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3,192,913

VALVE APPARATUS FOR INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 1

Fig. 1.

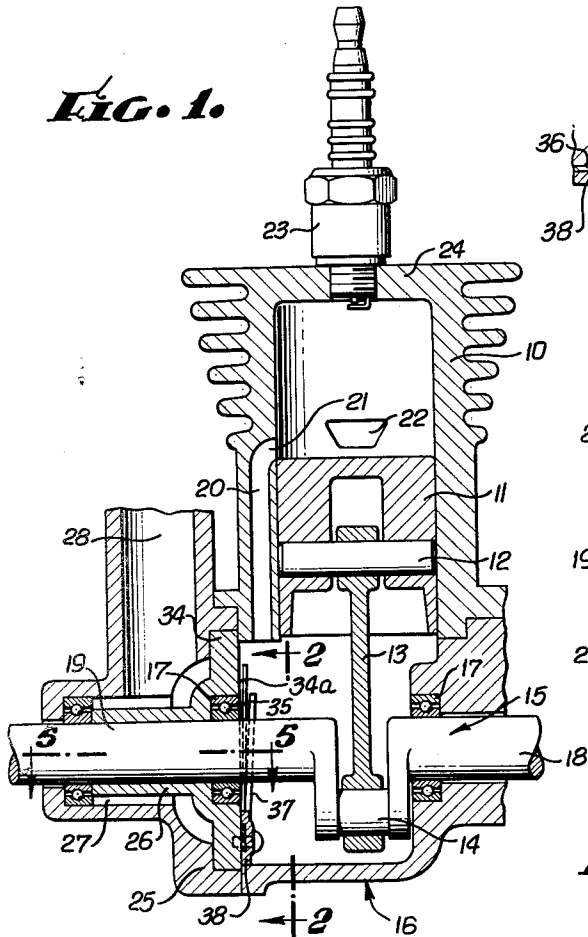


Fig. 2.

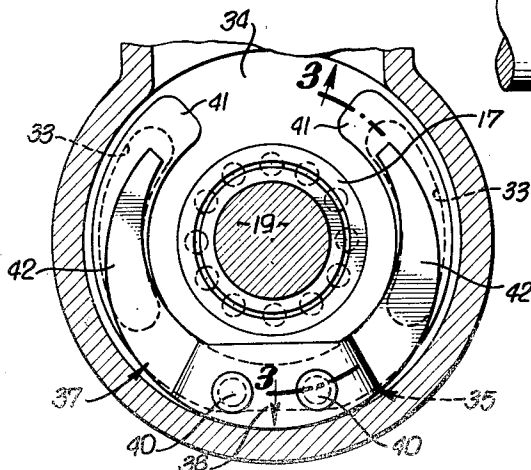


Fig. 3.

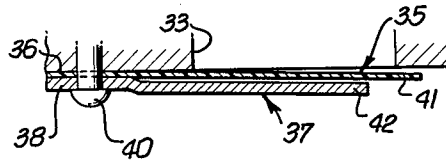


Fig. 4.

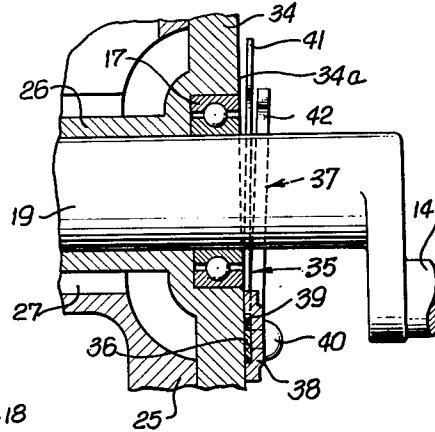
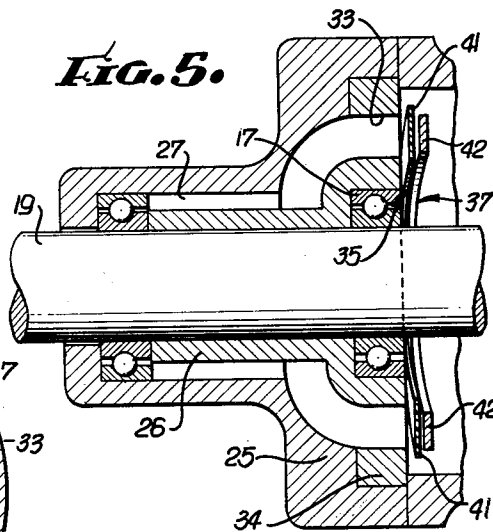


Fig. 5.



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FIG. 7.

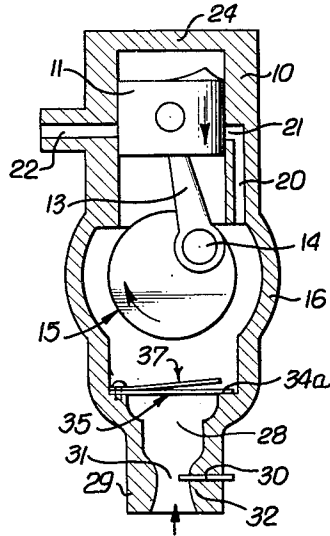
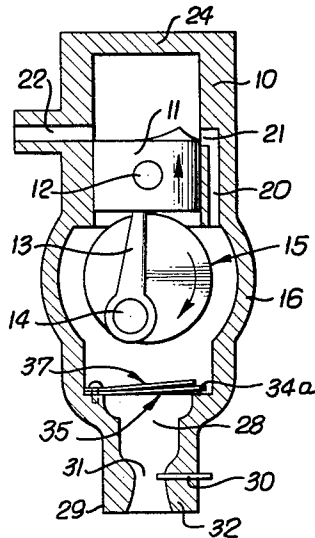


FIG. 9.



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VALVE APPARATUS FOR INTERNAL COMBUSTION ENGINES

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9 Claims. (Cl. 123—73)

The present invention relates to internal combustion engines, and more particularly to engines utilizing crankcase compression for forcing a fuel-air mixture into the engine cylinder.

An object of the present invention is to provide an internal combustion engine embodying a crankcase fuel mixture inlet valve that opens more readily and sooner to secure feeding of a greater fuel mixture into the crankcase for subsequent discharge into the cylinder.

Another object of the invention is to provide an internal combustion engine embodying a crankcase fuel mixture inlet valve that enables the engine to be started more readily, operate at slower idling speeds, and operate efficiently over a wide range of speeds.

A further object of the invention is to provide an internal combustion engine embodying a fuel mixture inlet valve element that is substantially insensitive to sound waves or other vibration inducing influences of the engine that would tend to adversely affect opening and closing of the valve element with respect to the piston positions in the cylinder. The valve opens and closes in strict conformance with the positions of the piston and its directions of motion.

An additional object of the invention is to provide an internal combustion engine embodying a crankcase fuel mixture inlet valve element that has substantially no frequency of oscillation so that it will not vibrate like a reed, but, instead, will open sooner and close more readily in response to the positions of the piston in the cylinder, and will not bounce from its companion seat when moved into engagement therewith.

Yet another object of the invention is to provide an internal combustion engine embodying a crankcase fuel mixture inlet valve that minimizes the tendency of dirt, and other foreign matter, remaining in blocking position between the valve element and its companion seat, which might prevent full closing of the valve, and in which any dirt that might come between the valve and its valve seat is prevented from forestalling full closing of the valve.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a longitudinal section through a two-cycle internal combustion engine embodying the invention;

FIG. 2 is an enlarged section taken along the line 2—2 on FIG. 1;

FIG. 3 is a section taken generally along the line 3—3 on FIG. 2;

FIG. 4 is an enlarged fragmentary section of the induction or inlet valve portion of the engine disclosed in FIG. 1;

FIG. 5 is an enlarged section taken along the line 5—5 on FIG. 1;

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FIGS. 6, 7, 8 and 9 are diagrammatic views illustrating the operation of the engine and of its induction or inlet valve.

The internal combustion engine illustrated in the drawings is of the two-cycle type, including a cylinder 10 and a piston 11 reciprocable therein. A wrist pin 12 is mounted in the piston and receives one end of a connecting rod 13, the other end of which extends around a crankpin 14 of a crankshaft 15 rotatably mounted in a crankcase 16 suitably secured to the cylinder 10. Suitable ball or roller type of bearings 17 may be disposed between the opposite portions 18, 19 of the crankshaft 15 and the crankcase 16 itself.

A fuel-air mixture is fed from the crankcase 16 through an inlet passage 20 and inlet port 21 into the cylinder 10 when the piston is near the end of its stroke at crank end dead center; whereas, the spent or exhaust gases can discharge through an exhaust port 22 in the cylinder wall when uncovered by the piston 11. The movement of the piston to head end dead center as a result of rotation of the crankshaft 15 will compress the combustible charge in the cylinder, which will then be fired by a spark plug 23, or the like, mounted in the cylinder head 24, the piston being moved away from the cylinder head to uncover the exhaust port or ports 22 and the inlet port 21.

As specifically illustrated in the drawings, the crankcase includes an induction case portion 25 containing a valve body 26 through which one portion 19 of the crankshaft rotatably extends. The exterior of this valve body 26 is in spaced relation to the induction case 25 to provide an annular passage 27 therebetween communicating with an inlet passage 28 for the fuel-air mixture received from the engine carburetor 29. The carburetor is not disclosed specifically in FIGS. 1 to 5, but it is illustrated somewhat diagrammatically in FIGS. 6 to 9. Fuel from a suitable source can discharge from the carburetor jet 30 into the throat portion 31 of a venturi 32, air flowing through the venturi and drawing fuel from the carburetor jet 30 for admixture therewith, this combustible mixture then passing through the inlet 28 into the induction passage 27 and toward substantially diametrically opposed inlet ports 33 of a transverse or flange portion 34 of the valve body 26 suitably clamped between the induction case 25 and the main portion of the crankcase 16. The combustible charge flows through the inlet ports 33 into the crankcase 16 under the control of a one-way feather or flapper type of valve element 35 of generally U or horseshoe shape, which is disposed in the crankcase and which tends to seat against the valve body 34 over its inlet ports 33 to prevent the combustible mixture from passing back from the crankcase through the inlet ports 33 into the induction passage 27.

As specifically disclosed, the feather valve element 35 has its central or mid-portion 36 secured to the valve body flange 34 by a guard 37 of generally U-shape, and which overlies the feather valve element. As shown, the guard includes a central clamp portion 38 having a recess, pocket or tunnel 39 in which the mid-portion 36 of the feather valve is received. Suitable fastening elements 40, such as rivets, pass through the clamp portion 38 of the guard and through the mid-portion 36 of the feather valve to secure such mid-portion to the valve body flange 34.

Opposed curved or arcuate arms 41 of the feather valve element 35 extend around and on opposite sides of the crankshaft 15 in a position overlying the opposed inlet ports 33, which may also be arcuate in shape. The arms 41 extend beyond the ends of the inlet ports and also are substantially wider than the width of the ports so as to be capable of engaging the inner valve seating surface 34a of the valve body to close the ports 33. The arms 42 of the guard overlie the arms 41 of the feather valve, but are

spaced outwardly from the inner surface 34a of the valve body flange 34 to permit movement of the feather valve arms 41 away from the flange to open the inlet ports 33, the guard arms 42 limiting the extent of movement of the feather valve arms so that they can be acted upon by the pressure of the combustible charge in the crankcase 16 for immediate closing against their companion valve seating surfaces 34a surrounding the inlet ports 33. Thus, the U-shaped guard 37 serves the purpose of retaining the feather or flapper one-way valve element 35 in place, of protecting it, and of limiting the extent of its movement away from its companion valve seats 34a surrounding the inlet ports 33.

As shown in FIG. 1, the piston 11 has moved to its crank end dead center in which both the inlet and the exhaust ports 21, 22 are open. The piston then begins moving toward the cylinder head 24, and during such upward movement it will decrease the pressure in the crankcase 16 and allow the pressure differential in the inlet and induction passage 27 to open the feather valve 35 and draw a combustible charge into the crankcase. When the piston 11 reaches substantially its head end dead center position, the spark plug 23 fires, igniting the combustible charge, the piston then being moved in the cylinder 10 towards the crankshaft 15. At the commencement of such downward stroke, the combustible charge in the crankcase below the piston is compressed and closes the feather valve 35 against its companion seat 34a to close the inlet ports 33. Continued movement of the piston then further compresses the charge in the crankcase until the piston uncovers the exhaust port 22, allowing the spent gases to exhaust therefrom, and also uncovers or opens the inlet port 21, allowing the compressed charge in the crankcase 16 to flow through the inlet passage 20 into the cylinder. When the piston 11 starts on its return stroke toward the head end 24 of the cylinder, it will again cover or close the inlet ports 21, creating a suction effect in the crankcase 16 and drawing a combustible charge from the inlet 28, through the induction passage 27 and inlet ports 33, the feather valve 35 having moved away from its seat 34a to open position.

Heretofore, the feather valve element or reed valve element has been made of a relatively stiff thin steel, or similar metal, which normally tends to remain closed against its companion seat to close the inlet port or ports. It is necessary for sufficient suction to be developed in the crankcase upon movement of the piston toward the head end of the cylinder to deflect the metal reed valve from its seat and draw the combustible charge into the crankcase. The pressure developed in the crankcase during the downstroke of the piston in the cylinder retains the metallic reed in closed position against its seat, and such closed position remains until after the piston has reached its crank end dead center position. Because of the inherent tendency of the stiff, thin steel reed to close against its companion seat, the amount of combustible charge entering the crankcase is reduced in view of the necessity for first creating a certain suction in the crankcase to effect opening of the valve. In addition, dirt or other foreign matter that might settle on the seat or on the valve itself is clamped between the valve and the companion seat and prevents full closing of the reed valve. Moreover, because of the frequency of vibration of the steel valve element, it becomes sensitive to the sonic waves in the engine itself, which adversely affects its proper functioning in that it may not close against its seat at the time desired, may bounce from its seat, and may remain closed against its seat for a greater period.

In the induction or inlet valve device illustrated in the drawings, the valve element 35 inherently tends to assume an open position with respect to its seat 34a, and it requires a pressure differential in the crankcase 16 to move the valve element into engagement with its seat. The valve element is made of a material that is light, dead and substantially springless, having substantially no oscillation frequency. The valve element may be made of a soft pli-

able, light sheet material, such as rubber, leather, or a tetrafluoroethylene resin, marketed as Teflon. The valve element 35, made of a soft pliable, light sheet material, has very little, if any, closing tension, tends to remain in open position with respect to its valve seat 34a, and opens fully more readily, as limited by its engagement with its protective guard 37. Such material, having substantially no oscillation frequency, closes as soon as the pressure in the crankcase rises, and does not vibrate. Consequently, it is not influenced by vibrations in the engine, but will move into and from engagement with its seat 34a in strict accordance with the positions of the piston 11 in its companion cylinder 10. Moreover, when engaging the seat 34a, it has no tendency to bounce therefrom, but will remain closed thereagainst. In the event that any dirt particles tend to adhere to the seat 34a, the valve element 35 will deform around such particles and still effect its full closing against its seat 34a to prevent retrograde flow of any of the compressed fuel in the crankcase through the inlet ports 33. The fact that the valve element 35 normally tends to possess an open position when not subjected to the fluid pressure in the crankcase enables any dirt that might have been deposited on the valve seat 34a, or on the face of the feather valve element 35 itself, to be flushed or cleaned therefrom by the inflow of the combustible charge through the inlet ports 33 and past the valve seat and the feather valve.

The feather valve element 35, which inherently tends to assume a valve opening position, enables the engine to operate in a much better manner, which, perhaps, can be best understood by reference to the diagrammatic views illustrated in FIGS. 6 to 9, inclusive, of the drawings. As disclosed in FIG. 6, the piston 11 is on its compression stroke and has created a suction in the crankcase 16, in which the feather valve 35 is elevated from its seat 34a, or in open position, the combustible charge being drawn through the carburetor 29 and inlet passage 28 past the open feather valve 35 into the crankcase. Upon the piston reaching its head end dead center position, the fuel charge in the cylinder is ignited to drive the piston 11 downwardly in the cylinder. As soon as the piston begins moving away from the cylinder head 24, pressure is developed in the crankcase 16 which moves the feather or flapper valve 35 against its seat 34a to close the inlet ports 33, the combustible charge previously drawn past the valve into the crankcase then being compressed (FIG. 7). Such compression will continue until the piston uncovers the exhaust and inlet ports 22, 21 of the cylinder, the spent gases passing outwardly through the exhaust port 22 and the pressurized combustible charge in the crankcase 16 then passing upwardly through the inlet passage 20 and the inlet port 21 into the cylinder above the piston.

As soon as the pressure in the crankcase 16 decreases sufficiently, the feather valve 35 will open immediately, and this will occur as soon as, or slightly before, the piston 11 reaches crank end dead center, such as disclosed in FIG. 8. In prior devices embodying relatively stiff, thin steel reed valve elements that normally tend to remain closed against their companion seat, the valve would only open after the piston 11 has moved upwardly to some extent on its suction stroke. In the present case, as the piston returns toward the cylinder head 24 on its compression stroke, the feather valve 35 is opened to its fullest extent, as limited by engagement with its guard 37, as illustrated in FIG. 9, to draw the combustible charge into the crankcase.

Because of the inherent characteristics of applicant's feather valve element 35, it will open at an earlier point in the cycle of operation of the engine, enabling a larger quantity of fuel to be drawn into the crankcase 16 during movement of the piston 11 in the cylinder 10 toward its head end. This enables the engine to develop greater horsepower. It has also been found that the engine is easier to start and will idle at slower speeds. The feather valve 35 has a very low frequency of vibration and is,

therefore, immune to adverse action with respect to its valve seat 34a due to the frequency of the engine, which can vary with the engine speed. The lack of vibration in the flapper valve element itself prevents it from fluttering with respect to its seat 34a and renders it immune to sonic waves developed within the engine itself.

The opposed arms 41 of the feather or flapper valve element 35 are, in effect, hingedly secured to its mid-portion 36, which is clamped against the valve body 34 by the guard 37. In view of the pliant material of which the feather valve element 35 is made, it is disposed within the pocket 39 in the guard so that its mid-portion 36 cannot be adversely deformed as a result of clamping the guard to the valve body flange 34 by the rivets 40. The compression of the mid-portion 36 is limited by engagement of the guard portion 38 on opposite sides of the mid-portion of the valve element with the surface 34a of the flange 34.

I claim:

1. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body having an inlet adapted to communicate with the crankcase, and a valve element constructed and arranged to normally and inherently tend to occupy a position opening said inlet in the absence of a pressure differential acting thereon and adapted to be engaged with said valve body to close said inlet in response to compression of the fuel mixture in the crankcase.

2. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body having an inlet adapted to communicate with the crankcase, and a pliant, elastic valve element constructed and arranged to normally and inherently tend to occupy a position opening said inlet in the absence of a pressure differential acting thereon and adapted to be engaged with said valve body to close said inlet in response to compression of the fuel mixture in the crankcase.

3. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body having an inlet adapted to communicate with the crankcase, and a valve element of tetrafluoroethylene sheet material secured to said valve body and constructed and arranged to normally and inherently tend to occupy a position opening said inlet in the absence of a pressure differential acting thereon and adapted to be engaged with said valve body to close said inlet in response to compression of the fuel mixture in the crankcase.

4. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body through which said crankshaft extends and having inlets on opposite sides of said crankshaft adapted to communicate with the crankcase, and a valve element disposed on opposite sides of said crankshaft and constructed and arranged to normally and inherently occupy a position opening said inlets in the absence of pressure differential acting thereon and adapted to be engaged with said body across said inlets to close the same in response to compression of the fuel mixture in the crankcase.

5. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression

and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body through which said crankshaft extends and having inlets on opposite sides of said crankshaft adapted to communicate with the crankcase, and a pliant, elastic valve element having a central portion and arm portions extending from said central portion on opposite sides of said crankshaft in overlying relation to said inlets, means securing said central portion to said valve body, said arm portions being constructed and arranged to normally and inherently occupy a position away from said valve body to open said inlets in the absence of pressure differential acting thereon, said arm portions being engaged with said body across said inlets to close the same in response to compression of the fuel mixture in the crankcase.

6. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body through which said crankshaft extends and having inlets on opposite sides of said crankshaft adapted to communicate with the crankcase, and a valve element of tetrafluoroethylene sheet material having a central portion and arm portions extending from said central portion on opposite sides of said crankshaft in overlying relation to said inlets, means securing said central portion to said valve body, said arm portions being constructed and arranged to normally and inherently occupy a position away from said valve body to open said inlets in the absence of pressure differential acting thereon, said arm portions being engaged with said body across said inlets to close the same in response to compression of the fuel mixture in the crankcase.

7. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body through which said crankshaft extends and having inlets on opposite sides of said crankshaft adapted to communicate with the crankcase, and a pliant, elastic valve element having a central portion and arm portions extending from said central portion on opposite sides of said crankshaft in overlying relation to said inlets, means securing said central portion to said valve body comprising a guard having a central portion provided with a recess receiving said central portion of said element, said guard having arms overlying said arm portions and spaced from said valve body, said arm portions being constructed and arranged to normally and inherently occupy a position away from said valve body to open said inlets in the absence of pressure differential acting thereon, said arm portions being engaged with said body across said inlets to close the same in response to compression of the fuel mixture in the crankcase.

8. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body through which said crankshaft extends and having inlets on opposite sides of said crankshaft adapted to communicate with the crankcase, and a valve element of tetrafluoroethylene sheet material having a central portion and arm portions extending from said central portion on opposite sides of said crankshaft in overlying relation to said inlets, means securing said central portion to said valve body comprising a guard having a central portion provided with a recess receiving said central portion of said element, said guard having arms overlying said arm portions and spaced from said valve body, said arm portions being constructed and arranged to normally and inherently occupy a position away

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from said valve body to open said inlets in the absence of pressure differential acting thereon, said arm portions being engaged with said body across said inlets to close the same in response to compression of the fuel mixture in the crankcase.

9. In a two-cycle internal combustion engine having a cylinder, a crankshaft, and a crankcase for said crankshaft adapted to receive a fuel mixture for compression and transfer to the cylinder, a valve device controlling the induction of the fuel mixture into the crankcase comprising a valve body having an inlet adapted to communicate with the crankcase, a pliant, elastic valve element in overlying relation to said inlet, means securing said valve element to said body comprising a guard having a recess receiving said element, said guard having a portion overlying said element and inlet and spaced from said valve body, said valve element being constructed and arranged

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to normally and inherently tend to occupy a position opening said inlet in the absence of a pressure differential acting thereon and adapted to be engaged with said valve body to close said inlet in response to compression of the fuel mixture in the crankcase.

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