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Smith

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[54] **AUTOMATIC COMPRESSION RELIEF MECHANISM**

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[52] **U.S. Cl.** **123/182**

[51] **Int. Cl.** **F01l 13/08**

[58] **Field of Search**.... 123/182, 97 B, 90.15, 90.16, 123/90.17

[56] **References Cited**

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3,362,390	1/1968	Esty	123/182
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3,511,219	5/1970	Esty	123/182
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Primary Examiner—Charles J. Myhre
Assistant Examiner—James D. Liles

[57] **ABSTRACT**

A centrifugally responsive compression release mechanism for an internal combustion engine has a C-shaped flyweight mounted to swing edgewise across one face of the camshaft gear. Between that gear and the cam the camshaft has a cavity shaped like a Woodruff keyway in which an arcuate cam member is slidingly-rockingly received. A camming surface on an edge portion of the flyweight cooperates with one end portion of the cam member to so position it that its other end portion is retracted at engine running speeds but protrudes radially at cranking speeds to cooperate with a valve tappet in holding the valve unseated during the compression stroke.

4 Claims, 5 Drawing Figures

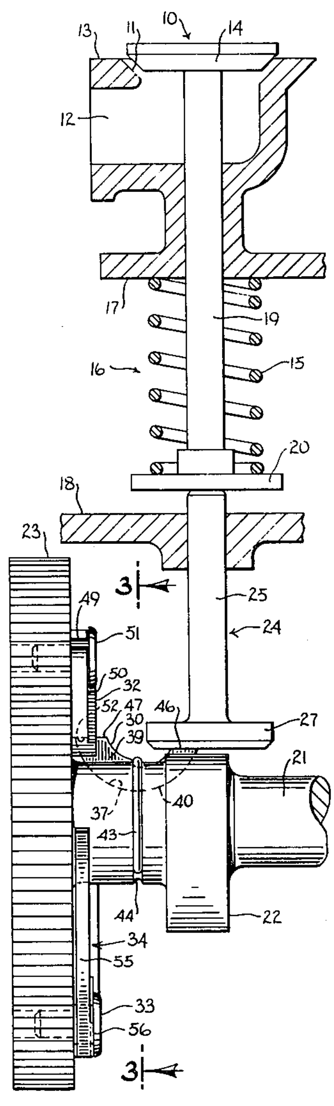

FIG.1.

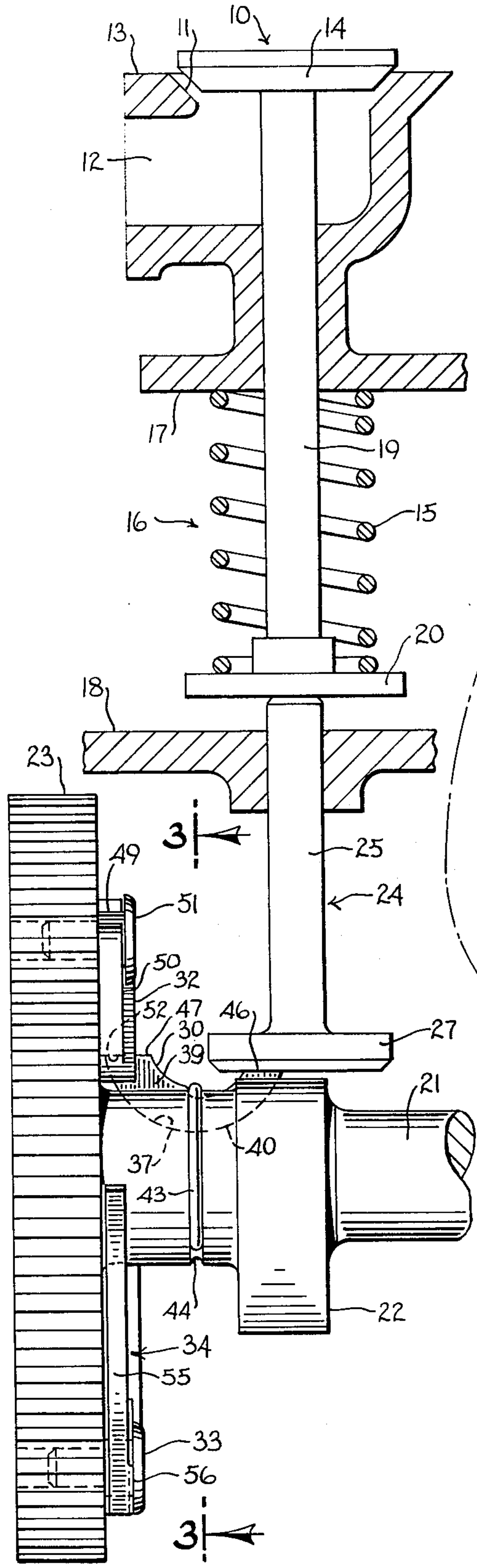
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FIG.2.

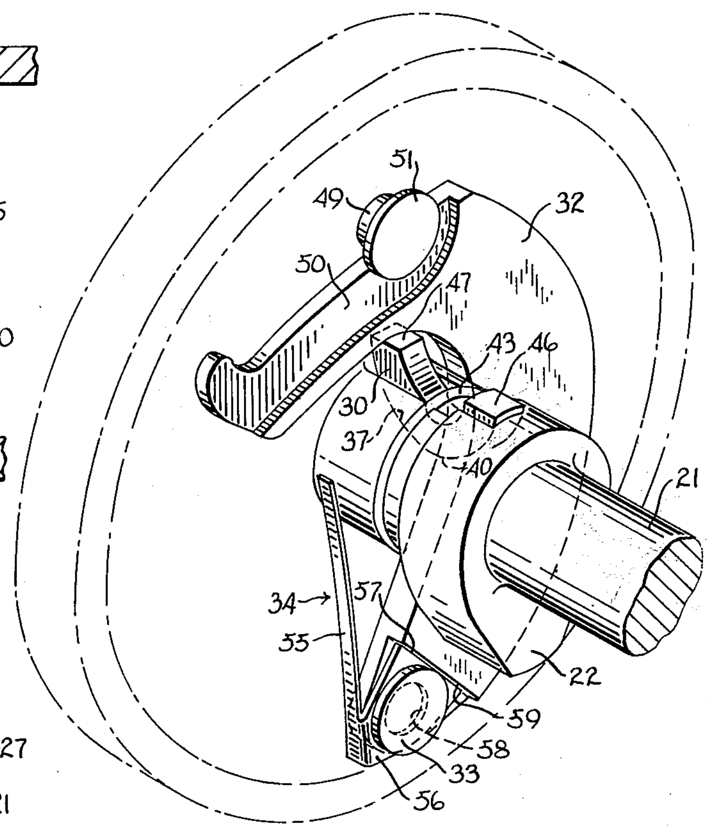
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FIG.3.

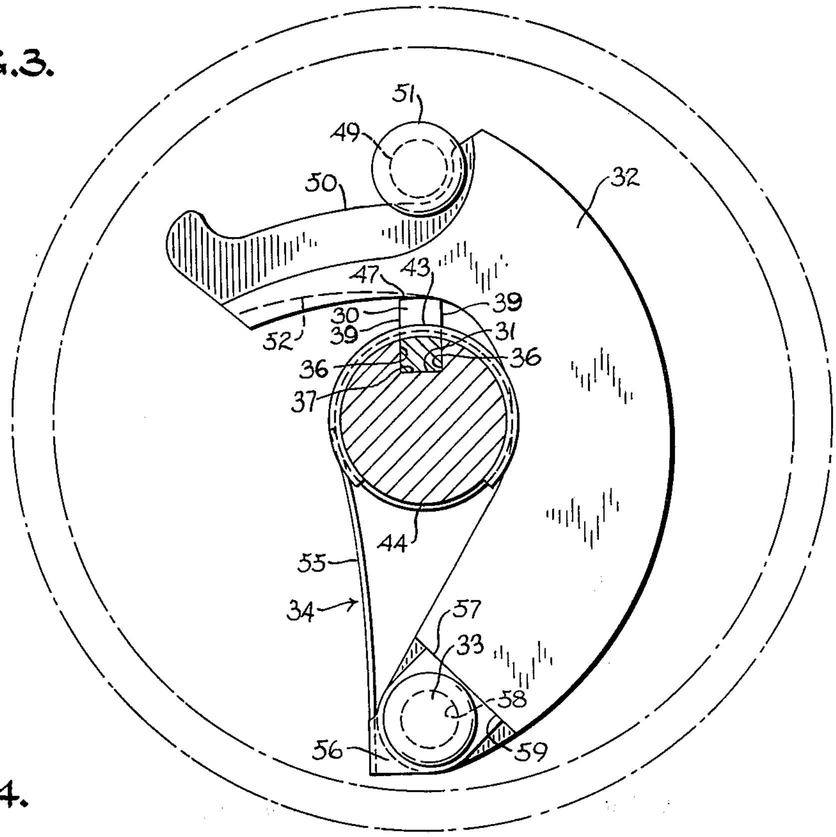


FIG.4.

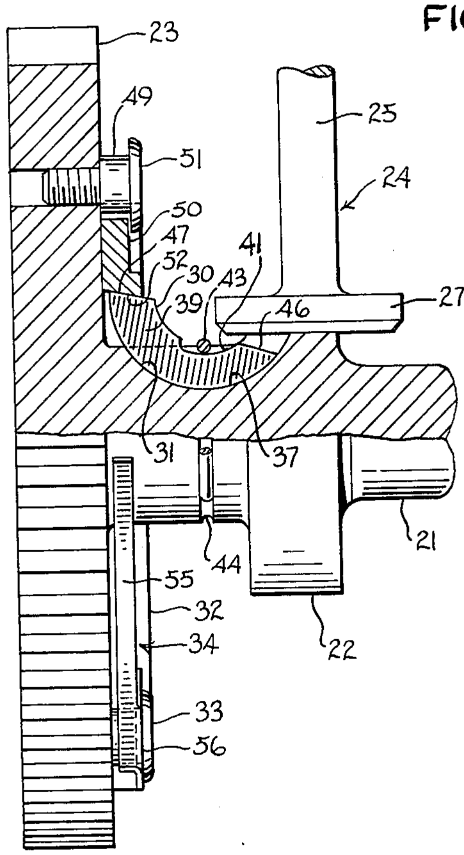
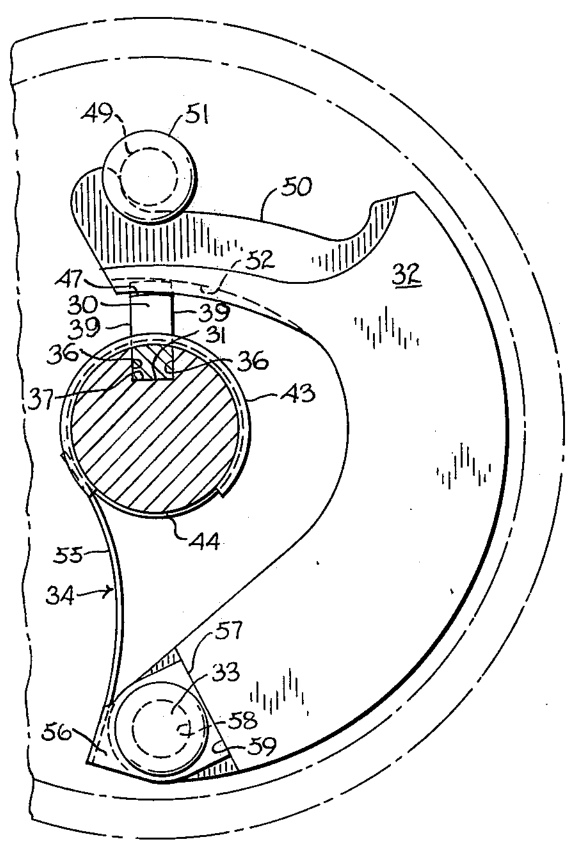


FIG.5.



AUTOMATIC COMPRESSION RELIEF MECHANISM

This invention relates to automatic compression relief mechanisms for internal combustion engines and is more particularly concerned with centrifugally responsive apparatus by which, during the compression stroke of an internal combustion engine, compression is partially relieved at engine cranking speeds but is allowed to build up to full value at running speeds.

Very generally the compression relief mechanism of the present invention is of the type disclosed in the U.S. Pat. Nos. to Fenton, 3,314,408, to Esty, 3,362,390, to Campen, 3,381,676, to Kruse, 3,395,689, and to Harkness, 3,620,203. In each of those prior devices, as in the mechanism of this invention, a valve that controls flow of gas through a port communicated with the engine combustion chamber is held slightly off its seat during the compression stroke, at cranking speeds of the engine, to allow a certain amount of gas to be displaced through the port, thus relieving the force of compression that opposes cranking rotation of the engine crankshaft. At running speeds the valve is permitted to remain seated during the compression stroke so that the normal performance of the engine is not impaired.

Such operation of the valve is controlled by a cam member on a camshaft that rotates in timed relation to the engine cycle, the cam member being carried for rotation with the camshaft and also for motion relative to it between a retracted position, occupied when the engine is at running speed, and a radially projecting position in which the cam member effects the desired unseating of the valve for compression relief. The position of the cam member is in turn controlled by a flyweight that is carried by the camshaft for rotation with it and for motion relative to it between defined limits in directions transverse to the camshaft axis. The flyweight is biased to one of its limits of motion and is moved to its other limit by centrifugal force. A connection between the flyweight and the cam member translates bias produced motion of the flyweight towards its said one limit into movement of the cam member towards its projecting position and provides for retraction of the cam member upon centrifugally responsive movement of the flyweight to its other limit of motion.

The prior compression relief expedients of the general type just described were characterized by parts that had relatively complicated shapes. Such parts were rather expensive to manufacture, especially because of the need for maintaining close tolerances, and they were not as easy to assemble as might have been desired. Although none of the prior devices was notably undependable, it is a fact that the likelihood of a device to fail in service tends to increase with increasing complexity of its parts, whereas simplicity goes hand in hand with dependability.

With these considerations in mind, it is a general object of the present invention to provide an automatic compression relief mechanism for internal combustion engines which is of the general character described above but which, as compared with prior such mechanisms, has few parts, each of less complicated shape, and which can be incorporated into existing engine models without the need for extensive modification of engines of the facilities for producing them.

It is thus another general object of this invention to provide an automatic compression relief mechanism that is easy to manufacture and assemble, low in cost, and sturdy and reliable.

Another object of the invention is to provide an automatic compression relief mechanism which is inherently of such character that it can provide for a valve to be held unseated, for compression relief, through a relatively long portion of the compression stroke, thus affording optimum ease of engine cranking.

With these observations and objectives in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings, which exemplify the invention, it being understood that changes may be made in the specific apparatus disclosed herein without departing from the essentials of the invention set forth in the appended claims.

The accompanying drawings illustrate one complete example of an embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a view in elevation of a valve of an internal combustion engine and actuating mechanism therefor that embodies the principles of this invention, the parts being shown in the positions they occupy during the compression stroke at engine cranking speeds;

FIG. 2 is a fragmentary perspective view of the camshaft and cam gear portion of an engine equipped with the compression relief expedient of this invention;

FIG. 3 is an end view of the camshaft, cam gear and compression relief means, taken on a plane between the cam and the cam gear and showing the parts in the positions they occupy at engine cranking speeds;

FIG. 4 is a fragmentary view generally similar to FIG. **1**, but with portions broken away and showing the parts in the positions they occupy at normal engine running speeds; and

FIG. 5 is a fragmentary view generally similar to FIG. **3** but illustrating conditions at engine operating speeds.

Referring now to the accompanying drawings, the numeral **10** designates one of the valves of an internal combustion engine. So far as the present invention is concerned, the valve **10** may be either the intake valve or the exhaust valve, or even a valve especially provided for purposes of compression relief; but in any case it controls flow of gas through a port **11** that communicates the combustion chamber of the engine with a passage **12** outside the combustion chamber. The combustion chamber is not shown, although it is in part defined by a wall portion of the engine block that is indicated at **13,** which wall portion has the port **11** formed in it. The port can comprise the annular seat for the head **14** of the valve, sealingly engaged by the valve head when the valve is in its closed or seated position.

The valve is biased towards its seated position by means of a coiled spring **15** that is located in a spring compartment **16** defined by other wall portions **17** and **18** of the engine block. The stem **19** of the valve is guided in a hole in the top wall **17** of the spring compartment, through which it extends into that compartment, where it is encircled by the valve spring **15.** The spring reacts between the underside of the wall **17** and a spring seat flange **20** on the bottom of the valve stem.

If the valve **10** is considered to be the inlet valve, the passage **12** can be taken as the inlet passage from which combustible mixture can be drawn into the chamber when the valve is open; and if the valve **10** is considered to be the exhaust valve, then the passage **12** can be regarded as the exhaust passage through which spent gases leave the combustion chamber when the valve is open. In either case, it will be evident that when the engine is running normally, the valve **10** should be closed during substantially the entire compression stroke of the engine, to provide for optimum compression of the combustible charge in the combustion chamber. On the other hand, if, while the engine is being cranked, the valve is held slightly unseated during at least a part of each compression stroke, a part of the charge can be relieved into the passage **12**, thus reducing the force on the piston that opposes cranking, and correspondingly reducing the effort required for cranking.

The valve is opened, against the force of its spring **15**, by means of a camshaft **21** which rotates in timed relation to the engine cycle and on which there is a single lobe cam **22**. The camshaft is driven for such rotation by the engine crankshaft (not shown) on which there is a gear (also not shown) that meshes with a gear **23** on one end of the camshaft. The cam **22** on the camshaft, which is axially adjacent to the camshaft gear **23**, cooperates with a tappet **24** that has its stem **25** coaxial with the stem **19** of the valve and projecting through a guide hole in the bottom wall **18** of the spring compartment. The upper extremity of the tappet stem is engageable with the underside of the spring seat flange **20**. An enlarged foot **27** on the bottom end of the tappet rides on the cam **22**, so that during each revolution of the camshaft the lobe of the cam lifts the tappet, and through it the valve, to propel the latter to its open position.

The centrifugally responsive compression relief mechanism of this invention comprises, in general, an arcuate cam member **30** that is slidingly and rockingly received in a cavity **31** in the camshaft, a flyweight **32** connected to the camshaft gear **23** by means of a pivot pin **33** eccentrically mounted on the camshaft gear with its axis parallel to that of the camshaft, and a spring **34** that reacts between the flyweight and the camshaft to bias the flyweight in one direction of its motion relative to the camshaft.

The cavity **31** in the camshaft, which opens radially outwardly, is very similar to a Woodruff keyway, having side surfaces **36** which extend lengthwise of the camshaft and which are flat and parallel to one another, and a bottom surface **37** that is concavely curved to a cylinder segment about an axis which is transverse to that of the camshaft and is spaced outwardly a substantial distance from the mouth of the cavity. Axially of the camshaft the cavity extends partway into the cam **22** and has its opposite end near the camshaft gear **23**.

The arcuate or crescent-shaped cam member **30** is received in the cavity with a close sliding fit, and hence it has flat side surfaces **39** that slidingly oppose the side surfaces **36** of the cavity and a cylindrical segment inner surface **40** that mates with the curved bottom surface **37** of the cavity. The size of the cam member is such that at least one end portion of it always projects radially out of the cavity and beyond the adjacent curved surface on the camshaft. Hence when a force is applied to one end portion of the cam member, in a direction radially inward relative to the camshaft, such force tends to slide the cam member lengthwise in the cavity and concomitantly rock it so that its other end portion is carried out of the cavity.

The surface **41** of the cam member that is exposed at the mouth of the cavity is curved concentrically with its inner surface **40**. A spring ring retainer **43**, circumferentially embracing the camshaft and extending across the medial portion of the cam member, confines the cam member in the cavity without interfering with its slidingly rocking motion relative to the camshaft. Preferably the ring **43** is recessed in a closely fitting circumferential groove **44** in the camshaft to confine it against axial displacement.

The end portion **46** of the cam member that is adjacent to the cam **22** is of course in a position to cooperate with the foot **27** on the tappet, so that when said end portion of the cam member is projected, it will hold the valve unseated each time the rotation of the camshaft brings it around to engage the tappet. It will be understood, therefore, that the cavity **31** is in such angular relationship to the lobe on the cam **22** that the cam member comes into juxtaposition to the tappet during the compression stroke, in that portion of the engine cycle when compression relief is desired during cranking.

The flyweight **32** cooperates with the opposite end portion **47** of the cam member to position the cam member in accordance with engine speed, holding its tappet engaging end portion **46** radially projected at cranking speeds and permitting it to be retracted at running speeds.

The flyweight is generally flat, to overlie the face of the camshaft gear **23** that is adjacent to the cam **22**, and it is more or less C-shaped in outline so that it curves around the camshaft. The pivot pin **33** extends through a captive end portion of the flyweight, at one side of the camshaft, and constrains the flyweight to rotate with the camshaft while permitting it to swing edgewise relative to the camshaft in directions transverse to the camshaft axis. Limits of such swinging motion are defined by a stop pin **49** which projects from the cam gear at a location diametrically opposite the pivot pin and which cooperates with abutments on the flyweight that are defined by a bay **50** in its outer edge, near its free end. As shown, the marginal portion of the flyweight adjacent to the bay **50** is of reduced thickness and is overlain by a flange-like head **51** on the stop pin that confines the flyweight to edgewise swinging motion.

On its inner edge, near its free end, the flyweight has an arcuate camming surface **52** that is engageable with its adjacent end portion **47** of the cam member. The camming surface is curved on a non-uniform radius about the axis of the pivot pin **33**, such that as the flyweight swings outwardly in response to centrifugal force there is a gradual increase in the distance between said camming surface and the camshaft axis, as measured through cam member **30**. Hence, as the engine decelerates from running speed to a stop, and the flyweight consequently swings inwardly under the influence of its spring **34**, the flyweight applies radially inward force to its adjacent end portion **47** of the cam member, projecting the tappet engaging end portion **46** of the cam member to its valve unseating position. Conversely, as the flyweight swings outwardly in response to centrifugal force developed at engine operating speeds, its camming surface allows the flyweight engaging end portion **47** of the cam member to move radially outwardly as the tappet engaging end **46** of the cam member is pushed into its cavity **37** by the biasing force of the valve spring **15**, acting through the tappet; and the cam member is then ineffective to unseat the valve. As the flyweight swings outwardly, the cam member also has an inherent tendency to rock to its inoperative position shown in FIG. 4, inasmuch as the portion of the cam member that is adjacent to the flyweight end **47** has a greater thickness (measured between its arcuate surfaces) than its other end, and therefore has more mass to be subject to centrifugal force as the camshaft rotates.

As shown, the spring **34** that biases the flyweight towards its engine-cranking limit of motion is a leaf spring that is formed in one piece, having a flat, elongated spring arm **55** and a securement portion **56** that is bent from the spring arm to lie in a plane normal to the plane of the spring arm and parallel to its length. The securement portion has a straight edge **57** and has a hole **58** in which the pivot pin **33** is received. The said securement portion flatwise overlies the captive end portion of the flyweight, which is of reduced thickness to define a straight shoulder **59** against which is engaged the straight edge **57** on the spring, thus enabling spring force to be imposed upon the flyweight. The free end of the spring arm **55** bears flatwise against the camshaft, at the side thereof that is opposite the medial portion of the flyweight, to maintain flexing stress in the spring.

It will be apparent that the flyweight can be of relatively simple geometrical shape, so that it is very inexpensive to manufacture. The cam member is likewise of simple shape, and the cavity in the camshaft in which it is received is of such configuration that it can be formed with a standard cutter. The relatively few and simple operations that are required for assembly of the compression relief mechanism of this invention will be apparent from the foregoing description of its parts and their relationship, from which it will also be evident that no special tools or fixtures are needed for such assembly.

Those skilled in the art will appreciate that the invention can be embodied in forms other than as herein disclosed for purposes of illustration.

The invention is defined by the following claims:

I claim:

1. In an internal combustion engine having a valve which controls flow of gas through a port communicable with the engine combustion chamber and which is biased towards a seated position, a part connected with said valve and against which a cam element is cyclically engageable to unseat the valve, and a camshaft rotatable in timed relation to the engine cycle, automatic compression relief means for causing the valve to be unseated during a predetermined portion of each engine cycle at engine cranking speeds and to occupy its seated position during said engine cycle portion at engine running speeds, said automatic compression relief means being characterized by:

A. the camshaft having a radially outwardly opening cavity with flat, parallel side surfaces that extend axially of the camshaft and with a concave bottom surface curved as a cylinder segment about an axis transverse to that of the camshaft, one end portion of said cavity being near said part;

B. a flyweight carried by the camshaft for rotation therewith and for movement relative thereto between defined limits in directions transverse to the camshaft axis, said flyweight being biased towards one of its said limits and being centrifugally movable towards the other one, said flyweight having, near the other end of said cavity, a camming surface which is at one distance from the camshaft axis when the flyweight is at its said one limit and is at a greater distance from the camshaft axis when the flyweight is at its said other limit; and

C. an arcuate cam member received in said cavity and having surfaces mating with and slidingly engaging said surfaces of the cavity, so that the cam member is guided for slidingly rocking motion that alternately projects and retracts its opposite end portions relative to the camshaft, said cam member further having

1. its end portion adjacent to the first mentioned end of the cavity formed to provide, when projected, a cam element cooperable with said part, and
2. its other end portion cooperable with said camming surface on the flyweight whereby movement of the flyweight to its said one limit causes the first mentioned end portion of the cam member to be projected and movement of the flyweight to its other limit allows that end portion of the cam member to be retracted.

2. The internal combustion engine of claim **1**, further characterized by:

D. a ring-like retainer circumferentially embracing the camshaft and extending across the medial portion of the cam member to confine the latter in said cavity.

3. In an internal combustion engine having a valve movable to and from a seated position towards which it is biased and at which it blocks flow of gas through a port communicated with the engine combustion chamber, an automatic centrifugally responsive compression relief mechanism of the type comprising a camshaft rotatable in timed relation to the engine cycle, a flyweight carried by the camshaft for rotation therewith and for movement relative thereto between defined limits in directions transverse to the camshaft axis, said flyweight being biased towards one of said limits to remain at the same at engine cranking speeds and being movable to the other limit under centrifugal force developed at engine running speeds, and a cam member carried by the camshaft for rotation therewith and movement relative thereto and having a connection with the flyweight by which motion of the flyweight to its said one limit moves the cam member to an operative position at which it unseats the valve during a predetermined portion of the engine cycle and motion of the flyweight to its said other limit enables the cam member to occupy an inoperative position in which it allows the valve to remain seated during said portion of the engine cycle, said compression relief mechanism being characterized by:

A. the camshaft having a radially outwardly opening cavity with axially extending flat, parallel side surfaces and a concave bottom surface curved as a cylindrical segment about an axis transverse to that of the camshaft;

B. the cam member being arcuate and confined in said cavity, and having surfaces slidingly engaged with said surfaces of the cavity whereby the cam member is guided for slidable rocking relative to the camshaft by which its opposite end portions are alternately moved to and from positions protruding radially from the camshaft, one end portion of said cam member being so formed that when in its protruding position it holds the valve unseated during said portion of the engine cycle; and

C. said connection comprising cooperating camming surfaces on the flyweight and on the other end portion of the cam member whereby motion of the flyweight to its said one limit of motion moves said other end portion of the cam member away from its protruded position and motion of the flyweight to its other limit allows said other end of the cam member to move out of its protruded position.

4. The internal combustion engine of claim **3** wherein the flyweight is biased to its said one limit of motion by means of a spring member that comprises:

1. an elongated flat, resilient spring arm having a free end which bears against the camshaft under flexing bias; and
2. an integral securement portion on the other end of said arm, said securement portion being flat and perpendicular to the plane of the arm and having a hole therethrough by which it is pivoted on a pin that also pivots the flyweight for its said limited motion, said securement portion having a straight edge portion engaged along its length with a straight opposing abutment on the flyweight to constrain the flyweight to swing about said pin in unison with edgewise rotation of the securement portion of the spring member.

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