Fig. 3.  

Fig. 4.  

Fig. 5.  

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This invention relates generally to apparatus for suppressing noise and more particularly to a noise suppression device which is specifically adaptable for utilization with engines of various types or other such apparatus which during the utilization thereof emit a relatively fast moving fluid stream into a relatively slow moving or still fluid medium; for example, during operation of a jet or rocket engine.

It has long been recognized in the prior art that a jet or rocket exhaust creates noises which are untenable under normal operating circumstances. It has further been recognized that under some conditions the exhaust can impair damage to personnel or to structures which are subjected to the very high intensity noise levels created by such exhausts. Above a critical sound level, sound is transmitted directly through the bone structure of the human head, thus rendering conventional ear protective devices useless. Even below this critical level, the efficiency of the personnel working in the area can be seriously impaired. Mistakes resulting from the lowered efficiency can be costly in terms of life and property, especially where sophisticated equipment is concerned. Intense sound fields can damage missile guidance systems and other delicate mechanisms. In addition, the loud sounds present at airfields and test sites annoy the local population. The principal causes of the noise produced by the exhaust have been recognized as emanating from the interior of the engine and from the exhaust port. The exhaust usually creates two types of noise: that produced as a result of the shear of the high velocity primary fluid stream emanating directly from the exhaust upon impact with the relatively quiescent ambient fluid such as the atmosphere; and in addition thereto the disipation of the thermal energy contained within the exhaust stream through conversion into acoustical energy.

A number of prior art devices have been produced in an attempt to combat this problem. Although each of the devices thus far produced have eliminated the noise level to some degree, a number of disadvantages still remain.

The principal disadvantage extant in most prior art devices is the resultant inefficiency of the engine through the use of the noise suppression apparatus, attached thereto or constructed as an integral part thereof. For the most part such apparatus creates an untenable back pressure which reduces the thrust of the engine at those times when it is needed most, such as during lift-off with heavy loads.

In addition to the foregoing the prior art apparatus for the most part consists of complex and movable parts which must be operated under infrequent conditions, to accomplish suppression of the noise created by the exhaust.

Accordingly it is an object of the present invention to provide an apparatus for suppressing noises created by high velocity exhaust fluids which is exceedingly simple to construct, requires little or no maintenance, is exceedingly rugged, and relatively inexpensive to manufacture and install.

It is another object of the present invention to provide a noise suppressor which has no moving parts and may be quickly and easily installed on or detached from existing engines or alternatively may be constructed as an integral part of an engine.

It is another object of the present invention to provide a noise suppressor which effectively reduces noise levels at both supersonic and subsonic frequencies.

It is another object of the present invention to provide a noise suppressor which does not affect the efficiency of operation of the engine to which it is affixed.

It is another object of the present invention to provide a noise suppressor which is light in weight, and introduces no appreciable drag upon craft to which the suppressor may be attached, and which may be utilized at all times during the operation of the engine.

Additional objects and advantages of the present invention will become apparent from a consideration of the following description taken in conjunction with the accompanying drawings which are presented by way of example only and are not intended as a limitation upon the scope of the present invention as defined in the appended claims and in which:

FIG. 1 is a perspective view of a noise suppressor partially in cross section constructed in accordance with the present invention and attached to the exhaust nozzle of the engine;

FIG. 2 is a cross sectional view in elevation of the preferred embodiment of a noise suppressor constructed in accordance with the present invention as illustrated in FIG. 1;

FIG. 3 is a rear view taken in cross section about the lines 3--3 of FIG. 2 of the noise suppressor, constructed in accordance with the preferred embodiment of the present invention;

FIG. 4 is a graph illustrating the flow pattern of primary fluid exhausted from a jet engine and secondary fluid generated as a result of the operation of the noise suppressor in accordance with the present invention;

FIG. 5 is a graph illustrating the velocity wavefront of the primary and secondary fluids at various points along the noise suppressor constructed in accordance with the present invention; and

FIG. 6 is a side elevational view in cross section of an alternative embodiment of a noise suppressor constructed in accordance with the present invention.

A noise suppressor constructed in accordance with the present invention includes a hollow tubular member affixed to the exhaust nozzle of an engine through which a primary stream of fluid is exhausted. The hollow tubular member has an unrestricted inner surface and defines a plurality of reliefs extending from the after end thereof to a point intermediate the two ends of the tubular member. A shroud surrounds the tubular member and extends substantially along the entire length thereof. The shroud is spaced from the outer surface of the tubular member and defines a substantially unrestricted space therewith. The space is open at each end thereof to provide means in conjunction with the tubular member for forcing a sheath of secondary fluid to be formed about the outer periphery of the primary fluid.

In accordance with a more specific aspect of the present invention the tubular member is a right circular cylinder having a plurality of V-shaped notches extending from the after end thereof to a point intermediate the two ends thereof. The shroud surrounding the cylinder includes an inner and an outer sheath having a partition spaced therebetween thus providing an inner and an outer enclosed space. Each of the two sheaths and the partition define a plurality of openings therethrough. The outer space has disposed therein an acoustic absorbent material.

It should be expressly understood that the noise suppressor constructed in accordance with the present invention may be utilized with any engine, such as a rocket.
or jet engine, which exhausts a high velocity primary fluid. However for purposes of simplicity and clarity the following description will be given utilizing the jet engine of an aircraft as a specific example of use and operation.

Referring now to the drawings and more particularly to FIGURES 1 through 3 thereof, there is illustrated a preferred embodiment of a noise suppressor constructed in accordance with the present invention. As is therein illustrated the noise suppressor 11 is affixed to the exhaust nozzle 12 of a jet engine 12 by means of a flange 13 which mates with a flange 13’ formed as a part of the jet engine 12. The two flanges 13, 13’ are brought into sealing engagement by affixing means such as rivets 14. Although the noise suppressor 11 is illustrated as being attached by means of the flanges and rivets, it should be expressly understood that it may be constructed as an integral part of an engine if such is desired.

The noise suppressor 11 is constructed of a hollow tubular member such as a right circular cylinder 15 having its forward end formed into the flange 13 which is attached to the jet engine 12. The after end of the cylinder 15 defines a plurality of spaces or reliefs 16 which are provided as V-shaped notches 17 extending from the terminal or after end of the cylinder 15 to a point 18 intermediate the forward and after ends of the cylinder 15. It should be noted that the reliefs extend over a substantial part of the longitudinal distance of the cylinder 15. Although these reliefs 16 may extend over between 15 to 90 percent of the length of the cylinder 15, it has been found that the most efficient operation occurs when the reliefs extend longitudinally for a distance of between 50 and 60 percent thereof.

A similar cylinder 15 along substantially the entire length thereof. The shroud 20 is constructed of an inner shroud 21 and an outer shroud 22 having a partition 23 disposed therebetween. The inner and outer shadots and the partition form cavities or chambers which are closed at either end by closing means such as annular member 24 at the forward end of the shroud 20 and a similar member 25 at the after end thereof. The annular closing means 24 and 25 may be formed of a V-shaped member as illustrated which is fitted into place in such a manner that the partition 23 fits within the apex of each of the two V’s and the arms of the two V’s are oriented or otherwise affixed to the cylinder 15 and the inner shroud 21. A chamber 33 which is enclosed and which is positioned adjacent the outer surface of the cylinder 15 is provided between the inner shroud 21 and the partition 23.

As should be noted from the drawing as illustrated in FIGS. 1 through 3, each of the two shafts and partition define openings extending through thereof. Although it is not critical, it has been found that excellent results during operation, as will be more fully described below, have been obtained by providing openings within the inner shadots which constitute approximately 30 percent of the area thereof and which are approximately ¼” in diameter. As is illustrated particularly in FIG. 2 the after edge portion of each of the openings is depressed inwardly into the space 39 so as to form a louvered type construction such as is illustrated at 34. The openings in the outer shadots are formed with ¼” diameter holes covering approximately 5% of the area of the outer shadot while the partition has openings of ¼” diameter through thereof constituting approximately 90% of the area thereof.

During operation of the noise suppressor as constructed in accordance with the present invention and as is illustrated in FIGS. 1 through 3, a primary stream of fluid such as is illustrated by the arrows 35 in FIG. 2 is exhausted by the operation of the jet engine 12. The primary stream of fluid is at substantially high velocity and is moving at a relatively high velocity with respect to the ambient fluid of the atmosphere. The movement of the primary stream of fluid through the tubular member 15 so that it exhausts out the after end thereof sets up aspiration in such a manner that a secondary stream of fluid as illustrated by the arrows 36 is drawn from the ambient fluid of the atmosphere through the opening 27 to form a sheath of air which in the absence of the reliefs 16 surrounds the primary stream of fluid.

As a result of the aspiration which occurs thus causing the flow of a secondary stream of fluid through the openings 27 formed between the inner shroud 21 and the outer surface of the cylinder 15 a venturi type action is instituted with respect to the resident fluid in the chamber 33 and that trapped within the steel wool 26 thus causing the resident fluid therein to be withdrawn through the openings in the inner shroud 21 and forming of the secondary fluid through the opening 27. As a result thereof a partial vacuum is created within the chamber 33 which in turn causes ambient air to be drawn through the openings in the outer shroud as is illustrated by the plurality of arrows 37 spaced about the periphery of the outer shroud as illustrated in FIG. 2.

As the high velocity primary stream of fluid passes the point 18 which is the apex of the space 16 formed by the notch 17 a venturi effect is established with respect to the secondary stream of fluid which is moving at a velocity which is substantially less than that of the primary stream for example, approximately ½ thereof. The venturi principle thus instituted draws the secondary stream into contact with the primary stream.

The particular flow patterns of the primary and secondary fluid streams are illustrated in FIG. 4 to which reference is hereby made. As is therein illustrated the secondary and primary fluid stream flow patterns are plotted along various points longitudinally of the suppressor 11 as illustrated in FIGS. 1 through 3. As is therein shown the dashed line 41 is the forward edge of the shroud 20, the dashed line 42 represents the point 18 at which the reliefs 16 begin, the line 43 represents the after edge of the shroud 20 and the line 44 represents the partition 23. The length of the arrows in the primary and secondary stream flow patterns is indicative of the relative velocities between the two fluid streams.

As is illustrated, the primary fluid stream flow pattern from the exhaust nozzle (which is the ordinate of FIG. 4) to the dashed line 42 (which is the point 18) is dependent only upon pressure, velocity, and configuration of the exhaust nozzle and the forward portion of the cylinder 15, which is a direct continuation of the exhaust nozzle of the jet engine. At the point 18 which is the beginning of the relief 16 the primary fluid stream flow pattern begins to widen slightly. As the primary fluid stream approaches the after edge of the shroud 20 (illustrated by the dashed line 43) it has spread a slight amount more so that it occupies a portion of the space defined by the inner shroud 21 of the shroud. It should also be noted at this point that the velocity of the primary fluid stream at the outer edges thereof has reduced somewhat. It should be understood that the primary stream flow pattern as depicted in FIG. 4 is taken at a cross section through the cylinder 15 which coincides with a pair of the apexes or points 18 formed by the notches 17. If the flow pattern were plotted at the very end of the cylinder 15 and upon a cross section taken about the very tips of the arms of the V-shaped notches or reliefs 16 a restricted primary fluid stream flow pattern would be evidenced over the greater portion of the length of the cylinder 15. At any point between the two extremes
the flow pattern of the primary fluid stream would be expanding as is generally illustrated in FIG. 4. The secondary fluid stream flow pattern is as is illustrated in FIG. 4. Again the stream flow pattern for the secondary fluid is plotted about a cross section taken through the points 18 as illustrated in FIGS. 1 and 2. Between the forward edge of the shroud 20 and the point 18 upon the cylinder 15 as is indicated by the dashed line 42 in FIG. 4 the secondary air stream is confined within the space 27 and is as illustrated between the dashed lines 41 and 42 on FIG. 4. At the point where the secondary air stream is exposed to the forces established by the primary fluid stream flow the venturi action above referred to is set up and the lower portion of the secondary fluid stream is subjected thereto, thus causing a portion of the secondary fluid stream to be diverted downwardly and into the primary fluid stream thus intermixing therewith. As the area of the relief increases from the intermediate point 18 toward the end of the cylinder 15 more and more of the secondary fluid is subjected to the forces set up by the faster flowing primary fluid stream and thus a greater portion of the secondary fluid is drawn into the primary fluid stream. Under these conditions the secondary stream and the primary stream are readily intermixed which can be visualized by superimposing the two stream flow patterns one upon the other as they are illustrated separately in FIG. 4. As the initial mixing of the secondary fluid and primary fluid streams occurs the primary fluid stream is then gradually caused to expand as is illustrated in its flow pattern in FIG. 4. The outer periphery of the secondary fluid stream is not as strongly affected by the primary fluid stream flow and thus maintains somewhat of a circular shell or sheath of secondary fluid surrounding the mixture between the primary and secondary fluid streams already described.

As the intermixed primary and secondary fluid streams pass beyond the after edge of the shroud 20 as is represented by the dashed line 43, they begin to expand into the ambient medium. This initial expansion is indicated by the arrows in the secondary fluid stream flow pattern in FIG. 4 immediately beginning to turn in an outward direction just beyond the dashed line 43. Since the outer periphery of the secondary fluid stream is moving at a slower velocity than the remaining portion of the mixed fluid stream it begins to expand into the ambient medium much more rapidly than the remainder of the fluid streams. As the distance beyond the shroud and the after end of the cylinder 15 is increased the fluid streams expand further and further until they are finally dissipated.

It should be readily seen that as a result of the mixing of the secondary fluid with the primary fluid internally of the suppressor 11 and particularly the rather rapid intermixing which occurs between the end of the cylinder 15 and the apex 18 of the V-shaped notches two effects are realized. The first of these effects is that the temperature of the primary fluid is rapidly reduced since there is a large temperature differential between the secondary fluid and the primary fluid. Thus by reducing the temperature of the primary fluid prior to its being exhausted into the surrounding medium there is less thermal energy to be converted into acoustic energy.

The second effect which is realized is created both by the mixing action and by the slight expansion of the area with which the mixed and secondary fluids are finally exhausted. This effect is a reduction in the velocity of the primary stream and the exhausting of a fluid stream having a relatively uniform velocity wavefront.

The velocity wavefront of the fluid streams flowing through the suppressor unit 11 is illustrated in FIG. 5 to which reference is hereby made. As is illustrated in FIG. 5 the velocity wavefront of the secondary stream is substantially in the shape of a small cone 51 illustrating an increased velocity toward the center of the space provided between the outer surface of the cylinder 15 and the inner sheath 21 of the shroud 20. The velocity is greater at the center of the space than it is at the edges thereof as a result of the friction imparted by the surfaces of the sheath and the cylinder to the fluid stream. The velocity wavefront of the primary stream is similar to that of the secondary stream as is illustrated at 52 with the one very notable exception in that the velocity at the center of the primary stream is approximately twice that of the secondary stream. As the primary and secondary streams pass the point 18 in the cylinder 15 as illustrated in FIG. 4 the intermixing of the primary and secondary streams causes the relative velocities of the primary and secondary streams to begin to merge and become more uniform. This merging or lessening of the difference in velocities between the primary and secondary streams continues to occur as the intermixed streams progress downwardly along the length of the suppressor as is illustrated by each of the successive wavefront waveforms 53 through 57.

As a result of the lessening of the relative velocities between the primary and secondary fluid streams it would become apparent that the absolute velocity of the primary stream is reduced particularly at the periphery thereof. The reduction in the velocity of the primary stream at the periphery thereof causes the shear forces or the impact of the exhaust fluids upon contact with the ambient fluid to be attenuated greatly, thus reducing the noise otherwise generated.

The velocity wavefronts as illustrated in FIG. 5 were taken about a cross section through the point 18 on the cylinder 15 as illustrated in FIGS. 1 and 2. If a cross section were taken through the points forming the notches and at the terminal after end of the cylinder, the wavefronts would appear substantially unchanged throughout from those shown by curve 53. At points inbetween these two extremes, the wavefront would fall inbetween that shown by 51–52 and that shown at 57. Another way of viewing the foregoing is as follows: If a rear elevational view were plotted of the velocity at various points across the after end of the suppressor, it would appear substantially star-shaped with the higher velocity portions falling within the confines of the star. This illustrates the increased area of contact between the primary and ambient medium fully described below.

The operation of the noise suppressor in bringing the primary and secondary fluid streams into contact with each other may also be viewed as initial and gradually increasing mixing between the primary and secondary fluid streams internally of the suppressor, with finally an exposure to the ambient fluid after this initial and continuously increasing mixing has occurred. Thus the noise which would normally be generated upon the exhaust of the relatively high velocity primary fluid stream is prevented from occurring by the initial and gradually increasing intermixing internally of the suppressor.

Measurements have shown that the impact of the primary fluid stream with the atmosphere over a relatively small area at the exhaust nozzle sets up a high intensity shock wave. This shock wave appears to radiate from the exhaust nozzle in all directions at an angle of approximately 90 degrees with respect to the longitudinal axis of the primary stream. At the point where the present invention, the primary stream is brought into contact with the ambient fluid over a large area at the exhaust point. Furthermore the contact by the primary stream with the secondary stream (which is fast moving ambient) begins at a point internally of the suppressor and rapidly increases in area until the exhaust is reached. This may readily be seen from FIGS. 1 and 2 which show the triangular notches such as 17. By thus spreading the area of contact between the primary stream
and the ambient, the shock wave intensity is greatly reduced. Furthermore, by surrounding the primary stream, and the intermixed primary and secondary streams, with a sheath of slower moving secondary fluid that first contacts the ambient fluid, the shock wave is further reduced in intensity. By thus reducing the intensity of the shock wave, the noise level is also reduced.

Referring again to FIGS. 1 and 2 and particularly to FIG. 3, it should be seen that the plane 27 defined between the cylinder 15 and the sheath 21 is a gradually increasing space from the forward end of the shroud 20 to the after end thereof. This gradually increasing space 27 aids in the aspiration effect and also presents less friction to the secondary fluid stream as it passes along the suppressor. The cylinder 15 is constructed in such a manner that it is slightly larger in diameter at the after end thereof than it is at the forward end thereof, again to reduce friction upon the primary fluid stream, thereby preventing any unnecessary back pressure that might otherwise possibly be created even though the inner surface of the cylinder 15 is completely unrestricted.

Another feature of the present invention with particular reference to the shroud is that the cross section of the shroud is such that the overall width thereof is greater at the forward end than it is at the after end, thus providing a wing-shaped structure to the shroud. Such a wing-shaped structure prevents the flow of a shock wave from the forward to the after end of the cylinder 15, thus preventing interference with normal aircraft operation.

Although the above description of the operation of the suppressor in accordance with the present invention was given with respect to aspiration or venturi action causing the flow of the secondary air stream through the space 27 it should also be apparent that the flow of secondary air through the space 27 is created as a result of the ram effect of the ambient during the time that the aircraft is moving therethrough.

As was above referred to, noises are also contained within the primary stream exhausted from the exhaust nozzle of the jet 12 as a result of combustion or acoustic noises generated within the burning chamber of the jet engine. These noises as they travel through the primary stream, upon reaching the relief 16, spread radially outwardly from the cylinder 15 and come into contact with the inner sheath 21. As a result of the large plurality of openings defined therethrough these combination and acoustical noises created internally of the jet engine pass through the openings in the sheath 21 and into the cavity or chamber 33. The chamber 33 is designed such that it is an acoustical resonating chamber, serving to increase the noises created by the internal combustion effects of the jet engine. These noises are thus attenuated within the chamber 33 and are also transmitted through the large plurality of openings within the partition 23 and into the acoustic absorbing material 26 disposed between the partition 23 and the outer sheath 22.

It can thus be seen that noises generated from the three primary sources thereof in jet engines are substantially reduced by the noise suppressor constructed in accordance with the present invention as illustrated in FIGS. 1 through 3. The thermal energy contained within the primary fluid stream is reduced in intensity as a result of mixing of the secondary fluid having a much lower temperature therewith. The shear or impact of the exhaust stream is lessened by reducing the effective velocity of the primary stream at its contact area with the ambient through the intermixing of a secondary stream having a much lower velocity therewith. The noises generated as a result of combustion take place within the jet engine are substantially reduced by presenting an acoustical resonating chamber and a sound absorbing or acoustic absorbing material immediately adjacent the relieved areas of the tubular or cylindrical member 15.

It has been found that in some instances the noises generated as a result of combustion within the jet engine are not particularly objectionable. Under such conditions the resonating chamber and the acoustic material may consequently depart from the spirit or scope of the present invention. A suppressor so constructed is schematically represented in FIG. 6 as an alternative embodiment of the noise suppressor in accordance with the present invention.

As is therein illustrated the suppressor member 60 includes a cylindrical member 61 surrounding it over a substantial part of the length thereof. A plurality of reliefs 63 in the form preferably of V-shaped notches are provided by the after end of the cylinder 61 and extend to a point 64 intermediate the ends of the cylinders 61. The shroud 62 is provided thereby by standards 65 thus spacing the shroud 62 a predetermined distance from the surface of the cylinder 61 and thereby providing a space 66 through which secondary air may flow. The operation of the noise suppressor as illustrated in FIG. 6 is substantially the same as that above described with respect to the preferred embodiment of the invention as illustrated in FIGS. 1 through 3.

Although the reliefs provided within the after portion of the cylinder of the noise suppressor in accordance with the present invention have been illustrated in each embodiment as a plurality of V-shaped notches spaced equidistant about the circumference of the cylinder, it should be expressly understood that any number of such reliefs may be utilized and that they may be formed in any geometric configuration desired, so long as they do not present surfaces to the primary and secondary air stream which would tend to present a drag thereon.

There has thus been disclosed a noise suppressor for use with jet type engines, such as jet engines such as jet nozzle engines, jet rocket engines, jet fans, rocket engines etc. for reducing the noise generated in the jet engines. The suppressor is comprised of a noise absorbing chamber located in the jet engine and extending as much as a desired distance therefrom, a second noise absorbing chamber located thereon spaced therefrom and a suppressor member having a plurality of reliefs extending thereon.

What is claimed is:

1. A noise suppressor for exhaust nozzles comprising: a hollow tubular member having an unrestricted inner surface affixed to said exhaust nozzle, said tubular member defining a plurality of reliefs extending from a point intermediate the ends thereof outwardly to the after end thereof and gradually increasing in area from said intermediate point to said end; a shroud surrounding said tubular member and extending along the length thereof and terminating short of the after end of said tubular member, said shroud defining a substantially unrestricted space between it and the inner surface of said tubular member, said space being open at each end thereof whereby a sheath of secondary fluid is forced through said space during the time primary fluid is being exhausted through said tubular member.

2. A noise suppressor for exhaust nozzles comprising: a hollow tubular member having an unrestricted inner surface affixed to said exhaust nozzle, said tubular member defining a plurality of reliefs extending from a point intermediate the ends thereof outwardly to the after end thereof and gradually increasing in area from said intermediate point to said end; a first sheath surrounding said tubular member extending substantially the entire length thereof and being spaced therefrom to define a space between said tubular member and said first sheath, said first sheath defining a plurality of openings therethrough; a second sheath surrounding said first sheath and spaced therefrom; and means closing said space between said first and second sheaths at each end thereof, thereby defining an acoustical resonating member adjacent said tubular member.

3. A noise suppressor as defined in claim 2 in which said space defined between said sheaths gradually decreases in cross-sectional area from the forward to the after portion thereof.

4. A noise suppressor as defined in claim 2 in which
said openings in said first sheath constitute approximately 30% of the total area thereof.

5. A noise suppressor for exhaust nozzles comprising: a hollow tubular member having an unrestricted inner surface affixed to said exhaust nozzle, said tubular member defining a plurality of reliefs extending from a point intermediate the ends thereof outwardly to the after end thereof and gradually increasing in area from said intermediate point to said end; a hollow shroud surrounding said tubular member and extending along substantially the entire length thereof, said shroud defining a substantially unrestricted space between it and the outer surface of said tubular member, said space being open at each end thereof whereby a sheath of secondary fluid is forced through said space during the time primary fluid is being exhausted through said tubular member; each surface of said hollow shroud defining a plurality of openings therethrough, and acoustic absorbing means disposed within at least a portion of the interior of said hollow shroud.

6. A noise suppressor for exhaust nozzles comprising: a hollow tubular member having an unrestricted inner surface affixed to said exhaust nozzle, said tubular member defining a plurality of reliefs extending from a point intermediate the ends thereof outwardly to the after end thereof and gradually increasing in area from said intermediate point to said end; a hollow shroud surrounding said tubular member and extending along substantially the entire length thereof, said shroud defining a substantially unrestricted space between it and the outer surface of said tubular member, said space being open at each end thereof whereby a sheath of secondary fluid is forced through said space during the time primary fluid is being exhausted through said tubular member, a partition extending longitudinally along the entire length of said hollow shroud thereby separating the hollow interior thereof into two separate enclosed spaces, each surface of said shroud and said portion defining a plurality of openings therethrough, and acoustic absorbing means disposed within the space between said partition and the outer surface of said hollow shroud.

7. A noise suppressor for exhaust nozzles comprising: a hollow right circular cylinder having a plurality of V-shaped notches extending from the after end thereof to a point intermediate the ends thereof; a first sheath surrounding said cylinder along substantially the entire length thereof and being spaced therefrom to define a space between said cylinder and said first sheath; a second sheath surrounding said first sheath and spaced therefrom; a partition disposed intermediate said sheaths and extending longitudinally along the entire length thereof, closing means affixed to each end of said sheaths and said partition thereby to define an inner and an outer enclosed space; each of said sheaths and said partition defining a plurality of openings therethrough; and acoustic absorbing means disposed within said outer enclosed space.

8. A noise suppressor as defined in claim 7 in which said closing means is a pair of V-shaped annular members.

9. A noise suppressor as defined in claim 7 in which the space between said first and second sheaths gradually decreases from the forward to the after end thereof.

10. A noise suppressor as defined in claim 7 in which the space defined by said first sheath and said cylinder gradually increases from the forward to the after end of said suppressor.

11. A noise suppressor as defined in claim 7 in which said acoustic absorbing material is stainless steel wool.

12. A noise suppressor as defined in claim 7 in which the openings in said first sheath constitute approximately 30% of the area thereof, the openings in said second sheath constitute approximately 5% of the area thereof, and the openings in said partition constitute approximately 90% of the area thereof.

13. A noise suppressor for exhaust nozzles comprising: a hollow tubular member having an unrestricted inner surface affixed to said exhaust nozzle, said tubular member defining a plurality of reliefs extending from a point intermediate the ends thereof outwardly to the after end thereof and gradually increasing in area from said intermediate point to said end; a shroud surrounding said tubular member and extending along the length thereof, each terminal end of said shroud being spaced inwardly from the respective terminal ends of said tubular member, said shroud defining a substantially unrestricted space between it and the outer surface of said tubular member, said space being open at each end thereof whereby a sheath of secondary fluid is forced through said space during the time primary fluid is being exhausted through said tubular member.

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