United States Patent

Thien et al.

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[54] **INTERNAL COMBUSTION ENGINE WITH SOUND-PROOFING CASING**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **F02p 1/02**

[58] **Field of Search** ..123/195 P, 195 C, 198 E, 41.7; 60/31; 181/33.4

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[57] **ABSTRACT**

A sound-proofed internal combustion engine having a casing spaced around the engine and having a cooling-air blower driven by the engine arranged inside the casing with inlet and outlet in the casing and an exhaust pipe extending through the casing and exposed to the cooling-air stream of the blower to produce both a sound proofing and heat absorbing effect.

3 Claims, 4 Drawing Figures

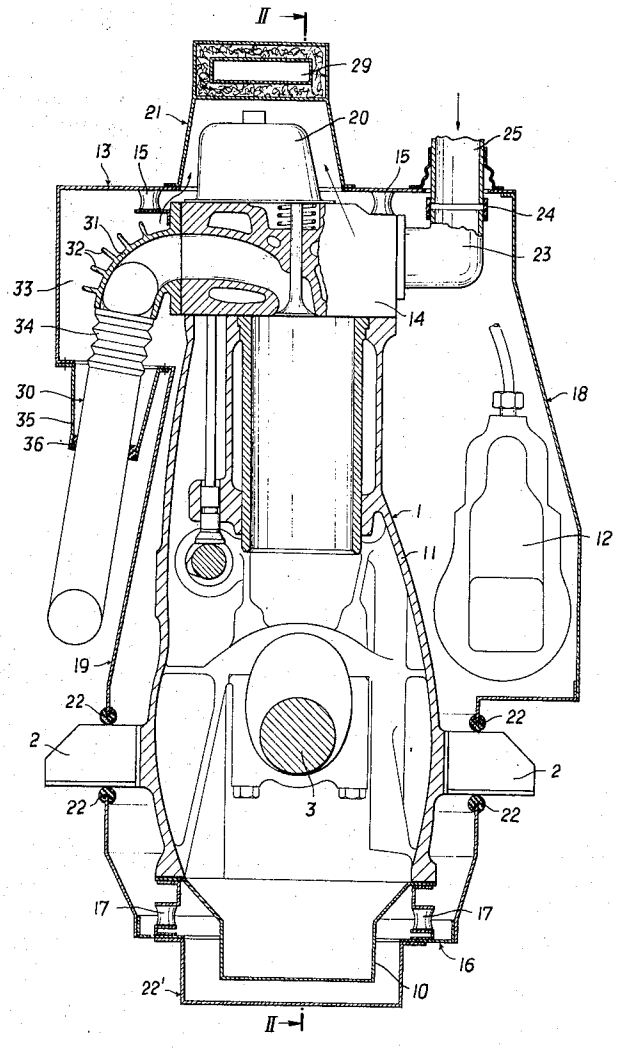

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FIG. 1

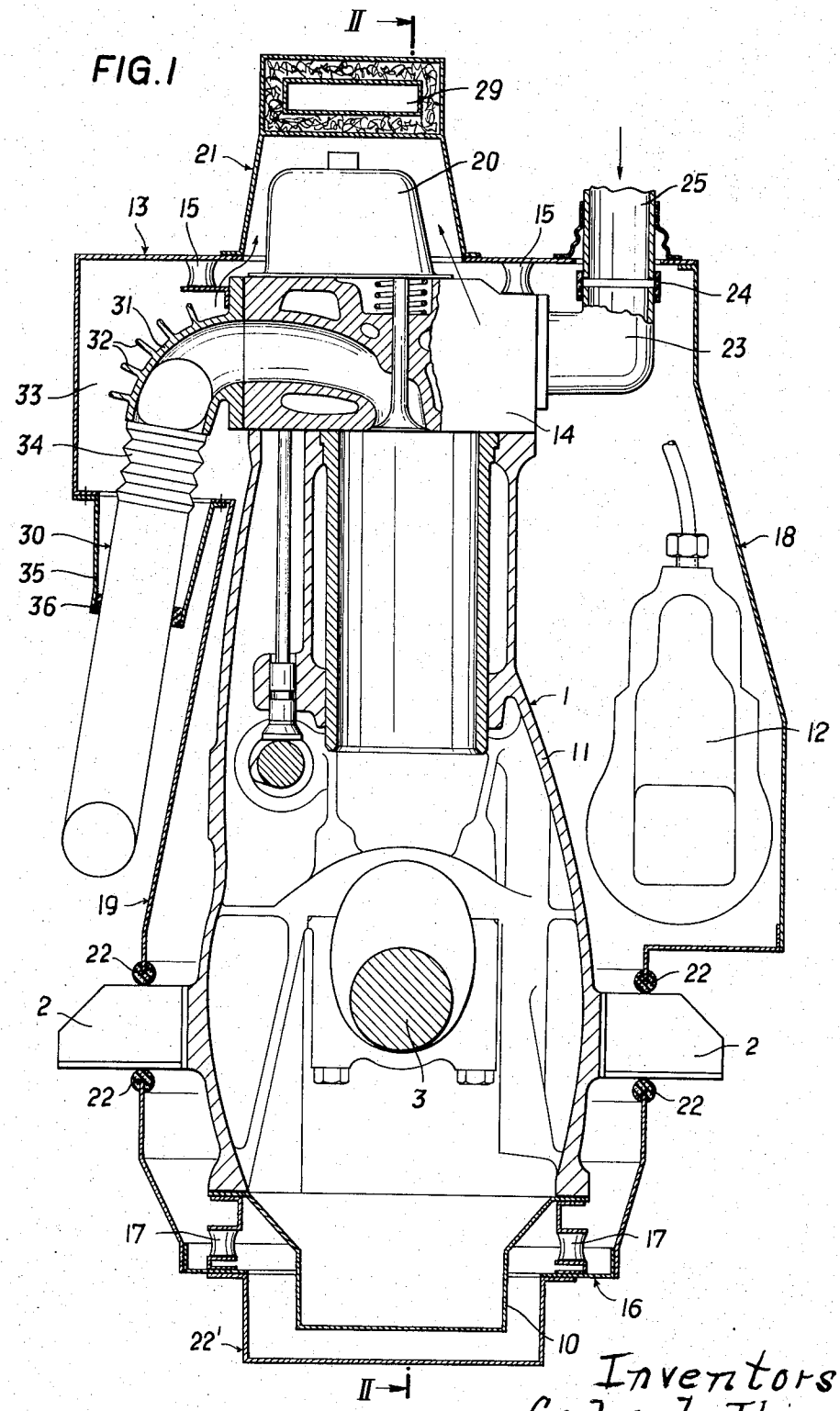

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FIG. 2

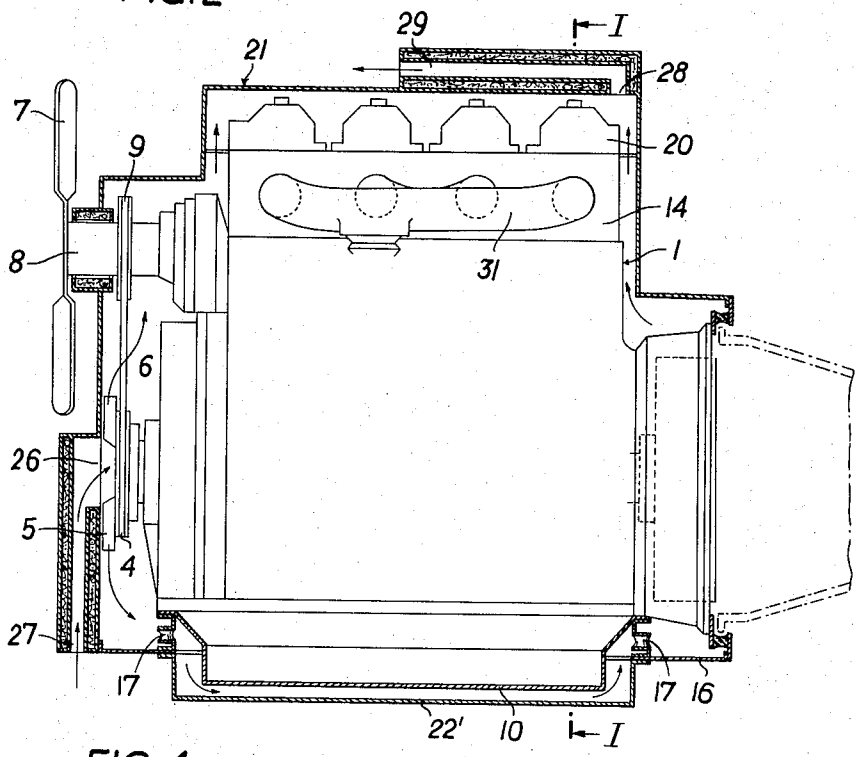

FIG. 4

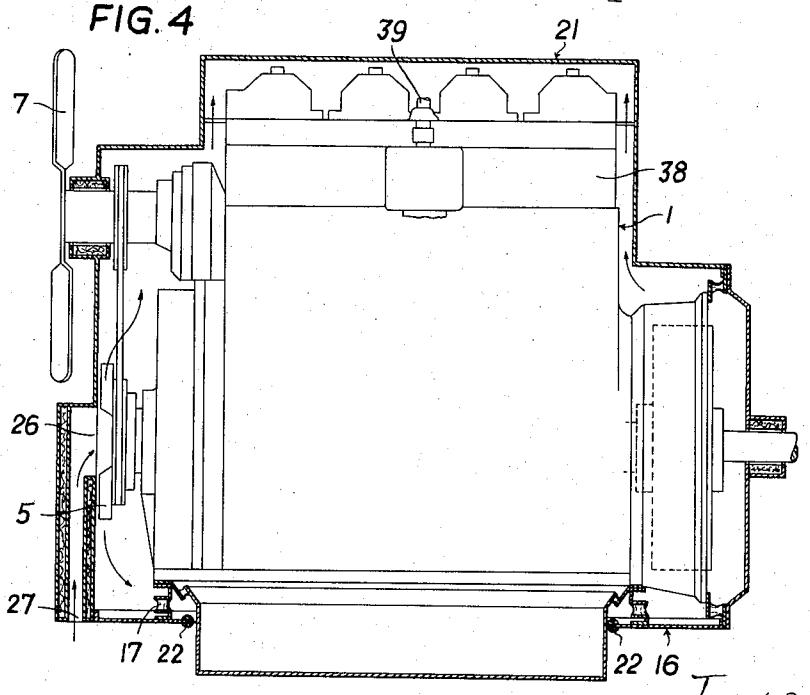

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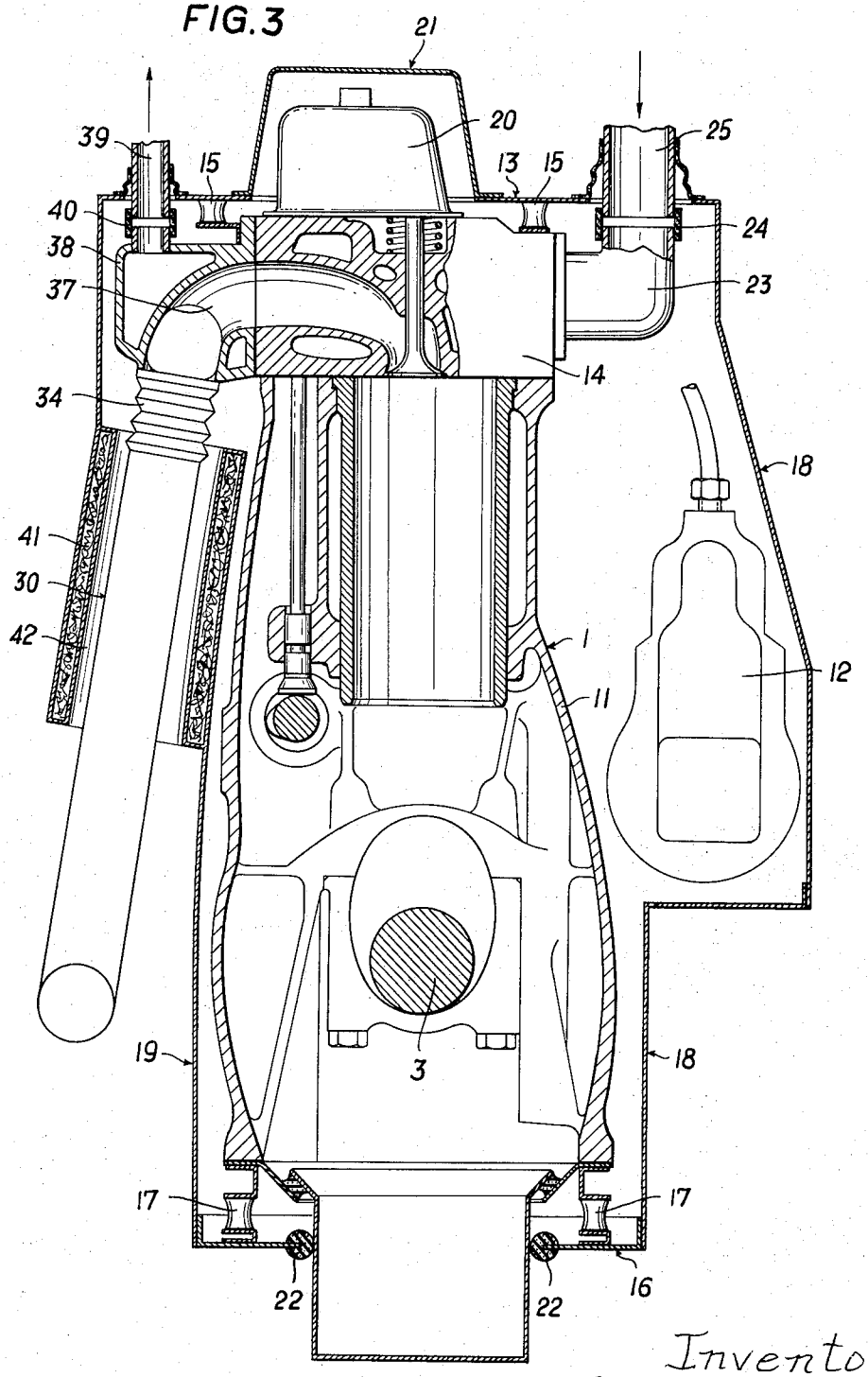
FIG. 3



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INTERNAL COMBUSTION ENGINE WITH SOUND-PROOFING CASING

The invention relates to an internal combustion engine with a sound-proofing casing arranged in spaced relation to and round the engine, further comprising a cooling-air blower located preferably inside the said casing and driven by means of the internal combustion engine, at least one inlet and one outlet each preferably provided inside the casing for the cooling air delivered by the blower, and an exhaust pipe extending through the said casing.

Internal combustion engines of this type which are at least partly encased for the purpose of reducing noise radiation, usually require additional cooling, particularly for the oil-wetted wall members and for such auxiliary machines of the engine as are located inside the casing, in order to compensate for the reduction of heat radiation caused by the casing by means of the transfer of heat to the cooling air passing through the casing. Thus overheating of such parts of the internal combustion engine as are subject to a particularly high thermal stress is avoided and the provision of an oil-cooler of ordinary size is amply sufficient.

A problem which has not as yet been solved in a satisfactory manner arises in connection with similar types of sound-proofed internal combustion engines with regard to the location and design of the exhaust piping. Apart from radiating a substantial amount of heat, the exhaust piping with its bends and pipes is a considerable source of objectionable sounds which, unless provided with adequate screening, is liable to cancel at least part of the sound-proofing effect of the encasing out again.

It is the object of the present invention to eliminate the shortcomings of internal combustion engines of the type hereabove described by providing for a special both acoustically and thermally satisfactory arrangement and design of the exhaust piping. According to the invention, the exhaust piping is directly exposed to the cooling-air stream of the blower at and/or in front of the point where it extends through the casing and traverses the casing in such a manner as to produce a sound-and-heat-absorbing effect. By these means local overheating of structural elements of the casing adjoining the exhaust piping is avoided and sound radiation from the external surfaces of the pipes and bends of the exhaust piping is reduced to the minimum. In this connection, the cooling-air stream inside the casing is preferably concentrated on the portions of the exhaust system requiring cooling by the provision of adequate fixtures. In order to improve the transfer of heat between the surfaces of the exhaust system requiring cooling and the cooling air passing thereabove, it is possible to increase the velocity of flow in those areas.

According to another embodiment of the invention it is possible to provide cooling ribs at least on part of the exhaust piping extending inside the casing, particularly on the exhaust manifold. This augmentation of the cooling surfaces of the section of the exhaust piping extending inside the casing is responsible for a considerable drop of temperature in the exhaust piping as a result of which the pipe temperatures prevailing at the point where the exhaust piping extends through the casing are only very moderate and easily controllable.

In one of the embodiments of the invention as hereabove described the exhaust piping is sealed by some means of heat-absorbing material at the point where it extends through the casing. This sealing means also serves to sound-proof the point where the exhaust piping extends through the casing.

It is, however, also possible according to the invention, for the exhaust piping to extend through the casing inside a preferably tubular muffler defining an annular clearance with the exhaust piping, through which the cooling air emerges from the casing. The heat radiated by the exhaust piping is transferred to the cooling air swiftly traversing the annular clearance, as a result of which any overheating of the adjoining areas of the casing is positively avoided. The muffler may be formed by a separate member of the casing internally lined with a sound-absorbing coating, for example, and connected with the adjacent portions of the casing, if necessary in such a manner as to be easily detachable.

According to an further feature of the invention a sound-insulating intermediate piece, preferably a corrugated tube, is inserted in the exhaust piping between the point where it is attached to the cylinder head and the point where it extends through the casing. This serves not only to restrict the passage of sound to such parts of the exhaust system as are located outside the casing, but also to reduce heat dissipation via the exhaust pipe to the outside. Where the intermediate piece is designed as a corrugated tube a larger cooling surface for the transfer of heat to the passing cooling air is available.

Finally, it is advantageously possible, according to a feature of the invention as applied to water-cooled internal combustion engines, to arrange the exhaust manifold in a housing traversed by the cooling water from the cylinder head, and possible integral with the cylinder head, the cooling-water return pipe of the engine emerging preferably from the said housing. Thus a sizeable portion of the heat of the exhaust gases is transferred to the cooling-water system of the internal combustion engine already in the area of the exhaust manifold, so that relatively low temperatures prevail at the point where the exhaust piping extends through the casing.

Further details of the invention will become apparent from the following description of several preferred embodiments of the invention with reference to the accompanying drawing, in which

FIG. 1 shows a cross-sectional view of an internal combustion engine according to the invention on line I—I of FIG. 2,

FIG. 2 is a partial cross-sectional view of the same engine on line II—II of FIG. 1, and

FIGS. 3 and 4 each show another variant of the internal combustion engine according to the invention as illustrated in FIGS. 1 and 2, respectively.

The water-cooled internal combustion engine as shown in FIGS. 1 and 2 comprises a closed-type crankcase 1 with laterally spreading engine supports 2. At one extremity the crankshaft 3 of this four-cylinder inline internal combustion engine carries a vee-belt pulley 4 with an adjacent blower impeller 5. A vee-belt 6 drives the shaft 8 carrying the fan 7 by means of an additional vee-belt pulley 9.

The crankcase 1 is closed by means of an oil sump 10 tightly attached to its lower connecting flange 11. The fuel-injection pump 12 of the internal combustion engine is mounted on a side-wall 11 of the crankcase.

The internal combustion engine is provided with a sound-proofing casing comprising sound-insulating casing elements arranged around the engine in spaced relation thereto. These elements comprise a frame-like upper casing member 13 threadedly engaged or otherwise attached to the cylinder head 14 by means of flexible, sound-insulating spacers 15.

Another frame-like casing member 16 is attached to the underside of the crankcase 1 by means of sound-insulating supporting members 17.

Between the upper casing element 13 and the lower one 16 lateral casing members 18 and 19 extend, which together with another casing member 21 located above the valve-rocker covers 20 and a casing member 22' mounted on the casing member 16 beneath the oil sump 10 define a closed sound-insulating housing surrounding the internal combustion engine in spaced relation thereto.

The engine supports 2 extend through the two lateral casing members 18 and 19 at openings which are sealed off by means of flexible sealing elements 22. The upwardly curved suction pipe 23 mounted on the cylinder head 14 comprises a pipe section 25 attached thereto with the interposition of a sound-insulating connecting piece 24, the said pipe section extending through an opening of the upper casing element 13.

At the front end of the casing a cooling-air inlet 26 preceded by a muffler 27 is located. The cooling-air drawn in from the blower 5 via the opening 26 passes, as shown by arrows in the drawing, inside the casing over the external walls of the cylinder block and emerges from the casing at the cooling-air outlet designated by reference number 28 and coated with a muffler 29.

An outstanding feature of the invention is the particular design and arrangement of the exhaust piping 30 of the internal combustion engine. In order to extend the sound-insulating measures so as to include also the exhaust system of the engine, essential parts of the exhaust piping 30 are directly exposed to the cooling-air delivered by the blower 5. For that purpose, in the design illustrated in FIGS. 1 and 2, the exhaust manifold 31 flanged to the cylinder head 14 opposite the suction pipe 23 is provided with cooling ribs 32 and arranged inside a chamber 33 covered by the casing member 19, where a vigorous stream of cooling-air prevails.

The exhaust piping 30 is connected to the exhaust manifold 31 with the interposition of a sound-insulating intermediate piece defined by a corrugated tube 34, and extends through the casing inside a sleeve 35 attached to the casing member 19 and/or cast integral with same. At the point where the exhaust piping 30 emerges from the sleeve 35, it is surrounded by a sealing means 36 made of a heat-absorbing material. As a result of these measures, sound-radiation from the portions of the exhaust system close to the engine is considerably reduced and part of the heat of the exhaust gases is transferred to the cooling air already in the area of the exhaust manifold 31. By the sealing means 36 the point where the exhaust piping 30 extends through the casing is sealed off acoustically on the one hand, and on the other hand, the transfer of heat from the exhaust piping 30 to the casing is reduced.

Apart from several variations in casing design which are, however, not essential for the scope of the present invention, the internal combustion engine illustrated in FIGS. 3 and 4 differs from the embodiment of the invention as hereabove described only in regard of the following details: The air-cooled exhaust manifold 31 is here replaced by the arrangement of the exhaust manifold 37 inside a housing 38 traversed by cooling water, from which the cooling-water return pipe 39 emerges. The housing 38 can also be cast integral with the cylinder head. The return pipe 39 is connected to the housing 38 with the interposition of a sound-proofing intermediate piece 40 and extends through the upper casing member 13 mounted on the cylinder head 14.

The exhaust piping 30 connected to the housing 38 by means of the corrugated tube 34 extends through a muffler 41 arranged on a lateral casing member 19, the said muffler 41 defining together with the exhaust piping 30 and annular chamber 42 through which the cooling air delivered by the blower 5 emerges from the casing system in the direction indicated by arrows in the drawing. The annular chamber 42 with the surrounding muffler 41 serves as a substitute for the cooling-air outlet 28 screened off by means of the muffler 29 as provided for in the first-mentioned embodiment of the invention.

In the internal combustion engine illustrated in FIGS. 3 and 4, part of the heat of the exhaust gases is transferred to the cooling-water system of the internal combustion engine already in the area of the exhaust manifold 37. The cooling-air passing along the exhaust piping 30 inside the annular chamber 42 transfers yet another portion of the remaining heat radiated off the exhaust piping 30. Thus overheating of the adjacent parts of the casing system is avoided. The corrugated tube 34 reduces the transmission of sound to the external portions of the exhaust system. The muffler 41 positively restricts sound-radiation from the exhaust piping 30.

We claim:

1. A sound-proofed internal combustion engine comprising a sound-proofing casing arranged around the engine in spaced relation to same, a cooling-air blower driven by the internal combustion engine and arranged inside said casing, at least one inlet and one outlet in said casing provided for the passage of the cooling air delivered by said blower, an exhaust pipe extending through said casing, a sleeve mounted on said casing in the area of the point at which the exhaust pipe traverses said casing, said sleeve being formed as a muffler surrounding said exhaust pipe in spaced relation to same and defining an annular clearance together with the exhaust pipe, said annular clearance forming an outlet for the cooling air delivered by said blower, and a corrugated tube located in said exhaust pipe between the point where said exhaust pipe is attached to the engine and the point where said exhaust pipe traverses said casing, said corrugated tube forming a sound-insulating intermediate piece for said exhaust pipe.

2. An internal combustion engine according to claim 1 wherein said muffler is in the shape of a tube surrounding said exhaust pipe.

3. An internal combustion engine according to claim 1, further comprising a cylinder-head traversed by cooling-water, a housing on said cylinder head, a cooling-water chamber located inside said housing and connected to a water-carrying chamber of said cylinder head, said exhaust pipe extending through said housing inside said cooling water chamber, and a cooling-water return pipe emerging from said housing and extending through said casing in the area of said housing.

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