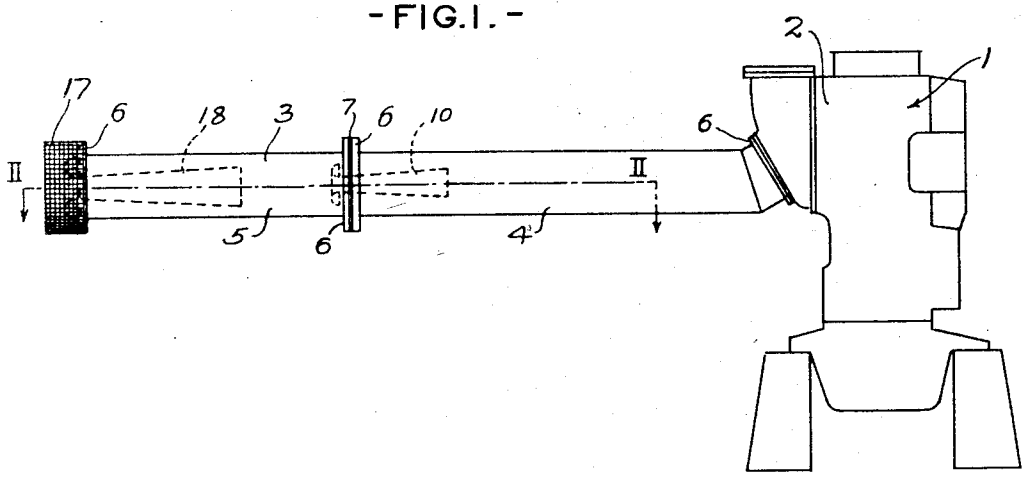
Jan. 21, 1941. W. M. NICHOLS ET AL 2,229,119

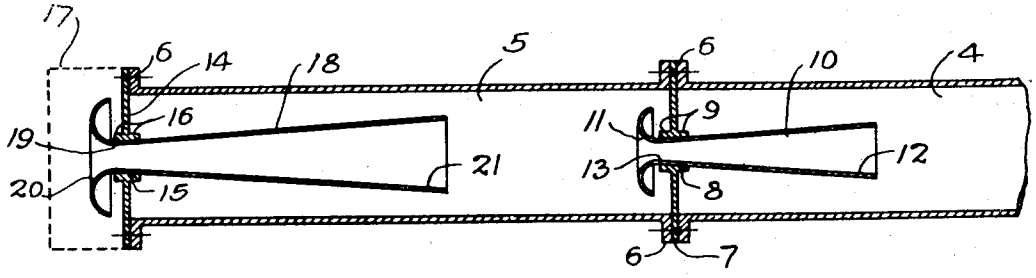
VENTURI SILENCER

Filed Sept. 20, 1939

- FIG. 1. -



- FIG. 2. -



INVENTORS
William M. Nichols
Albert C. Cavileer
Paul M. Kochensperger
George Aue

BY S. C. Yeaton
ATTORNEY

Patented Jan. 21, 1941 2,229,119

UNITED STATES PATENT OFFICE

2,229,119

VENTURI SILENCER

William M. Nichols, Albert C. Cavileer, Paul M. Kochensperger, and George Aue, Auburn, N. Y., assignors to American Locomotive Company, New York, N. Y., a corporation of New York

Application September 20, 1939, Serial No. 295,746

3 Claims. (Cl. 181—47)

This invention relates to a silencer and more particularly to a silencer for muffling certain sounds produced by an engine. The invention has its greatest application to reciprocating engines, and more particularly to reciprocating pumps for pumping gas, such for instance as air compressors for supplying the required compressed air to internal combustion engines.

For illustrative purposes the invention will be hereinafter described in connection with a reciprocating pump for supplying compressed air to the intake manifold of an internal combustion engine, such as a stationary two-cycle Diesel engine, for charging and scavenging same.

Silencers for such pumps have been heretofore employed having a volume or expansion chamber in the form of a pipe which is connected at one of its ends to the inlet to the pump, the silencer further employing a Venturi tube, serving as an inlet nozzle, hereinafter designated venturi for brevity, which is connected to the opposite end of the pipe. The air enters the venturi, and passes through the pipe to the pump. As is well known, the air enters the pump intermittently and at relatively low frequency producing corresponding pulsations in the air thereby causing the sound, which appears as a low pitch drumming, which it is the purpose of the silencer to muffle. Or stated differently, it is well known that a venturi used in connection with a volume chamber between the venturi and compressing means, results in beneficial silencing of sounds in the air passing to the pump, especially those caused by the intermittent flow of this air.

Good silencing may be obtained if the volume of the chamber is sufficiently enlarged, but this would be beyond practical limits. Furthermore increased silencing of the drumming sound may be obtained by increasing the velocity of the air through the venturi, that is to say, by sufficiently decreasing the cross-sectional area of the throat of the venturi, but such a decreased throat produces a high pitch hissing sound which is generated at the mouth of the venturi. Furthermore with decrease in throat area there is a corresponding loss of capacity of the pump and power of the engine. Therefore the required capacity of the pump and power of the engine are factors in determining the maximum air velocity permissible in the venturi.

It is the object of the present invention to silence both the drumming and hissing sounds without unduly increasing the volume of the chamber or decreasing the capacity of the pump and consequently the power of the engine. To this end applicants' invention comprises a plurality of volume chambers arranged in series, each provided at its inlet end with a venturi, the venturis thereby being also arranged in series.

Referring to the drawing forming a part of the present application, Figure 1 is a diagrammatic end elevation of an internal combustion engine employing an air pump inlet pipe equipped with the silencer of the present invention; and Fig. 2 is an enlarged section on the line II—II of Fig. 1.

Referring to the drawing, the engine containing the reciprocating pump is indicated generally by the reference numeral 1. It might be, for example, a two-stroke cycle stationary Diesel engine employing a single reciprocating piston pump 2 at one end of the engine for supplying the power cylinders of the engine with scavenging and charging air. In the case of stationary engines disposed in buildings, the air for the engine is usually drawn from the exterior of the building through a pipe which leads directly to a pump or a manifold as the case may be.

The present invention comprises in place of such pipe, two volume or expansion chambers, although these may be in the form of a continuous passageway, as for instance the pipe 3 which is formed in sections, and of a capacity sufficiently larger than the displacement of the pump so that a sufficient supply of air will always be available regardless of the speed at which the pump is working. In the drawing the pipe 3, providing the chambers, is dimensioned to have a capacity about six to ten times the pump displacement.

The pipe 3 is formed of two sections providing the chambers 4 and 5, but it may be made in one piece if desired. The chamber 4 as shown has approximately twice the volume of the chamber 5, but chamber 5 may be larger or smaller if desired. Chamber 4 may be considered as the main expansion chamber and chamber 5 as an auxiliary expansion chamber.

The chambers 4 and 5 are provided with end flanges 6 for attaching purposes by means of bolts or otherwise (not shown). The chamber 4 is secured to the pump 2 by its flange 6 adjacent thereto. The chambers 4 and 5 are secured together by means of their adjacent flanges 6, a plate 7 being disposed between the flanges to separate the chambers. A central orifice 8 is formed in the plate, around which orifice, on either side of the plate 7, there is a flange 9 which gives the orifice 8 a long inner cylindrical wall.

A venturi 10 is disposed in the orifice 8 and is firmly engaged by the cylindrical wall of the orifice, which thereby rigidly supports it and to which it may be secured as by welding or otherwise. The venturi 10 has a wide bell-shaped inlet or mouth 11 disposed in the chamber 5, a long, flaring diffusor tube or diverging nozzle 12 disposed in the chamber 4, and a throat 13 connecting the mouth 11 and nozzle 12 and disposed adjacent the orifice 8. The venturi 10 thus serves as the outlet of chamber 5 and the inlet of chamber 4. The venturi is shown in Fig. 2 as having streamline surfaces offering a minimum of resistance to the flow of air. However, other shapes of venturis may be employed if desired.

The outer end of the chamber 5 is closed by a plate 14 which is similar to the plate 7, the difference being that the diameter of its orifice 15 and flanges 16 is larger. The flanges 6 on the outer end of the chamber 5 enable the plate 14 to be secured thereto. On the outer side of this plate is mounted an air filter 17. A venturi 18 is disposed in the orifice 15. It may be similar to the venturi 10, but to obtain the best results it should have a larger throat 19 as shown. The advantages thus gained are later set forth. All other parts of the venturi 18 are proportionately larger. The mouth 20 of the venturi 18 is disposed in the filter 17 and the flaring diverging nozzle 21 is disposed in the chamber 5, with the throat disposed adjacent the orifice 15.

The venturis may be assembled with the plates in any desired manner. For instance, the bell-shaped mouth of each venturi may be made as a separate piece and secured, as by welding, to its respective throat, the diverging nozzle being integral with the throat, the mouth being secured after the throat is assembled with the plate.

Coming now to the operation of the present invention, the drumming sound that would be audible at the outer end of the pipe, for instance the chamber 4 were this chamber only employed with no venturi, is substantially silenced by the employment of the venturi 10, due consideration being given to the volume of the chamber 4 and the cross-sectional area of the throat of the venturi 10. Proper proportioning of the throat of the venturi 10 within permissible limits as to loss in pump capacity and engine power effects substantially complete silencing of this drumming sound but on the other hand there is produced at the mouth of the venturi 10 the before-mentioned hissing sound. This hissing sound obviously would be audible at the outer end of the chamber 5 if this outer end were open or unrestricted, but it is substantially silenced by the employment of the venturi 18, due consideration being given to the volume of the chamber 5 and the cross-sectional area of the throat of the venturi 18. It has been previously stated that the smaller the cross section of the throat of the venturi, that is to say, the greater the velocity, the more complete will be the silencing of the drumming sound. Therefore a sufficiently small cross section within practical limits, producing some hissing sound, is given the throat of venturi 10. It has been found however, that it is not necessary to so restrict the throat of venturi 18 to satisfactorily muffle the hissing sound, and as throat restriction is attendant with loss in pump capacity and engine power, the cross section of throat 19 is made larger. The filter and smooth inner surfaces of the venturis, properly dimensioned, are advantages.

The chambers 4 and 5 have equal cross sections and the chamber 5 is substantially one-half the length of the chamber 4. These relative sizes give satisfactory results. Chamber 5 may be made smaller to some extent but beyond this there is a loss in the silencing of the sound.

In tests made of the present invention in connection with the air inlet for the pump of a two-stroke cycle internal combustion engine, known as "Alco-Sulzer M–4–14x23½ engine, rated 720 B. H. P. at 277 R. P. M.," a twenty inch diameter pipe was employed, the throat of the venturi in the section or chamber 4 of the pipe being four and three-quarters inches in diameter and the throat of the other venturi being six and one-quarter inches in diameter. Various lengths of pipe sections were tested. In one instance the length of the chamber 4 was twenty feet and that of the chamber 5 six feet. These proportions gave good silencing results but there was a faint surging noise audible at the inlet end of the pipe. In another instance the length of the chamber 5 was increased to ten feet and better silencing followed. In still another instance chamber 4 was increased to forty feet and chamber 5 was maintained at ten feet. Here there was perfect silencing. These tests are given merely by way of illustration but not as limiting.

While venturi 18 is primarily for silencing the hissing sound, nevertheless it will operate as a silencer for any slight drumming or other sound that might escape the venturi 10. In order to obtain the best results careful consideration should be given to the proper proportioning of the venturi. Good results have been obtained by employing a venturi in which the area of the opening at the mouth is six times the area of the throat and the curvature of the mouth in a longitudinal plane is of a radius equal to the diameter of the throat. The diverging nozzle has an angle of approximately eight degrees and the area of the outlet end of this nozzle is from seven to ten times the area of the throat. While these dimensions are not essential they have produced satisfactory results.

The invention claimed and desired to be secured by Letters Patent is:

1. A silencer comprising a conduit having an inlet end and an open outlet end, and providing a passageway therebetween for conducting gas from said inlet end to said outlet end; a plate disposed transversely across said passageway intermediate said ends and secured to said conduit, separating said passageway into two expansion chambers, one at each side of said plate; a plate disposed transversely across said passageway at said inlet end and secured to said conduit; and a Venturi tube extending through each of said plates, the tube through said passageway separating plate affording communication between said chambers and having a smaller throat than said other tube, the tube having a larger throat serving as the inlet for the chamber adjacent thereto and said smaller throat tube serving as the outlet thereof and as the inlet for the other chamber, said tubes and expansion chambers cooperating to silence sounds passing through said gas.

2. A silencer providing an inlet passageway for conducting a current of air to a reciprocating air pump of an internal combustion engine and for silencing sound passing through said air against said current, arising from the pumping of said air, comprising a main pipe section adapted to be connected at its inner end to the inlet port of said pump and closed at its outer end by

an inner plate having an opening; an auxiliary pipe section arranged in series with said main section, connected at its inner end to said main section adjacent said plate and closed at its outer end by an outer plate having an opening, said main section providing a main expansion chamber and said auxiliary section providing an auxiliary expansion chamber of a volume less than the volume of said main chamber; a Venturi tube disposed in said inner plate opening having a mouth disposed in said auxiliary chamber, a diverging nozzle disposed in said main chamber and a throat between said mouth and nozzle; and a Venturi tube disposed in said outer plate opening having a mouth disposed to the exterior of said plate, a diverging nozzle disposed in said auxiliary chamber, and a throat between said last mentioned mouth and nozzle of a larger diameter than said throat of said tube disposed in said inner plate, said main chamber and smaller throat tube cooperating to silence the low pitch sounds moving through said air in said main chamber in a direction opposite to the flow of said air caused by the pumping of said air, and said auxiliary chamber and larger throat tube cooperating to silence any residue of sound passing into said auxiliary chamber from said main chamber and to silence any sound caused by the passage of air through said smaller throat tube.

3. A silencer comprising a conduit providing a passageway for conducting a current of air to a reciprocating air pump of an internal combustion engine, said conduit being adapted to be connected at its front end to the inlet port of said pump, said air flowing in a direction from the rear end to said front end of said conduit for supplying said pump; and means cooperating with said conduit for attenuating sounds produced by said pump travelling in said passageway in a direction counter to the flow of said air, said means including a transverse partition disposed across said passageway intermediate said conduit ends and secured to said conduit, providing thereby forwardly thereof a front expansion air chamber of large capacity relative to said pump displacement, said partition having an orifice, and a cover at said rear end of said conduit disposed transversely across said passageway and secured to said conduit, providing a rear expansion air chamber forwardly thereof extending between said cover and said partition, said cover having an orifice for the admission of air to said passageway, said means further including a forward Venturi tube extending through said partition orifice in spaced relation to the wall of said conduit and having a throat, a flaring admission mouth extending rearwardly from said throat and opening into said rear chamber and a nozzle extending forwardly from said throat through the rear end portion of said front chamber provided with an inner face flaring gradually outward from said throat for effecting a high velocity air flow through said throat without effecting substantial loss in air volume or drop in pressure in said conduit, said forwardly extending nozzle being relatively long, said tube and said front chamber cooperating to attenuate sound in said front chamber emanating from said pump, and a rear Venturi tube extending through said cover orifice in spaced relation to the wall of said conduit and having a throat, a flaring admission mouth extending rearwardly from said rear tube throat, opening to the rear of said cover for admission of air therefrom and a nozzle extending forwardly from said rear tube throat through the rear end portion of said rear chamber provided with an inner face flaring gradually outward from said rear tube throat, said rear tube and said rear chamber cooperating to attenuate sound in said rear chamber emanating from said forward tube.

WILLIAM M. NICHOLS.
ALBERT C. CAVILEER.
GEORGE AUE.
PAUL M. KOCHENSPERGER.