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3,247,835

COMPRESSION RELEASE FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 8, 1964

2 Sheets-Sheet 1

FIG 1

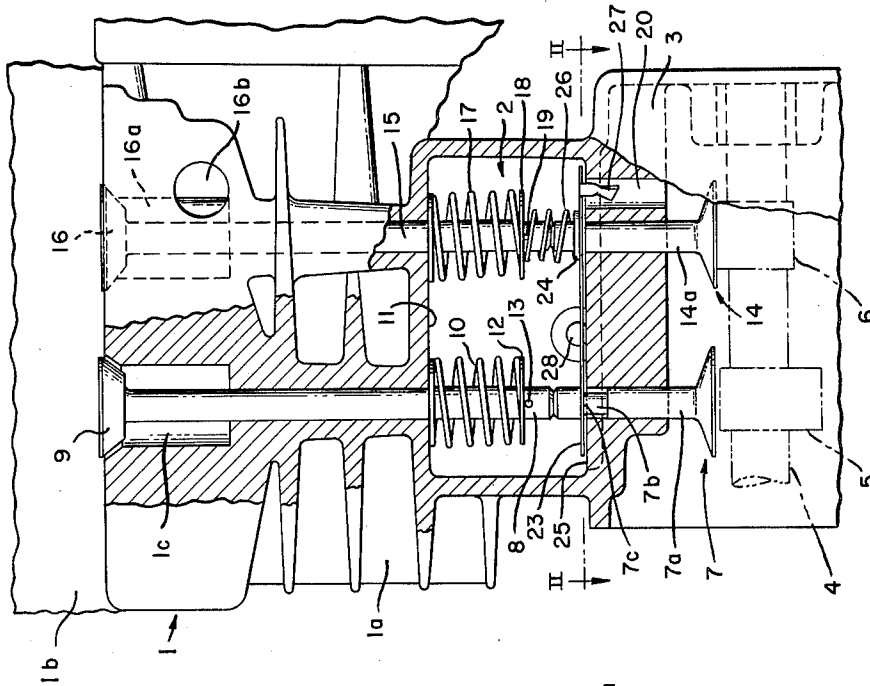


FIG 2

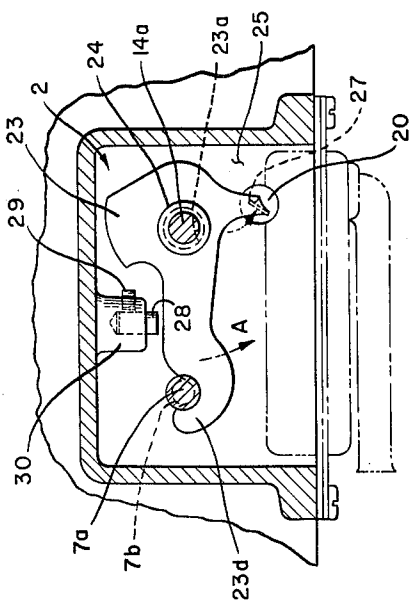
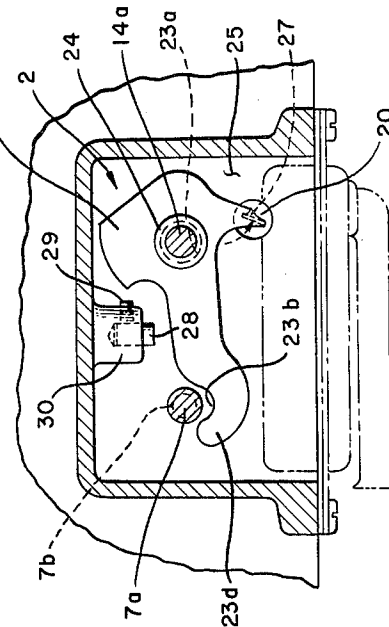


FIG 3



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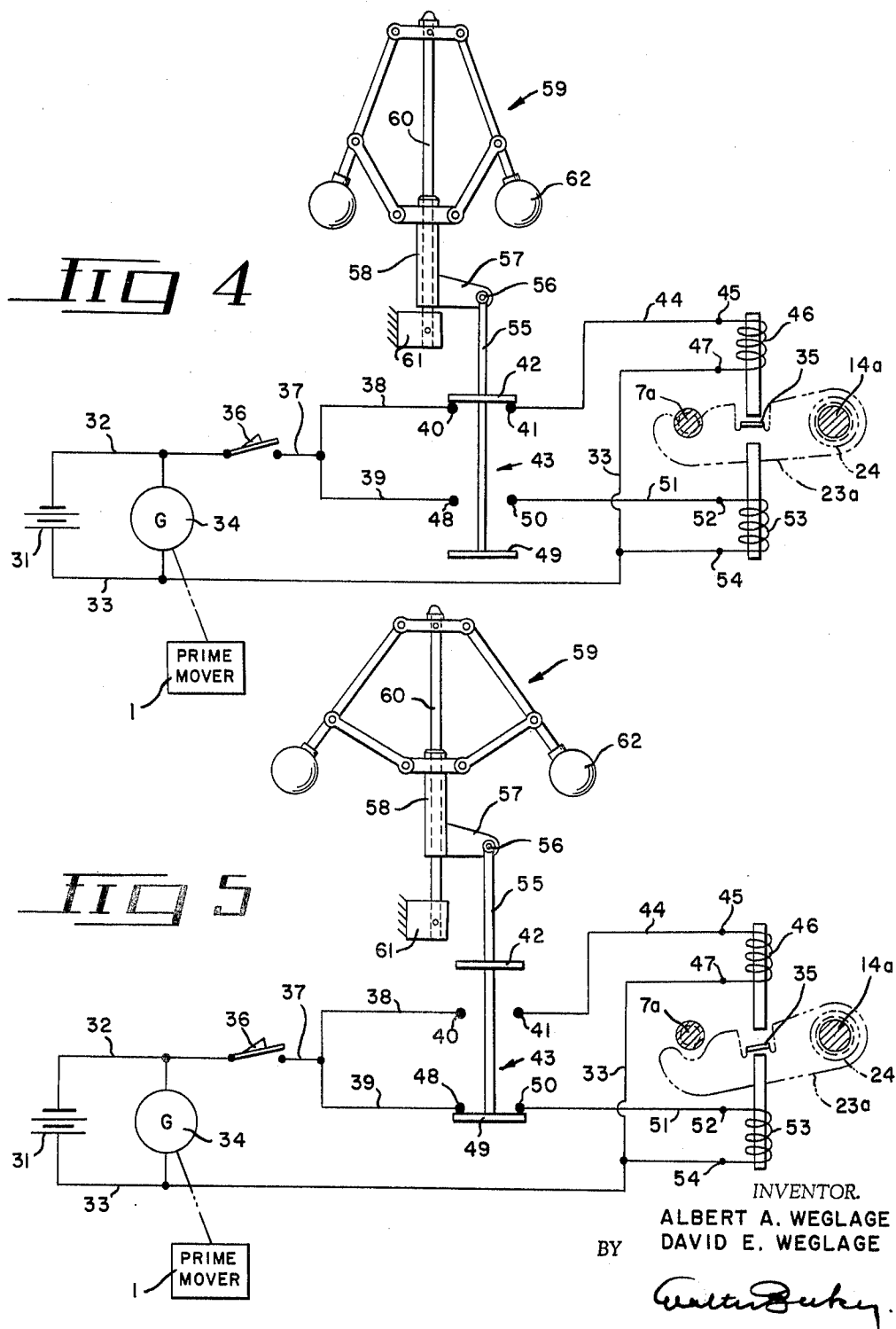
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COMPRESSION RELEASE FOR INTERNAL COMBUSTION ENGINES

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3 Claims. (Cl. 123-182)

The present invention relates to internal combustion engines, and, more particularly, concerns a compression release for facilitating the starting of such engines.

In our copending application Ser. No. 299,602, filed August 2, 1963, there has been described a compression release for facilitating the starting of internal combustion engines.

It is an object of the present invention to provide further compression release means for internal combustion engines having an inlet valve and an outlet valve, the function of which will be independent of any gravity effect.

It is also an object of this invention to provide a compression release means for internal combustion engines having a reciprocable valve member, which are particularly simple and effective and adapt themselves equally well for horizontal as well as upright engines.

It is a further object of this invention to provide compression release means as set forth above, which are fully automatic and independent of a source of air under pressure.

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

FIGURE 1 is a partial section through a portion of a cylinder block and the cam shaft containing housing of a four-stroke cycle internal combustion engine with upright cylinders and valve members, and showing the inlet valve in closed position and the outlet valve held partially open by a compression release mechanism according to the present invention;

FIGURES 2 and 3 represent sections taken along the line II-II of FIGURE 1 but respectively shown in different positions;

FIGURES 4 and 5 diagrammatically illustrate a modified compression release mechanism according to the present invention, which differs from the compression release mechanism of FIGS. 1 to 3 primarily in that it is totally independent of the supply of air pressure.

General arrangement

The compression release mechanism according to the present invention is particularly suitable for internal combustion engines in which cam shaft operable cam means actuate lifting members, which in turn operate the valve stems of the inlet and outlet valves.

The compression release mechanism according to the present invention, which is automatically effective when initiating the starting of the respective engine and automatically becomes ineffective when the engine has been started, comprises lever means which, during the starting phase, engage one of the lifter members and, through the latter, prevent the respective valve controlled thereby from seating while, when the engine has started said lever means, automatically disengages the respective lifter member and engages the latter again only when the engine speed is such that the engine will come to a standstill.

The compression release mechanism according to the present invention is characterized primarily in that magnetic means are provided for positively causing said lever means to engage said lifter member when the speed of the engine has dropped below its idling speed. Accord-

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ing to one embodiment of the present invention, the lever means is disengaged from the lifting member by air conveyed from the crank case to the spring chamber. According to another modification of the present invention, the lever means is disengaged from the lifting member by magnetic means. In the last-mentioned instance, electromagnet means may be employed the effectiveness of which will be speed responsive, i.e., responsive to the speed condition of the engine.

Structural arrangement

Referring now to the drawings in detail and FIGS. 1 to 3 thereof in particular, the arrangement shown therein comprises a cylinder block 1 with a cylinder 1a (a portion thereof only being shown). Mounted on cylinder block 1, in customary manner, is a cylinder head 1b. Cylinder block 1 comprises a spring chamber 2 which has connected thereto a housing or crank case 3. Journalled in said housing 3 is a cam shaft 4 which is drivingly connected to the crank shaft (not shown) of the engine, in a manner customary with such engines and disclosed, for instance, in U.S. Patent 2,999,491. In customary manner, cam shaft 4 is provided with a first cam 5 and a second cam 6. Cam 5 normally, i.e., during the ordinary driving operation of the engine, is in continuous engagement with a lifter 7 having a lifter shank 7a which in its turn engages the stem 8 of the exhaust valve 9 controlling the connection of the engine cylinder with an exhaust port (not shown) through a passage 1c.

As will be seen from FIG. 1, that portion of valve stem 8 which extends into spring chamber 2 is surrounded by a valve spring 10 having one end resting against the spring wall chamber 11. The other end of spring 10 rests against a spring keeper 12 holding spring 10 under preload and being held in its position on one hand by a pin 13 extending through stem 8, and on the other hand by said spring 10. As will be evident from the above, spring 10 continuously urges valve 9 into its closing position.

Cylinder block 1 furthermore, in customary manner, comprises a lifter 14 controlled by cam 6 on cam shaft 4. Lifter 14 through its shank 14a and through valve shank 15 controls inlet valve 16, which latter controls a passage 16a communicating with a fuel supply passage 16b. Similar to the outlet valve 9, also the inlet valve 16, likewise located within spring chamber 2, is provided with a spring 17, a spring keeper 18, and a pin 19 holding spring 17 under pre-load, said spring 17 continuously urging inlet valve 16 into closing position.

In conformity with the standard design of four-stroke cycle internal combustion engines, the spring chamber 2 communicates with the interior of the housing or crank case 3 through a passage 20 through which air customarily pumped into the crank case 3 by the reciprocating movement of the engine piston, is pumped into spring chamber 2.

While the diameter of said passage may vary with various designs, in conformity with the requirement for releasing the pumped air from the crankcase, merely by way of example, it has been found that with a piston diameter of 2 1/8" in a one-cylinder engine, a passage diameter of 3/8" has proved highly successful in connection with the present invention.

From said spring chamber 2, likewise in a well-known manner, the air is released into the atmosphere through a standard breather which may, for instance, be of the type described in our copending application Ser. No. 299,602, of August 2, 1963, and shown in FIGS. 3, 4 and 12 thereof.

As will also be seen from the drawings, and particularly FIG. 1 thereof, the lifter shank 7a is provided with

a reduced diameter section 7b thereby creating a collar surface 7c adapted to be engaged and disengaged by a compression release control lever 23. The length of said reduced diameter section 7b is in excess of the maximum possible stroke of the valve 9 plus the thickness of the compression release control lever 23. This compression release control lever 23, henceforth briefly called "control lever" is substantially of the same type as the control lever 23 of our above-mentioned copending application Ser. No. 299,602, filed August 2, 1963.

More specifically, control lever 23 is provided with a bore 23a by means of which it is tiltably journaled about lifter shank 14a of lifter 14. Preferably, control lever 23 is not directly journaled on lifter shank 14a but instead is journaled on ring member 24 in the manner described in our above-mentioned copending application Ser. No. 299,602, filed August 2, 1963, especially with regard to FIGS. 9 and 10 thereof. This ring member 24 is slipped over lifter shank 14a and has a neck extending through bore 23a of control lever 23. The length of said neck is slightly longer, for instance, by about 0.15" than the thickness of the control lever 23, so that control lever 23 can freely swing about the outer peripheral surface of said neck. In order to hold ring member 24 against the adjacent wall 25 of crank case 3, there is provided a relatively weak spring 26 one end of which rests against ring member 24 whereas the other end of spring 26 rests against spring keeper 18. In order to reduce the friction of control lever 23 with the adjacent wall 25 to a minimum, the control lever may, if desired, be provided with slight indentations, as likewise described in our above-mentioned copending application Ser. No. 299,602.

Lever 23 is provided with a fin 27 of a design as described in our copending application Ser. No. 299,602. This fin extends into the passage 20 (FIG. 1) in such a way that the air pumped through the passage 20 will impinge upon said fin 27 in such a direction as to swing lever portion 23d away from the respective lifter member, in this instance lifter shank 7a, so that the control lever 23 will move in the direction of the arrow A, i.e. from its FIG. 2 to its FIG. 3 position. In this way, the neck portion 7b of the lifter shank 7a is disengaged by control lever 23, and is moved out of the range of the collar surface 7c. Fin 27 is twisted in a somewhat propeller-like manner, preferably in such a way that when the engine is running normally, the fin occupies a position in which it subdivides the adjacent mouth of passage 2 into approximately two equal sections. This prevents control lever 23 from fluttering.

That portion of control lever 23 which is adapted to engage and disengage neck portion 7b of lifter 7 has a corresponding cutout 23b (see FIG. 3) so as to be able to engage the collar surface when lever 23 engages neck portion 7b. This engagement represents the effective or compression release position of control lever 23 inasmuch as in this position of control lever 23, lifter shank 7a is prevented from fully returning to its deepest position in the crank case 3, so that, as long as control lever 23 engages the collar portion 7c of lifter shank 7a, valve 9 cannot fully close. The extent to which valve 9 is kept open when control lever 23 is in its effective position, i.e. engages the neck portion 7b, may preferably be within the range of from .005" to .020", and the location of the collar surface 7c is selected accordingly. Tests have proved that excellent results are obtained by locating the collar surface 7a so that when the control lever 23 is in its effective position, valve 9 will remain open by approximately .009".

According to the present invention, there is provided a small permanent magnet 28 stationarily arranged in spring chamber 2. The magnetic force of magnet 28 is such that when the control lever 23 occupies its FIG. 3 position and the engine speed has dropped below idling speed, the magnet 28 will pull control lever 23 from its

FIG. 3 position into its FIG. 2 position in which lever 23 engages the neck portion 7b and thereby the collar surface 7c so as to prevent valve 9 from seating, or, expressed differently, so as to hold valve 9 open, for instance by .009". Magnet 28 which preferably is slightly spaced from lever 23 when the latter occupies its FIG. 2 or effective position, will firmly hold lever 23 in its FIG. 2 position. However, when the engine after having been started, again reaches a certain speed, the air pumped through passage 20 and acting upon fin 27 exerts sufficient pressure on lever 23 so as to swing the latter from its FIG. 2 position against the pull of magnet 28 into FIG. 3 position. It will be obvious that the magnet 28, i.e. its pulling force, will have to be selected in conformity with the air pressure acting upon fin 27 at idling speed of the engine. While in general, it will suffice, after locating magnet 28 in a certain position in which it will perform as described above, permanently to locate said magnet in said position, it is, of course, also possible to hold the magnet 28 by means of a set screw 29 in a corresponding bore in an eye 30, so that, if, for some reason, the magnet 28 has to be adjusted, it is merely necessary to loosen the set screw 29 and to adjust magnet 28 accordingly. The said magnet 28 is a permanent magnet.

Operation of the embodiment of FIG. 2

It may be assumed that the engine, a portion of which is shown in the drawing and which, by way of example is assumed to be a single cylinder engine, with vertically extending lifter and valve shanks, is at a standstill. In this position, the compression release or control lever 23 is in its FIG. 2 position in which the collar surface 7c of lifter 7 engages control lever 23. In this position the outlet valve 9 is kept slightly open, for instance by .009", which is sufficient to effect satisfactory compression release for an engine of the assumed type. When the crankshaft is now turned, for instance manually, for starting the engine, for example by means of a pulley connected to the crankshaft and a rope extending around the pulley, as is standard in numerous lawnmower engines, the piston moves only slowly so that the pumping action of the piston upon the air in the crank case is insufficient to create an air flow in passage 20 which would be able, by acting on fin 27, to swing control lever 23 out of engagement with neck portion 7b and collar surface 7c.

While the length of the neck portion 7b is sufficient to allow cam 5 to lift lifter 7 to its normal maximum extent and thereby to open the exhaust valve 9 to its normal maximum extent, control lever 23 will at this time remain in its effective position in view of the magnetic force exerted upon control lever 23 by magnet 28, so that valve 9 cannot fully close. However, as soon as during the rotation of the crankshaft and cam shaft and during the reciprocation of valve 9, the mixture in the cylinder is ignited and thereby the engine has been started, the engine piston will assume at least its normal idling speed and thereby will exert a fast and rapid pumping action on the air in the crank case. As a result thereof, the air pressure in passage 20 will increase to such an extent that its action upon fin 27 will swing control lever 23 out of engagement with lifter shank 7 and out of the range of the collar surface 7c against the pull of the magnet 28. Control lever 23 will, therefore, now be in its ineffective position and will remain in this position as long as the engine is in normal operation and has at least its normal idling speed at which latter speed the necessary air pressure prevails in passage 20 for retaining lever 23 in its ineffective position.

However, as soon as the speed of the engine decreases below idling speed, i.e. is almost at a standstill, the magnetic force or pull exerted by magnet 28 will be sufficient to pull control lever 23 from its ineffective position to its effective position in which control lever 23 again prevents valve 9 from fully closing. In this way, the com-

pression release is effective again when the engine is again to be started.

While the compression release described so far has been described as controlling the exhaust valve 9, it is, of course, to be understood that the compression release according to the invention is not limited to the control of the outlet valve 9, although this is preferable, but may also be used instead in connection with the control inlet valve. In this instance, the arrangement is, of course, precisely the opposite from what has been described, i.e. the lifter members 7 and 14 would be interchanged, and the member 23 would be pivotally supported by the lifter operating the outlet valve.

Modification of FIGS. 4 and 5

While according to the arrangement of FIG. 2 a permanent magnet is provided for pulling the control lever 23 from its ineffective position to its effective position, and to hold the control lever in this position, whereas the movement of the control lever out of its effective position to its ineffective position is brought about by the air pumped from the crank case 3 to the spring chamber 2, according to the modification of FIGS. 4 and 5 both the action of the permanent magnet and the action of the air flow have been replaced by electromagnets.

More specifically, the arrangement of FIGS. 4 and 5 comprises an electric circuit which includes a source of electric energy, for instance a battery 31 having one terminal thereof connected to a conductor 32 while its other terminal is connected to a conductor 33. In parallel arrangement to battery 31 is a generator 34 which may, in customary manner, be drivingly connected to the prime mover 1 equipped with the compression release according to the invention. Inasmuch as the prime mover and the cooperation of the control lever with the respective valve to be controlled of the prime mover is precisely the same as described in connection with FIG. 1, FIGS. 4 and 5 merely show the control circuit characteristic for the modification of FIGS. 4 and 5 with the control lever. Since this control lever, however, is not acted upon by air, control lever 23a does not require any fins corresponding to the fins 26 of control 23 described above. Instead, control lever 23a is provided with an upwardly extending tongue or protrusion 35, for a purpose which will presently appear. The journalling of control lever 23a, however, fully corresponds to that described in connection with FIG. 1 and, therefore, similar reference numerals have been employed.

Referring back to the circuit, the conductor 32 includes a switch 36 which may selectively be opened and closed and which, when in closed position, connects the conductor 32 with the conductor 37. The conductor 37 is connected to a conductor 38 and to a conductor 39. Conductor 38 leads to a terminal 40 adapted to be connected to a terminal 41 by a blade 42 of a double switch generally designated 43. The terminal 41 is connected to a conductor 44 leading to a terminal 45 and electromagnet 46. The other terminal 47 of electromagnet 46 is connected to the conductor 33.

The conductor 39 leads to the terminal 48 adapted to be connected by blade 49 of double switch 43 with the terminal 50. The terminal 50 is connected to conductor 41 with the terminal 52 of an electromagnet 53 the other terminal 54 of which is connected to the conductor 33.

As will furthermore be seen from the drawing, the arm 55 carrying the blades 42 and 49 is at 56 linked to an arm 57 of a sleeve 58 of a centrifugal governor generally designated 59. The sleeve 58 is slidably mounted on a supporting member 60 the lower end of which is in any convenient manner fixedly connected to a stationary member 61 of the prime mover, for instance the engine 1. The centrifugal governor 59 may be of any standard design and operation. When the engine equipped with the compression release arrangement of the present invention is at a standstill, the governor 59 occupies the position shown in FIG. 4 in which the blade 42 interconnects the

terminals 40, 41 while the terminals 48 and 50 are not interconnected. When the engine has been started and reached at least idling speed, blade 42 is lifted off the terminals 40 and 41 whereas blade 49 interconnects the terminals 48 and 50, as shown in FIG. 5.

Arranged between the electromagnets 46 and 53 is the control lever 23a, and, more specifically, the extension 35 thereof. FIG. 4 shows the lever 23a in its effective position in which valve 9 is kept open, in the manner described above in connection with FIG. 1, whereas FIG. 5 shows lever 23a in its ineffective position corresponding to the position of lever 23 in FIG. 3.

Operation of modification of FIGS. 4 and 5

It may be assumed that the engine is at a standstill, in which instance all parts of the modification of FIGS. 4 and 5 occupy the position shown in FIG. 4. If it is now intended to start the engine, the operator closes switch 36 to establish electric communication between conductors 32 and 37. Consequently, electric current from battery 31 energizes electromagnet 46. This merely holds the lever 23a positively in engagement with the neck portion 7b by electromagnetic pull, but it should be kept in mind that lever 23a moved into this position shortly before the engine previously came to a standstill.

As soon as the engine has been started, the centrifugal balls 62 begin to rise in standard manner and when the engine has reached idling speed, sleeve 58 and thereby arm 55 have risen to such an extent that blade 42 interrupts electric communication between terminals 40 and 41 thereby de-energizing electromagnet 46. Shortly thereafter, blade 49 establishes communication between the terminals 48 and 50 thereby energizing electromagnet 53. As a result thereof, the pull exerted by electromagnet 53 on the extension 35 of lever 23a pulls the lever 23 from its FIG. 4 position into its FIG. 5 position. This means that while the engine is now running, lever 23a is in its ineffective position corresponding to the position of lever 23 in FIG. 3, so that valve 9 is fully controlled by cam 5 or, expressed differently, the normal operation of the engine is in no way interfered with by the compression release.

Preferably, the electromagnets 46 and 53 are so arranged that when either one is energized, there will always remain a slight gap between the respective energized electromagnet and the extension 35 on lever 23a.

From the above, it will be evident that the arrangement of FIGS. 1 to 3 and also the arrangement of FIGS. 4 and 5 represent compression release mechanisms which will well operate in connection with engines having upright cylinders and upright valves. However, the arrangement of FIGS. 4 and 5 is independent of air pressure.

I will also be evident from the above that the centrifugal governor 59 is merely one of numerous speed responsive elements which can be used for controlling the double switch 43 and that any other speed responsive means available in connection with internal combustion engines may be employed for this purpose.

It will also be evident from the preceding description that the arrangement described above may also be used for engines with horizontal cylinders and valve members.

It is, of course, to be understood that the present invention is, by no means, limited to the specific embodiments shown in the drawings but also comprises any modifications within the scope of the appended claims. Thus, if desired, control lever 23a may also be designed similar to control lever 23 of FIGS. 1 and 2 for air operation as described above in connection with FIGS. 2 and 3. In this instance, electromagnet 53 with the conductors 51 and 54 would be omitted. Switch blade 49 and conductor 39 with the terminals 48 and 50 would, of course, likewise be superfluous. The arrangement would then amount to the design of FIGS. 2 and 3 but with the permanent magnet 28 replaced by the electromagnet 46 with the energizing circuit therefor.

What we claim is:

1. An internal combustion engine, which comprises: a cylinder, a cam shaft, a crank case, a chamber, air conduit means establishing communication between the interior of said crank case and said chamber, a valve member associated with said cylinder and operable during normal operation of said engine alternately to move into opening and closing position, reciprocable means actuable by said cam shaft and operable to control said movement of said valve member, a control member movably arranged in said chamber and movable into an effective position so as to engage said reciprocable means and to cause the same to prevent said valve member from moving into its closing position, magnetic means arranged adjacent said control member for urging the latter into said effective position, said control member also being movable out of said effective position so as to disengage said reciprocable means and thereby to permit normal operation of said valve member including its movement into closing position, and means connected to said control member and responsive to a certain pressure of air passing from said crank case through said conduit means into said chamber automatically to bring about movement of said control member out of said effective position.

2. An internal combustion engine having a crank case, a chamber, conduit means establishing communication between the interior of said crank case and the interior of said chamber, a rotatable cam shaft, a cylinder with a first opening and a second opening, a first valve member operable during normal operation of the engine alternately to move into opening and closing position for respectively opening and closing said first opening, a second valve member operable during normal operation of said engine alternately to move into opening and closing position for respectively opening and closing said second opening, first and second reciprocable means respectively associated with said first and second valve members and operable by said cam shaft for controlling the opening and closing movement of said first and second valve members respectively, said first and second reciprocable means extending into said chamber, a control member arranged within said chamber and movably supported by said second reciprocable means, said control member being movable into an effective position so as to engage said first reciprocable means and to thereby prevent said first valve member from moving into its closing position, magnetic means arranged adjacent said control member for urging the latter into said effective position, said control member also being movable out of said effective position so as to disengage said first reciprocable means and to thereby permit normal operation of said first valve member including its movement into closing position, and means connected to said control member

and extending into said conduit means and operable in response to a certain air pressure in said conduit means in conformity with a certain speed of said engine to automatically bring about movement of said control member out of said effective position.

3. In an internal combustion engine: a cylinder having a first opening and a second opening, a first valve member and a second valve member respectively associated with said first opening and said second opening and operable during normal operation of said engine alternately to move into opening and closing position for respectively opening and closing said first and said second openings, a piston reciprocably mounted in said cylinder, a crank case communicating with said cylinder and said piston, chamber means, conduit means establishing communication between said crank case and said chamber means, a cam shaft, first and second reciprocable means operable by said cam shaft for controlling said first and second valve members respectively, said first and second reciprocable means extending into said chamber means, a control member movably arranged in said chamber means and pivotally supported by said second reciprocable means and movable into an effective position so as to engage and cause said first reciprocable means to prevent said first valve member from moving into its closing position, magnetic means arranged adjacent said control member for urging the latter into said effective position, said control member also being movable out of said effective position so as to disengage said reciprocable means and thereby to permit normal operation of said first valve member including its movement into closing position, and means connected to said control member and responsive to a certain pressure of air pumped by said piston from said crank case into said chamber means to automatically bring about movement of said control member out of said effective position.

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