Oct. 9, 1962 E. HATZ, JR 3,057,336

DECOMPRESSION DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed March 15, 1961 2 Sheets-Sheet 1

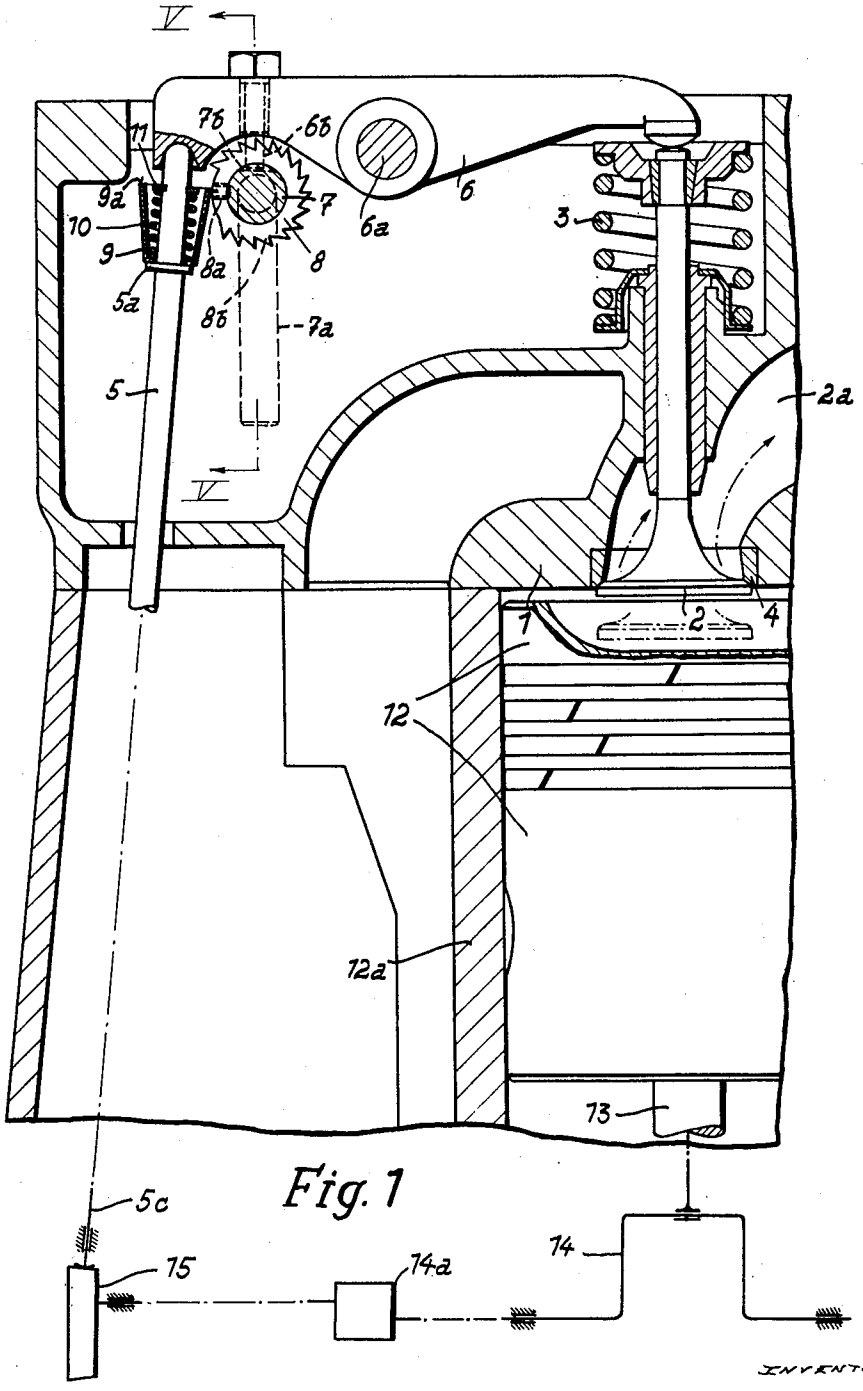


Fig. 1

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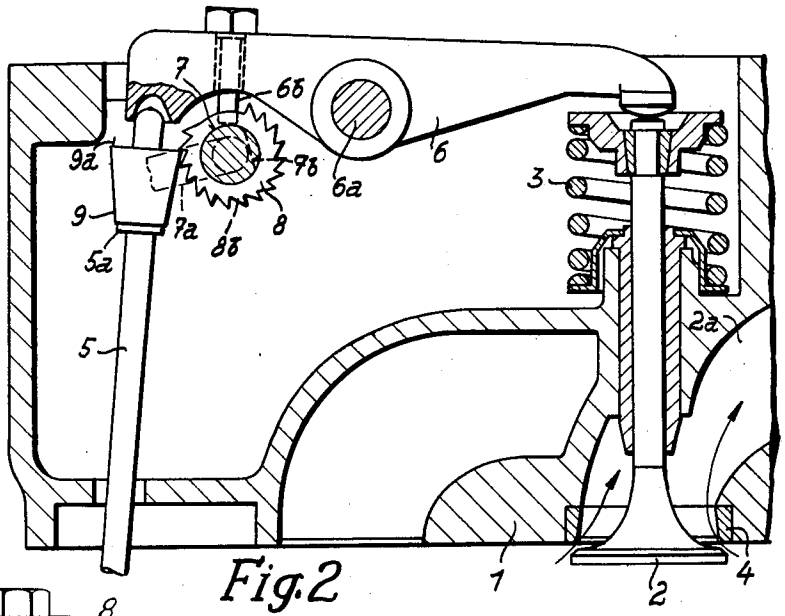


Fig.2

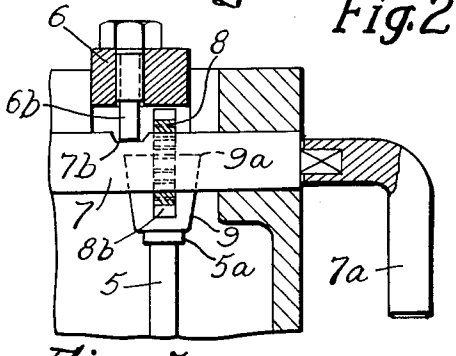


Fig. 5

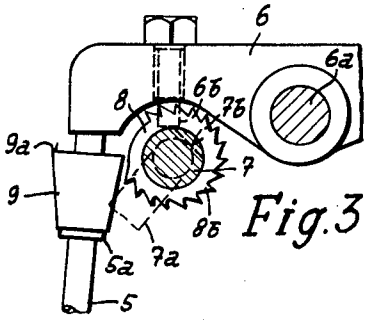


Fig.3

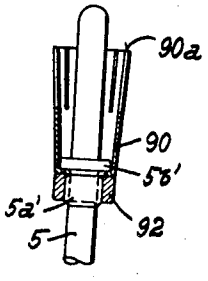


Fig.4

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3,057,336
Patented Oct. 9, 1962

3,057,336
DECOMPRESSION DEVICE FOR INTERNAL COMBUSTION ENGINES

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Filed Mar. 15, 1961, Ser. No. 95,996
Claims priority, application Germany Oct. 6, 1960
11 Claims. (Cl. 123—182)

This invention relates to decompression devices for assisting in the starting of valve controlled internal combustion engines.

In this connection the invention is primarily applicable to an injection combustion, i.e. compression ignition, engine equipped with a decompression device of the kind comprising a decompression cam, arranged to act on a valve rocker actuated by an axially reciprocable push rod, such cam being adapted to be rotated in a direction to discontinue the decompression, either manually, or by automatic means consisting of a driving disc which is connected to the said cam and a driver co-operating therewith. In such an arrangement each upward stroke of the push rod so actuates the rocker as to open the valve, whereas at each downward stroke of the said rod the valve is normally permitted to close.

In a known decompression device of this character the driver is driven directly by teeth provided on a valve rocker, with the result that the complete decompression assembly must be arranged above this rocker. This, however, is a disadvantage because it considerably increases the space required by the device and hence also the overall dimensions of the engine.

In another known form of decompression device, a leaf spring is connected to the rocker and acts on a driving disc arranged above the latter. It has been found, however, that this form of drive for the decompression cam strains the spring and results in poor power transmission characteristics.

The object of the present invention is to obviate the disadvantages of these known constructions and to provide a simple, compact and particularly efficient improved form of decompression device of the kind herein referred to.

According to this invention, a decompression device of the kind specified is characterized in that the driver is in the form of a member which is provided on the axially reciprocable push rod, said member being of circular form in transverse cross-section and having a peripheral edge which engages with and turns the driving disc during valve opening strokes of the push rod, the said member or a portion thereof moving idly aside radially in relation to the driving disc during valve closing strokes of the said rod.

In a preferred embodiment of the invention the driver is in the form of a cup-shaped sleeve which surrounds the push rod and is resiliently biased against a collar on this rod. Alternatively, however, the driver may be in the form of a cup-shaped sleeve which surrounds the push rod and is firmly connected thereto, this sleeve being axially slit partially along its length suchwise as to provide around the circular periphery a plurality of resilient tongues each capable of engaging with the driving disc.

In order that the invention may be more clearly understood and readily carried into practical effect, specific constructional examples thereof will now be described with reference to the accompanying drawing, wherein,

FIGURE 1 is a vertical cross sectional view of so much of an internal combustion engine as is necessary to illustrate the application thereto of one form of the decompression device provided in accordance with the invention,

FIGURES 2 and 3 show, in two different operative positions, part of the device illustrated in FIGURE 1,

FIGURE 4 depicts, in detail, a modification of this device, and

FIGURE 5 is a view of section V—V taken on FIG. 1.

In FIGURE 1 the reference numeral **2** indicates an exhaust valve of an injection combustion engine of known form. This valve is arranged within a valve housing **1** and is pressed upwardly against its seat **4** under the influence of a closure spring **3**. A push rod **5**, adapted to be moved up and down by an operating means (not shown), engages a double armed rocker **6** which is fulcrumed at *6a* in the housing **1**, thereby effecting and controlling the opening and closing of the valve. Thus, when the push rod **5** moves upwards the valve **2** is opened, whilst the latter closes under the influence of its spring **3**, in response to the descent of push rod **5**.

To facilitate hand cranking of the engine during starting, the valve is prevented from complete closure by means of a decompression device by means of which the development of a compression in the operating chamber of the engine to such an extent that it will make the cranking unduly difficult is also prevented. In the illustrated example, the decompression device consists of a rotatable decompression spindle **7** which is mounted beneath the rocker **6** and extends at right angles thereto. This spindle **7** has a tapered end which projects from the valve housing **1** and is furnished with a setting lever *7a*. The said spindle, moreover, is flattened by a milled-out portion *7b* below the rocker **6**. Thus, the portion of the rotatable spindle which is flattened at one side thereof is in the nature of, and will be regarded as, a cam. Mounted in the lever **6**, directly above this milled-out portion, is a set screw *6b* which constitutes a decompression abutment. If the decompression spindle **7** is so turned and set by lever *7a* that the milled-out portion *7b* is located beneath the set screw *6b* (FIGURE 1), the rocker **6** can move without obstruction in the counter clockwise direction to permit of complete closure of the valve **2**. As will be apparent from FIGURE 1, the internal combustion engine operates on a conventional 4-stroke cycle, viz. (1) suction, (2) compression, (3) expansion and (4) exhaust. Thus, in FIGURE 1 the piston **12** is shown in full lines at its upper dead central position, i.e. the position it takes up at the commencement of a suction stroke or at the end of a compression stroke. The open position of the exhaust valve **2** which it assumes during the exhaust stroke of the piston is indicated in chain lines. During each such exhaust stroke, combustion products escape from the cylinder *12a* into the exhaust conduit *2a*, i.e. in the direction indicated by the chain line arrows. If, on the other hand, the decompression spindle **7** is turned so that a cylindrical part of its periphery is opposed to the set screw *6b* (FIGURE 2 or FIGURE 3), the said screw will then strike the spindle **7** during a movement of the rocker **6** in a counter clockwise direction so that the valve **2** cannot entirely close. FIGURE 2 illustrates the positions of the parts during starting of the engine. As will be seen, the exhaust valve **2** is prevented from closing entirely, so that during a compression stroke of the piston **12** the fuel-air mixture escapes, past the partially open exhaust valve and in the direction indicated by the full line arrows, into the exhaust conduit *2a*. Consequently, there is no compression on starting.

If an operator has brought this decompression device into its operative position to prevent complete closure of the valve **2** prior to the starting of the engine, the device must be rendered inoperative again to permit the valve to close as soon as the fly wheel has achieved the rotational rate required for starting. For this purpose the operator has heretofore had to return the setting lever *7a* by hand to the condition illustrated in FIGURE 1. This manual movement is, however, very troublesome in the case of large engines because, having regard to the

internal friction in the engine, particularly under cold conditions, the cranking handle has to be turned with both hands.

To avoid this troublesome manual re-setting of the lever 7*a* after starting, which is also a frequent cause of accidents, we also provide in accordance with the present invention, an automatic cut-out device for the decompression system. The construction of such cut-out device will now be described. Secured on the decompression spindle 7 by a screw 8*a*, alongside the milled-out portion 7*b*, is a driving disc 8. A collar 5*a* is provided on the push rod 5 and an annular bottom of a cup-shaped sleeve 9, functioning as a driver, is pressed down by a compression spring 10 upon this collar. The upper end of this spring, which surrounds the push rod 5, bears against a spring ring 11 seated in a groove in the push rod. It is convenient to mention here that the piston 12, which is reciprocable in the cylinder 12*a*, is coupled in the conventional manner to a connecting rod 13 which drives the crankshaft 14. In turn, this crankshaft drives, through suitable gearing at 14*a*, a control cam 15 adapted to move up and down a mushroom-headed plunger 5*c*. The purpose of the plunger 5*c* is to act on and move the push rod 5 in the manner previously explained herein. For simplicity in FIGURE 1, the parts 5*c*, 13, 14, 14*a* and 15 are shown in purely diagrammatic fashion.

When the engine is running or is stopped, the decompression device is in the inoperative condition illustrated in FIGURE 1. That is to say, the set screw 6*b* projects with play into the milled-out portion 7*b*, and an untoothed portion of the disc 8 is disposed opposite to the rim 9*a* of the sleeve 9. Thus, the valve 2 is completely closed and the sleeve 9 moves idly up and down relatively to the stationary disc 8. But if, on the other hand, a stopped engine is to be started with the help of the decompression device and the latter is to be automatically cut-out again after starting, the adjusting lever 7*a* is then first turned from the inoperative position illustrated in FIGURE 1, in the clockwise direction, until the rim 9*a* engages the driving teeth 8*b* on the disc 8. As a consequence of upward movement of the push rod 5 on cranking the engine, the disc 8 is turned through one toothed division in the clockwise direction (as viewed in the drawing), whilst the disc remains stationary during the downward movement of the push rod 5. During such downward movement of the push rod the upper part of the sleeve 9, sliding idly over a tooth 8*b* is pushed away radially against the action of the spring 10 so as to rock about the fulcrum 5*a*, being later brought back into its axially parallel position under the spring action when the rim 9*a* thereof drops behind the next tooth 8*b*. This procedure is repeated until the rim 9*a* takes up a position behind the last tooth 8*b*, this coinciding with the relocation of the milled-out portion 7*b* beneath the set screw 6*b* and the consequent termination of the decompression.

Thus, the duration of the decompression, that is to say the time during which the valve is prevented from fully closing, is freely at the discretion of the operator. If the operator sets the driving disc 8 in such a way, before the commencement of the starting operation, that the rim 9*a*—see FIGURE 2—engages behind the first or second driving tooth 8*b* of the disc 8, the decompression period lasts longer; that is to say, the driving disc 8 will not be completely rotated and the decompression will not be terminated until after a number of strokes of the push rod 5. On the other hand, the further the driving disc 8 is turned forward in the clockwise direction relatively to the rim 9*a*, the shorter will be the decompression period. It is to be clearly understood that even when there is provided an automatic cut out means for the decompression, which can be set to a chosen period, provision may nevertheless also be made for a manual cut-out. For this purpose only the operative position of the decompression spindle 7 has to be adjusted (see FIGURE 3), the set screw 6*b* bearing against the periphery of the spindle 7 and preventing closure of the valve 2, whereas the rim 9*a* of the sleeve 9 is disposed away from the toothed part of the driving disc 8. In this case a condition of so-called permanent decompression is set up and this lasts until the operator moves back the adjusting lever 7*a* by hand in a counter clockwise direction from the position shown in FIGURE 3 to that shown in FIGURE 1. It is also to be noted that at least the primary positions of the decompression device, for example the rest position according to FIGURE 1 and the permanent decompression position of FIGURE 3, can be determined by a sensitive catch mechanism, for example by a spring loaded ball catch associated with the decompression spindle. Moreover, if particular operating circumstances require it, a catch means, for example a pawl and ratchet arrangement, can additionally be used to permit rotary motion of the spindle 7 and of the disc 8 in the clockwise direction only. This will prevent the lever 7*a* and the disc 8 from being accidentally moved in the counter clockwise direction during the setting operation, as a result of which the movement of the rim 9*a* of the driving sleeve 9 might be impaired by the teeth 8*b*.

It is also pointed out that the restoring power of the spring 10, the width of the support collar 5*a* and the taper of the sleeve 9 should be so interrelated that the sleeve 9 cannot rock during the upward movement of the push rod 5 and will as a consequence positively entrain the disc 8.

FIGURE 4 illustrates another constructional form of driving means provided on the push rod 5. Here again, these driving means take the form of a cup-shaped sleeve 90 which surrounds the push rod 5 and is drawn up tightly against a collar 5*b'* on the push rod by a nut 92 which is screwed on to a screw threaded part 5*a'* of the said push rod. The periphery of the sleeve 90 is slotted to a suitable depth at a number of locations therearound so that the rim 90*a* of any one of the tongues thereby formed is stiff enough to engage with the teeth on and turn the driving disc 8 in response to upward movement of the push rod 5, whereas during the downward stroke of the latter this tongue is able to be deflected radially inwards against the spring influence so as to slide idly over the teeth 8*b* of disc 8. In this construction, as in the preceding arrangement, the push rod 5 rotates unintentionally about its longitudinal axis although this capability of rotation does not in any way interfere with the proper functioning of the device. The reason why the push rod 5 tends to rotate is that, in practice, the mushroom-headed plunger 5*c* is displaced to a small extent laterally in relation to the cam 15 and hence also to the longitudinal axis of the said push rod. In other respects, this decompression device is operated in the same way as the construction first described above.

The cost of constructing and installing the automatic cut out means in a decompression device according to this invention is very small. The said means comprise only a small number of additional parts which can very easily be mass produced as turnings, stampings or pressings. Finally, it is to be additionally pointed out that the space taken up by the parts is very small and that therefore the cut out device can be installed without difficulties in any type of engine, and may even be readily incorporated in an existing engine.

I claim:

1. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, a closure spring arranged normally to press said valve against said seat, a valve rocker fulcrumed in the valve housing and arranged for action upon the exhaust valve to effect and control opening and closing thereof, a push rod for actuating the valve rocker, means for axially reciprocating

said rod, a decompression cam which is arranged for action on the valve rocker suchwise as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being rotatable in a direction to discontinue the decompression, a driving disc connected to said cam, and a driver which is provided on the axially reciprocable push rod, said driver consisting of a member of circular form in transverse cross-section and having a peripheral edge which engages with and turns the driving disc in the aforementioned direction during valve opening strokes of the push rod, at least a portion of the driver moving idly aside radially in relation to the driving disc during valve closing strokes of said push rod.

2. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, means to urge said valve against said seat, a valve-actuating member, a push rod for operating said member, means displacing said rod, a decompression cam which, when operative, so influences the valve-actuating member as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being movable in a sense to discontinue the decompression, a driving element associated with said cam, and a driver which is provided on the push rod, said driver being adapted to engage and move the driving element in the aforesaid sense during valve opening displacements of the push rod, at least a portion of the driver moving idly aside relatively to the driving element during valve closing displacements of said push rod.

3. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, a closure spring arranged normally to press said valve against said seat, a valve rocker fulcrumed in the valve housing and arranged for action upon the exhaust valve to effect and control opening and closing thereof, a push rod for actuating the valve rocker, means for axially reciprocating said rod, a decompression cam which is arranged for action on the valve rocker suchwise as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being rotatable in a direction to discontinue the decompression, a driving disc connected to said cam, a collar on the axially reciprocable push rod, an abutment on said rod spaced axially from said collar, a driver in the form of a cup-shaped sleeve of circular cross-section which surrounds the push rod and rests on the collar, and a compression spring which surrounds the said rod and is interposed between the abutment and the bottom of the cup-shaped sleeve to resiliently bias the latter against the collar, the circular rim of the said sleeve being adapted to engage and turn the driving disc in the direction to discontinue decompression during valve opening strokes of the push rod and the sleeve moving idly aside radially in relation to the driving disc during valve closing strokes of said push rod.

4. A combination according to claim 3, wherein the cup-shaped sleeve is downwardly tapered and its circular rim is engageable with teeth on the driving disc.

5. A combination according to claim 3, wherein the abutment on the push rod is in the form of a ring seated in a groove in the said rod.

6. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, a closure spring arranged normally to press said valve against said seat, a valve rocker fulcrumed in the valve housing and arranged for action upon the exhaust valve to effect and control opening and closing thereof, a push rod for actuating the valve rocker, this rod being rotatable about its axis, means for axially reciprocating said rod, a decompression cam

which is arranged for action on the valve rocker suchwise as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being rotatable in a direction to discontinue the decompression, a driving disc connected to said cam, and a driver in the form of a cup-shaped sleeve of circular cross-section which surrounds the push rod and is rigidly connected thereto, said sleeve being axially slit partially along its length suchwise as to provide around its periphery a plurality of resilient tongues each capable of engaging and turning the driving disc in the direction to discontinue decompression during valve opening strokes of the push rod and of being pressed idly aside radially in relation to the driving disc during valve closing strokes of said push rod.

7. A combination according to claim 6, wherein the cup-shaped sleeve is drawn up tightly against a collar on the push rod by means of a nut screwed on to a screw-threaded part of the said rod.

8. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, a closure spring arranged normally to press said valve against said seat, a valve rocker fulcrumed in the valve housing and arranged for action upon the exhaust valve to effect and control opening and closing thereof, a push rod for actuating the valve rocker, means for axially reciprocating said rod, a decompression cam in the form of a turnable spindle having a flattened side, an abutment on the valve rocker for engagement with the periphery of said spindle, the arrangement being such that with the spindle turned to present the flattened side to the abutment the exhaust valve is permitted to close fully to discontinue decompression whereas when the spindle is turned to present a normally rounded portion of its periphery to the said abutment the said valve will be prevented from complete closure to produce such a condition of decompression, a driving disc rigidly connected to said spindle, and a driver which is provided on the axially reciprocable push rod, said driver consisting of a member of circular form in transverse cross-section and having a peripheral edge which engages with and turns the driving disc in the aforementioned direction during valve opening strokes of the push rod, at least a portion of the driver moving idly aside radially in relation to the driving disc during valve closing strokes of said push rod.

9. A combination according to claim 8, wherein the spindle is furnished with a lever whereby said spindle can be initially set to determine the length of the decompression period during starting of the engine.

10. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, means to urge said valve against said seat, a valve-actuating member, a push rod for operating said member, means displacing said rod, a decompression cam which, when operative, so influences the valve-actuating member as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being movable in a sense to discontinue the decompression, a driving element associated with said cam, a collar on the displaceable push rod, an abutment on said rod spaced axially from said collar, a driver in the form of a cup-shaped sleeve of circular cross-section which surrounds the push rod and rests on the collar, and a compression spring which surrounds the said rod and is interposed between the abutment and the bottom of the cup-shaped sleeve to resiliently bias the latter against the collar, the circular rim of the said sleeve being adapted to engage and move the driving element in the aforesaid sense during valve opening displacements of the push rod, at least a portion of the driver moving idling aside relatively to the driving element during valve closing displacements of said push rod.

11. In a valve controlled internal combustion engine, in combination, a cylinder, a valve housing which adjoins said cylinder and has formed therein an exhaust conduit, a valve seat at the entrance to said conduit, an exhaust valve mounted within said housing, means to urge said valve against said seat, a valve-actuating member, a push rod for operating said member, means displacing said rod, a decompression cam which when operative, so influences the valve-actuating member as to hold the exhaust valve off its seat and so produce a condition of decompression, said cam being movable in a sense to discontinue the decompression, a driving element associated with said cam, and a driver in the form of a cup-shaped sleeve of circular cross-section which surrounds the push rod and is rigidly connected thereto, said sleeve being axially slit partially along its length suchwise as to provide around its periphery a plurality of resilient tongues each capable of engaging and moving the driving element in the sense to discontinue decompression during valve opening displacements of the push rod and of being pressed idly aside radially in relation to the driving element during valve closing displacements of the push rod.

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