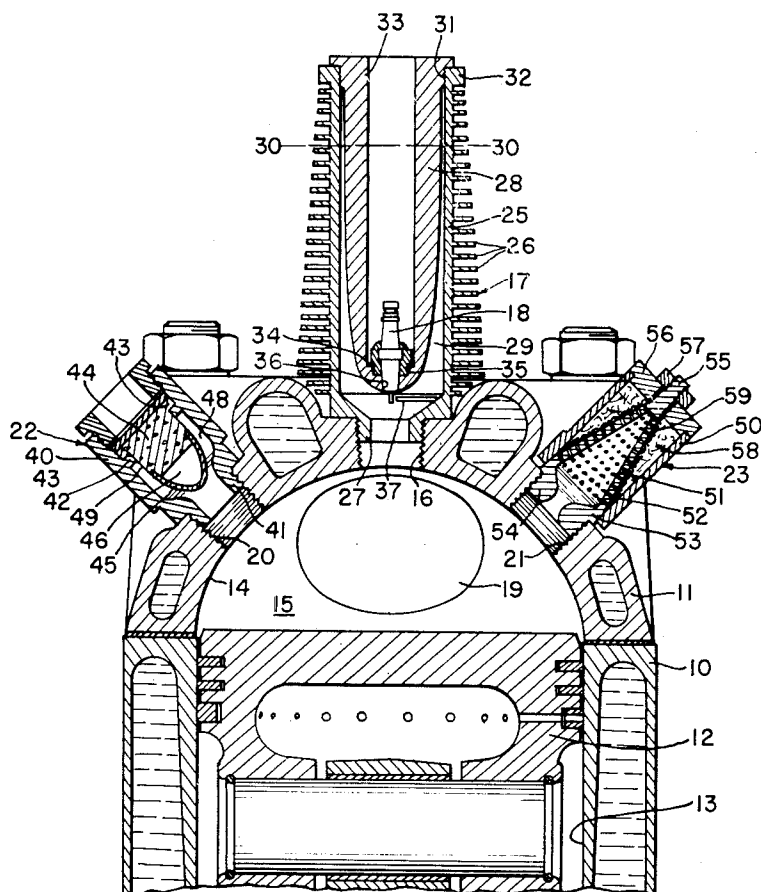


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ACOUSTIC DETONATION SUPPRESSION PLUG-IN
DEVICE FOR INTERNAL COMBUSTION ENGINES
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ACOUSTIC DETONATION SUPPRESSION PLUG-IN DEVICE FOR INTERNAL COMBUSTION ENGINES

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Application October 24, 1951, Serial No. 252,818, which is a division of application Serial No. 234,688, July 2, 1951, now Patent No. 2,573,536, dated October 30, 1951. Divided and this application December 6, 1955, Serial No. 551,262

5 Claims. (Cl. 123—191)

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 a division of my copending application Ser. No. 252,818, filed October 24, 1951, entitled Engine Detonation Control By Acoustic Methods and Apparatus, which was a division of my earlier application Ser. No. 234,688, filed July 2, 1951, entitled Engine Detonation Control By Acoustic Methods and Apparatus (now Patent No. 2,573,536), which last-mentioned case was in turn a continuation-in-part of my prior parent applications Serial No. 24,744 filed May 3, 1948, entitled Acoustic Means for Suppressing Detonation in Internal Combustion Engines, now abandoned, and Ser. No. 161,695, filed May 12, 1950, entitled Acoustic Means and Method for Suppressing Detonation in Internal Combustion Engines (now Patent No. 2,662,513).

The present invention is based on the fact that detonation in an engine combustion chamber produces sound waves, a large part of which are at high amplitude at resonant frequencies of the chamber, and on my discovery that the sound waves produce 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 the frequencies at which detonation-induced sound waves appear at high amplitudes.

One type of acoustic attenuation means disclosed in my aforementioned earlier applications, with which the present application is connected by copendency, comprised a plug-in device adapted to be screwed into a port formed in a wall of the combustion chamber, and the present invention is directed primarily to forms of attenuator of this general character.

An object of the present invention is the provision of an effective detonation controlling sound wave attenuator of a type capable of being screwed or plugged into a suitable port formed in a wall of the combustion chamber.

Further objects are concerned with the provision of improved devices of this general type characterized by simplicity, low cost, effectiveness, minimum modification of existing combustion chamber designs, and ease of disassembly from the engine for purpose of clean-out or replacement.

The invention will be best understood by referring immediately to several illustrative embodiments thereof, reference for this purpose being had to the accompanying drawings, in which the drawing shows a vertical trans-

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verse section through the block and head of a typical engine incorporating forms of the invention.

The drawing shows a valve-in-head engine of modern type, having a water-cooled block 10, water-cooled head 11 fastened to block 10, and a piston 12 working in a cylinder 13 within block 10. Head 11 comprises a generally domed or hemispherical chamber wall of head wall 14 in a threaded port 16 which may be of a size and type to receive a conventional spark plug, and while in certain practices of the invention the spark plug may be directly installed in this port 16, I have here illustrated a case in which an attenuator 17 is installed in the port 16, the attenuator 17 in turn mounting the spark plug designated at 18, here shown as of the miniature type.

Continuing with the description of the illustrative engine, intake and exhaust valves will be understood to open to combustion chamber 15 through wall 14, an exhaust valve 19 being shown, and it being understood that an intake valve (not shown) will be located symmetrically with respect to the exhaust valve, forwardly of the plane of the drawing.

Formed in the generally hemispherical wall 14 of engine head 11, somewhat below port 16, and between the intake and exhaust valves, are additional threaded ports 20 and 21 for reception of additional acoustic attenuators 22 and 23, respectively.

In the drawing I have shown a group of three attenuators, and for illustrative purposes, I have shown these of three different types, it being understood, however, that the attenuators may be used singly or in groups, as here illustrated. Further, an ordinary spark plug may be employed in port 16, and attenuators used in one or both of ports such as 20 and 21. Other combinations or arrangements will be obvious.

The attenuator 17 incorporates a wave guide of the exponential horn type, such as described generally and broadly claimed in my aforesaid Patent No. 2,573,536. The illustrative embodiment shows the attenuator 17 as optionally mounting a spark plug. A cylindrical housing 25 formed preferably with external cooling fins 26, has at one end a reduced and threaded neck portion 27, adapted to be screwed into the spark plug port in the head of a conventional engine, or into a special port provided for the purpose. Received through the upper end of cylindrical housing 25 is a body 28 whose longitudinal curvature is such as to form between its exterior surface and the interior surface of housing 25 a longitudinal annular passageway or wave guide 29 having a cross-sectional area which diminishes in an upward direction in the manner of an exponential or other flared type horn. In other words, the annular chamber space 29 is the equivalent of the space inside such a horn, and functions acoustically in the manner of the horn-shaped chambers fully discussed in my said Patent No. 2,573,536. Preferably, the body 28 is formed substantially on an exponential curve up to plane 30, where the clearance passage between the body 28 and the wall of housing 25 is of the order of a few thousandths of an inch or thereabouts. The clearance passage extends at this dimension from the plane 29 to a point where the body 28 has a screwthreaded section 30 screwed into the internally screwthreaded portion 31 of the upper end of the housing.

The operation of the wave attenuator 17 is generally that of the horn type attenuators discussed fully in my Patent No. 2,573,536, and need not be repeated in detail. Suffice it to say that detonation generated sound waves entering the passage 29 through the neck 27 experience great increase in energy density in moving up the horn-like wave guide passage 29, and the sound wave energy is then largely dissipated and converted into

heat within the narrow clearance passage above the plane 30. This heat is dissipated into the atmosphere by means of the aforementioned radiating fins 26.

As an optional feature, the body 28 is formed with a longitudinal bore 33 extending from its upper end to an annular seat 34, and extending downwardly through said seat is a threaded socket 35 for spark plug 18, the downwardly projecting insulator portion of which is tightly received within an aperture 36 opening through the lower end of the body 28. The electrode tip of the spark plug is spaced from a grounded electrode rod 37 projecting from the side wall of housing 25. Thus the one auxiliary device combines a detonation wave attenuating means and spark plug.

In my aforementioned earlier applications, detonation sound wave attenuators were described of a type involving porous absorbers, as well as Helmholtz resonator forms embodying generally the concept of a Helmholtz resonator cavity with a porous plug or wall across the effective "neck" of the cavity. See, for example, the attenuator 51 of Fig. 21 of Patent No. 2,573,536, also that of Fig. 22 of said patent, together with the accompanying description of theory and operation. The attenuator 22 of the present application is related to these basic types, and incorporates further improvements as will now be described.

The attenuator 22 comprises a tubular body 40 formed with a reduced screw-threaded tubular stem 41, adapted to be screwed into combustion chamber port 20, and this body 40 has, located somewhat towards its upper end, an internal annular flange 42 affording an upwardly facing annular shoulder for the support of the external annular flange 43 formed at the top of porous plug 44, the latter extending downwardly below flange 42 with substantial clearance from the inside surfaces of body 40. Mounted on the lower end portion of plug 44 is a nose cap 45 enclosing a Helmholtz resonator cavity space 46 adjacent the bottom end of plug 44. This nose cap 45 is also adequately spaced from the inner surfaces of body 40 to permit unrestricted passage of detonation sound waves from the combustion chamber of the engine up through the clearance space 43 to the exposed cylindrical side wall 49 of plug 44. The fundamental operation is as described in Patent No. 2,573,536 for more elementary forms of attenuator of this general Helmholtz type. Briefly, the porous plug 44 presents a large plurality of fine pores, passages or crevices, furnishing highly restricted sound wave communication to the resonator cavity space 46. The distinctive feature of this embodiment is the presentation of the resonator cavity wall 45 to the heat of the combustion chamber, whereby cavity 46 is maintained at a high temperature sufficient to oxidize carbonaceous residue tending to accumulate within the cavity.

The attenuator 23 comprises a tubular body 50 containing a conical chamber wall 51, perforated throughout its length, as at 52, and formed at its large end with an end enclosure wall 53 having threaded neck 54 screwed into combustion chamber port 21. The large end of the chamber wall 51 is press-fitted inside the body 50, and its small end has a stem 55 projecting through a center bored removable end closure cap 56 for the body, the extremity of stem 55 being threaded to receive nut 57 by which cap 56 is screwed in position. Body 50, in back of perforated wall 51, is packed with a porous body 53 comprised of a fibrous sound wave absorptive material such as fiber glass, tungsten fibers, copper fibers, silica fibers, or the like. A screen 59 is used around said wall 51 to confine the fibrous material against loss through the perforations. Sound waves entering the housing from the combustion chamber communicate with the

absorptive body of material by entering through the neck 54 and passing through wall perforations 52. The wave front traveling down the conical wall 51 and out through its perforations encounters a gradually increasing thickness of the absorptive material 58, and this annular "wedge" effect tends toward progressive absorption of the wave, avoiding sharp increases in impedance such as might cause wave reflections back out of the device. Such a sound wave absorber is again predominantly responsive to a given wave frequency but the response curve is relatively flat, and the attenuator in this form is responsive to a wide frequency band. The fibrous type of material here used for sound wave absorption is found in practice to be particularly effective in such a device.

It will be understood that the drawings and description are merely illustrative of certain specific embodiments of the invention, and that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

I claim:

1. A sound wave attenuator for the combustion chamber of an internal combustion engine, comprising a generally conical chamber having a perforated side wall and a neck at one end thereof for connection to a combustion chamber, a housing surrounding the perforated wall of said chamber, and a body of wave absorptive material in the space between said conical wall and said housing.

2. An internal combustion engine having a combustion chamber, and an acoustic wave attenuator chamber connected in communication with said combustion chamber, said wave attenuator chamber comprising an external casing connected at one end to said combustion chamber and a body centrally mounted in said casing and forming a wave guide space between itself and the surrounding casing which diminishes according to an exponential function in the direction away from the combustion chamber.

3. An acoustic detonation attenuator adapted to be screwed into a threaded port in the wall of the combustion chamber of an internal combustion engine, comprising: a hollow casing having a bore and having an externally threaded hollow neck at one end thereof adapted to be screwed into said threaded port, and a body closing the other end of said casing projecting centrally within said bore in said cylinder and forming a wave guide space between itself and the surrounding wall of the bore which diminishes substantially according to an exponential horn function in the direction away from the combustion chamber.

4. The subject matter of claim 3, wherein the extremity of said body nearest the combustion chamber is adapted for mounting a spark plug.

5. An acoustic detonation attenuator adapted to be screwed into a threaded port in the wall of the combustion chamber of an internal combustion engine, comprising: a hollow casing forming a chamber and having a hollow externally screwthreaded neck communicating with said chamber and adapted to be screwed into said threaded port, a porous body mounted in said hollow casing at the end thereof remote from said hollow neck, and a wall mounted on a portion of said porous body within said casing chamber and enclosing a Helmholtz resonator cavity adjacent a portion of said porous body, said porous body having an external surface area within said chamber and in communication through said chamber with said hollow neck, whereby a portion of said porous body is interposed between said hollow neck and said Helmholtz cavity.

No references cited.