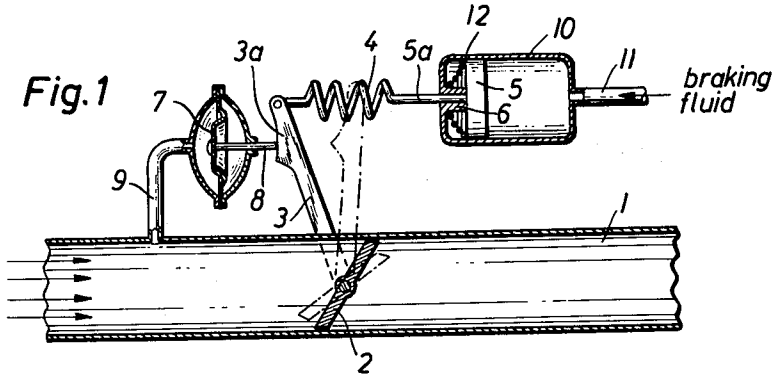
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FOUR-CYCLE INTERNAL COMBUSTION ENGINE WITH EXHAUST BRAKE

Filed Dec. 3, 1959

Fig.1



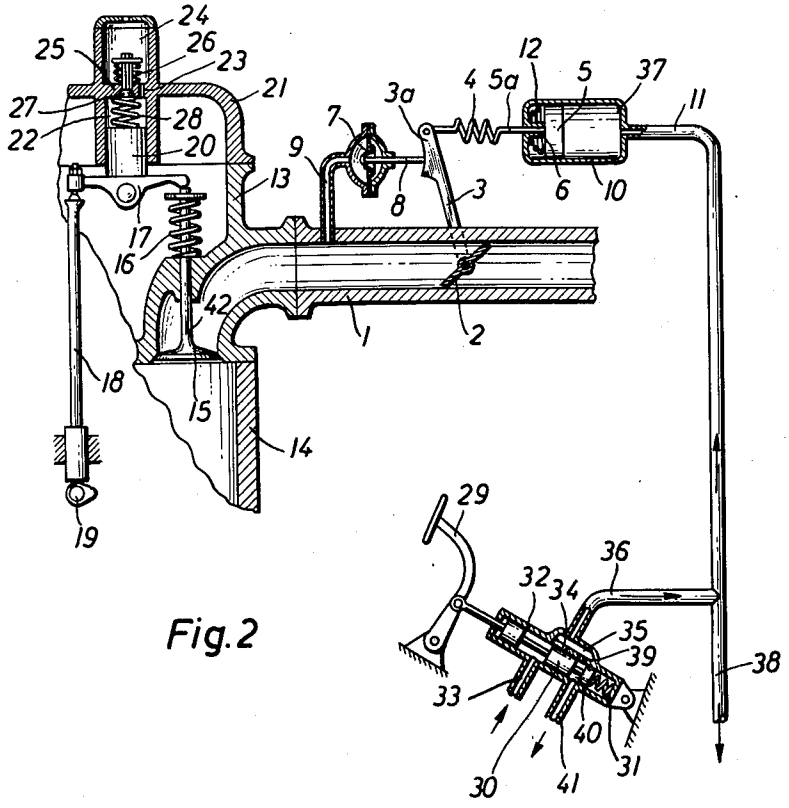


Fig.2

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FOUR-CYCLE INTERNAL COMBUSTION ENGINE WITH EXHAUST BRAKE

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The present invention relates to an internal combustion engine and, more specifically, concerns a valve-controlled four-cycle internal combustion engine with throttling means in the exhaust conduit for increasing the braking effect of the engine especially for use in connection with motor vehicles.

The invention furthermore concerns an internal combustion engine of the above mentioned type, which is provided with means for limiting the pressure head which will build up in the exhaust conduit between the brake and the engine after the exhaust brake has been made effective so that the force of the accumulated exhaust gases will tend to open the discharge valve while said last mentioned force will be less than the closing forces of the exhaust valve spring.

It is an object of the present invention to provide actuating means for the exhaust valve in the exhaust conduit, which will not be affected by pressure variations of the braking air or the braking fluid.

It is another object of this invention to provide an arrangement as set forth in the preceding paragraph, which will be rather simple and also highly effective with four-cycle internal combustion engines in which the exhaust valve control has associated therewith hydraulically operable means for compensating for valve play.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing in which:

FIG. 1 diagrammatically illustrates partly in section an exhaust brake system according to the present invention.

FIG. 2 diagrammatically illustrates the exhaust brake system according to FIG. 1 supplemented by an exhaust valve control and a control device for controlling the pressure fluid for actuating the brake system.

The exhaust brake system according to the present invention is characterized primarily in that when the exhaust valve in the exhaust conduit is in closed position during the braking operation, a spring acting upon the exhaust valve will be preloaded by means of a piston which latter is held against an abutment by the braking air or the braking fluid. In addition thereto, said spring is preloaded by piston means acting upon the exhaust valve in opening direction and acted upon by braking fluid. The arrangement is such that the closing spring, the piston means acting upon the exhaust valve in opening direction thereof, and the lever ratios of a possibly provided power transmission link system are so dimensioned or related to each other that the closing moment exerted by the preloaded spring and the opening moment depending on the exhaust pressure in the exhaust conduit will substantially equal each other at a certain higher pressure head in the exhaust conduit. The piston for preloading the spring acting upon the exhaust valve in the exhaust conduit in closing direction is so dimensioned that during the braking operation it will remain in engagement wth the abutment limiting the preload of the spring and will do so even at the lowest occurring pressure of the braking air or the braking fluid.

Referring now to the drawing in detail, the exhaust conduit of a non-illustrated four-cycle internal combustion engine is designated with the reference numeral 1, while

the throttle valve or throttle flap acting as exhaust brake has been designated with the reference numeral 2. Exhaust valve 2 is adapted to be actuated by a lever 3 the free end of which has connected thereto one end of a spring 4 tending to move the lever 3 in counterclockwise direction and thereby to move the valve 2 into closing position. The other end of spring 4 is connected to a piston rod 5a which in its turn is connected to a piston 5 reciprocably mounted in a cylinder 10 adapted through a conduit 11 to be connected to a pressure fluid supply source (not shown). As pressure fluid may be used, e.g. compressed air or oil under pressure. Between piston 5 and the left hand side (with regard to the drawing) of cylinder 10 there is arranged a spring 12 which continuously urges piston 5 to move into and normally, e.g. when no exhaust braking is intended, holds piston 5 in its right hand position so that lever 3 will be in its dot-dash position, and valve 2 will occupy its open position also indicated in dot-dash lines.

For purposes of carrying out a braking operation, braking fluid is conveyed to piston 5 so as to cause the latter to compress spring 12 and to act upon spring 4 so as to cause the latter through lever 3 to move valve 2 into closing position shown in full in the drawing. In order to preload spring 4 always by the same amount, piston 5 is so dimensioned that at even the lowest occurring braking fluid pressure, piston 5 will be moved against an abutment 6. The closing force acting upon valve or flap 2 will thus not be varied by fluctuations of the braking fluid pressure. Lever is provided with a surface 3a against which acts a pressure pin 8 which in its turn is connected to a diaphragm 7. As will be evident from the drawing, the pressure pin 8 will be able in response to diaphragm 7 bulging out toward lever 3 to move lever 3 in clockwise direction and thereby to open valve 2 Moreover, pin 8 acts upon a shorter lever arm of lever 3 than does spring 4.

That side of diaphragm 7 which faces away from lever 3 communicates through a conduit 9 with the exhaust conduit 1 so that the pressure head of the exhaust gases in conduit 1 will be able to act upon diaphragm 7. Diaphragm 7, spring 4 and the effective lever arms of lever 3 acted upon by spring 4 and pin 8 respectively are so dimensioned and related to each other that the closing moment exerted by the preloaded spring 4, and the opening moment depending on the exhaust pressure at a certain higher pressure head in the exhaust conduit 1 will substantially equal each other. If this higher pressure head is exceeded, diaphragm 7 further bends and opens and keeps open valve 2 until the pressure head has dropped to its previous value.

The present invention can also be successfully employed in connection with such four-cycle internal combustion engines in which the valve control system is provided with hydraulically operable means for compensating the valve play in a manner known per se. With such engines, the discharge valves are still kept open after the exhaust brake has been made ineffective by valve play compensating devices. Heretofore, with this type of engine, a motor operation was not possible after effected braking. This difficulty has been overcome according to the present invention by so dimensioning the actuating means for the valve that the force by means of which the exhaust gases in the exhaust conduit tend to open the exhaust outlet valve during exhaust braking operation is less than the closing thrust of the exhaust valve spring reduced by the thrust of the hydraulically operable valve compensating devices.

More specifically, the arrangement set forth in the preceding paragraph is shown in FIG. 2. As will be seen therefrom, the exhaust conduit 1 is connected to the cylinder head 13 of the cylinder 14 of an internal combustion engine. The passage of exhaust gases from cyl-

inder 14 into exhaust conduit or manifold 1 is controlled by a valve 15. This valve is preloaded by a spring 16 and is adapted to be actuated by cam shaft 19 of the engine through the intervention of a rocker arm 17 and a push rod 18. The rocker arm 17 is journalled on an extension of a piston 20 which piston is in a sealing manner vertically movably mounted in a cylindrical portion of a hood 21 mounted on cylinder head 13. Piston 20 represents a displacement piston whose cylinder 22 is filled with fluid and through a narrow throttling bore 23 communicates with a chamber 24 which is located above cylinder 22 and is partly filled with the same fluid which is contained in cylinder 22. The partition 25 separating cylinder 22 from chamber 24 and containing the throttling bore 23 has mounted therein a check valve 27 which is preloaded by a spring 26 and is adapted to open into the cylinder 22.

As will also be evident from the drawing, a pressure spring is interposed between piston 20 and partition 25 which spring continuously urges piston or plunger 20 to move in downward direction. Plunger 20 together with the elements associated therewith and with the cylinder 22 and chamber 24 operates as valve play compensating device in the following manner:

When the exhaust valve 15 occupies its closed position, the pressure spring 28 will see to it that the rocker arm 17 engages the push rod 18 and also the valve shank 42. When the valve is raised, which normally is effected very quickly, piston 20 acts as a stationary element because the fluid in cylinder 22 is unable quickly to escape through the throttling bore 23. However, if the piston should, nevertheless, have deviated in upward direction to a small extent, this deviating movement is nullified by the pressure spring 28 during the closure of the exhaust valve 15. It will be appreciated that spring 28 presses piston 20 downwardly so that check valve 27 opens and thereby immediately opens up an unthrottled passage for the liquid which was previously displaced into chamber 24 so that this liquid can pass back into cylinder 22.

With this operation it is clear that the pressure spring 28 will reduce the closing force of the exhaust valve spring 16 inasmuch as spring 28 acts counter to spring 16 and thereby forcibly brings about a reduction in the maximum pressure head in exhaust pipe 1 ahead of the throttle 2. This fact is naturally to be taken into consideration when dimensioning the mechanism described above for controlling throttle 2.

The pressure fluid employed for actuating the brake mechanism is controlled by a piston 30 operable by a foot pedal 29 against the thrust of a spring 31. The pressure fluid passes through conduit 33 into the cylinder 32 of piston 30. When pedal 29 is depressed, that side of piston 30 which faces pedal 29 releases a passage 34 in cylinder 32 so that pressure fluid through conduit 33 passes into a lateral chamber 35 of a cylinder 32 and from there passes through passage 36 on one hand into cylinder 37 of the actuating piston 5 for the exhaust brake, and on the other hand passes through a branch line 38 to the brake cylinders associated with the wheels of the vehicle. After chamber 35 is thus in communication with the conduit 33, chamber 35 will for a short period of time communicate with a relief valve conduit 41 through a throttling bore 39 and an annular passage 40 in piston or valve spool 30. When the pedal 29 is further depressed, piston or valve spool 30 closes the throttling bore 39. The said throttling bore 39 has the purpose that when depressing pedal 29, the fluid in conduit 36 is placed under pressure only to such an extent that the throttle valve 2 in exhaust conduit 1 will close, whereas the wheel brakes are made effective only slightly. With increasing closing of the bore 39, the pressure increases to such an extent that also the effectiveness of the wheel brakes will be increased.

It is, of course, to be understood that the present invention is, by no means, limited to the particular construction shown in the drawing but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. An exhaust brake system for a four-stroke cycle internal combustion engine having an exhaust conduit: brake valve means mounted in said exhaust conduit and movable in a closing direction and in an opening direction, first spring means operatively connected to said brake valve means for actuating the same, fluid operable cylinder piston means arranged for connection with a source of fluid pressure, said cylinder piston means being movable selectively from a first position to a second position and vice versa, second spring means associated with said cylinder piston means and continuously urging said cylinder piston means to and normally holding the same in said first position, said cylinder piston means being operatively connected to said first spring means and being operable in response to a desired minimum braking fluid pressure acting upon said cylinder piston means to move to said second position to thereby pre-load said first spring means against the thrust of said second spring means for closing said brake valve means, abutment means connected to a part of said cylinder piston means for determining said second position, and fluid pressure responsive means communicating with said exhaust conduit and operatively connected to said brake valve means and adapted to move the same in opening direction in response to a certain pressure head built up in said conduit, the adjusting forces exerted upon said valve means on one hand by said first spring means in said preloaded condition and on the other hand by said fluid pressure responsive means balancing each other just below said certain pressure head.

2. An exhaust brake system for a four-stroke cycle internal combustion engine having an exhaust conduit: brake valve means mounted in said exhaust conduit and movable in a closing direction and in an opening direction, a cylinder arranged for connection with a source of fluid pressure, a piston reciprocably mounted in said cylinder and movable from a first position into a second position and vice versa, abutment means connected to said cylinder for abutment with said piston at the end of the movement of the latter to said second position, first spring means interposed between said piston and said cylinder and continuously urging said piston to and normally holding the same in said first position, second spring means, connecting rod means having one end connected to said piston and having the other end connected to one end of said second spring means, lever means having one end pivotally connected to the other end of said second spring means and having its other end connected to said brake valve means for actuating the latter, diaphragm means, rod means connected to said diaphragm means and operable to engage said lever means at a point located between the ends of said lever means but closer to the pivotal connecting point of said lever means to said second spring means than to the connecting point of said lever means with said brake valve means, and conduit means establishing communication between that side of said diaphragm means which faces away from said lever means and said exhaust conduit at a point ahead of said brake valve means when looking in the direction of flow of the exhaust gases to said brake valve means, said diaphragm means being adapted to actuate said lever means in response to a certain pressure head built up in said exhaust conduit, the adjusting forces exerted upon said valve means on one hand by said first spring means when said piston is in its second position and on the other hand by said diaphragm means balancing each other just below said certain pressure head.

3. An exhaust brake system according to claim 1, which includes an exhaust outlet valve governing the passage of exhaust gases from said engine into said exhaust conduit, said exhaust outlet valve normally occupying a

closed position but movable from said normally closed position into an open position for permitting the passage of exhaust gases from said engine into said exhaust conduit, exhaust valve spring means associated with said exhaust outlet valve and continuously urging the same into and normally holding said exhaust outlet valve in its closed position, actuating means operatively connected with said exhaust outlet valve and operable to open the latter against the thrust of said exhaust valve spring means, plunger means provided with an extension pivotally supporting said actuating means and operable to move said actuating means toward said exhaust outlet valve, a fluid receiving cylinder having said plunger means reciprocably mounted therein, an auxiliary partly fluid filled container communicating with said cylinder through a throttling bore, auxiliary spring means provided in said cylinder and continuously urging said actuating means toward said exhaust outlet valve, and check valve means interposed between said auxiliary container

and said cylinder and adapted to move from a normally closed position into an open position to effect additional fluid comminication between said auxiliary container and said cylinder for permitting quick passage of fluid from said auxiliary container into said cylinder, the pressure head in said exhaust conduit being so limited that the force by means of which the exhaust gases in said exhaust conduit tend to open said exhaust outlet valve during an exhaust braking operation is less than the closing thrust of said exhaust valve spring means reduced by the thrust of said auxiliary spring means.

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