United States Patent

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[72] Inventors **Sebastian F. Judd**
Whitesboro;
Paul J. Bilodeau, Utica, N.Y.

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[73] Assignee **Chicago Pneumatic Tool Company**
New York, N.Y.
a corporation of New Jersey

[54] **DETACHABLE ELASTOMER MUFFLER FOR PNEUMATIC PERCUSSIVE TOOLS**
13 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **181/36,** 181/57
[51] **Int. Cl.** **F01n 1/08**
[50] **Field of Search** 181/36, 36.1, 47, 57, 47.1

[56] **References Cited**

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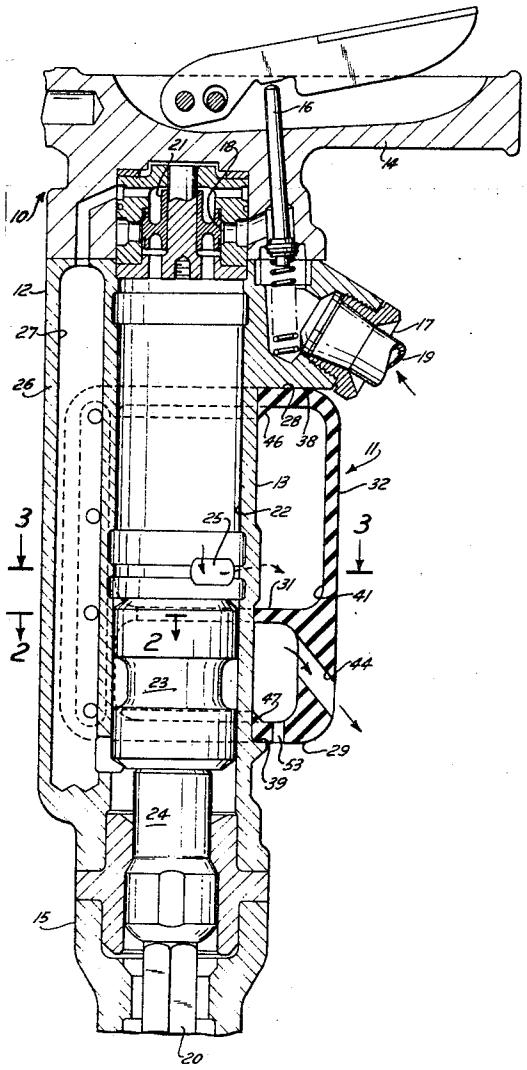
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3,225,861	12/1965	Reynolds	181/36(.1)

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932,373	7/1963	Great Britain	181/36(.1)

Primary Examiner—Robert S. Ward, Jr.
Attorney—Stephen J. Rudy

ABSTRACT: A one-piece muffler formed of elastomer material, having a C-configuration adapted to collar over the exhaust ports of a pneumatic percussive demolition tool, and adapted to be detachably clamped in fluid tight relation to the tool. The muffler defining with the surface of the tool a pair of internal connected chambers, each tuned to filter out certain objectionable noise characteristics of the air exhausting from the tool before the exhaust air is discharged to atmosphere. The elastomer construction serves to minimize ice formation within the muffler, and to resist damage from rough handling and impact blows.



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SHEET 1 OF 2

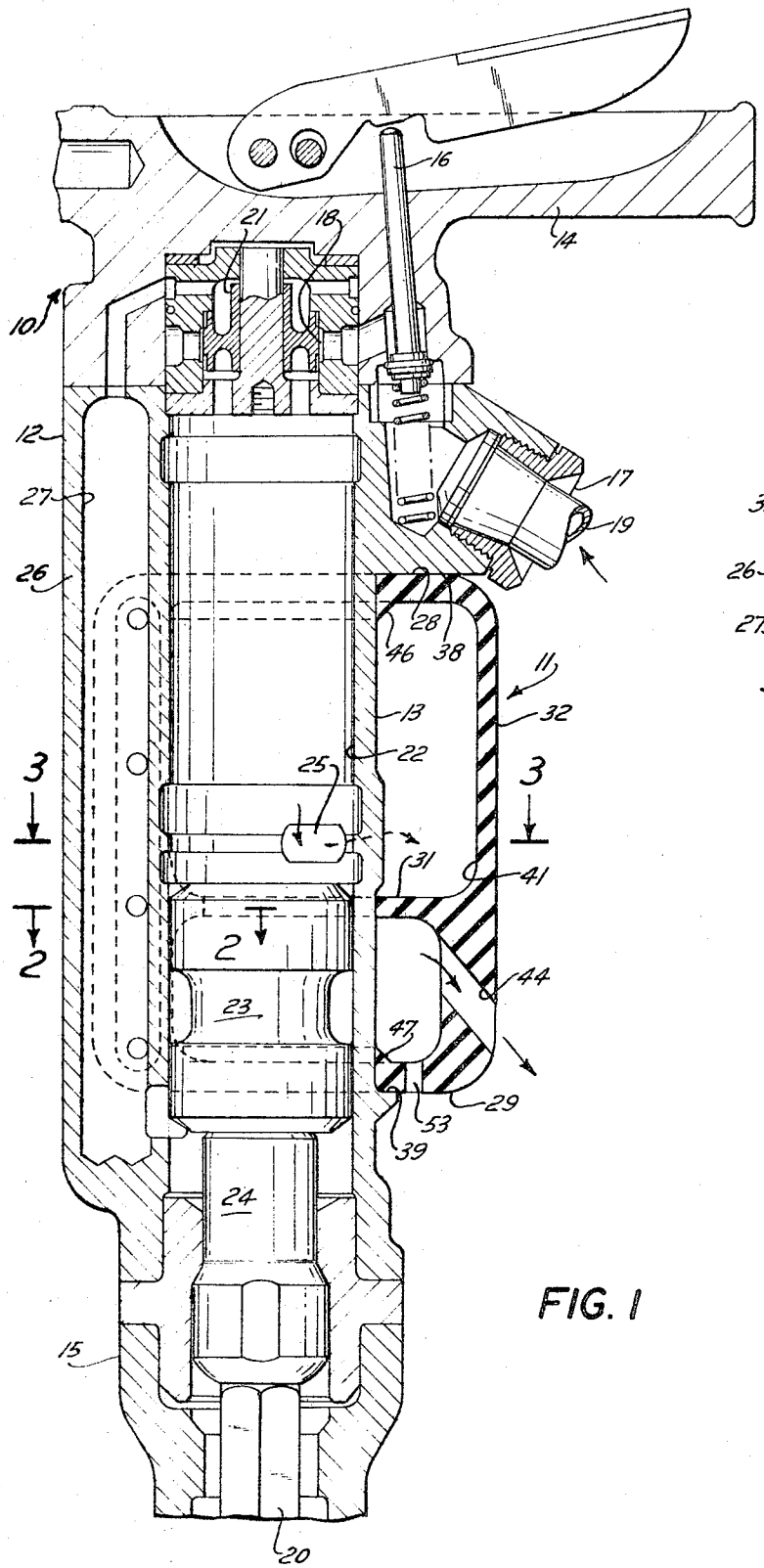


FIG. 1

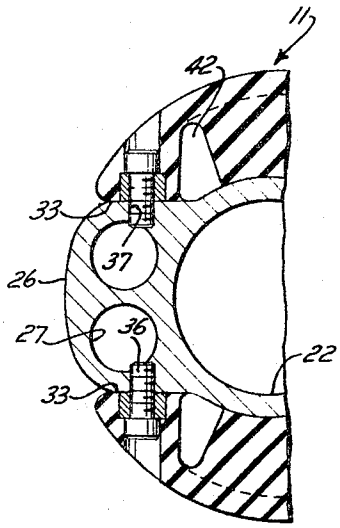


FIG. 2

INVENTORS:
SEBASTIAN F. JUDD
PAUL J. BILODEAU
BY
Stephen J. Rudy
ATTORNEY

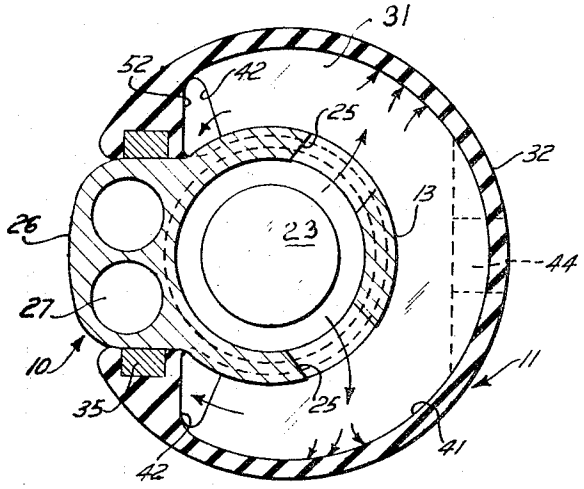


FIG. 3

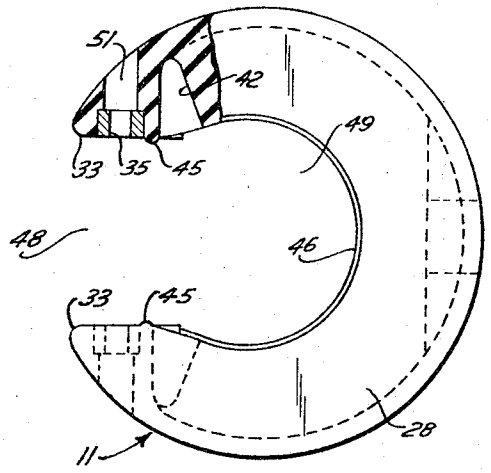


FIG. 6

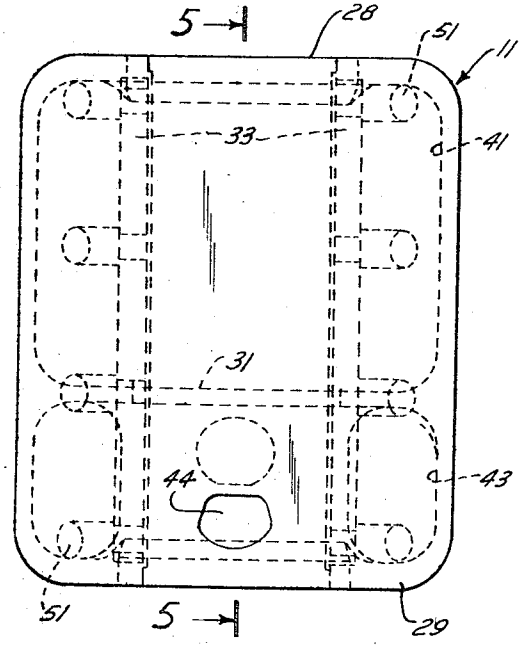


FIG. 4

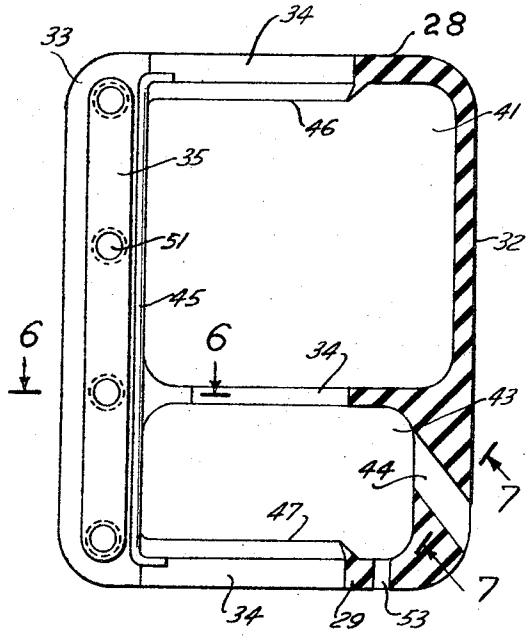


FIG. 5

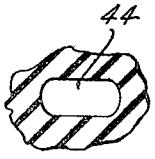


FIG. 7

INVENTORS:
SEBASTIAN F. JUDD
PAUL J. BILODEAU
BY
Stephen J. Rudy
ATTORNEY

DETACHABLE ELASTOMER MUFFLER FOR PNEUMATIC PERCUSSIVE TOOLS

BACKGROUND OF THE INVENTION

This invention is directed to an elastomer muffler for the exhaust of pneumatic percussive tools.

The invention is especially suited for application to percussive tools of the demolition type such as are used in breaking up concrete and in tearing up the pavement of city streets. In this kind of tool, a heavy piston is pneumatically reciprocated to repeatedly pound in anvil against a work steel. The piston is reciprocated at a rapid rate. With each piston stroke spent operating air normally exhausts directly to atmosphere and expands to produce objectionable pulsating noise varying in intensity and pitch.

The general objective of this invention is to transform this objectionable noise into an auditorily acceptable substantially nonpulsating steady sound of comparatively low pitch and reduced intensity; and to provide a detachable muffler for this purpose of an improved nature.

The muffler of the present invention is in the nature of a hood which collars the housing of the tool over its exhaust ports.

A problem associated with mufflers of this general nature is icing of its internal wall surfaces due to excessive cooling of the tool by the rapidly exhausting air and consequent freezing of the water vapor normally present in the operating air.

Mufflers of this general hood nature for percussive tools are known from U.S. Pat. No. 3,224,527 and from the British Pat. Specification No. 932,373. The muffler known from the U.S. patent is of metal construction made integral with the housing of the tool. This known structure, while having acceptable silencing characteristics, adds excessively to the weight of the tool. Internal icing of this metal muffler results in external surface condensation.

The muffler of the present invention is formed of tough, resilient plastics or elastomeric material which, because of its light weight, improves over the metal type. Because of its resilience, as well as its inherent smoothness and slipperiness, problems of internal icing and external condensation are reduced to a minimum. Because of its resilience, air exhausting from the tool tends to vibrate the muffler's walls to cause ice coatings developing thereon to shatter and fall away before they can build up to an undesirable degree. Because of its toughness, the muffler is capable of resisting abrasion and is able to absorb the impact of heavy blows without cracking or tearing. The muffler material is not subject to deterioration from the oil and water moisture usually present in the operating air.

The muffler known from the British patent specification is formed of resilient material. But this muffler has various structural and mounting deficiencies creating various problems. It is made of two separable halves clamped together, a condition which tends, for one thing, to reduce its overall resiliency. It has mounting faults, particularly at its neck end which, together with sound deadening material disposed in a chamber of the device, are likely to cause undesirable back pressure and leakage. Back pressure would effect the operating efficiency of the tool; exhaust leakage around the neck of the muffler would interfere with comfortable handling of the tool by the operator. Icing that might accumulate in the deadening material is very likely to impede exhaust flow.

The muffler of the present invention also materially improves over that of the known British structure. It is a one-piece structure detachably mountable to the tool. It is of an open collar or C-form having mounting means at its terminal end which does not undesirably affect its resiliency. It is associated with the housing of the tool in a clamping manner so that undesirable exhaust leakage is avoided; and the ends of the muffler are not likely to be blown out by the force of exhausting air. It does not require deadening material in its interior since it functions to silence the exhaust noise by means of sound filtering chambers. It further includes internal exhaust flow passages so arranged that it is difficult for them to become blocked by pieces of ice that might fall from the wall of the muffler. These passages allow free flow of the exhaust air through the muffler to atmosphere without undesirable development of back pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawing:

FIG. 1 is a view in vertical section of a pneumatic percussive demolition tool embodying the invention;

FIG. 2 is a section taken on line 2–2 of FIG. 1;

FIG. 3 is a section taken on line 3–3 of FIG. 1;

FIG. 4 is a view in front elevation of the muffler apart from the tool;

FIG. 5 is a section taken on line 5–5 of FIG. 4;

FIG. 6 is a top plan view of FIG. 4, part being shown in a section made on line 6–6 of FIG. 5; and

FIG. 7 is a fragmentary section taken on line 7–7 of FIG. 5.

DESCRIPTION OF PREFERRED EMBODIMENT

Reference is now directed to the drawing wherein there is disclosed a conventional pneumatic percussive tool **10** of the demolition type to which an elastomeric muffler unit **11** is detachably mounted. The tool includes a general housing **12** having a piston cylinder section **13** connected at one end to a backhead handle section **14** and connected at its other end to a front end section **15**. A manipulative throttle valve **16** in the handle section controls feeding of operating air from a supply inlet **17** to a valve chamber **18**. The inlet is connected by hose line **19** to an external source of live air having a constant pressure. A conventional air driven slide valve **21** is reciprocable in the valve chamber in known manner to cause the inlet air to be applied alternately to opposite ends of a piston chamber **22** to reciprocate a heavy piston **23**.

The piston reciprocates at the rate of about 20 cycles per second to pound an anvil **24** against a work steel **20**. Following each piston stroke, which occurs about 2,400 times per minute, the spent air exhausts forcefully from the tool through a pair of side ports **25**. Except for the muffler unit **11**, the exhausting air upon issuing from the side ports to atmosphere would expand and produce an objectionable loud pulsating noise varying in intensity and pitch.

The piston cylinder section **13** of the housing is substantially cylindrical or curved for the major portion of its length except for a radial rib **26** extending lengthwise of its back. The rib serves to accommodate a pair of vertical inlet air feed passages **27** connecting with the lower end of the piston chamber. The exhaust ports **25** open radially at the same level through the curved portion of the piston cylinder at about midway of the length of the latter.

The muffler **11** is a separable unit of a general C-configuration. It serves to materially attenuate the noise of the exhaust air. It is in the nature of a hood which collars the piston cylinder portion of the housing over its exhaust ports **25**. The muffler is a one-piece structure formed as by molding from tough elastomeric material. It includes a top wall **28**, a bottom wall **29** and an intermediate partition wall **31**, all being parallel and concentric to one another. Each wall is offset radially inward from a common curved outer sidewall **32**. The several walls, including the sidewall, extend for approximately three-fourths of a circle and terminate at their free ends in a pair of common opposed laterally spaced vertical end walls **33**. The top, bottom and intermediate walls have narrow inner radiused walls **34** which conform to the curvature of the piston cylinder and snugly engage the latter. Each end wall **33** is thickened so as to define a vertical pad having a broad inner face which overlies a corresponding side face of the rib of the tool and is detachably bolted thereto, as in FIG. **2**.

A metal bar insert **35** molded into the inner face of each end wall at the time of forming the muffler provides a means for rigidly mounting the muffler to the tool. A series of bolts **36**

extending through the inserts and threadedly drawn tightly into holes 37 in the sides of the housing rib securely retain the muffler to the tool.

In the mounted condition of the muffler (FIG. 1) its top wall 28 lies in abutment with an overhead radial shoulder 38 extending about the piston cylinder; and its bottom wall 29 is seated upon a second radial shoulder 39 extending about the lower end of the piston cylinder. Further, in the mounted condition of the muffler, a first curved chamber 41 is defined above the partition wall 31. This chamber connects by means of a pair of openings or passages 42 through the partition wall with a second curved chamber 43 defined below the partition. The exhaust ports 25 open into the upper chamber. Air exhausting in conventional manner from the tool into the upper chamber passes through the openings 42 to the lower chamber and exits to atmosphere through a discharge port 44. The latter is located at the front of the muffler opposite to the rib 26; and directionally away from the position normally taken by the operator so that the venting air does not inconvenience the operator.

The construction of the muffler and its mounting arrangement with the tool is such that its areas of contact with the housing are sealed against leakage of the exhaust air forcefully flowing through the muffler. In this respect, a bead 45 of the elastomeric material forming the muffler extends lengthwise of each of the free end walls 33 of the muffler. Upon tightening of the mounting bolts 36, each bead is resiliently compressed against the corresponding face of the rib of the housing as appears in FIG. 3, to seal against leakage from the muffler in the area of the rib.

The surface contact with the tool of the inner radiused wall 34 of the top wall 28 of the muffler is axially extended by means of a lip portion 46 tapering downwardly toward the tool's surface. A similar oppositely extending lip 47 is provided on the inner radiused wall 34 of the bottom wall 29 of the muffler. In the unmounted condition of the muffler, as appears in FIG. 5, the lip portions 46 and 47 incline slightly inwardly of normal. In the mounted condition of the muffler, as in FIG. 1, these lip portions are resiliently pressed tightly about the tool housing in fluid tight sealing relation to the latter. By means of this mounting arrangement of the muffler, undesirable leakage of exhaust air about the top and bottom walls of the muffler is avoided. Leakage in these areas would cause discomfort to the operator; and would create an undesirable working condition.

The housing shoulders 38 and 39 provide a rigid backing for the top and bottom walls of the muffler. The support provided prevents these resilient walls from being blown outwardly relative to the tool by the force of the air exhausting into the muffler.

It is to be noted from FIGS. 3 and 6 that the muffler extends for about three-quarters of a circle and that the spacing 48 between the free ends 33 thereof is shorter than the outer diameter of the curved portion of the piston cylinder. This is of advantage in that it permits the muffler to be resiliently mounted in a naturally clamped condition about the tool.

The muffler may be readily mounted to the tool without difficulty. In this operation, its resiliently expansible free ends 33 are passed over the cylindrical portion of the piston cylinder between the housing shoulders 38 and 39 until the cylindrical portion of the cylinder is fully received into the complementary central open area 49 of the muffler. The free ends 33 are then drawn rearwardly a little to align the holes 51 of the inserts with those 37 of the housing rib 26 and to cause simultaneous compression of the lip portions 46, 47 into sealing contact with the tool. The bolts are then entered and securely tightened sufficiently to compress the beads 45 fluid tight against opposite faces of the rib.

To remove the muffler for replacement or repairs, the bolts 36 are removed and the muffler is resiliently withdrawn from about the tool.

A problem associated with mufflers of the general hood type is a tendency of moisture usually present in the operating air to freeze and coat the interior wall area of the muffler with ice. This problem is favorably minimized in the muffler of the present invention by the resilient and flexible nature of the muffler as well as by a smooth and slippery condition of its internal wall surface. The particular arrangement of the exhaust ports 25 of the tool relative to the muffler also aids in preventing ice buildup on the muffler. In this respect, the exhaust ports open out of the tool about 60° apart, as appears in FIG. 3, and in such manner that exhaust air forcefully issuing from each port strikes an area of the opposed muffler sidewall that is centered between the front or crest of the muffler and an end 33 of the muffler. This is an area of the muffler which will most readily be flexed by the striking air stream.

It can be seen by this advantageous construction of the muffler and its arrangement relative to the exhaust ports, that it will be difficult for ice to adhere to its smooth and slippery surface; and that any coating of ice that should form will readily crack up and fall away as the muffler walls are flexed and vibrated by the spurting exhaust air stream.

The problem of blocking the muffler's internal passages 42 with falling chunks of ice is also favorably minimized in this respect, as best indicated in FIG. 3, each of the two openings or passages 42 communicating the upper chamber of the muffler with the lower chamber is located at an end of the chamber. By means of this location, the walls of the passage are defined in part by a vertical wall portion 52 of the muffler and in part by a vertical wall portion of the piston cylinder 13. It can be seen that, should chunks of ice fall upon the partition wall 31, the vertical wall portions 52 and 13 will tend to prevent the ice from landing in a blocking condition over the passages 42.

The discharge port 44 for the muffler is inclined downwardly through the crest or front area of the lower chamber 43 of the muffler. This location and form of the discharge port reduces the possibility of ice chunks landing to clog it. Port 44 also serves to conduct exhaust air forwardly and away from the operator. A small drain hole 53 for water developing in the muffler is located in its bottom wall 29.

A further advantage of the muffler is provided by its resilience and its inherent toughness. Because of these characteristics, the muffler is capable of absorbing forceful impacts occasioned by rough handling and dropping; and, as a consequence, it is not subject to cracking.

The elastomer from which the muffler is molded is characterized by its inherent resistance to water, oil and abrasion by its smooth and slippery properties and by its resilience. Here, an elastomer material preferred for this purpose is a polyurethane resin containing about 10 percent Teflon.

If the exhausting air stream from the tool were permitted to issue directly to atmosphere, it would produce an objectionable complex pulsating noise, characterized by sounds of a varying low basic frequency with multiple harmonics extending through the sound frequency spectrum and further characterized as having a high decibel noise level. The muffler of the present invention is designed to materially attenuate and smooth out the objectionable nature of this noise. To this end, the muffler is designed to define a sound filtering system through which the exhausting air stream must pass before issuing to atmosphere.

The exhaust air is caused, as its sound wave pattern is being acted upon by the muffler, to pass through the muffler in such manner that no undesirable back pressure develops to interfere with the operating efficiency of the tool. The exhaust sound that finally issues from the tool to atmosphere is relatively steady without objectionable pulsation; is substantially reduced in intensity and pitch; and is relatively quiet.

The air stream exhausts in spurts from the exhaust ports 25 in two streams into the upper chamber 41 slightly above the partition or floor 31 of the upper chamber. Each air stream spurts forcefully against the opposed resilient sidewall 32 of the muffler causing the latter wall to develop an oscillating frequency in phase with the issuance of the stream. This tends to initially reduce the intensity of the moving air. The air

stream then circulates about the upper chamber and enters in equal volume in two streams through the openings **42** to the lower chamber **43** at opposite ends of the latter. After entering the lower chamber, the two air streams are guided by the parallel curved walls of the piston cylinder and the sidewall of the muffler an equal distance to the discharge port **44** located at the front or crest of the muffler. Some of this air also issues in small volume through the drain hole **53**.

It is to be noted that the openings **42** in the dividing partition wall **31** of the muffler correspond in dimension to the exhaust ports **25** of the tool and that the volume of the upper chamber **41** is relatively large to the volume of exhaust air that can spurt from the exhaust ports with each stroke of the piston. Accordingly, no undesirable back pressure will develop in the upper chamber that might affect the operating efficiency of the tool. And, since the spurting of exhaust air into the muffler is intermittent, the continuously open discharge port **44** is adequate to allow continuous discharge of spent air from the lower chamber **43** without undesirable back pressure developing. The discharge port corresponds in its cross dimension to that of one of the exhaust ports. In effect, the rate and volume of fluid entering from the exhaust ports into the upper chamber does not exceed that flowing through the openings **42** into the lower chamber; and the rate and volume of fluid entering the lower chamber does not exceed that being discharged from the discharge port **44**.

The upper and lower chambers **41** and **43** are in the nature of sound filtering chambers tuned to different design frequencies, as determined by their size and vertical dimension, whereby undesirable sound frequencies are materially attenuated. The upper chamber functions to attenuate objectionable high sound frequencies and some of the lower sound frequencies. The lower chamber serves to further attenuate objectionable high sound frequencies escaping from the upper chamber as well as undesirable lower sound frequencies.

It is to be noted that the length of the upper chamber is approximately twice that of the lower chamber, or in the ratio of 2:1. The volume of the upper chamber to the lower chamber is also approximately in the same ratio. It has been found that this construction is productive of good sound attenuating results. The final sound that issues to atmosphere is relatively quiet, free of objectionable pulsing, and materially reduced in intensity and pitch.

We claim:

1. In a pneumatic tool having a cylinder section provided with exhaust ports through which spurts of air spent in reciprocating a piston rapidly and forcefully issue, a one-piece noise muffler formed of resilient flexible material detachably mounted to the cylinder section of the tool defining with the outer surface of the latter a pair of sound filtering chambers, the area of contact of the muffler with the cylinder section being fluid tight, the exhaust ports being of equal area dimension and opening into one of the chambers, ports corresponding in number and area dimension to that of the exhaust ports connecting the one chamber to the second chamber, a discharge port from the second chamber corresponding in area dimension to that of an exhaust port, so that exhaust air flow from the exhaust ports through the pair of chambers to the discharge port is without consequent back pressure, and the chambers being unequal in volume and length, so that each chamber differs in its design sound wave frequency from that of the other.

2. A pneumatic percussive tool having a cylinder section provided with exhaust port means through which spurts of air spent in reciprocating a piston rapidly and forcefully issue, a one-piece noise muffler having a C-configuration formed of elastomeric material detachably mounted to the cylinder section defining with the outer surface of the latter a sound filtering chamber system into which the exhaust port means opens, the chamber system having an exhaust air discharge port means connecting the chamber system with atmosphere, wherein means is provided for detachably clamping the muffler to the tool in such manner that its perimetric edges are in fluid tight contact with the surface of the cylinder section of the tool.

3. A pneumatic percussive tool as in claim **2**, wherein the cylinder section includes a radial rib along its back and an adjacent curved forward portion through which the exhaust port means opens, the muffler has a curved wall portion collaring the curved portion of the cylinder section and has a pair of free end walls clamped to opposite faces of the rib.

4. A pneumatic percussive tool as in claim **3**, wherein the muffler has top and bottom walls offset radially from corresponding ends of its curved wall portion, the top and bottom walls each having an inner radiused axially extending narrow wall in conforming contact relation with the curved forward portion of the cylinder section.

5. A pneumatic percussive tool as in claim **4**, wherein the cylinder section has upper and lower radial flat shoulders lying respectively in backing relation to the top wall and the bottom wall of the muffler so as to support said top and bottom walls from being blown resiliently outwardly relative to the muffler under force of exhaust air entering the muffler.

6. A pneumatic percussive tool as in claim **4**, wherein the inner radiused axially extending narrow wall of the top wall of the muffler has a depending lip tapered toward the curved forward portion of the cylinder section and resiliently pressed upon the latter, and wherein the radiused axially extending narrow wall of the bottom wall has an upwardly extending lip tapered toward the curved forward portion of the cylinder section and resiliently pressed upon the latter.

7. A pneumatic percussive tool as in claim **3**, wherein a bead portion is formed vertically of each of the free end walls and is resiliently pressed against the corresponding face of the rib.

8. A pneumatic percussive tool as in claim **4**, wherein a partition wall is offset radially from the curved wall portion of the muffler in axially spaced relation between the top and bottom walls and has a inner radiused axially narrow wall engaging the curved wall portion of the cylinder section of the tool so as to define an upper chamber and a lower chamber for the muffler.

9. A pneumatic percussive tool as in claim **8**, wherein the exhaust ports of the tool open radially into the upper chamber, the upper chamber communicates with the lower chamber by means of a pair of openings through the partition wall at opposite ends of the upper chamber, each opening being defined in part by a vertical wall portion of the muffler and in part by a wall portion of the cylindrical section of the tool.

10. A pneumatic percussive tool as in claim **9**, wherein the length of one chamber relative to that of the other is in the ratio of 2:1.

11. An elastomer muffler unit for the exhaust of a pneumatically percussive tool, comprising a one-piece curved body of C-configuration having an outer curved side wall, a top wall offset radially from the upper end of the sidewall, a bottom wall offset radially from the lower end of the sidewall in parallel relation to the top wall, and having an intermediate wall offset radially from the sidewall between the top and bottom walls, the several walls terminating at opposite ends in a pair of spaced opposed common vertical end walls each having a broad inner face in opposed relation to the other and each having an inner vertical sidewall, a notch formed in one end of the partition wall having as one edge thereof the inner vertical side of one end wall, and a similarly formed notch in the opposite end of the partition, each of the radial walls having an inner radiused wall adapted to engage about a complementary surface of a pneumatic tool, and the vertical end walls being adapted to be detachably mounted to opposite faces of a back rib of the said tool.

12. An elastomer muffler as in claim **11**, wherein a bar insert is embedded in each of the inner faces of the end walls, the insert having a plurality of openings spaced one above the other for reception of mounting bolts.

13. An elastomer muffler as in claim **11**, wherein a lip coextensive with the inner radiused wall of the top wall is inclined downwardly and radially inwardly of the said radiused wall, and wherein a similar lip in opposed relation to the lip of the top wall is coextensive with the inner radiused wall of the bottom wall.