Dec. 21, 1965 R. J. WALDRON 3,224,527

PERCUSSIVE DRILL WITH NOISE SILENCER

Filed April 3, 1964

5 Sheets-Sheet 1

FIG. 1

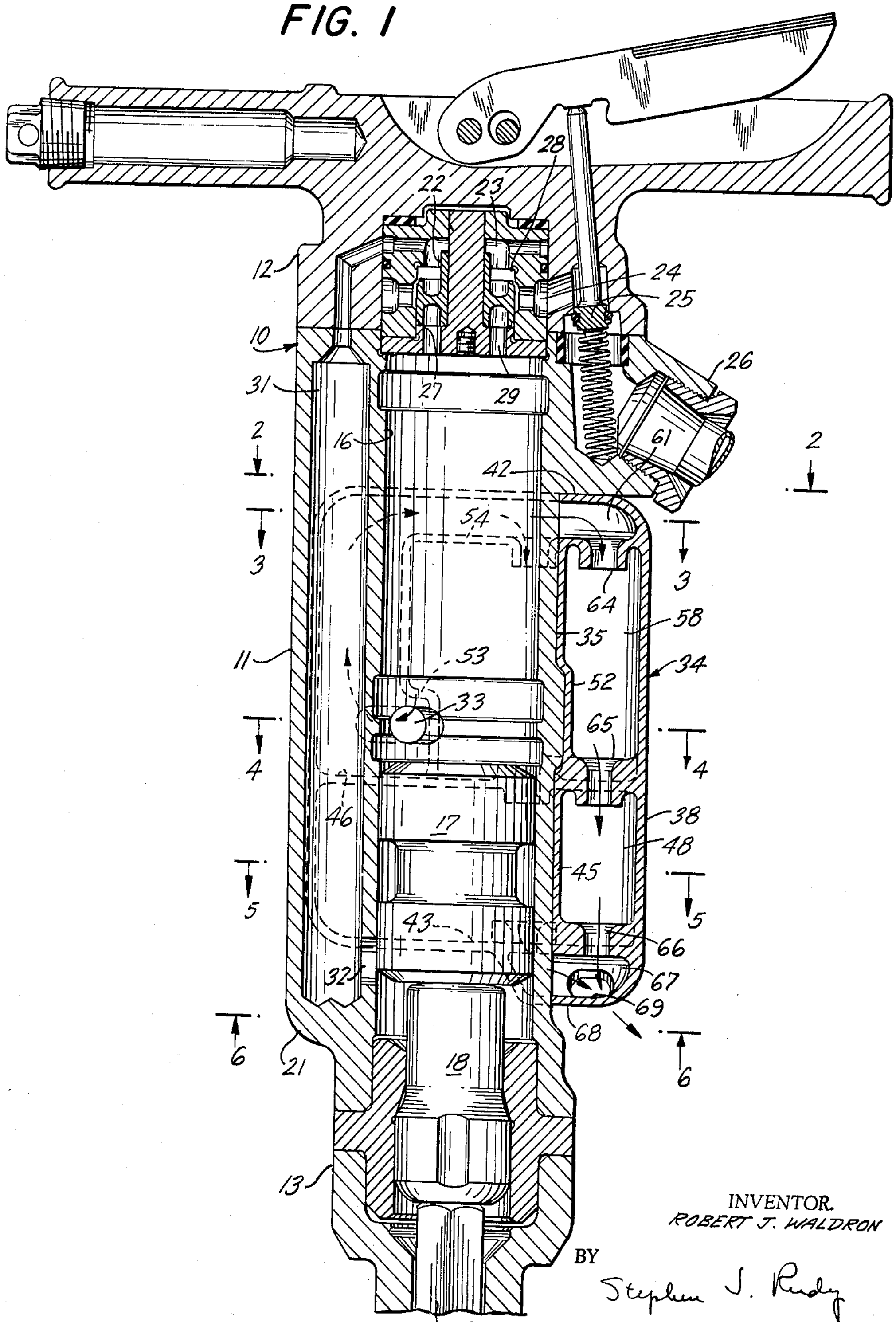

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FIG. 2

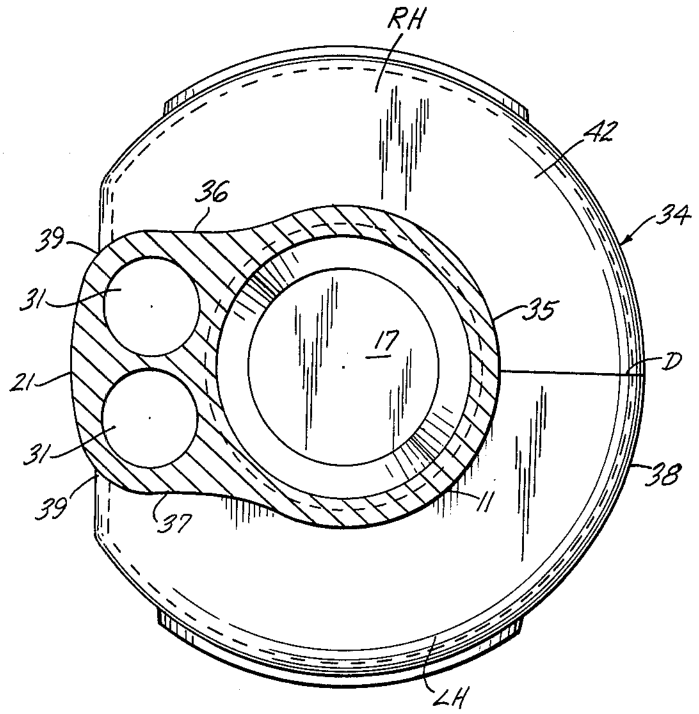

FIG. 3

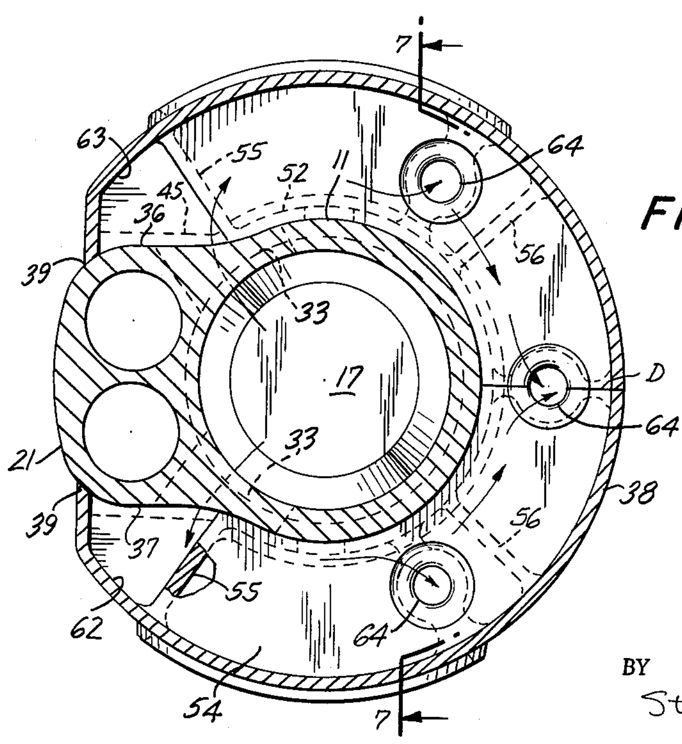

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FIG. 4

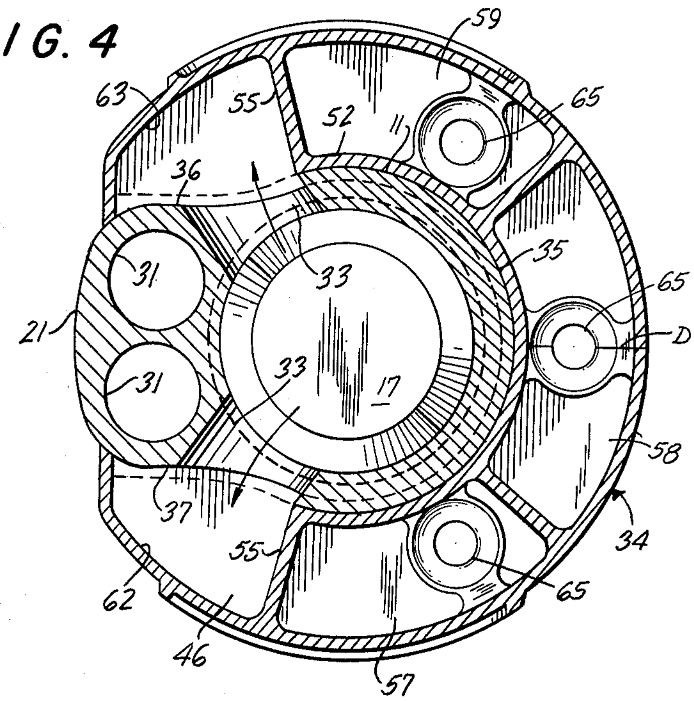

FIG. 5

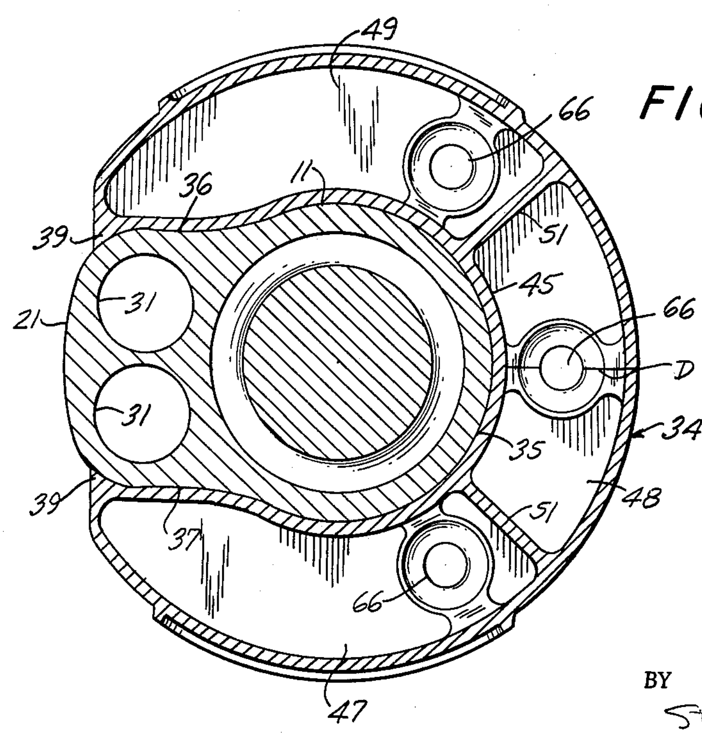

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FIG. 6

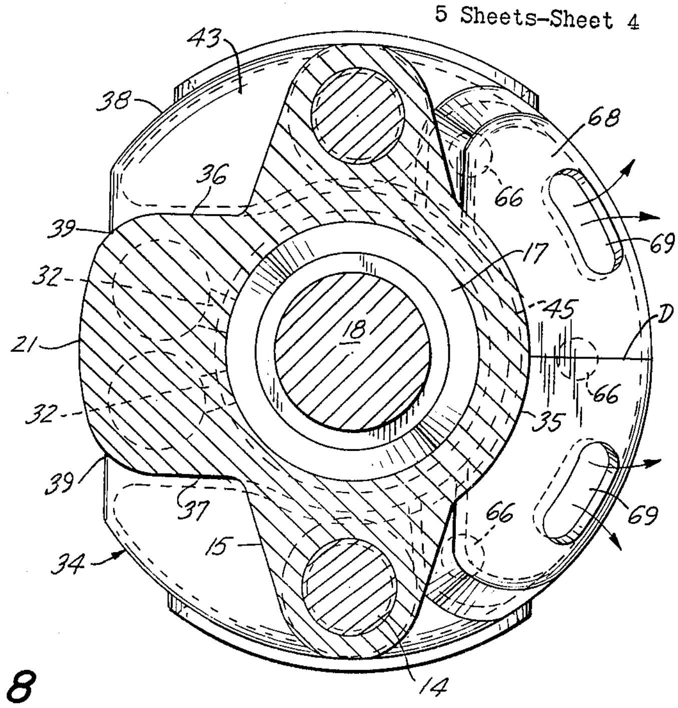

FIG. 8

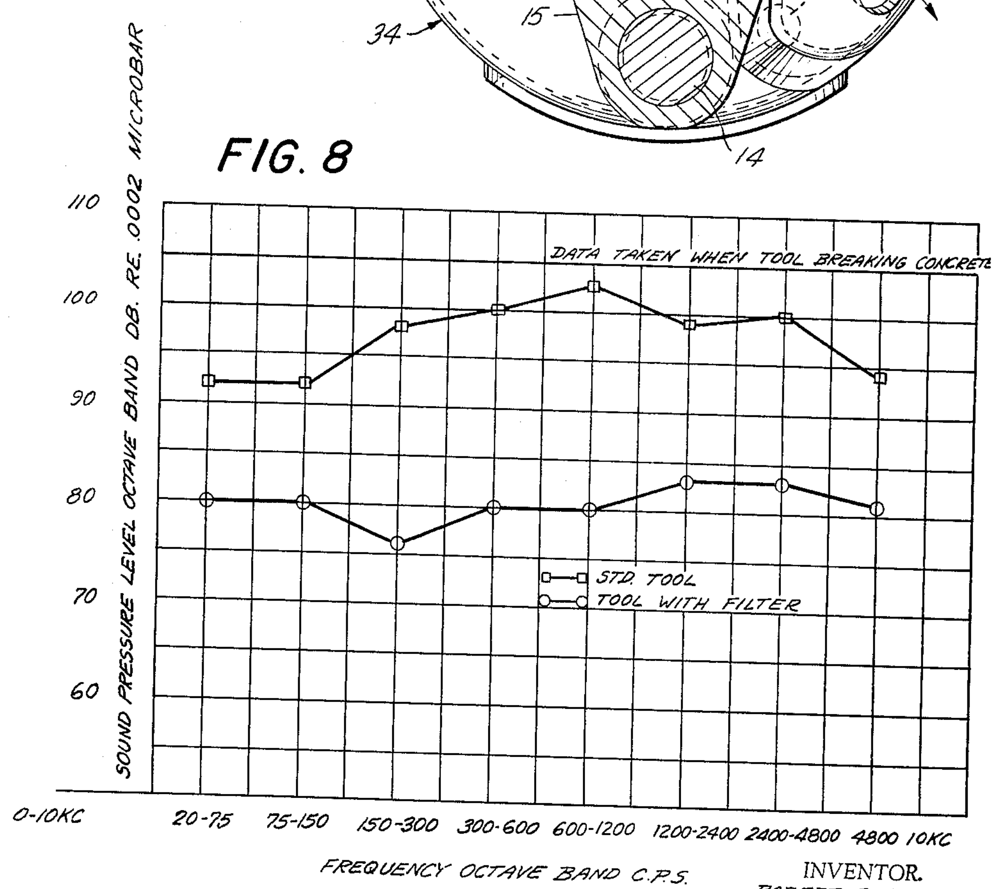

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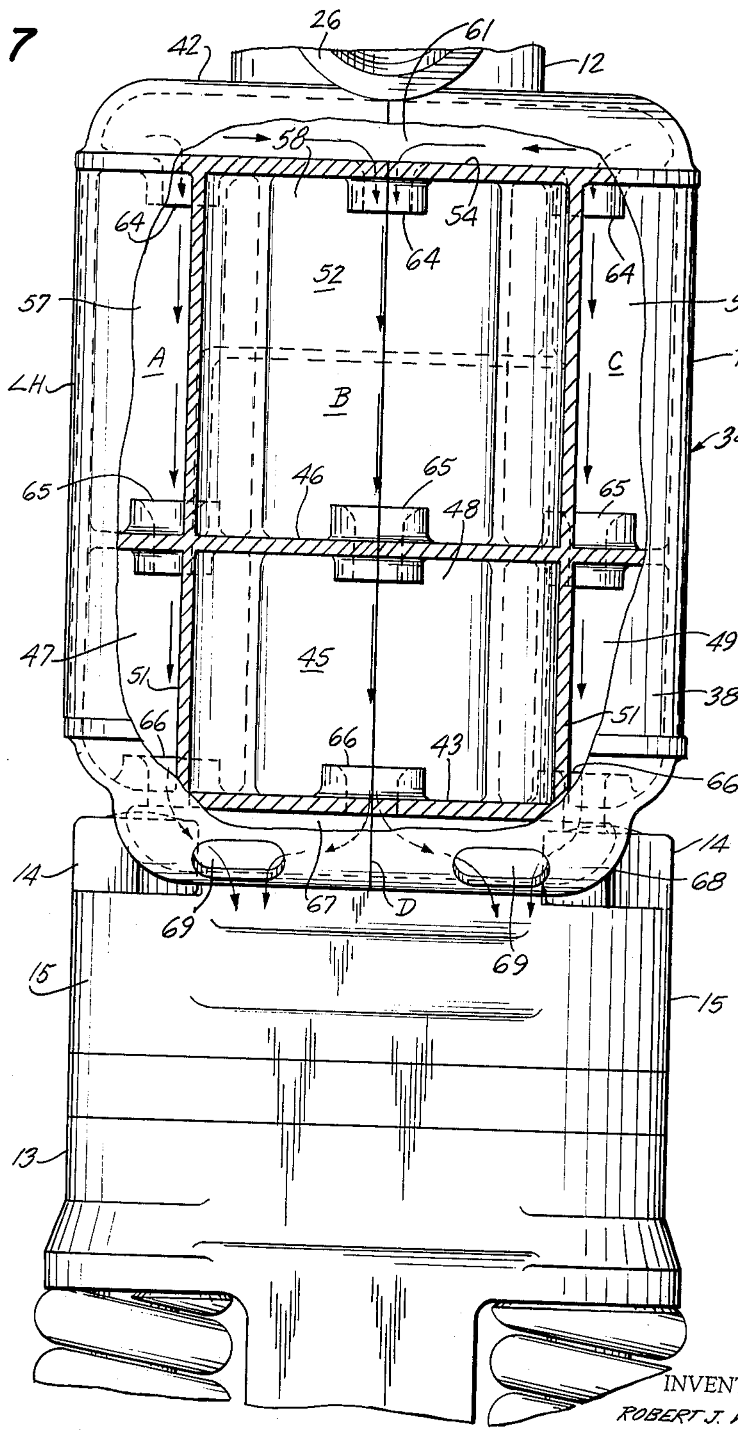
FIG. 7



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3,224,527
Patented Dec. 21, 1965

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3,224,527

PERCUSSIVE DRILL WITH NOISE SILENCER

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Filed Apr. 3, 1964, Ser. No. 357,039
20 Claims. (Cl. 181—36)

This invention relates to improvements in the construction of a pneumatic tool so as to provide the latter with a sound filter unit as an integral part of the tool for quieting its exhaust sounds.

The invention is illustrated herein as applied to a pneumatic percussive tool of the type commonly known as a pavement breaker. The tool is so characterized as it is commonly used in tearing up the pavement of city streets. A tool of this type includes a heavy hammer piston which is rapidly reciprocated by pneumatic power to repeatedly pound an anvil against a work steel to effectively operate the latter. Air spent in reciprocating the piston is intermittently exhausted or pulsed to atmosphere following each piston stroke. Upon expanding outside of the tool to atmosphere the exhausted air produces an objectionable pulsating noise varying in intensity and pitch, including sounds of low and high pitch.

Muffling devices characterized by tortuous passages, baffles, sound absorbing materials, or the like have been used in attempts to quiet the noise of such tools. But an objectionable feature of these devices is that they create an undesirable back pressure to the flow of the exhausting air which tends to interfere with the reciprocating action of the piston. Mufflers have been made in the form of various types of attachments which, when associated with the tool unduly increase its bulk and tend to interfere with the efficient handling of the tool by the operator.

An object of the present invention is to provide means for quieting the exhaust sounds of a pneumatic tool, as well as structure for this purpose which does not undesirably add to the bulk of the tool, and which functions without developing ony objectionable back pressure that would interfere with the operating efficiency of the tool.

A further object of this invention is to provide in a pneumatic percussive tool an exhaust sound quieting construction which is an integral part of the casing of the tool, and functions to transform the usual objectionable complex pulsating exhaust noise into a non-objectionable and substantially non-pulsating steady sound of comparatively low pitch and reduced intensity.

A more particular object of this invention is to provide a sound quieting structure for a pneumatic percussive tool in the form of an enclosed hood which conforms to and fits about the body of the tool and is integrally joined thereto.

A further and more general object of this invention is to provide an improved construction in a pneumatic percussive tool of the pavement breaker type which materially nullifies the objectionable excessive loudness, high pitch and erratic pulsating noise that characterizes conventional tools of this type.

A percussive tool embodying the invention includes a body section defining a piston cylinder having a pneumatically reciprocating hammer piston therein, a pair of exhaust ports from the piston cylinder, and a sound filter unit in the form of an enclosed hood arranged in coaxial surrounding relation to the piston cylinder, wherein the hood comprises: a plurality of sound filter systems arranged successively and in parallel relation to each other in the hood; an overhead passage common to the several filter systems having at opposite ends thereof communication with the exhaust ports, each filter system having a first stage sound attenuating chamber and a second stage sound attenuating chamber, one stage varying in length and volume from the other, a separate contracted inlet throat connecting the first stage chamber of each filter system with the overhead passage, an intermediate throat connecting the first stage chamber of each filter system with its second stage chamber, a discharge passage common to the several filter systems having a pair of vents to atmosphere, and a separate discharge throat connecting the second stage chamber of each filter system with the discharge passage, the several throats and passages, exhaust ports and vents of the filter unit being of adequate cross sectional area to permit substantially unrestricted exhaust flow therethrough.

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The foregoing and other objects and features of this invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purposes of illustration and description and they are not to be construed as defining the limits of the invention.

In the accompanying drawings:

FIG. 1 is a vertical section through a pneumatic percussive tool, known as a pavement breaker, 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 section taken on line **4—4** of FIG. 1;

FIG. 5 is a section taken on line **5—5** of FIG. 1;

FIG. 6 is a section taken on line **6—6** of FIG. 1;

FIG. 7 is a front elevational view, with some portions omitted, of the tool shown in FIG. 1, rotated 90 degrees clockwise from the FIG. 1 position, and having a portion of the outer wall of the filter unit broken away along the irregular line **7—7** in FIG. 3; and

FIG. 8 is a graph showing the noise attenuation effected in a tool embodying the invention as compared to a tool not embodying the invention.

The pneumatically operated percussive tool illustrated in the accompanying drawings includes a main casing **10** having an intermediate body or piston cylinder section **11**. To the top end of the piston cylinder is mounted a backhead **12**. To its bottom end a fronthead **13** is mounted as by bolting means **15** extending through side bossed portions **15** of the casing. The piston cylinder provides an elongated piston chamber **16**. In the piston chamber a heavy solid hammer piston **17** is rapidly reciprocable by means of pneumatic power to repeatedly and forcefully pound an anvil **18** against a work steel **19**. The piston cylinder **11** is substantially cylindrical for the major portion of its length, except for a radial rib **21** formed lengthwise of its back, and except for the radial extension of the bossed sides portions **15** at its bottom end.

A distributing valve **22** is arranged in a chamber **23** of the backhead. This chamber is connected by passage means **24** through a manually operable throttle valve **25** to an inlet projection **26** connectable to a suitable source of pressure air. The distributing valve functions automatically, as long as the throttle valve is held open, to feed operating air alternately to opposite ends of the piston chamber. The distributing valve is slidable in the chamber 23 of the backhead relative to a pair of seats **27**, **28**. It has a first position, as in FIG. 1, on seat **27** wherein the air supply passage **24** is closed off from a port **29** leading to the top end of the piston chamber, and the passage **24** is in communication through chamber **23** with passages **31**. The latter extend longitudinally through the cylinder rib 21 and are connected at their bottom ends by ports 32 to the lower end of the piston chamber. The reverse situation exists when the distributing valve is in its second position on seat 28.

Operating air fed alternately to opposite ends of the piston chamber reciprocates the piston. Following each stroke of the piston spent air exhausts through a pair of identical ports 33. These ports are at the same level at about mid-way of the piston cylinder; and they open radially from the piston cylinder through opposite sides of the rib, as appears in FIG. 4. The piston chamber and the piston are of such linear proportions that the piston is able to travel in either direction beyond the exhaust ports 33, so as to enable spent driving air behind the piston to escape through the exhaust ports.

The distributing valve 22 is automatically shiftable by means of pneumatic pressure from one seating position to the other in response to the reciprocating action of the piston. In this respect, on the work stroke of the piston residual air trapped in the piston chamber ahead of the piston is forced over the passages means 31 to the distributing valve to reverse the seating position of the latter. On the return stroke, residual air trapped ahead of the piston acts through the port 29 to again reverse the seating position of the distributing valve. This interrelated shifting action of the distributing valve and the reciprocation of the piston continues automatically as long as the throttle valve is held open. The exhaust ports 33 are of adequate cross-sectional area to permit free and unrestricted escape of exhaust air so as to avoid any development of objectionable back pressure in the piston chamber. If objectionable back pressure were permitted to develop, it would interfere with the necessary rapid valving action of the distributor valve and, as a consequence, would interfere with the effective operation of the piston.

The tool is supplied with operating air at a constant pressure of 90 p.s.i. Accordingly, air spent in reciprocating the piston escapes forcefully through the exhaust ports following each piston stroke. The piston reciprocates at a rapid rate of 40 cycles per second, effecting 1200 blows per minute. Because of this rapid reciprocating action of the piston, the exhaust air is rapidly pulsed from the exhaust ports. If this pulsating exhaust air were permitted, as it does in conventional tools, to expand from the exhaust ports directly into the atmosphere, it would produce the objectionable pulsating complex noise mentioned earlier herein, characterized by sounds of a low basic frequency with multiple harmonics extending through the whole sound frequency spectrum, and further characterized by a high decibel noise level, as indicated by the upper graph line in FIG. 8. To minimize the objectionable nature of this exhaust noise, the tool of the present invention has incorporated in its structure a sound reducing or sound attenuating filter unit 34 through which the exhaust from the piston cylinder is caused to flow before it is permitted to issue to atmosphere. The sound that finally issues from the filter unit is realtively even without objectionable pulsation; is substantially attenuated in pitch and intensity; and is relatively quiet, as indicated by the lower graph line in FIG. 8. This effect is produced without any undesirable objectionable back pressure occurring in the piston chamber.

The structure of the sound filter unit 34 is such as to accomplish a three-fold purpose; namely, not to undesirably increase the bulk of the tool; to allow exhaust air to pass through it without creating undesirable back pressure that would interfere with the valving action of the distributing valve of the tool; and to materially attenuate and smooth out the exhaust sounds of the tool.

This filter unit 34 is in the form of a closed-ended hollow hood of arcuate shape which collars the piston cylinder over the exhaust ports 33 between the backhead 12 and the radially bossed portions 15 above the front head 13. The hood overlies a forward cylindrical surface

portion 35 of the piston cylinder and also the opposite sides 36 and 37 of the back rib portion 21 of the piston cylinder. It includes an arcuate outer or external wall 38 disposed coaxially with the piston cylinder. This wall is joined, as by welding, along its opposite ends 39 to the rear of the opposite sides 36 and 37 of the rib 21 of the piston cylinder. This outer wall (FIGS. 1, 2) continues radially inward at its upper end to provide a top wall 42 for the hood. This top wall collars the cylindrical surface portion 35 as well as the sides 36 and 37 of the rib 21 of the piston cylinder at a level a little below the inlet projection 26. This top wall 42 is sealed, as by welding, to the piston cylinder to provide an air tight junction with the latter. The outer wall 38 of the hood continues (FIGS. 1, 6, 7) radially inward at its lower end to provide a bottom closure wall 43 located just above the bossed side mounting portion 15 of the casing. This bottom wall continues (FIGS. 1, 4, 5) upwardly to define an inner wall of the hood comprising a lower portion 45 and an upper portion 52. The lower portion 45 overlies (FIG. 5) a lower part of the cylindrical surface portion 35 and the sides 37 and 36 of the rib 21 of the piston cylinder. This lower portion 45 of the inner wall is integrally joined at its upper end (FIGS. 1, 7) by means of a radially outwardly extending intermediate horizontal partition 46 with the outer wall 38. The enclosed area of the hood below the intermediate partition 46 is divided off (FIGS. 1, 5, 7) into three sound attenuating chambers 47, 48 and 49 by means of a pair of radially extending partitions 51. The three chambers are of the same length, and are of substantially the same volume. The level of the intermediate partition 46 is a little below that of the exhaust ports 33 (FIG. 1). The upper portion 52 (FIGS. 1, 3, 4, 7) of the inner wall of the hood extends upwardly above the intermediate partition 46. This upper portion overlies only the cylindrical surface portion 35 of the piston cylinder; it does not overlie the opposite sides 36, 37 of the rib 21. It is contoured, as at 53 in FIG. 1, so as not to cover the exhaust ports 33 which open through opposite sides of the piston cylinder, partially through the rib 21 and partially through the cylindrical portion 35. The top end of the inner wall of the hood is spaced a little below the top wall 42 of the hood, from where it extends radially outward by means of a horizontal partition 54 to join the outer wall 38 (FIGS. 3, 7). Radial partitions 55 depending downwardly at opposite sides of the upper partition 54 join the latter partition with the intermediate partition 46 and join the inner wall of the hood with the outer wall 38. By means of the latter construction an enclosed area is provided above the intermediate partition 46 which is divided by means of a pair of further radial partitions 56 into three upper sound attenuating chambers 57, 58 and 59 which are of the same length and substantially of the same volume. The space (FIGS. 1, 7) between the upper partition 54 and the top wall 42 of the hood defines an arcuate overhead exhaust flow passage 61 about the piston cylinder. This passage connects at its ends with a pair of identical exhaust flow passages 62, 63, each extending downwardly along an opposite side of the rib 21 and connecting at its lower end with a separate one of the exhaust ports 33. The lower portion 45 of the inner wall of the hood is sealed as by welding about its bottom end to the piston cylinder to provide an air tight joint.

The several upper and lower chambers of the sound filter unit 34 define three separate sound reducing or filtering systems (FIG. 7) designated as A, B, and C. These are arranged successively in the hood in parallel relation to each other and to the axis of the piston cylinder, and extend downwardly relative to the overhead passage 61. System A includes the upper chamber 57 and the lower chamber 47; system B includes the upper chamber 58 and the lower chamber 48; and system C includes the upper chamber 59 and the lower chamber 49.

Each of the upper chambers is connected to the overhead passage 61 by means of an identical separate inlet throat 64, which throat depends a little into its related upper chamber. The mouth end of each of these inlet throats is bell-shaped and tapers in the direction of the flow. This construction of the inlet throats avoids the development of eddy currents and consequent back pressure as exhaust air entering the overhead passage from the piston cylinder flows through the throats.

The inlet throats are further arranged relative to each other and to the opposite ends of the overhead passage 61 so as to allow unimpeded flow of exhaust air from the exhaust passages 62, 63 to the several inlet throats. To this end, the inlet throats of systems A and C are spaced (FIG. 3) circumferentially in the hood at equal distances from the corresponding exhaust flow passages 62, 63; and the inlet throat of system B is centered circumferentially in the hood between the other two throats. By means of this arrangement exhaust streams entering the overhead passage 61 flow about the latter in opposite directions, each stream flowing in order over one of the inlet throats before reaching the center inlet throat. In effect, the two streams flowing in the overhead passage are caused to divide, and to enter the three throats with a minimum of eddy currents and back pressure. The inlet throats are of adequate cross-sectional area to permit unrestricted flow therethrough. The exhaust flow passages 62, 63 as well as the overhead passage 61 are also of adequate cross-sectional area to allow substantially unrestricted exhaust flow therethrough.

Each of the upper chambers 57, 58 and 59 is connected to its correpsonding lower chamber by means of a separate and identical intermediate throat 65 extending through the intermediate partition 46. These intermediate throats extend above and below the latter partition for a short distance. They are of the same diameter as the inlet throats; and each intermediate throat is axially aligned with its corresponding inlet throat, so that the main flow of the stream passing through the upper chamber will flow into the lower chamber without restriction. The mouths of the intermediate throats are also bell-shaped to avoid eddy currents in the entering stream. The intermediate throats are of a greater length than the inlet throats so as to provide an attenuating effect on the sound carried by the exhausting stream, which effect is different from that provided by the inlet throats. Here, the length of the upper chamber is approximately one and one-half times that of the lower chamber; or at a ratio of 3 to 2. The volume of the upper chamber to its lower chamber is also approximately at the same ratio.

Each of the lower chambers 47, 48 and 49 connects through the bottom wall 43 of the hood by means of a separate identical discharge throat 66 with an arcuate collector or discharge passage 67. The latter is defined at the underside of the bottom wall 43 of the hood by means of an underlying wall 68. These discharge throats extend upwards for a short distance into their respective lower chambers; they also are bell-shaped in their mouth ends. The length of each of these throats is substantially equal to that of each of the inlet throats. The discharge throat 66, intermediate throat 65 and inlet throat 64 in each filter system are of the same diameter and axially aligned, so that the main flow of the stream entering the inlet throat will flow without restriction through the intermediate and discharge throats.

The underlying discharge passage 67 exhausts to atmosphere through a pair of identical vents 69 formed in the wall of the discharge passage. Each vent is centered (FIGS. 1, 6, 7) between two of the discharge throats. The discharge throat of the center filter system B is common to both vents, so that the exhaust from system B passes in substantially equal parts through both vents. Each vent is equal in cross sectional area to approximately the total area of the related two discharge throats. Due to the elongated dimension of each in a transverse direction relative to its two associated discharge throats and due to the close proximity of the vent below the latter, flow from the discharge throats to the vents and then to atmosphere is substantially direct and unrestricted. It is clear from the foregoing construction of the filter unit that the flow of exhaust air from the exhaust ports 33 through the filter unit to atmosphere is substantially unrestricted and without appreciable back pressure, so that no undesirable interference is presented to the valving action of the distributing valve 22 of the tool, nor to the reciprocating action of the piston.

The arrangement of the sound filtering unit on the tool and its relative dimensions do not undesirably add to the bulk of the tool. It is to be noted that the outer wall 38 of the filter unit does not extend radially beyond the vertical plane of the radially extending bossed portions 15 of the tool; that it covers over only the piston cylinder section 11; and that at its rear it does not extend radially beyond the rib 21 of the piston cylinder. This close and compact arrangement of the filter unit relative to the body of the tool serves to define its dimensions to the overall outer normal dimensions of the casing 10 of the tool. Accordingly, the sound filter unit 34 does not undesirably increase the size or bulk of the tool, and thus does not interfere with the operator's handling of the tool.

From the foregoing it is clear that the sound filter unit is of such structure and design that it does not interfere with the efficient handling of the tool by the operator, and it permits the high pressure exhaust air to pass through it without affecting the operating efficiency of the tool. The beneficial effects of the sound filtering unit upon the complex sound carried by the high pressure air exhausted from the piston cylinder will also be apparent from the further description which follows.

Due to the rapid reciprocating action of the piston at a rate of 40 c.p.s. to effect 1200 blows per minute, high pressure exhaust air is pulsed from the piston cylinder on each stroke of the piston simultaneously through both exhaust ports 33 directly into the exhaust flow passages 62, 63 of the sound filtering unit. The sound wave pattern impressed upon the exhausting air is complex. It has a basic or fundamental frequency of 40 c.p.s. with multiple harmonics extending through the sound frequency spectrum of 10,000 c.p.s. The provision of two exhaust ports 33 of equal size and at the same level in the piston cylinder is significant, in that the exhaust from the piston chamber is thereby initially divided into two equal stream portions with a consequent reduction in the driving air mass behind each portion as it flows through the filter unit. The exhaust air from the exhaust passages 62, 63 enters the overhead passage 61, wherein it divides within a minimum development of eddy currents into three separate streams as it empties through the inlet throats 64 into the upper chambers 57, 58 and 59 of the three filter systems A, B and C. This division of the exhausting air flow into three streams further reduces the driving air mass behind each individual stream. Dividing the exhaust air into a group of separate streams serves to reduce the intensity of the sound carried by each exhaust stream.

Each of the filter systems provides in series a two-stage action upon the sound carried by the air stream exhausting through it. The first stage which is represented by the inlet throat 64 and the associated upper chamber, has a design frequency of 250 c.p.s. In this stage the open ends of the inlet throat 64 serve as sound wave reflection points. An effect of the first stage is to attenuate the pitch of sounds having frequencies above the design frequency. The second stage, which is represented by the intermediate throat 65 and by the related lower chamber, has a design frequency of 350 c.p.s. The intermediate throat is of greater length than the inlet throat; and the lower chamber is of shorter length than the upper chamber. In this second stage the open ends of the intermediate throat 65 act as sound wave reflection points. An effect of this second stage is to further attenuate the pitch of sounds in the high frequency range above its design frequency. By means of this arrangement some of those objectionable high pitched sounds which escape through the first stage are attenuated by means of the second stage. The discharge throat **66** in each filter system has a length approximating that of the inlet throat; and has a subsantially direct communication with the discharge vents **69** because of the shallow depth of the discharge passage **67**. The discharge throat acts to further attenuate some of the high frequency sounds which might have escaped through the first and second stages.

A further effect on the sound wave pattern of the exhausting air is provided because of the serial arrangement of the upper and lower chambers in each filter system. The effect of having two chambers connected in series by contracted throat means wherein the upper chamber is relatively longer and of greater volume than the other, together with contracted inlet, intermediate and discharge throats all of the same diameter and axially aligned, permits the smaller lower chamber during the operation of the tool to discharge continuously and at a steady rate substantially without pulsation. This occurs while at the same time the exhaust from the piston cylinder is being pulsed into the longer upper chamber. In this respect, the volume of the lower chamber and the diameters of the inlet, intermediate and discharge throats are such that the rate of entry of fluid into the lower chamber from the upper chamber does not exceed the rate of discharge from the discharge throat.

A further advantage is provided in having three filter systems arranged in parallel relation and offset from an overhead exhaust flow passage, as here, in that each system acts on a lesser volume of moving air per unit of time than if each system were serially arranged one below the other. Accordingly, there is a more efficient filtering out by each system of objectionable sounds, and such is done without appreciable resultant back pressure than would otherwise be the case.

To facilitate the application of the filter unit to the piston cylinder, the filter unit may be advantageously formed in two half sections, such as by casting, the division line being radially through the center filter system A, as indicated by the line D. By this means one-half section designated RH (FIGS. 2, 7) may be fitted and welded in place about the piston cylinder between the projecting overhead portions such as the inlet projection **26** of the backhead and the projecting underlying bossed portions **15**. The second-half section LH may be similarly fitted in opposed relation to the first section and welded where required to the piston cylinder and along the point of juncture to the other half section. It is also to be noted that the wall **68** underlying the discharge passage **67** depends at the front **35** of the piston cylinder clear of the bossed portions **15**.

While an embodiment of the invention has been illustrated and described in detail, it is to be expressely understood that the invention is not limited thereto. Various changes might be made in the design and arrangement of the components thereof without departing from the spirit and scope of the invention. Accordingly, it is my intent to claim the invention not only as shown and described herein, but also in all such forms and modifications thereof as might be reasonably construed to fall within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a pneumatic percussive tool including a piston cylinder body section having a piston chamber and a piston pneumatically reciprocable in the latter, a backhead section closing over the top end of the piston cylinder having an operating air distributing valve responsive to pressure of air trapped alternately at opposite ends of the piston during reciprocation of the piston to effect distribution of operating air alternately to opposite ends of the piston chamber, and exhaust port means in the piston cylinder for exhausting directly from the piston chamber to the outside of the piston cylinder air spent on each stroke in reciprocating the piston; a sound filtering unit disposed about the piston cylinder and the exhaust port means comprising a plurality of individual sound filter systems arranged successively and in parallel relation about the piston cylinder, each system having an upper sound attenuating chamber and a lower sound attenuating chamber varying in length from the upper chamber, an overhead passage common to the several filter systems, exhaust flow passage means connecting the overhead passage to the exhaust port means, a separate inlet throat connecting the overhead passage with the upper chamber of each filter system, an intermediate throat in each filter system connecting the related upper chamber with the corresponding lower chamber, a discharge passage common to the several filter systems having vent means to atmosphere, and a discharge throat in each filter system connecting the related lower chamber with the discharge passage, the inlet, intermediate and discharge throats of each filter system being of the same diameter and axially aligned with one another and being of adequate cross-sectional area to allow unrestricted exhaust flow therethrough.

2. In a pneumatic tool according to claim **1**, wherein the sound filtering unit is joined integrally with the body section of the tool.

3. In a pneumatic percussive tool according to claim **1**, wherein the tool includes radially extending portions at opposite ends of the body section, and the filter unit is in the form of a hood overlying the body section between the said radially extending portions and having an outer arcuate wall the radial distance of which from the body section does not extend beyond the said radially extending portions of the tool.

4. In a pneumatic percussive tool according to claim **1**, wherein the sound filtering unit is of arcuate form comprising a pair of identical opposed half sections, each overlying identical areas of the body section of the tool.

5. In a pneumatic percussive tool according to claim **1**, wherein the mouth of each throat in each filter system is bell-shaped, tapering in the direction of flow.

6. In a pneumatic percussive tool according to claim **1**, wherein the length of the one chamber relative to that of the other chamber in each filter system is in the ratio of 3:2.

7. In a pneumatic percussive tool as in claim **6**, wherein the intermediate throat in each filter system is longer than the corresponding inlet and discharge throats.

8. In a pneumatic percussive tool according to claim **1**, wherein the exhaust port means comprises a pair of identical ports disposed in spaced relation to each other at the same level.

9. In a pneumatic percussive tool according to claim **8**, wherein the overhead passage is arcuate in form and open at opposite ends, the exhaust flow passage means comprises a pair of identical passages extending longitudinally relative to the piston cylinder in parallel spaced relation to each other and each connecting one of the exhaust ports with a separate one of the ends of the overhead passage.

10. In a pneumatic percussive tool as in claim **9**, wherein the inlet throat of one of the sound filter systems is centered between the inlet throats of the other two sound filter systems and is located equally away from opposite ends of the overhead passage.

11. A pneumatic percussive tool comprising a casing including a body section defining a piston chamber having a hammer piston reciprocable therein, a backhead section closing over a top end of the piston cylinder having an operating air distributing valve responsive to the pressure of air trapped at opposite ends of the piston in the piston chamber during reciprocation of the hammer piston to effect distribution of operating air alternately to opposite ends of the piston chamber, a pair of identical exhaust ports disposed at the same level in the piston cylinder each exhausting an equal amount of exhaust air from the piston cylinder following each stroke of the hammer piston, a hood arcuate in configuration fitted about the body section of the tool, a group of upper and lower chambers in the hood, an arcuate passage in the hood overhead of the upper chambers being open at opposite ends, a pair of identical passages defined in opposed portions of the hood each connecting a separate one of the exhaust ports with a separate open end of the overhead passage, a separate contracted inlet throat connecting the overhead passage with a separate one of the upper chambers, a separate intermediate contracted throat varying in length from the related inlet throat connecting each upper chamber with a separate lower chamber, each lower chamber having a length and volume varying from that of the corresponding upper chamber, a discharge passage defined at the bottom of the hood underlying the group of lower chambers, and a separate contracted discharge throat connecting each lower chamber with the discharge passage.

12. A sound filtering unit of the character described for use in combination with a pneumatically powered tool having a pair of spaced exhaust ports, comprising a hood adapted to be fitted to the tool over the exhaust ports, a group of upper and lower sound attenuating chambers in the hood, the upper chambers varying in length from the lower chambers, an exhaust flow passage in the hood overhead of the upper chambers being open at opposite ends, a pair of longitudinally extending conduits in the hood, each communicating one of the exhaust ports with a separate open end of the exhaust flow passage, a separate inlet throat connecting the exhaust flow passage with a separate one of the upper chambers, a separate intermediate throat connecting each upper chamber with a separate lower chamber, and a separate discharge throat connected with each lower chamber.

13. A sound filtering unit as in claim **12**, wherein the upper chambers are each of the same length, and the lengths of the lower chambers are identical to one another.

14. A sound filtering unit as in claim **13**, wherein the corresponding inlet, intermediate and discharge throats are of the same diameter and axially aligned.

15. A sound filtering unit as in claim **14**, wherein the ratio of the length and volume of each upper chamber to its lower chamber is that of 3 to 2.

16. A sound filtering unit as in claim **12**, wherein the hood is of arcuate configuration comprising a pair of identical casting half-sections integrally joined together.

17. A sound filtering unit as in claim **16**, wherein each casting section has an inner wall portion conforming to a corresponding surface area of the pneumatically powered tool with which the hood is to be combined.

18. A sound filtering unit for use in combination with a pneumatic percussive tool of a type having a cylindrical portion, a radial rib lengthwise of the cylindrical portion, and a pair of spent air exhaust ports each opening in identical manner through an opposite face of the radial rib, the sound filtering unit comprising a pair of identical casting half-sections each adapted to overlie an opposed surface area of the radial rib and cylindrical portion of the tool and adapted to be welded to each other and to the surface of the tool, the sound filtering unit having a pair of opposed longitudinally extending openings each adapted to overlie one of the sides of the rib over one of the exhaust ports, a group of upper chambers, a group of lower chambers, separate intermediate throat means connecting each upper chamber with a separate lower chamber, a separate discharge throat means connected to each lower chamber, an arcuate opening in the filtering unit overhead of the upper chambers adapted to overlie opposite sides of the rib and the cylindrical portion of the tool, the arcuate opening merging at opposite ends with the longitudinally extending openings, and separate inlet throat means connecting each upper chamber with the overhead opening.

19. A sound filtering unit as in claim **18**, wherein the upper chambers vary in length and volume from the lower chambers.

20. A sound filtering unit as in claim **19**, wherein the separate inlet throat means, intermediate throat means and discharge throat means corresponding to an upper and lower chamber are axially aligned, are of the same diameter, and wherein the intermediate throat means varies in length from the length of the inlet throat means.

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LEO SMILOW, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,224,527 December 21, 1965

Robert J. Waldron

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 41, for "ony" read -- any --; column 2, line 47, for "15" read -- 14 --; line 56, for "sides" read -- side --; column 3, line 21, for "passages" read -- passage -- line 58, for "realtively" read -- relatively --; column 5, line 74, after "each" insert -- vent --; column 6, line 20, for "define" read -- confine --; line 51, for "within" read -- with --.

Signed and sealed this 25th day of October 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents