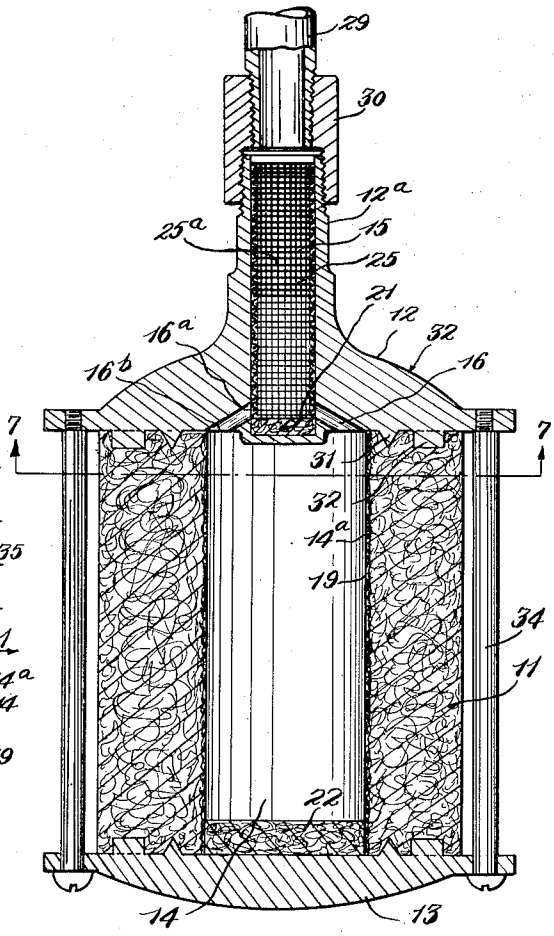

FIG. 6

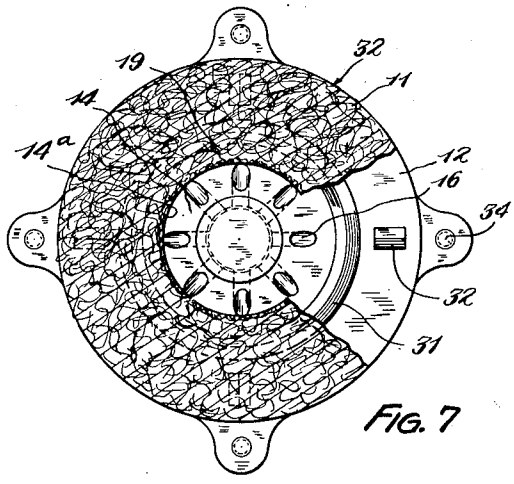

FIG. 7

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MUFFLER WITH A PLURALITY OF PASSAGES

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Application November 16, 1948, Serial No. 60,356

4 Claims. (Cl. 181—56)

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This invention has to do with the muffling of noises in a pressure fluid exhaust such as the exhaust from a compressed air operated power cylinder or tool and, as one of its objects, aims to provide a novel means by which the exhaust fluid is expanded and the energy thereof is dissipated in a manner which is highly effective in silencing the exhaust noises.

Another object of this invention is to provide a novel means for muffling exhaust noises in which a stream of exhaust fluid is directed into an expansion chamber having a resilient wall and against such wall in an angular relation to cause reverberation of the stream in the chamber for dissipating the energy of the fluid.

A further object is to provide a novel means for muffling exhaust noises in which a plurality of streams of exhaust fluid are directed at spaced points into a chamber having a resilient wall and against such resilient wall in an angular relation to cause reverberation of the streams in the chamber in conflicting or opposing relation to each other such that the energy of one such stream is dissipated in counteracting the energy of another such stream.

Still another object is to provide a novel exhaust silencing means of the character mentioned, in which the chamber into which the stream or streams of exhaust fluid are directed is defined, at least in part, by a porous wall and the fluid is released to atmosphere by a diffused flow through such porous wall.

Yet another object is to provide a novel exhaust silencing means in which a substantial portion of the noise producing energy of an exhaust fluid is dissipated by directing a stream or streams of the exhaust fluid through a small-mesh screen in an oblique angle relation to the plane of the screen.

It is likewise an important object of this invention to provide a novel exhaust silencing means in which a stream of pressure fluid exhaust is directed through a turbulating means, such as the above mentioned small-mesh screen, to produce a highly turbulated stream in which numerous different portions of the stream have rapid swirling movements and such turbulated stream is directed into a chamber having a resilient wall in such angular relation thereto that the stream portions impinge against numerous different portions of the resilient wall so as to expend their energy thereagainst.

This invention further provides a novel exhaust silencing means in which a plurality of streams of the exhaust fluid are directed through a

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turbulating means to produce highly turbulated streams in which numerous different portions of the streams have rapid swirling movements and such turbulated streams are directed at spaced points into a chamber having a resilient wall and in such angular relation to the resilient wall that said stream portions repeatedly impinge against different portions of the resilient wall and expend energy thereagainst and the stream portions of one of the turbulated streams conflict with and dissipate the energy of the stream portions of another of the turbulated streams.

As a further object this invention provides a novel muffler having a chamber adapted to receive pressure fluid exhaust and in which a resilient or porous means forms a wall at one end of the chamber against which the exhaust fluid impinges and expends a substantial portion of its energy.

Still another object is to provide an improved muffler having a chamber and passage means for discharging streams of pressure fluid exhaust thereinto in an angular relation to cause reverberation of the streams in the chamber for dissipating the energy of the fluid and in which the chamber is defined, at least in part, by a porous and resilient wall means formed of felted fibrous material.

As another of its objects this invention provides a novel muffler of the character mentioned in which the silencing chamber into which the stream or streams of exhaust fluid are directed is defined, at least in part, by a tubular member having a porous wall formed of felted fibrous material and in which the inner surface portion of such wall has a characteristic for producing increased reflection of such stream or streams.

It is also an object of this invention to provide a novel means for muffling exhaust noises in which a stream of exhaust fluid is directed into a chamber having a resilient wall and against such wall in an angular relation to cause reverberation of the stream in the chamber for dissipating the energy of the fluid and in which a deflecting means, preferably resilient, is disposed in said chamber so as to be impinged by the stream and deflect the same against another portion of said wall.

Another object of this invention is to provide a novel muffler having a chamber adapted to receive pressure fluid exhaust and in which the wall of the chamber is formed, at least in part, by numerous minute resilient diaphragms against which a substantial portion of the energy of the exhaust fluid is dissipated.

Other objects and advantages of the invention will become apparent in the following detailed description and in the accompanying drawings in which,

Fig. 1 is an outside perspective view showing a muffler embodying the present invention;

Fig. 2 is a vertical longitudinal section taken through the muffler, as indicated by section line 2—2 of Fig. 3;

Fig. 3 is a transverse section taken through the muffler substantially as indicated by section line 3—3 of Fig. 2;

Fig. 4 is a partial longitudinal section similar to Fig. 2 and diagrammatically illustrating the path of flow and behavior of the streams or stream particles of the exhaust fluid;

Fig. 5 is a plan view, diagrammatic in form, further illustrating the behavior of the streams or stream particles of the exhaust fluid in the silencing chamber;

Fig. 6 is a vertical longitudinal section similar to Fig. 1 but showing a modified form of the improved muffler;

Fig. 7 is a transverse section therethrough taken on section lines 7—7 of Fig. 6;

Fig. 8 is a partial longitudinal section similar to Fig. 6 and diagrammatically illustrating the path of flow and behavior of the streams or stream particles of the exhaust fluid; and

Fig. 9 is a fragmentary sectional view showing the minute resilient diaphragms on an enlarged scale.

As one embodiment of the invention, Figs. 1 to 4 inclusive, show an improved muffler 10 having a sectional housing formed by a body member or disseminator 11 and a pair of end members or covers 12 and 13. The body member 11 is here shown as being tubular in form and having a central passage or opening extending therethrough. The end members 12 and 13 engage the upper and lower ends of the body member 11 and cooperate with this member so that the axial passage or opening thereof forms a substantially closed main chamber 14 which is at times also referred to as a silencing chamber or expansion chamber.

The end members 12 and 13 can be made of any hard dense material, such as metal or plastic. The upper end member 12 has an axially extending inlet chamber 15 therein to which pressure fluid exhaust, such as the exhaust from a compressed air operated cylinder or tool, is adapted to be supplied. The upper end member 12 is also provided with a group of passages 16, in this case fix such passages, which connect the inlet chamber 15 with the main chamber 14 and are disposed in a certain inclined angular relation for the accomplishment of an important function which will be further described hereinafter. The end members 12 and 13 can be held in connected relation to each other and in engagement with the ends of the body member 11 by suitable connecting means such as the central axial rod or screw 17 shown in this instance. The screw 17 carries a head 17*a* at one end thereof which engages in a countersunk recess 18 provided at the lower end of the inlet chamber 15. The other end of the screw 17 carries a threaded portion 17*b* which engages in a threaded hollow boss 13*a* of the lower end member 13.

In accordance with an important feature of the present invention, the body member 11 forms a resilient porous wall for the main chamber 14.

In this instance the body member 11 is formed of felted fibrous material, such as felted vegetable fibers or felted animal fibers or hair, or a mixture of such vegetable and animal fibers. If desired, the body member 11 may have a suitable binder incorporated therein for assisting in holding together the felted fibers. The porous characteristic of the body member 11 results from the fact that the felted fibers constituting this member have numerous small irregular spaces or interstices therebetween which form minute circuitous passages extending through this member and the inlet ends of which passages are distributed over substantially the entire inner surface 14*a* of the chamber 14. The resilient characteristic of the wall of the body member 11 results from the fact that the individual fibers are of a springy or resilient nature and when felted together form a yielding or cushion-like member.

Although the body member 11 has been described above as being formed of felted fibrous material, this invention also contemplates that the porous characteristics can also be suitably obtained when this body member has various other forms of construction. For example, this body member could be molded or otherwise formed from suitable granular or porous material, such as carbon, charcoal, ground cinders, or various other such materials or could be made of cork or cork particles or from a suitable pulp or cellulose. The body member 11 could also be formed from a suitable ceramic material or from a porous or cellular plaster or cement.

In accordance with another feature of the invention, the body member 11 has a surface characteristic for the inner surface 14*a* of the chamber 14 such that it will have greater ability to reflect streams or particles of exhaust fluid which impinge thereagainst. This characteristic can be obtained by constructing the body member 11 so that the inner surface portion thereof has a greater density than the outer portions thereof. In this instance the body member 11 has the inner surface portion thereof treated or impregnated with any one of various materials suitable for increasing the density thereof. For example, this inner surface portion can be treated or impregnated with an adhesive binder, such as shellac, varnish, lacquer, synthetic resin or the like. The increased density and increased reflecting characteristic for this inner surface portion can also be obtained by impregnating this portion of the body member 11 with a suitable oil, grease or wax or with asphalt.

In the drawings, this treatment or impregnation of the inner surface portion of the body member 11 is indicated by the layer 19 which need be only a relatively thin layer or stratum having a radial thickness on the order of one thirty-second of an inch, although the density and thickness of this layer can be varied according to the results desired and the type and amount of the material with which this portion of the body member is impregnated. The portions of the body member 11 lying outwardly of the reflective layer 19 are preferably of a substantially uniform or homogenous character. The inner surface 14*a* is preferably not smooth but has numerous minute depressions and elevations distributed thereover and which have an important value in dissipating the energy of the exhaust fluid.

Another important purpose of the inner layer 19 of increased density is that it provides a resistance to the flow of the exhaust fluid through the porous body member 11. It is desirable to

provide such resistance to the flow of the fluid through the body member 11 because it prevents a direct penetration of the porous wall by the streams impinging thereagainst and causes the chamber 14 to function as a pressure chamber in which a back pressure is quickly built up by the exhaust fluid discharged thereinto. The pressure thus built up in the chamber 14 acts as a pneumatic cushion against which the incoming exhaust fluid must act and expend some of its energy. This back pressure also causes the exhaust fluid to be so distributed in the chamber 14 that it will flow through all portions of the inner surface 14a and good diffusion of the fluid in passing through the porous body member 11 will accordingly be obtained. Very satisfactory functioning has been obtained when the density of the body member 11 and its resistance to flow of the fluid therethrough have been such that a pressure drop of approximately two pounds occurs in the fluid in passing through this member.

In accordance with the present invention, the improved muffler 10 also includes a deflecting means in the silencing chamber 14 and which, in this instance, is in the form of a resilient element 20 carried by the screw 17. The cover 20 can be made of felted fibrous material, such as one of the fibrous materials mentioned above or from paper or paper pulp, and is in the form of a sleeve or tube which extends axially of the chamber 14 in surrounding relation to the screw 17. The upper end of the sleeve 20 engages the end member 12 and its lower end engages the end member 13 or the boss 13a of the latter.

It is also an important feature of this invention that the inlet chamber 15 and the expansion silencing chamber 14 are provided at the lower end thereof with resilient wall members 21 and 22. The wall member of the inlet chamber 15 is here shown as being seated on the head 17a of the screw 17 and forms a transverse bottom wall for this chamber. The wall member 22 is seated against the end member 13 and in this instance is in the form of a ring or washer surrounding the boss 13a and forms a transverse bottom wall for the chamber 14. The wall members 21 and 22 are resilient in character by reason of the fact that they are made of felted fibrous material, such as one of the materials mentioned above in describing the body member 11. The wall members 21 and 22 preferably are also porous as well as resilient.

The fibrous sleeve 20 and the fibrous wall members 21 and 22 are preferably, though not necessarily, treated or impregnated with a waterproofing material such as rubber solution, varnish, lacquer or the like. This material increases the resilient character of the sleeve 20 and the wall members 21 and 22, and by rendering the sleeve 20 and the wall member 21 substantially non-absorbent and impervious to water, the screw 17 will be protected from corrosion by water or other contaminating liquids carried by the exhaust fluid.

In accordance with another important feature of the present invention, the passages 16 of the end member 12 extend in an inclined relation to the axis of the chamber 14 such that they will direct streams of the exhaust fluid against the inner surface 14a at an oblique angle to this surface. This angle of impingement is shown in Figs. 2 and 4 as being an angle of approximately ten degrees, although it can be a smaller angle or can be a longer angle such as the sixty degree angle shown in Figs. 6 and 8.

When the streams of exhaust fluid are directed against the inner surface 14a of the chamber 14 in such an oblique angular relation they will be reflected by this surface at substantially the same angle. When thus reflected by the inner surface 14a, these streams or substantial portions of these streams will impinge against the resilient deflector 20 formed by the cover surrounding the screw 17. The streams or stream portions which thus impinge the deflector 20 will be deflected or reflected thereby and will again impinge against the inner surface 14a. This reflection of the streams back and forth between the inner surface 14a and the deflector 20 is represented by the directional lines 24 of Fig. 4.

From the construction and functioning of the muffler 10 as thus far described, it will be seen that the streams of exhaust fluid are directed into the tubular chamber 14 at one end thereof and reverberate back and forth between the surface 14a and the deflector 20 as the streams advance along this chamber. This reverberation results in the numerous particles of the streams impinging against the surface 14a and the deflector 20 at numerous different points, and since the body member 11 and the deflector 20 are resilient in character, these impingements will cause a substantial portion of the energy of the streams to be dissipated and this dissipation of energy produces a sound deadening effect.

The exhaust fluid which is to be muffled or silenced is usually discharged into the inlet chamber 15 with a substantial velocity and this causes a precussive impingement of such fluid against the resilient end wall 21 of this chamber. This percussive impingement of the fluid against this resilient end wall causes a substantial portion of the noise producing energy of the fluid to be absorbed and dissipated at this point. Similarly, the streams of exhaust fluid which are directed into the main chamber 14 by the inclined passages 16 and are deflected back and forth between the surface 14a and the deflector 20 ultimately impinge against the resilient wall 22 with a percussive action. This percussive engagement of the streams against the resilient end wall 22 results in another substantial portion of the energy of the streams being absorbed and dissipated. Although the resilient end walls 21 and 22 in the inlet and silencing chambers 15 and 14 serve an important purpose in absorbing and dissipating energy of the exhaust fluid, they can, however, be omitted if desired.

Since the streams of exhaust fluid which are directed into the chamber 14 by the passages 16 have considerable velocity and this chamber is a substantially closed chamber, a pressure will quickly build up in this chamber. The pressure thus formed in the chamber 14 will cause the exhaust fluid to pass through the minute pores or interstices of the body member 11 to the atmosphere. This release of the exhaust fluid from the chamber 14 to atmosphere takes place as a diffused flow through the body member 11 and results in a further absorption or dissipation of the energy of the exhaust fluid.

In accordance with still another important feature of this invention, a turbulating means is provided in the inlet chamber 15 of the end member 12 and produces a highly turbulated condition in the streams of exhaust fluid which are supplied to the chamber 14 by the passages 16. In this instance the turbulating means is in the form of a small-mesh screen 25 through which the streams of exhaust fluid are directed. A

thirty mesh per inch screen made of wire ten-thousandths of an inch in diameter has been found to be very satisfactory for this turbulating means, but various other forms of screens or turbulating means could be employed. It is an important feature of this turbulating means that the streams of fluid which are directed through the screen by the passages 16 are directed therethrough at an oblique angle to the plane of the screen. This is important because it increases the turbulating effect of the screen during the passage of the streams therethrough.

The turbulating effect produced on the streams of exhaust fluid by the screen 25 results in a condition in which numerous different portions of each stream have rapid swirling or eddying movements and the action of the screen in producing these rapid swirling movements of the stream particles also dissipates some of the energy of the streams. The turbulated condition of the streams of exhaust fluid results, in part, from a diffusion of the fluid by its passage through the numerous small openings of the screen and, in part, from the fact that the velocity flow of the fluid past the numerous small wires of the screen creates a partial vacuum in back of these wires and the tendency for a flow of the various stream portions into these partially evacuated spaces produces the turbulated condition of the rapidly swirling or eddying movements of the individual stream particles. Since the passages 16 extend at an oblique angle to the screen 25 and have truncated inlet ends 16a across which the screen extends, a much larger number of screen openings will be traversed by the streams and a larger number of the wires of the screen will be effective in producing the partially evacuated spaces which contribute to the formation of the above-mentioned swirling and eddying movements of the stream particles.

When the turbulated streams of the passages 16 are directed into the chamber 14, a relatively sudden expansion of the streams takes place with the result that the swirling stream particles gyrate in generally circular paths of progressively increasing size. This results in a distribution of the swirling stream particles such that these particles impinge against a very large number of different portions of the inner surface 14a and expend their energy against the resilient body member 11. In addition to the impingement of these stream particles against the inner surface 14a of the resilient body member 11, the particles of one stream will repeatedly impinge against particles of another stream and this condition of conflict between the streams results in a substantial portion of the energy of one stream being dissipated in counteracting the energy of another stream.

This expansion of the turbulated streams in the chamber 14 and the conflicting condition resulting therefrom between the different streams, is illustrated diagrammatically in Fig. 5. In this view the dotted circles 16b represent the location of the discharge ends of the passages 16 and the numerous full line circles 27 of progressively increasing diameter surrounding the dotted circles 16 represent the paths of the swirling or gyrating stream particles. It should be understood also that these swirling stream particles also impinge against the resilient deflector 20 and reverberate back and forth between the inner wall 14a and the deflector, as represented by the lines 24 of Fig. 4, and may ultimately impinge against the resilient wall member 22 and be reflected thereby.

The muffler 10 can be applied to the exhaust opening of a pressure fluid cylinder or tool in any suitable way which will cause the exhaust fluid to be discharged directly into the inlet chamber 15. In this instance the end member 12 is provided with a stem 12a having a threaded portion 28 adapted to be screwed into an internally threaded exhaust outlet. In some cases it may be desirable to connect the muffler 10 with the exhaust outlet by means of a pipe 29 and in that case the threaded stem portion 28 can be connected with the pipe by means of a coupling 30. The inlet chamber 15 has a diameter which is somewhat larger than the diameter of the exhaust outlet or pipe with which the muffler 10 is connected so that the inlet chamber will serve as an expansion chamber in which some expansion of the exhaust fluid will take place for dissipating a part of its pressure and energy.

Another feature of importance in the present invention is the provision of numerous minute resilient diaphragms 25a against which the exhaust fluid acts and dissipates a substantial portion of its energy. In this instance these diaphragms are located in the inlet chamber 15 and form a substantial portion of the wall thereof. The diaphragms 25a are obtained by dipping or otherwise treating the upper portion of the screen 25 with film-forming liquid. A rubber cement or a solution of rubber dissolved in a suitable liquid vehicle such as benzine has been found very satisfactory, although other suitable film-forming liquids could be used such as varnish, linseed oil, paint or the like.

When the screen 25 is coated with the film-forming material, this material forms numerous minute diaphragms 25a extending across the screen openings as shown in Fig. 9. After the film-forming material has dried on the screen the diaphragms 25a are highly resilient or elastic in character and form a resilient inner wall for the inlet chamber 15. When the exhaust fluid is discharged into the inlet chamber 15 it produces a pressure therein which acts against and deflects these minute diaphragms and, in so doing, the exhaust fluid expends a substantial portion of its energy which would otherwise produce noise.

It should also be explained that the engagement of the end members 12 and 13 with the body member 11 should be such as to form a seal therebetween. In this instance the seal is formed by providing each of the end members with a wedge-shaped annular ridge 31 which is indented into the end of the member 11, as shown in Fig. 2 of the drawings. To prevent relative rotation between the body member 11 and the end members 12 and 13, each of the latter is provided with substantially radially extending wedge-shaped projections 32 which are also indented into the ends of the body member. If desired, a suitable glue or cement can also be used in forming the seal between the end members and the body member 11.

From the foregoing detailed description of the improved muffler 10, it will be seen that when a stream of exhaust fluid is discharged into the inlet chamber 15 a partial expansion of the exhaust fluid will take place by reason of the fact that the inlet chamber is of a larger diameter than the passage of the pipe 29 or exhaust opening with which the muffler is connected. This expansion of the exhaust fluid results in a partial

dissipation of the pressure and energy thereof and a corresponding partial muffling of the exhaust noises. The stream of exhaust fluid entering the inlet chamber 15 also impinges directly against the resilient end wall member 21 with the above-mentioned percussive action and this impingement results in another portion of the energy of the stream being dissipated at this point. The exhaust fluid also acts against and deflects the minute diaphragms 25*a*, as explained above, and thus expends another substantial portion of its energy.

The stream of exhaust fluid causes pressure to build up quickly in the inlet chamber 15 and since the only outlet for the fluid is through the passages 16, the main stream will be subdivided into these smaller streams which must necessarily flow through the portions of the screen 25 which overlie the inlet ends 16*a* of these passages. The flow of these smaller streams through the screen 25 at an oblique angle to the plane of the screen produces the above explained turbulating effect in these smaller streams. The flow of the exhaust fluid through the screen 25 also absorbs a substantial portion of the energy of the fluid in producing the diffused and turbulated condition explained above.

When the turbulated streams are discharged into the main expansion and silencing chamber 14 by the passages 16, they impinge against the inner surface 14*a* at an oblique angle to produce the reverberation explained above and, in addition, the expanding and swirling effect in the streams themselves results in the various stream particles thereof impinging against numerous different portions of the surface 14*a* and of the deflector 20 and also against the resilient end wall member 22. These impingements and the impingements of the particles of one stream against the particles of another stream result in the dissipation of a great deal of the energy of the exhaust fluid. As previously mentioned herein, the discharge of the exhaust fluid into the chamber 14 quickly creates a pressure therein which causes the diffused flow of the fluid through the pores of the body member 11 to the atmosphere. This diffused flow further expands the exhaust fluid and dissipates energy remaining therein and by the time that the fluid reaches the atmosphere substantially all of its pressure and noise producing energy has been absorbed or dissipated and the release of the fluid to atmosphere takes place in a substantially noiseless manner.

Figs. 6, 7 and 8 of the drawings show a modified form of muffler 32 which is generally similar to the muffler 10 and embodies the same general features. In the modified muffler 32 the end members 12 and 13 are connected by tie rods 34 disposed in circumferentially spaced relation around the outside of the body members 11 instead of by a connecting means extending through the silencing chamber. It will also be noted that in the modified muffler there are eight of the passages 16 and they are inclined to the vertical axis at an angle of approximately sixty degrees which results in the turbulated streams of exhaust fluid being discharged into the silencing chamber 14 so that they impinge the inner side wall 14*a* at an angle which will cause a criss-cross reverberation of the streams in the silencing chamber, as represented by the directional lines 35 of Fig. 8. By arranging the passages 16 in the angular relation here shown, a steeper angle of impingement is obtained for the streams striking the surface 14*a* and results in a larger number of reverberations for the streams before they reach the resilient end wall member 22 and thus a greater conflict between the particles of the different streams. In other respects the modified muffler 32 is similar to the muffler 10 and functions in a similar manner and the same reference characters have been applied to corresponding parts.

From the foregoing description and the accompanying drawings it will now be understood that this invention provides a novel muffler construction for silencing the noises of a pressure fluid exhaust and in which the pressure and noise producing energy of the exhaust fluid is effectively absorbed or dissipated. It will be understood further that the improved muffler requires only a very small number of parts which can be economically manufactured and assembled. When the muffler herein disclosed is constructed so as to have a suitable size relationship to the pressure and volume of the pressure fluid exhaust which it is to handle, the muffler has an expansion ratio for the fluid on the order of 1:175 and this is very effective in eliminating exhaust noise.

Although the novel muffler of this invention has been disclosed herein to a detailed extent, it will be understood of course that the invention is not to be regarded as being correspondingly limited in scope but includes all changes and modifications coming within the terms of the claims hereof.

Having thus described my invention, I claim:

1. A muffler for silencing pressure fluid exhaust noises comprising, a porous tubular member, closure members cooperating with the ends of said tubular member to form a substantially closed chamber, one of said closure members having an inlet means therein to which exhaust pressure fluid is adapted to be supplied and passage means connecting said inlet means with said closed chamber for directing a plurality of streams of the exhaust pressure fluid into the latter, said passage means comprising a plurality of passages extending axially and outwardly in inclined relation to the inner surface of said tubular member and adapted to direct said streams against said inner surface at an oblique angle to cause reverberation of the streams in criss-cross conflicting relation in said chamber, a resilient fibrous member forming a transverse end wall at the inner end of said inlet means and against which the exhaust pressure fluid being supplied to said inlet means impinges, a small-mesh screen disposed relative to said passage means to require the exhaust pressure fluid of said streams to flow through the screen at an oblique angle to the plane of the screen, and a resilient fibrous member adjacent the other closure member and forming a transverse end wall for said closed chamber, said porous tubular member having numerous small passages therein providing the sole path for the escape of the exhaust pressure fluid from said closed chamber to atmosphere.

2. A muffler for silencing pressure fluid exhaust noises comprising, a porous tubular member, closure members cooperating with the ends of said tubular member to form a substantially closed chamber, connecting means connecting said closure members and disposed substantially centrally and axially of said porous tubular member, one of said closure members having an inlet means therein to which exhaust pres-

sure fluid is adapted to be supplied and passage means connecting said inlet means with said closed chamber for directing a plurality of streams of the exhaust pressure fluid into the latter, said passage means comprising a plurality of passages extending axially and outwardly in inclined relation to the inner surface of said tubular member and adapted to direct said streams against said inner surface at an oblique angle to cause reverberation of the streams in criss-cross conflicting relation in said chamber, a resilient fibrous member forming a transverse end wall at the inner end of said inlet means and against which the exhaust pressure fluid being supplied to said inlet means impinges, a small-mesh screen disposed relative to said passage means to require the exhaust pressure fluid of said streams to flow through the screen at an oblique angle to the plane of the screen, and a resilient fibrous member adjacent the other closure member and forming a transverse end wall for said closed chamber, said porous tubular member having numerous small passages therein providing the sole path for the escape of the exhaust pressure fluid from said closed chamber to atmosphere.

3. In a muffler of the character described, wall means defining an elongated tubular silencing chamber having inlet means at one end thereof for pressure fluid exhaust and also having restricted outlet passage means, said inlet means comprising a plurality of inlet passages communicating with said chamber at one end thereof and at substantially opposed points located on opposite sides of the axis of said chamber and a small-mesh screen at said inlet means extending across said inlet passages, said inlet passages being disposed such that they extend at an oblique angle relation to the plane of said screen and also extend toward said wall means at an oblique angle relation thereto, said inlet passages being adapted to direct said exhaust fluid through said screen at said oblique angle relation to produce turbulated streams and to direct said turbulated streams into said chamber and against the inner surface of said wall means at said oblique angle relation for causing conflicting portions of said turbulated streams to absorb energy from each other with portions of said turbulated streams reverberating in said chamber in criss-cross relation.

4. A muffler comprising, a pair of end members, a tubular porous member formed of felted fibrous material and extending between said end members to define therewith a silencing chamber, one of said end members having an inlet for receiving pressure fluid exhaust and a plurality of passages connecting said inlet with said chamber and adapted to direct streams of the exhaust fluid into the latter, said passages being located at substantially opposed points on opposite sides of the axis of said tubular member and extending axially and outwardly in a direction inclined to the inner surface of said tubular member such that said streams impinge against said inner surface at an oblique angle thereto and reverberate in criss-cross conflicting relation in said chamber, the pores of said tubular member providing numerous small outlet passages for a diffused flow of exhaust fluid therethrough and constituting the sole outlet passage means of said chamber, and a cushioning transverse end wall for said chamber formed of felted fibrous material located adjacent the other of said end members.

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