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2,882,881

CHOKE FLOW INTAKE SILENCER AND METHOD

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TO ENGINE SPEED GOVERNOR
OR THROTTLE LINKAGE

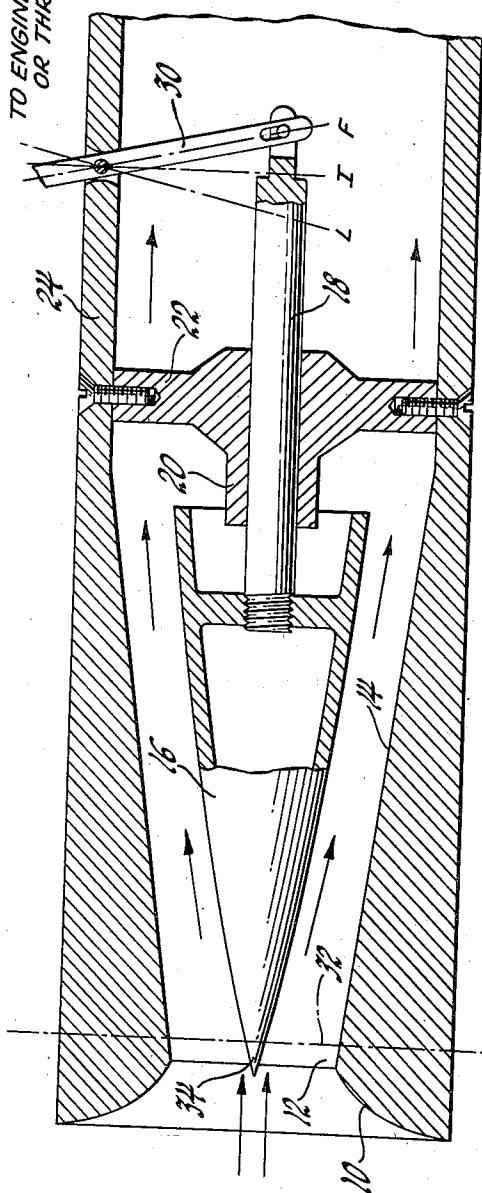


Fig. 1

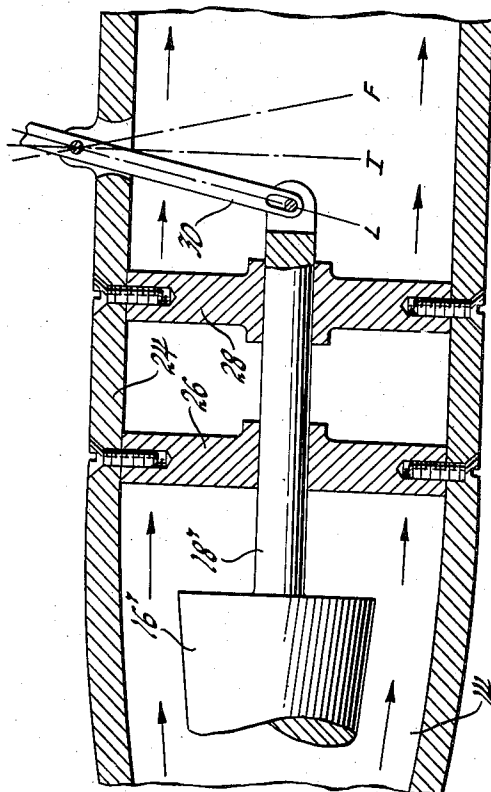


Fig. 2

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CHOKE FLOW INTAKE SILENCER AND METHOD

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The invention relates to a choke flow intake silencer and more particularly to such intake silencers for internal combustion engines, compressors or other machines having fluid intakes.

In the air intake duct of an engine, objectionable sounds travel in the direction opposite the air flow and out of the duct. These sounds originate at the engine and are transmitted through the incoming air. If the velocity of the incoming air in the duct is increased to equal or exceed the velocity of sound at all incoming-air conditions across a plane perpendicular to the duct center line at any one place along the length of the duct, this condition, known as choke flow, would operate as a sound barrier through which no sound waves could pass in the upstream direction. A sound barrier of this type is not frequency sensitive, but will effectively halt the sound over an extremely wide range of frequencies.

Venturis have previously been used in engine inlet ducts to aid in engine silencing. These venturis are used to decrease the area exposed to sound waves, in order to silence engine noises. Their function does not depend on air velocity and they are therefore not proportioned in accordance with air velocity considerations. At best they provide only a reduction of the noise and not eliminate it. They are frequency sensitive; that is, above a certain frequency which is determined by throat size they provide little or no noise reduction.

In the silencer now proposed, the air enters through a nozzle and is accelerated to the velocity of sound at the nozzle throat. It then passes through a diffuser in which it is decelerated and the pressure recovered. In order to keep the velocity at the throat equal to the velocity of sound as the air flow rate varies from idle flow to full-speed flow, the size of the nozzle throat is made adjustable in accordance with air flow requirements of the engine. The silencer imposes a minimum pressure loss in the inlet at all engine speed conditions. The loss in the first part of the silencer, which includes the nozzle, is small since air nozzles are inherently high-efficiency devices. The diffuser, which is the second part of the silencer, must be carefully designed, however, in order to operate efficiently. In the silencer here proposed, the adjustable nozzle plug is so shaped that the diffuser flow area varies along the axis approximately the same as a maximum efficiency diffuser in which a minimum loss is obtained at, or near, full-power flow. By extending the forward end of the plug upstream into the nozzle, the point of the plug is in a low-velocity plane. This position of the plug results in a minimum loss at that point.

In the drawing:

Figure 1 is a schematic sectional presentation of an intake silencer embodying the invention; and

Figure 2 shows a modified mounting for the adjustable portion of the silencer shown in Figure 1.

The intake silencer may be divided into sections including a first section having the air inlet 10 and the nozzle 12 and a second section including the diffuser 14, the adjustable cone or plug 16 and the cone-positioning mechanism.

Plug 16 has a positioning and support shaft 18 extending downstream and slidably mounted in a support bearing 20. This bearing may be centered within the intake duct and supported on a spider 22. The several legs of the spider 22 may be secured to the intake housing 24. A control link 30 may be pivotally attached to and extend through the housing 24 and may be connected with the downstream end of shaft 18. Link 30 may be attached to any control mechanism such as a manual control, the engine throttle linkage, an engine speed governor, an air-flow-sensitive piston or bellows or other control mechanism. As shown in Figure 1, the linkage is in the idle position. The appropriate control mechanism will move it from the low or idle speed position L through the intermediate position I to the full-speed position F, as shown. The throat of nozzle 12 is in the plane indicated by transverse line 32 and the forward end 34 of the plug 16 extends beyond this plane and into the area of the nozzle.

A variation in the mounting of the plug 16 is shown in Figure 2 and may include a pair of spider supports 26 and 28 for plug-positioning shaft 18'. These supports, being axially spaced, give a more accurate control of the position of the plug 16'.

Air enters through inlet 10 and passes through the nozzle 12 and is accelerated to the velocity of sound at the nozzle throat 32. It then passes through the diffuser 14 in which it is decelerated and the pressure recovered. The relative profiles of the plug 16 and the diffuser section of the housing 24 are so shaped that the flow area in the diffuser annulus may vary along the direction of flow about the same as a 10 degree conical diffuser. One of the most efficient air diffusers has been found to be a conical one with a 9 to 11 degree cone angle. Since it is desirable to maintain the diffuser within that angle while adjusting the nozzle throat area to maintain the velocity of air flow at the speed of sound throughout the range of air flows, the profiles of the plug 16 and the diffuser section of the housing are preferably kept within these limits. Other considerations may dictate the use of different diffusers, however.

By having the plug adjustable, an intake silencer with a minimum pressure drop is obtained which performs excellently over the entire speed range of the engine. Since the intake air is maintained at a velocity equal to the velocity of sound at the nozzle throat, there is a complete sound barrier for noise coming from the engine proper. The air velocity itself at this point may be a weak source of high-frequency sound but this sound can be easily attenuated if desired by the standard acoustic materials available. These materials may be used as desired.

What is claimed is:

1. In an adjustable air intake silencer for use with an internal combustion engine, said silencer accelerating the intake air flow for said engine to the velocity of sound, means for accelerating said flow including a nozzle having a nozzle throat and a plug extending into said throat, said plug being adjustable in accordance with the speed of said engine to maintain air velocity at substantially the speed of sound at said throat.

2. A method for silencing the air intake of an internal combustion engine throughout the range of operational speeds of said engine including the steps of receiving an intake air mass, accelerating said mass to the velocity of sound, maintaining said velocity substantially constant throughout said range of operational engine speeds, and decelerating said mass.

3. Means for blocking the passage of sound through an air intake duct for an internal combustion engine having an engine speed control, said means including a nozzle and a diffuser having a common adjustable member whereby air mass passing through said duct is accelerated to the velocity of sound at said nozzle under all engine

operating conditions, said member being positioned by said engine speed control.

4. An air intake nozzle for an internal combustion engine having a control including an adjustable conical plug extending through the throat of said nozzle and movable therein to maintain air flow through said throat at the velocity of sound, an engine speed governor and means for connecting said plug with said governor whereby said plug is moved in said throat by said governor.

5. In an air intake silencer for an internal combustion engine, an inlet duct housing having a nozzle and a diffuser formed therein, said nozzle and said diffuser having a generally circular cross section, a conical plug supported

coaxially within said housing and extending through said diffuser section and into said nozzle section, means for reciprocating said plug axially within said housing to vary the area of said nozzle and said diffuser whereby air passing through said nozzle is accelerated to the velocity of sound over a range of engine intake air flow commensurate with the speed of said engine, and means in said diffuser for absorbing sound waves trapped therein.

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