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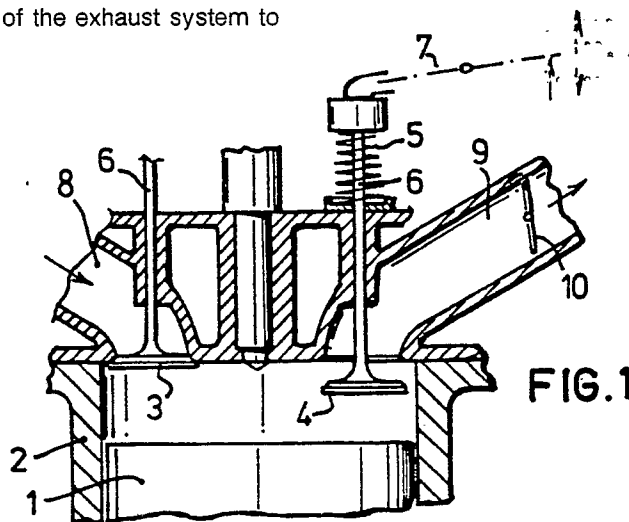
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54 **Engine compression brake.**

57 The invention relates to an internal combustion engine, comprising cylinders with pistons and inlet and exhaust valves, an exhaust system, an engine brake that is provided with means for disposing of the compression energy at the end of the compression stroke, the engine brake comprising means for closing a brake valve (10) in the exhaust system in order to establish a pressure increase in the cylinder (2), means for opening the exhaust valve (4) during the inlet stroke of the piston (1) synchronously to the number of revolutions per minute of the engine to such an extent that exhaust gas flows back through said cylinder exhaust valve of the exhaust system to the cylinder.



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Internal combustion engine, comprising an engine compression brake

The invention relates to an internal combustion engine, comprising cylinders with pistons and in- and exhaust valves, an exhaust system, an engine brake that is provided with means for destroying the compression energy at the end of the compression stroke.

This type of internal combustion engine is generally known.

As a result of opening the exhaust valve at the end of the compression stroke, the work performed by the piston during the compression stroke cannot be recuperated during the expansion stroke (pre-exhaust).

Another method comprises closing a valve of the exhaust system, resulting in higher pressure than usual in the cylinder during the exhaust stroke (exhaust throttling).

The braking action of an internal combustion engine is partly constituted as a result of loss due to friction and partly as a result of indicated energy.

Since the loss due to friction has only a slight impact on the engine brake action it has been tried to increase the indicated energy.

The above-stated pre-exhaust has the disadvantage that a complicated engine structure is required, since one must be able to interrupt the pre-exhaust during normal engine operation, for which purpose special profiles and/or operational mechanisms are required.

The above-indicated exhaust throttling is mostly applied. A drawback of exhaust throttling, however, is that the braking action is restricted by the occurring exhaust gas temperature and the possible occurrence of uncontrolled opening of the exhaust valves (valve bouncing).

Moreover the brake power, obtained with said pre-exhaust and exhaust throttling with respect to the engine power is low during normal operation if they are applied to super-charged engines. Furthermore the braking action of those two systems is insufficiently controllable, which is a drawback with higher brake powers.

When aiming at an increase of the indicated brake power, the following secondary terms should be taken into account.

The energy absorbed by the engine should be disposed of to the environment, preferably by a temperature increase of the exhaust gas.

Only minimal adjustments can be made to the cylinder head and the remaining engine parts, in view of the cost and the weight of the engine.

The fuel consumption of the normal operating engine should not increase.

The invention aims to remove the above-indicated drawbacks and to increase the average effective brake action in internal combustion engines within the scope of the stated secondary terms, in particular in super-charged engines.

For that purpose, the invention is characterized in that the engine brake comprises means for closing a brake valve in the exhaust system in order to create a pressure increase in the cylinder, means for opening the exhaust valve during the inlet stroke of the piston synchronously to the number of revolutions per minute of the engine to such an extent that exhaust gas flows back through said cylinder exhaust valve of the exhaust system to the cylinder.

By applying these measures an increased engine braking action is obtained that can be adjusted, e.g. by means of a variation of the passage of the brake valve. The thus obtained adjustment characteristic is less steep and subsequently leads to a more favourable dosability of the engine brake power. Moreover, since it is so easily controlled, the engine brake can be applied in combination with an anti-blocking system (ABS).

Said means for destroying the increased compression energy after the decompression stroke can e.g. consist of opening the outlet at the top dead centre.

There are tried mechanisms for transposing the standard exhaust cam profile so that for the benefit of the present engine braking system.

The invention will be further elucidated on the basis of the drawing.

Figure 1 schematically shows a cylinder head of an internal combustion engine, comprising an inlet and exhaust valve with brake valve according to the invention.

Figure 2 shows a cylinder head of the same type with another exhaust valve construction that is operable by gas pressure.

Figure 3 shows the same cylinder head of the same type with again another exhaust valve construction with operation mechanism.

The partly shown cylinder 2 in which a piston 1 is mounted, has a head 2 with inlet valve 3 and an exhaust valve 4, both provided with a valve spring 5, and a valve stem 6. The exhaust valve 4 is operated by a valve rocker 7 that is operable by a cam, a hydraulic or an electromagnetic system.

The cylinder head furthermore comprises an inlet system 8 and an exhaust system 9 in which a brake valve 10 has been mounted.

For the passage of the brake valve, several constructive embodiments are possible.

In figure 1 the exhaust valve 4 is opened via a valve rocker by a cam shaft (not shown). This can take place indirect through a bar system or direct from the cam system. The opening of the exhaust valve 4 can take place at any desired time.

In the construction of figure 2, the rigidity of the exhaust valve spring is such that the valve opens spontaneously under the influence of a pressure build-up in the exhaust system 9 by means of the operable brake valve 10.

The exhaust valve opens at the bottom dead centre of the piston under the influence of gas forces. This can to a limited extent be arranged by the choice of the closing force and the rigidity of the valve spring. The further course of the cycle in the internal combustion engine is equal to that of the embodiment of figure 1. Closing the brake valve can be performed manually, hydraulically, electrically or pneumatically (not shown).

In figure 3 an exhaust valve 4 is applied that has in its closed position a permanent (small) opening (negative valve clearance). The clearance amounts to some tenths of millimeters. This construction provides the possibility of both an increased charge during the inlet stroke and a de-compression during the compression stroke.

The adjustment means is e.g. operable by an eccentric cam (not shown) mounted on the shaft of the valve rocker.

If the exhaust valve with pre-exhaust is applied, this valve will be opened when nearing the end of the compression stroke by e.g. an hydraulic coupling between the exhaust valve and a cam suited for this purpose. If no cams with a suitable time adjustment are available, an extra cam per cylinder is required. The special valve operation (not shown) is interrupted during normal operation of the engine.

Claims

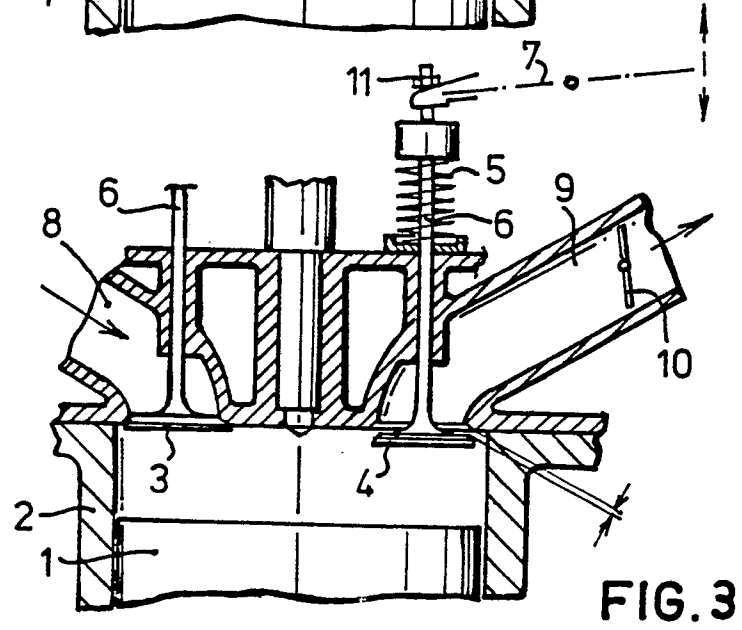
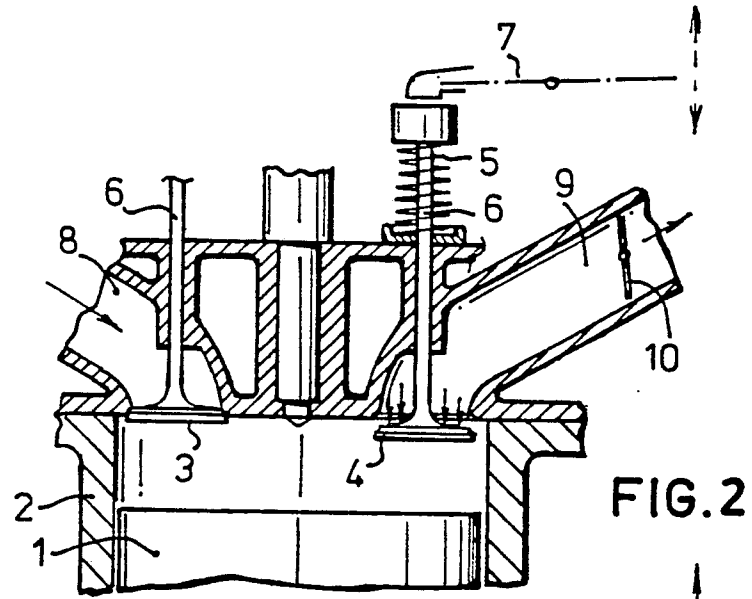
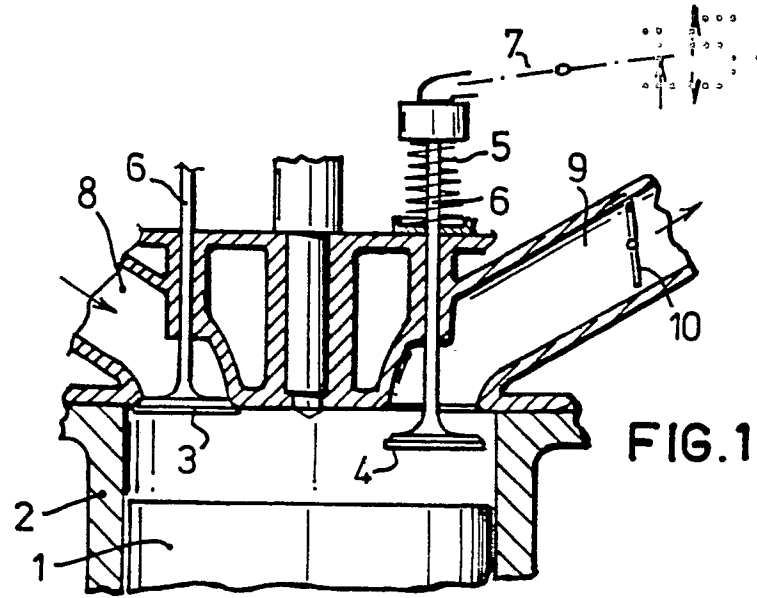
1. Internal combustion engine, comprising cylinders with pistons and inlet and exhaust valves, an exhaust system, an engine brake that is provided with means for destroying the compression energy at the end of the compression stroke, **characterized in that** the engine brake comprises means for closing a brake valve (10) in the exhaust system in order to establish a pressure increase in the cylinder (2), means for opening the exhaust valve (4) during the inlet stroke of the piston (1) synchronously to the number of revolutions per minute of the engine to such an extent that exhaust gas flows back through said cylinder exhaust valve of the exhaust system to the cylinder.

2. Internal combustion engine according to claim 1, **characterized in that** one of the means for opening the exhaust valve (4) comprises a valve rocker (7) that can be operated direct by the cam shaft or indirect through a rod system (figure 1).

3. Internal combustion engine according to claim 1, **characterized in that** opening the exhaust valve (4) is performed by means of a valve spring (5) being rigid to the extent that the valve opens spontaneously under the influence of the pressure build-up in the exhaust system (9) (figure 2).

4. Internal combustion engine according to claim 1, **characterized in that** one of the means for opening the exhaust valve (4) comprises an adjusting means for keeping the exhaust valve (4) permanently open, said adjusting means being operable by an eccentric cam mounted on the shaft of the valve rocker (7) (figure 3).

5. Internal combustion engine according to claim 4, **characterized in that** the exhaust valve (4) has negative valve clearance amounting to a few tenths of millimeters.





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DOCUMENTS CONSIDERED TO BE RELEVANT															
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)												
X	CH-A- 118 905 (F. BROZINCEVIC & CIE.) * page 2, column 1, line 18 - column 2, line 44; figures 1-8 *	1,2	F 01 L 13/06												
Y	---	3-5													
Y	DE-A-2 832 526 (MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) * page 3, line 1 - page 4, line 5; page 6, line 9 - page 8, line 33; figures 1-3 *	3-5													
A	US-A-3 234 923 (K.J. FLECK et al) * column 2, line 51 - column 3, line 54; column 4, lines 39-74; figures 2,3,5 *	1													
A	CH-A- 306 146 (A. SAURER AG) * whole document *	1													
A	DE-C- 335 332 (DEUTSCHE LAST-AUTOMOBILFABRIK A.-G.) * whole document *	1													
A	GB-A-2 162 580 (DAIMLER-BENZ AG) * whole document *	1,4,5													
The present search report has been drawn up for all claims															
Place of search BERLIN		Date of completion of the search 22-07-1988	Examiner NORDSTROEM U. L. N.												
<table border="0"><tr><td>CATEGORY OF CITED DOCUMENTS</td><td></td></tr><tr><td>X : particularly relevant if taken alone</td><td>T : theory or principle underlying the invention</td></tr><tr><td>Y : particularly relevant if combined with another document of the same category</td><td>E : earlier patent document, but published on, or after the filing date</td></tr><tr><td>A : technological background</td><td>D : document cited in the application</td></tr><tr><td>O : non-written disclosure</td><td>L : document cited for other reasons</td></tr><tr><td>P : intermediate document</td><td>& : member of the same patent family, corresponding document</td></tr></table>				CATEGORY OF CITED DOCUMENTS		X : particularly relevant if taken alone	T : theory or principle underlying the invention	Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date	A : technological background	D : document cited in the application	O : non-written disclosure	L : document cited for other reasons	P : intermediate document	& : member of the same patent family, corresponding document
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