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PISTON FOR INTERNAL-COMBUSTION ENGINES HAVING ACOUSTIC DETONATION SUPPRESSION MEANS

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Fig. 1

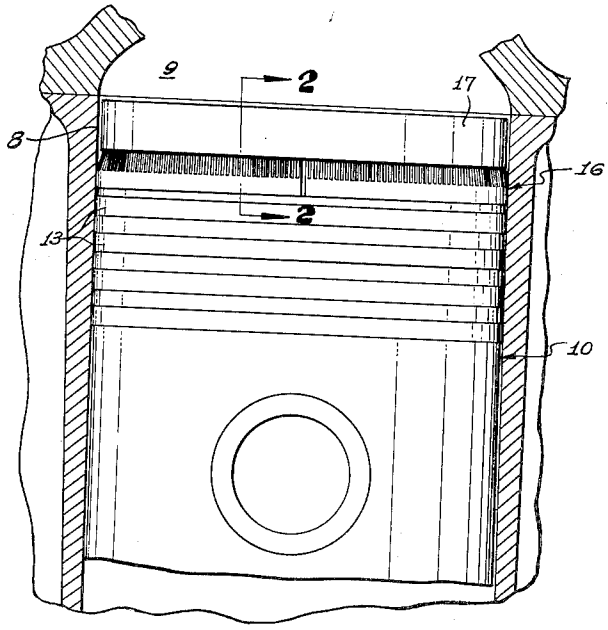


Fig. 2

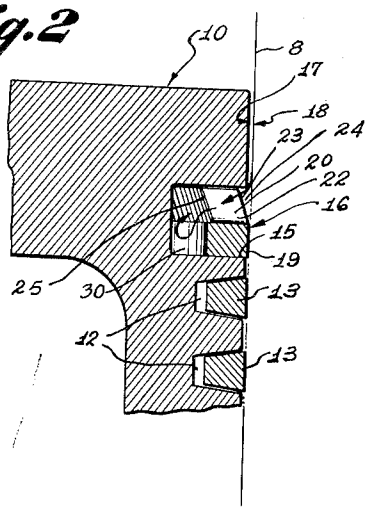
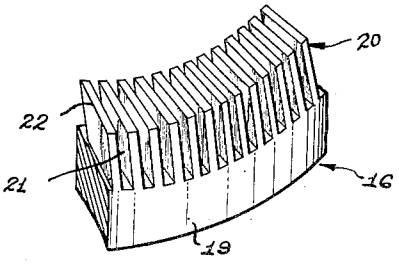


Fig. 3



INVENTOR.
ALBERT G. BODINE JR.
BY Forrest J. Kelly
Attorney

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PISTON FOR INTERNAL-COMBUSTION ENGINES HAVING ACOUSTIC DETONATION SUPPRESSION MEANS

Albert G. Bodine, Jr., Van Nuys, Calif.

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5 Claims. (Cl. 123—191)

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This invention relates generally to internal combustion engines and to means for suppressing irregular burning and detonation of fuel-air mixture therein. The invention is based on my discovery that detonation in combustion engines involves acoustic phenomena and can be alleviated by means of certain acoustic apparatus used in combination with the combustion chamber.

The present application is directed to improvements in the field covered by Patent No. 2,573,536, issued October 30, 1951, entitled Engine Detonation Control by Acoustic Methods and Apparatus. For a full discussion of the acoustic aspect of detonation in combustion, and my basic solution for controlling detonation in combustion, reference should be had to my said issued patent.

Only briefly stated herein, the present invention is based on the fact that detonation in an engine combustion chamber produces sound waves, a large part of which rise to high amplitude at resonant frequencies of the chamber, and on my discovery that the sound waves produce many of the various well-known and harmful manifestations of detonation. According to my basic invention, I inhibit or attenuate these harmful effects by interfering with or attenuating the high amplitude, detonation-induced sound waves, and this is done by use in connection with the combustion chamber of acoustic attenuation means made responsive to (operative at) the frequencies or wave lengths at which the detonation-induced sound waves build up to high amplitudes. One type of acoustic attenuation means broadly disclosed in my patent involved an attenuative configuration given to the upper end portion of the piston.

The general object of the present invention is the provision of an improved detonation controlling sound wave attenuator means of the class involving the piston structure.

Another object is the provision of a piston type of detonation attenuator which is improved as regards frequency response to and dissipation of the offensive sound wave frequencies encountered in combustion.

According to the present invention, there is formed around the piston, in the area between the upper ring grooves and the top of the piston, a deep groove which receives a slotted ring. The upper portion of the piston, above this ring and groove, has sufficient clearance from the side wall of the cylinder to permit passage of detonation sound waves from the combustion chamber to the slotted ring, and these waves enter through

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the slots into the bottom of the described groove. The bottom of the groove, in back of the ring, functions as a Helmholtz type of acoustic cavity, the slots in the ring, together with the clearance space between the upper portion of the piston and the cylinder wall, functioning as the constricted neck for the cavity. By proper proportioning of the parts, the cavity is made attenuative of the detonation frequencies which are most offensive. The device thus functions as a Helmholtz type of acoustic wave absorber, materially attenuating the offensive sound waves, and so reducing the manifestations of detonation.

The invention will be better understood from the following detailed description of an illustrative embodiment wherein:

Figure 1 is a side elevation of a piston in accordance with the invention shown inside the cylinder of an engine;

Figure 2 is a detail section taken on line 2—2 of Figure 1; and

Figure 3 in a fragmentary perspective view of a slotted ring.

In the drawings, an engine cylinder is designated at 8, opening into combustion chamber 9, and the numeral 10 designates generally the piston of the invention. The piston is furnished with conventional grooves 12 and rings 13. Above the top ring 13, the piston is formed with a relatively deep and wide groove 15, which receives a split, slotted ring 16. The portions of the piston above the groove 15 are slightly set back, forming a setback land 17, and between this land and the cylinder wall is a clearance space 18 for passage of the sound waves generated in the combustion chamber by attenuation.

The thickness of the ring 16, in the present design, is only about one-half the full depth of the groove 15.

The ring 16 consists of a lower solid portion 19, and an upper slotted portion 20, the two portions being formed to be receivable with free sliding fit within the groove 15. The slotted portion 20 is formed by cutting radial slots 21, which in this instance are of approximately the same thickness dimension as the remaining fins 20. The forward edges 23 of fins 22 are formed on an angle of approximately 15° with vertical, joining the outer surface of solid ring portion 19 at the bottom, and being offset inwardly at the top, all as clearly shown. This furnishes a desirable clearance space or vestibule 24, which facilitates progress of the sound waves from the clearance space 18 into the slots 20. The rearward edges 25 of

the fins may be made parallel to the forward edges 23.

The annular groove space 30 behind the slotted ring 16 forms an acoustic cavity, and this cavity, in combination with the clearance space 18, vestibule 24, and ring slots 21, forms a Helmholtz resonator. The space 30 is the cavity of such resonator, and the clearance space 18, vestibule 24, and ring slots form its restricted neck. Following ordinary techniques familiar in the science of acoustics, the acoustic wave frequency at which detonation is severe in the engine in which the piston is to be used is first ascertained. This frequency will be an acoustic resonant frequency of the combustion chamber. The dimensions of the Helmholtz resonator are then made such as to be responsive, i. e., resonant, to this detonation wave frequency.

It is known in acoustics that a Helmholtz resonator functions to attenuate a sound wave of the frequency to which it is resonant. This it does by reason of the fact that a sound wave having a frequency corresponding to the resonant frequency of the resonator causes high velocity gas oscillation in the restricted neck region of the oscillator, and the high velocity gas particles in the restricted neck region scrub against one another, thereby developing substantial friction, which means that the driving sound wave loses substantial energy. A sound wave can be very materially attenuated by this means.

The described Helmholtz resonator provided by the present invention is quite effective in subduing detonation by absorbing energy from the detonation sound wave. The neck of the resonator, comprising the clearance space 18, vestibule 24, and slots 21, is irregular and discontinuous in both cross-section and direction, and develops substantial frictional dissipation of the sound wave. In an annular acoustic cavity, such as the cavity 30, there is a tendency toward development of sound waves around the annulus. Any tendency for such waves within the chamber 30 results in further sound wave dissipation, since the annular sound wave conduit is bordered by the inner edges of the fins 22, which cause reflections all along the annulus, and consequent wave deterioration.

It will be understood that the drawings and description are illustrative only, and that various changes in design, structure and arrangement may be made without departing from the invention as defined by the appended claims.

I claim:

1. For use with an internal combustion engine having a combustion chamber and a cylinder opening into said chamber, a piston adapted for reciprocation in said cylinder, said piston having an upper end portion formed with a slightly set back outer side surface, so as to furnish a narrow sound wave passage between the upper end portion of the piston and the opposed wall of the cylinder wall, there being an annular groove around said piston communicating with said sound wave passage, and a piston encircling ring in said groove, said ring being adapted for sliding engagement with the cylinder wall, said groove being deeper than said ring, so as to afford an annular acoustic cavity behind said ring, and said ring having narrow sound wave passages therethrough to provide restricted sound wave communication between said sound wave passage and said annular acoustic groove cavity.

2. The subject matter of claim 1, wherein said ring passages are in the form of substantially radial slots extending through the upper portion thereof.

3. The subject matter of claim 1, wherein said ring comprises a lower portion slidably fitting the bore of the cylinder, and a substantially radially slotted upper portion.

4. The subject matter of claim 1, wherein said ring comprises a lower portion slidably fitting the bore of the cylinder, and a substantially radially slotted upper portion, the outer edges of the radial fins formed by said radial slotting being set back to form an annular vestibule between said annular sound wave passage and the entrance openings to the radial slots leading to the ring groove cavity.

5. The subject matter of claim 1, wherein said set-back surface of said piston is an uninterrupted surface of revolution about the longitudinal axis of the piston, so as to form said sound wave passage as a complete annulus.

ALBERT G. BODINE, JR.

No references cited.