March 1, 1960 F. C. MELCHIOR 2,926,743

VENTURI-FLOW MUFFLER

Filed July 29, 1954

Fig. 1.

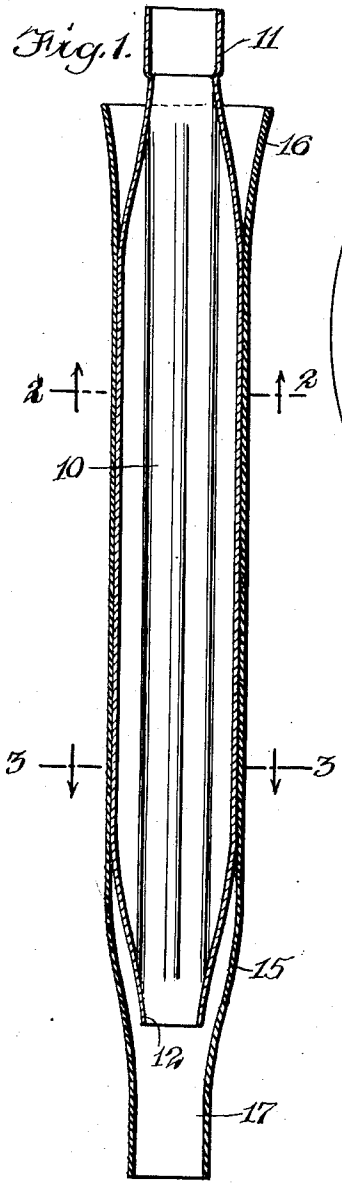


Fig. 2.

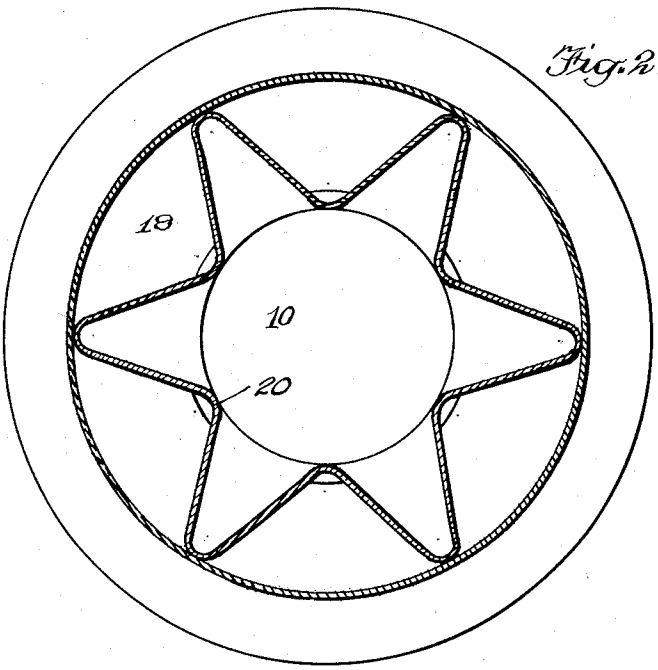
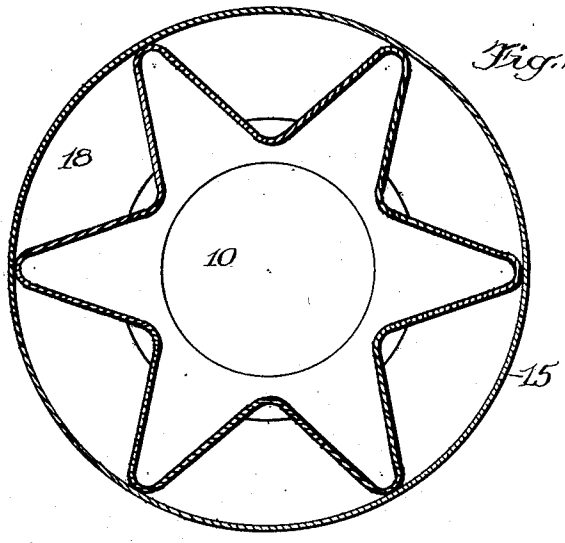


Fig. 3.



INVENTOR

Frederick C. Melchior

BY

John H. Glaccum

ATTORNEY

United States Patent Office 2,926,743
Patented Mar. 1, 1960

2,926,743

VENTURI-FLOW MUFFLER

Frederick C. Melchior, New York, N.Y.

Application July 29, 1954, Serial No. 446,438
1 Claim. (Cl. 181—47)

This invention relates to mufflers, or silencers, such as may be used in conjunction with internal combustion engines or other machines in which power is developed through the expansion of gases which must be silenced for obvious reasons. The invention aims particularly at high efficiency of performance so as to not only effectively silence the explosive expansion of the gases into the atmosphere but to do so in a manner so as not to impair the efficiency of the engine due to appreciable back pressure.

In the conventional type of mufflers commonly used on automobiles, the gases are usually baffled (deflected by baffles) in a manner so as to break up the positions of the pressure waves from the cylinders, or these pulsations are dissipated through perforations in the exhaust pipe into a surrounding chamber, the displacement of which serves as a damping cushion. In either case a certain amount of resistance is built up against the kinetic energy of the gases which substantially retain the heat, and this resistance expresses itself in a proportional amount of back pressure inimical to engine performance and life. Moreover, the trapped heat will in a relatively short time erode or "burn out" the muffler, and this destructive process is augmented by condensation of corrosive agents—such as sulfuric acid—which collect between the baffles and in the bottom of the muffler housing at idling or fractional power, when there is little heat in the exhaust. To do the job correctly, sound and efficient muffling should embrace three main processes, namely: (*a*) damping of the pressure waves through expansion into a larger displacement chamber; (*b*) effective cooling of the gases, on the principle that they expand and contract in approximately direct first power proportion to absolute temperatures; (*c*) final disposal of the gases, in a manner so as to further augment silencing—yet without any significant back pressure resulting in the process.

It is my aim with this invention to combine and perform these processes by means of a simple, efficient and inexpensive structure in a manner as more specifically indicated in the following objects.

One object of the invention is to damp the explosive effect of the expansion of the exhaust gases by absorbing the pressure waves in the larger displacement of an expansion chamber.

Another object is to efficiently cool the gases, thereby to contract them to a lesser volume with consequent reduced velocity and resultant, substantial reduction of back pressure from flow friction.

A further object is to augment the said cooling of the gases by using their kinetic energy to create induced flow suction of the cooling air in intimate contact with the heat transfer surfaces of the muffler.

Still another object is to finally dispose of the gases together with the cooling air in a most direct and efficient manner so as to avoid the building up of any resistance conducive to back pressure in this final process.

Other objects and features may become obvious from a study of the attached drawings, in which—

Fig. 1 is a longitudinal section indicating a muffler designed in accordance with the subject invention.

Fig. 2 is an enlarged cross-section taken on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged cross-section taken on the line 3—3 of Fig. 1.

As may be seen from these drawings the subject muffler consists of only two parts, an inner chamber or member **10** formed from metal tubing and swaged down at both ends to form nozzle-shaped ends, the end at **11** where the gases enter being somewhat larger in diameter than the other end **12** where the gases make their exit. As may be seen from the cross-sections, throughout its mid-section, and over the substantial portion of its length, it is fluted or formed into approximately the shape of a six-pointed star having long, straight, longitudinally extending outermost surfaces at the points of the star. This member serves as an expansion chamber. The exact shape of this cross-section is not essential to this invention which should in no way be limited to any particular shape. However, as shown, the section here illustrated is based upon purely practical consideration. For one thing, a symmetrical shape, in other words, an even number of points of the star, is desirable for tooling purposes. Secondly, a four-pointed star shape would render an unnecessarily low heat transfer area, whereas, one simulating an eight-pointed star would require a tube of excessive diameter to start with. The inner points **20** of the star terminate inwardly of the chamber to define a central unobstructed portion of the passage extending through the member. The latter portion of the passage is of substantially the same cross sectional area throughout as the cross sectional area of the intake end **11**.

The other member **15** is in the nature of a muff or jacket which fits snugly over the inner member **10**. As may be seen from Fig. 1, this outer member is flared to a somewhat larger diameter at the end **16** where the gases enter the member **10**, whereas, at the other end **17** it is swaged down to a nozzle-shape of a diameter somewhat larger than the entrance aperture of the inner member **10**.

From the foregoing the operation of the subject muffler is quite obvious. Exhaust gases from the engine enter the expansion chamber **10** at **11** at high velocity and relatively low static pressure. Expanding into the larger displacement of the chamber **10** they assume a lower velocity and a higher static pressure, according to Bernoulli's theory, which states that for a fluid in motion the total energy remains constant (except for losses through flow friction and heat dissipation). Flow through the chamber **10** at such a reduced velocity and increased static pressure, the gases come into contact with the vastly larger inner surfaces of the chamber **10** over a correspondingly longer period of time.

At the restricted nozzle-shaped exit aperture **12** of the chamber **10** the gases are again confined to a greatly reduced cross-sectional area of flow; and (still according to Bernoulli's theory) again they assume a proportional (inverse) increase in velocity with a corresponding decrease in static pressure.

Expelled from the nozzle-shaped exit aperture **12** of the expansion chamber **10** the gases thus pass with high remaining kinetic energy through the somewhat larger, likewise nozzle-shaped construction and exit aperture **17** of the outer member or muff **15** whence they may be disposed of directly, or by way of an auxiliary tail pipe, into the atmosphere. The high kinetic energy spells high velocity and low static pressure, causing a sharp pressure drop, which, together with the laminar flow friction (viscosity of gases increases with temperature) causes a "suction" of air through the muff **15** in the direction of the flow of the gases which draw the air with them in the process. Obviously, this causes fresh air to enter the open,

flared end 16 of the muff 15 and to pass through the spaces 18 between the said muff and the expansion member 10 in intimate laminar flow contact with the latter's large heat transfer areas which conduct the heat from the gases to the air in an effective cooling process.

This socalled "induced flow" suction is a powerful force which is used in various applications, such as vacuum pumps, steam jet exhausters, etc., which obtain high vacua or the equivalent pumping effects. In fact, my U.S. Patent No. 2,597,253 describes a jet propulsion nozzle employing the same working principle, as part of its function, for obtaining efficient back suction on the boundary layer of an aircraft wing surface.

Here, then, is in a single preferred structure and an integrated sequence the combination of the aforesaid three larger processes required for sound and efficient muffling and optimum engine scavenging, namely (*a*) damping of the explosion expansion of the exhaust gases, through absorption of the pressure waves by the cushioning effect of a larger displacement expansion chamber; (*b*) effective cooling of the gases through large heat transfer areas common to the said gases and the cooling air, the cooling being augmented by induced flow suction sustained by the kinetic energy of the gases as they are expelled from the chamber 10, the said suction, in turn, continually drawing fresh cooling air over and in intimate laminar flow contact with the aforesaid cooling or heat transfer surfaces; (*c*) final disposal of the gases in a process of diffusion caused by the induced flow suction, whereby the gases mingle with the cooling air in the final passage, thus further augmenting the silencing without significant back pressure accruing thereby.

Finally, it should be stressed that, due to the effective cooling, as well as the absence of drips or corners where corrosive condensates can lodge and remain, the life of the subject muffler is of an entirely different order than that of conventional types.

Of interest, also, is the fact that, consisting of only two parts, the forming of which is entirely a matter of the automatic machine operations (non fabrication necessary), its cost of manufacture is substantially lower than that of current types now in use.

I claim:

A free-flow muffler for internal combustion engines comprising an inner expansion member formed from metal tubing, said expansion member being hollow throughout and having a symmetrical star-shaped cross-

sectioned portion extending from one end to the other and of uniform cross sectional area substantially throughout its length, each end of said member being swaged down and forming nozzle-shaped ends extending outwardly of the star shaped cross section portion of said member, the inner walls of said nozzle-shaped ends constituting smooth continuations of said star-shaped cross sectioned portion, and the latter having end sections which converge inwardly toward said nozzle-shaped ends, one of said ends constituting a gas intake end, the other end constituting a gas discharge end, the inner points of said star-shaped cross sectioned portion defining a portion of a passage extending through said member which is of substantially the same cross section area throughout as the cross sectional area of said intake end, said intake end being larger than said discharge end, said muffler further comprising an outer jacket extending along and enclosing said star-shaped cross sectioned portion and being in abutting heat transmitting contact with the outer star points of said star-shaped cross sectioned portion of said inner member along substantially the full length of the latter, said jacket terminating inwardly of said intake end at one end but extending outwardly beyond said discharge end at its opposite end, said outer jacket forming a nozzle at the latter end outwardly of said discharge end of said inner member and enclosing the latter end of said inner member, the end of said jacket terrminating inwardly of said inlet end of said inner member flaring outwardly adjacent said inlet end, the flared portion of said jacket forming an air intake, said opposite end of said jacket forming a discharge nozzle for said muffler, said jacket being spaced from said expansion member intermediate the points of the star-shaped cross section along the length of said expansion member to provide air channels extending along the expansion member from said flared portion to the discharge end of said expansion member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,934,462	Hartsook	Nov. 7, 1933
2,169,658	Newton	Aug. 15, 1939
2,508,463	May	May 23, 1950

FOREIGN PATENTS

222,695	Great Britain	Oct. 9, 1924
49,204	France	Sept. 6, 1938