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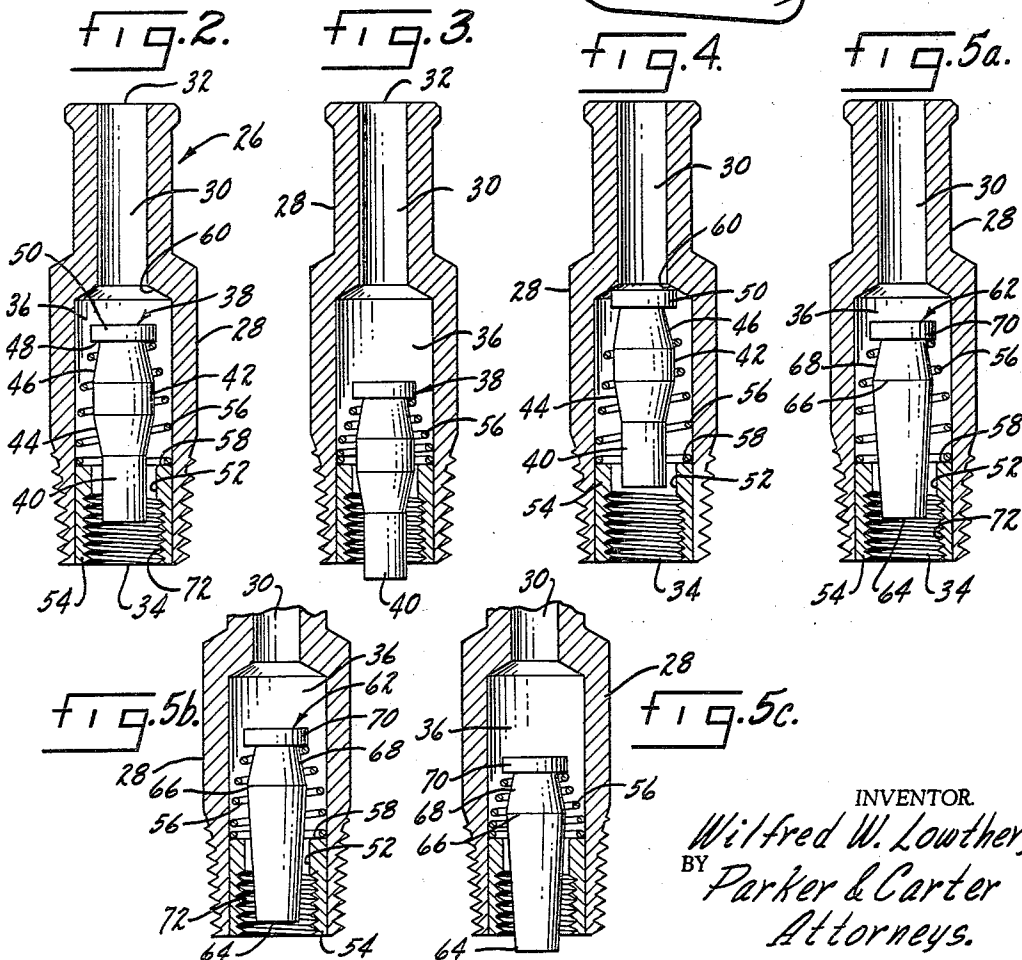
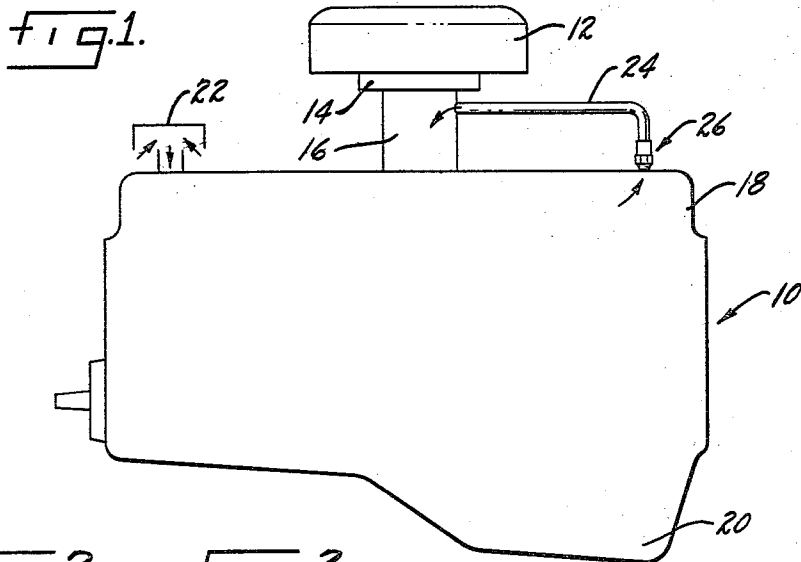
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3,105,477

CRANKCASE VALVE VENTILATING SYSTEM

Filed Jan. 8, 1962

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

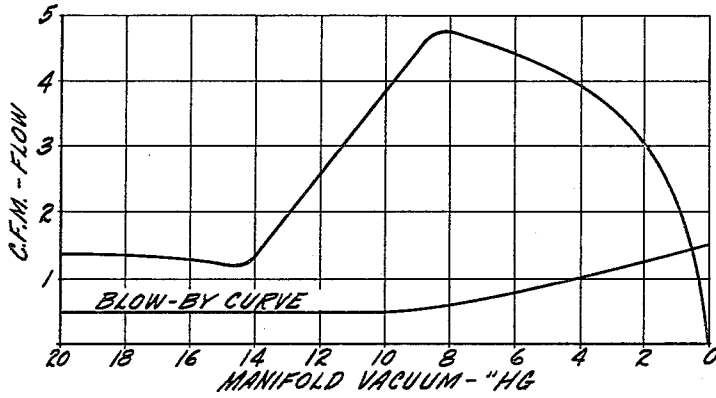


fig. 6.

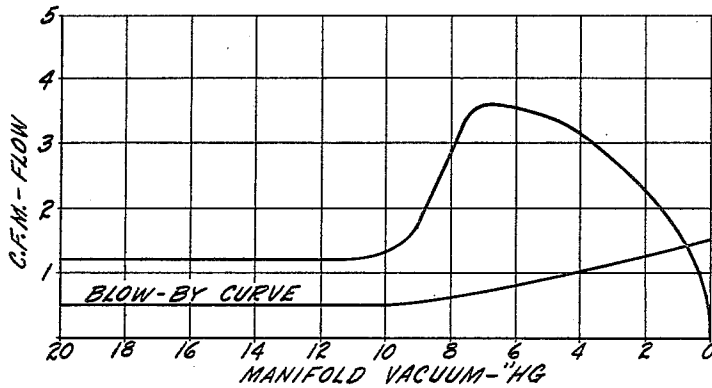


fig. 7.

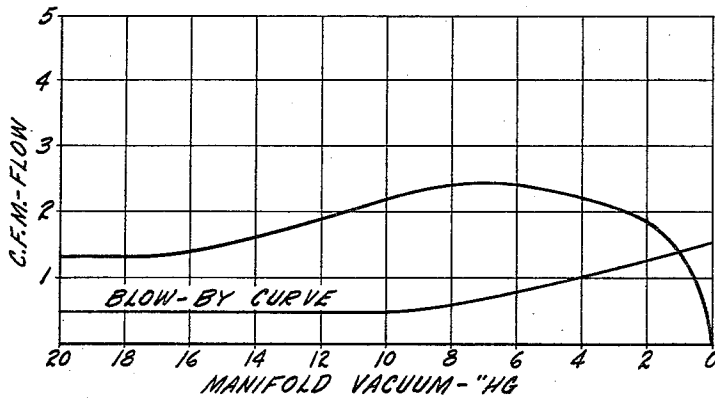


fig. 8.

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1

3,105,477

CRANKCASE VALVE VENTILATING SYSTEM
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This invention is in the field of crankcase ventilation systems for internal combustion engines. The invention is concerned with a valve structure for controlling the air flow for ventilating the crankcase of an internal combustion engine so that the blow-by from the cylinders will not be exhausted to the atmosphere.

A primary object of my invention is a control arrangement for a crankcase ventilating system which is self-cleaning and will not freeze up.

Another object is a valve for controlling the ventilation system of an internal combustion engine which will not plug up in use.

Another object is a crankcase ventilating system using a floating valve element.

Another object is a control for a ventilating system which insures an excess of ventilation over blow-by.

Another object is a crankcase ventilating system which guards against backfire.

Another object is a crankcase ventilating system control valve which may be easily adapted to the particular flow requirements of individual engines.

Another object is using the manifold vacuum to move air in desired amounts.

Other objects will appear from time to time in the ensuing specification and drawings in which:

FIGURE 1 is a schematic of an engine with my ventilation system;

FIGURE 2 is an enlarged sectional view of the valve in FIGURE 1 showing one position of operation;

FIGURE 3 is similar to FIGURE 2 but of another position;

FIGURE 4 is similar to FIGURES 2 and 3 showing the backfire position of the valve;

FIGURES 5a through c are of a modified form showing three positions of operation; and

FIGURES 6, 7 and 8 are graphs showing operating characteristics of the air flow versus manifold vacuum.

In FIGURE 1, I diagrammatically illustrate an engine at 10 which may have an air cleaner 12 and a carburetor 14 connected to an intake pipe or manifold 16. The upper portion 18 of the engine may be considered to be the rocker arm cover. The lower portion 20 may be considered to be the crankcase. In any event, I may position a breather cap of any suitable type, as at 22, on the rocker arm cover to admit fresh air to the inside of the engine. I may connect a passage 24 between the rocker arm cover and the intake pipe and having a valve structure 26 for providing a controlled flow of ventilating air from the crankcase back to the intake manifold. While I have shown the take-off on top of the rocker arm cover, it will be understood that this will provide effective communication between the crankcase and the air intake since the vapors of the crankcase will flow up through the push rod openings etc. The arrangement shown in FIGURE 1 is purely diagrammatic.

In FIGURE 2, I have shown the details of the valve structure 26 which may include a housing 28 having a generally centrally arranged passage 30 leading from an inlet 32 at one end to an outlet 34 at the other. In the center of the passage I provide an enlargement 36 which is a chamber for the valve. The valve is in the form of a pin 38 having a lower portion 40 of reduced diameter or dimension and an upper portion 42 of a somewhat enlarged diameter or dimension, interconnected by a

2

tapered portion 44. Above the upper portion, I may reduce the pin somewhat at 46 to provide a lower shoulder or abutment 48 with a head 50 above it.

In the lower portion of the housing, I may provide an orifice 52 which is defined by a sleeve 54 pressed or otherwise held in the lower end of the housing. The pin is held in place by a suitable spring, as at 56, which may be a coil spring or otherwise, the bottom of the spring rests against the upper shoulder of the orifice, as at 58, while the top rests against the shoulder on the pin. It will be noticed that the spring is a generally tapered coil spring but it may be otherwise. Also, it does not have to follow a uniform taper. Further, the small coil of the spring is at the top abutting the shoulder of the pin so that therebelow the coils of the spring move away from the body of the pin so that the pin is held in a suspended, free condition within the central passage through the housing. The central passage has a seat 60 above the pin chamber for backfire purposes.

In FIGURE 2, air from the crankcase enters the inlet 32 and goes out through the outlet 34 to the inlet manifold and then back into the cylinders. I have shown the inlet at the top in FIGURE 2, while in FIGURE 1 it would appear that the inlet is at the bottom. But either may be reversed. The point is that the valve will work with the inlet either up or down. So the housing in FIGURE 2 may be turned upside down, and this may be considered the FIGURE 1 position. Or I may reverse the valve in the FIGURE 1 arrangement with suitable piping so that the inlet is at the top with the pin supported on the spring, much like the FIGURE 2 position.

FIGURE 2 represents the full load or full speed condition where the manifold vacuum is the least. Whereas FIGURE 3 shows the pin pulled down at the no load or idling or light load condition where the pressure differential across the valve, due to high manifold vacuum, is the greatest. This may probably be best understood by reference to FIGURE 6. At no load or light loads or idling, the butterfly valve in the carburetor is closed. Thus, the pistons produce a high vacuum in the inlet manifold. Since the crankcase may be considered to be more or less at atmospheric pressure due to the opening through the breather 22, the pressure differential across the valve structure will be highest at idling and the low loads and speeds. Due to this high pressure differential, the pin will be pulled down into the orifice, such as shown in FIGURE 3, where the upper portion 42 will be generally positioned in the effective cross section of the orifice, as at 52. The upper portion 42 of the pin has a diameter or dimension less than the orifice dimension or diameter so that there will be a slight annular or peripheral clearance which will provide for air flow. This is the minimum clearance position and, therefore, the minimum air flow position. It should be noted that in the FIGURE 3 position, the sides of the pin are still out of contact with the orifice even though the clearance is the least. In fact, the pin is suspended on the spring which is compressed somewhat. Also, the coils of the spring do not touch, even though they are somewhat closer to each other. In fact, the open area between the coils is greater, by a great deal, than the minimum clearance area between the upper portion of the pin and the orifice so that the spring does not become a restriction. In other words, at no time is the spring compressed solid or anywhere near it. Note in FIGURE 6 that as the engine goes up in load and speed, the manifold vacuum will drop. For example at no load or idling, the manifold vacuum is shown as 20 inches of mercury. Thereafter, as the engine increases in load and speed, the manifold vacuum drops to 18, 16 etc. Someplace between 16 and 14 inches of mercury, say, roughly, 15, the pressure differential

across the pin has decreased sufficiently such that the spring begins to raise the pin. The upper portion 42 of the pin comes up out of the orifice and the tapered portion 44 becomes the effective part. Since the pin will be falling away from the orifice, so to speak, the effective clearance area between the sides of the tapered portion and orifice will increase. Thus, the opening through the valve will increase, which will allow a greater air flow. Thus, the curve indicating air flow in FIGURE 6 will move up. The rate of climb may be set by making the taper flatter or steeper. In the example shown in FIGURE 6, air flow will reach a maximum at something on the order of 8 inches of mercury manifold vacuum. Between about 15 and 8 inches of mercury manifold vacuum, the pin is modulating the air flow by providing an increasing clearance area, shown as approximately a straight line relationship, as manifold vacuum decreases. Since manifold vacuum is a direct indication of load and speed of the engine, the pin may be considered to modulate in direct relation to load and speed. In FIGURE 6, from about 8 inches manifold vacuum on up to wide open throttle where, theoretically, no pressure differential exists across the pin, the flow through the pin will fall off from the maximum to zero. It will be noted that the blow-by curve at all times lies below the ventilation flow curve, except possibly at wide open.

Because I can dimension the exterior of the freely floating pin to any dimension I want to gain any particular air flow characteristics, I can move the break-off which, as shown in FIGURE 6, runs from about 15 inches manifold vacuum to about 8 inches, to any suitable location. In other words, I can move the break-off or slant either left or right on the graph by dimensioning the pin properly, or changing the spring characteristics. I can make the slant steeper or flatter, again by pin dimensioning or spring characteristics, or a combination.

To illustrate this point, compare FIGURES 6 and 7. In FIGURE 6, the break-off starts at about 15 inches of mercury manifold vacuum and stops at about 8, running from an air flow about 1.3 c.f.m. up to about 4.8. If this is undesirable, the break-off can be shifted, for example to the right in FIGURE 7, by merely forming the different diameters on the pin. For example, in FIGURE 7 the break-off starts at about 11 inches of mercury manifold vacuum and is completed at about 7 inches, running from about 1.3 to about 3.6 c.f.m. air flow. FIGURE 7 has a much steeper break-off line than FIGURE 6 which starts later and ends slightly later. In effect, the break-off line or slant has been moved to the right. Compared to FIGURE 6, however, I could move the break-off line to the left, again by forming the pin with different diameters.

An important point about my valve structure is that the pin, although it freely floats in the chamber and does not necessarily have metal-to-metal contact in any position, nevertheless is dimensioned relative to the backfire seat and the orifice such that the lower end of the pin is always within the orifice. The most extreme position is shown in FIGURE 4 during backfire. The result is that the pin cannot become misaligned, but is held within predetermined limits of movement while it floats in the housing.

In FIGURE 4, I have shown the pin in a raised position where the head 50 rests against the seat 60 which may be considered the backfire position. It will be noted that the pin will still be centered, more or less, by the spring and will be out of contact with the orifice, but the lower or small end of the pin will still be within the orifice. Thus, there is no chance, even during backfire, of the pin, in rising to its maximum position, becoming misaligned with the orifice. Thus, there is no sticking or jamming.

Further, the spring and pin may be considered to float and the spring may, when backfiring takes place, still

rest on the orifice shoulder 53 or it may move up with the pin. In other words, the pin may move up inside the spring or the spring and pin may move up inside of the housing until the head 50 of the pin hits the seat 60.

In FIGURES 5a, b and c, I have shown a modified form in which the housing may be considered to be the same, the orifice the same, but the pin has been changed somewhat. In this case, the pin 62 has a full taper running from the lower end at 64 to an upper edge 66 with an indent 68 as a seat for the spring and a head 70 above it. In this form, the working portion of the pin, which is the lower part, from 66 to 64, below the head, is the part that cooperates with the orifice and, as such, I have no cylindrical portions which would correspond to the upper and lower portion in the FIGURE 2 form. Be that as it may, any cross section along the tapered portion from 64 to 66 may cooperate with the orifice to define an annular clearance area for any particular air flow desired. FIGURE 5a shows the raised position of the pin in which the lower portion 64 is within and confined by the orifice to define a maximum clearance area which corresponds to the full load or high speed operation of the engine. The upper portion 66, again on the taper, defines the minimum clearance area with the orifice and corresponds more or less to the no load or idling or low load and speed operation of the engine. In any event, the full effective length of the pin that cooperates with the orifice has a dimension throughout which is less than the orifice so that in all positions a clearance area, of greater or lesser extent, is defined. Thus, the pin will be suspended and will float within the housing in the same sense that the FIGURE 2 form does. FIGURE 5a corresponds to the idling or low load or low speed positions, while FIGURE 5b shows the pin in an intermediate position which may be considered a modulating position at some intermediate manifold vacuum.

FIGURE 8 is a graph showing the air flow against manifold vacuum when using a pin of the type shown in FIGURE 5 and it will be noted that a far less distinct break-off or rise is present at any given point and, in effect, this valve form will modulate practically throughout its entire length. It should also be noted that the blow-by curve is at all points below the air flow ventilation except at the extreme right end of the range which is the tremendously high speeds where automobiles, trucks, etc. rarely operate.

The backfire operation of the pin in FIGURE 5 may be considered to be the same as that of the FIGURE 2 pin.

In all forms, I may tap the inside of the orifice sleeve, as at 72, so that if the orifice is to be changed, a bolt may be run in to pull out the orifice sleeve. But this is optional.

The use, operation and function of my invention are as follows:

While I have shown the conduit connected to the cover for the rocker arms on top of an engine, it should be understood that it may be connected at any suitable point where access can be had to the crankcase of the engine. It will be understood in the form shown in FIGURE 1 that a free flow of the crankcase vapors will be obtained up through the push rod channels into the cover.

As illustrated by the graphs in FIGURES 6, 7 and 8, my valve has the advantage that when the pressure differential between the crankcase and the inlet manifold is highest, at idling and low loads, flow will be low since the large end or big diameter of the valve element or pin will be in the orifice. Thereafter, as the engine goes up in load and speed and inlet manifold vacuum decreases, the pressure differential across the valve will also decrease. At the high loads and speeds where the pressure differential is the least, the spring will move the pin until the small diameter is the only portion within the orifice. Thus, the opening will be the greatest and the air flow will

5

be more unrestricted. I shall refer to these as the no load and full load positions, but it should be understood that these are merely relative terms.

The valve is shown in the full load position in FIGURE 2 and the small or lower end of the pin is within 5 and laterally aligned with the orifice. No part of the exterior of the pin is necessarily in contact with the orifice nor is it in contact with the housing necessarily. Thus, the air flow will separate at the pin into an annular flow on all sides and then reunite when going through 10 the orifice and on to the manifold. The clearance area between the exterior of the small diameter of the pin and the orifice may be accurately and easily controlled by making the small portion of the pin either larger or smaller. Thus, the full load air flow through the control 15 system may be accurately and easily controlled. The same is true of the no load position since the clearance area between the large diameter of the pin and the orifice may also be easily changed by either enlarging or reducing the diameter of the large portion. Also, the characteristics of the valve may be easily changed by changing the spring. I have shown a conventional tapered coil spring, but it should be understood that in certain 20 situations, I might use a spring which in cross section, bowed either in or out, slightly bell shaped, or a combination of springs, one being effective during only a certain portion of the pin's movement and both effective during another portion of the pin's movement, as an example, to obtain certain flow and performance characteristics.

In the specification and claims, I have referred to the pin as being generally upright and I have used the terms top, bottom, upper, lower, etc. But it should be understood that these terms are used merely for purposes of designation and orientation, and the valve will operate satisfactorily in a horizontal or upside down position; in fact, in any position. Thus, in the specification and claims, the terms "upper," "lower," and the like, should not be interpreted to mean that the valve has to be operated vertically.

One of the most important points about the operation and structure of this valve is that in all positions the pin itself is freely suspended and is held merely by a balancing of forces, namely the air pressure differential and spring thrust. At no time does the pin bottom against a valve seat, except during backfiring, which is a necessary safety feature. But in normal operation, the pin is suspended or floats on the spring with no seating or metal-closing contact with the orifice or sleeve.

In the claims, I have made use of the term "upper portion" and "lower portion" and it should be understood that there may be additional structure below the "lower portion" or above the "upper portion." I use these terms simply to designate the position of the large and small diameter portions during the floating operation of the pin. It should also be understood that "upper portion" and "lower portion" do not have to be cylindrical, in the form shown in FIGURE 2. For example, I might have a full taper from one end to the other, such as in FIGURE 5, and the use of the terms "upper portion" and "lower portion" may be considered to read on a taper since a given cross section of the taper will be cylindrical and may be considered as the portion in question.

While I show a relatively small angle of divergence on the taper between the two portions in the FIGURE 2 form, it will be understood that this taper may be more or less. In fact, the taper does not have to follow a true conical form and the taper in either FIGURE 2 or FIGURE 5 may be slightly concave or convex in axial section if certain flow characteristics are desired.

One of the advantages of using a floating pin of this type is that by properly dimensioning and proportioning the length and the cross section relative to the spring strength and the characteristics of the spring and also

6

the orifice opening, I can obtain any combination of air flow characteristics at almost any point on the manifold vacuum curve. This is shown in the various flow forms of FIGURES 6 through 8. Furthermore, I may move the break-off point either to the left or right, as desired, depending upon the take-off point of the particular engine and manifold involved. I may make the break-off point as steep as desired, somewhat like FIGURE 7, or I may flatten it out, as shown in FIGURE 8. The comparison can be shown best by comparing FIGURES 6 and 7 where the step-off or break has been shifted somewhat to the right and lies generally between 11 and 7 inches of vacuum. In effect, the pin has been redimensioned or the spring changed or both so that the break-off or slope has been moved from FIGURE 6 to the right. But it might be the other way.

When the large portion or large diameter of the pin is within the orifice so that the minimum passage area is available for air flow, at low loads, the spring thrust is balanced against the vacuum thrust. In this condition, however, the spring is not compressed solid and there is sufficient opening, in fact, in excess of the cross section of the annular clearance, such that air flow is not effected.

In the various forms shown, I have formed a head on the pin to abut the small end of the spring, and I preferably make the spring flare out from the body of the pin therebelow, so that the main portion of the pin is free to move around in the spring. This has the advantage that the device will be self-cleaned and will not clog up. Furthermore, it will not freeze. There are no internal passages or external grooves in the pin to clog or freeze. Further, the spring provides the floating action which normally will center the pin in the passage but at the same time will allow it to wobble from side to side. Further, the small end of the spring may have a diameter which is just slightly greater than the diameter or dimension of the pin within it so that the pin may shift laterally somewhat to accurately self-center itself in the passage.

Since the pin floats and there is no metal-seating contact between the valve surface and the orifice surface, the pin itself can be made of an inexpensive metal and does not require surface hardening to prevent wear and abrasion. The same is true of the orifice.

In addition to the floating action of the pin, I also get a control flow by the ability to shape the diameters on the pin to produce any clearance area I want. Further, the device is simple and is made of a minimum number of parts. For example, I have a housing with a passage through it defining a chamber for the pin. One end is large enough to accept the pin and spring and the orifice can be pressed in and will serve as a support for the large end of the spring. Since I may shape the effective diameters along the length of the pin to any size I want to get any clearance area I want, I may get a modulated flow of air in the intermediate part of the taper and not an off-on situation.

In fact, my structure has so few parts that variation in performance can be quite easily obtained. For example, I may vary the spring, or the pin area, or the orifice, or a combination. I may taper the pin throughout its entire length or through only a portion. I may have a single spring or a combination of springs to give particular pin movement or a special pin shape.

Depending upon whether the device is mounted as shown in the drawings or upside down, the loading will be the metering pin plus gravity in one direction, or the spring less gravity on the other. The connection shown in FIGURE 1 is purely schematic and may be made in any suitable manner.

While I have referred to no metal-to-metal contact or no seating contact, it should be understood that the pin will contact the sides of the housing and orifice due to engine vibrations. However, this should be distin-

guished from the metal-to-metal contact that occurs in a normal valve closing operation. In essence, there is no stop or seat in my structure to plug up. Further, the airflow itself tends to center the pin, but at the same time the pin is free for lateral oscillation since it is only supported loosely at one end.

I have referred to, and the FIGURES 6 through 8 diagrams show, a theoretical manifold vacuum of 0 inch of mercury, and it will be understood that in practice this cannot be obtained. I have found, in practice, that there will be about 1 inch manifold vacuum when the throttle is wide open.

I have referred to the cross section of the pin as round, and it should be understood that it could be other than round, although I prefer the round cross section.

Also, in FIGURES 2 through 5, I have shown the orifice as an insert, but it should be understood that the orifice or sleeve may be an integral part of the housing and the inlet or top part 32 may be made as an insert. In order words, either end may be the insert to allow the pin to be inserted.

While I have shown and described the preferred form and suggested several modifications of my invention, it should be understood that suitable additional modifications, changes, substitutions and alterations may be made without departing from the invention's fundamental theme. I, therefore, wish that the invention be unrestricted, except as by the appended claims.

I claim:

1. For use in an engine crankcase ventilating system wherein a conduit communicates between the engine crankcase and the air intake for the cylinders, a valve structure adapted to be positioned in the conduit including a valve element and a housing having an orifice therein, the valve element being positioned in the housing and being in the form of an elongated solid pin adapted to be disposed normally in a generally upright position, the pin having a lower portion with a smaller exterior dimension than its upper portion, the body of the pin in between the two portions being generally tapered, a spring to bias the pin away from the orifice at all times, the at-rest position of the pin, when the spring is at its free length, being such that the small cross section lower portion of the pin will be generally within the confines and laterally aligned with the orifice, the exterior dimensions of both the upper and lower portions being less than the inside dimension of the orifice, the flow area defined between the lower portion of the pin and the orifice being substantially greater than the flow area defined between the upper portion of the pin and the orifice, the dimensions of the pin and rate of the spring being such that the pin is out of contact with the orifice under all load conditions.

2. The structure of claim 1 further characterized in that the load characteristics of the spring are such in relation to the vacuum and pressure conditions of the crankcase and intake for the cylinders, over the load and speed range of the engine, such that when there is a maximum pressure differential across the pin to draw the upper portion of the pin into the orifice thereby loading the spring, the pin will be held in suspension by the balance between the pressure differential and the spring thrust.

3. The structure of claim 1 further characterized by and including a head portion on the pin above the upper portion having a laterally disposed shoulder in engagement with the spring.

4. The structure of claim 1 further characterized in that the spring is a compression spring.

5. The structure of claim 1 further characterized by and including a head portion on the pin above the upper portion having a shoulder disposed generally laterally thereon and in engagement with the upper end of the spring, the spring being a compression spring, the lower end of the spring resting on the orifice.

6. For use in an engine crankcase ventilating system wherein a conduit communicates between the engine crankcase and the air intake to the cylinders, a valve structure adapted to be positioned in the conduit including a housing with a generally central passage having a valve enlargement between the ends thereof, with an inlet at one end and an outlet at the other, a valve element positioned in the enlargement and being in the general form of an elongated solid pin adapted to be disposed generally axially within the housing passage, and an orifice at the housing outlet, the pin having a lower portion with a smaller exterior dimension than its upper portion, the body of the pin between the two portions being generally tapered, a spring biasing the pin away from the orifice at all times, the at-rest position of the pin, when the spring is at its free length, being such that the pin will be out of contact with the side walls of the enlargement and the orifice, the spring engaging the side walls of the enlargement and the pin in a manner such that in all positions of operation the pin floats on the spring out of contact with the side walls of the enlargement.

7. The structure of claim 6 further characterized in that the orifice is in the form of an insert fitted in the outlet of the housing and providing a shoulder at its inner edge, the spring being generally tapered, small end up, the lower end of the spring resting against the shoulder provided by the orifice insert, the small upper end of the spring engaging the pin.

8. For use in an engine crankcase ventilating system wherein a conduit communicates between the engine crankcase and the air intake for the cylinders, a valve structure adapted to be positioned in the conduit including a valve element and housing having an orifice therein, the valve element being positioned in the housing and being in the form of an elongated pin having a lower portion with a smaller exterior dimension than its upper portion, the body of the pin in between the two portions being generally tapered, a spring to bias the pin away from the orifice at all times, the at-rest position of the pin when the spring is at its free length, being such that the flow area defined between the lower portion of the pin and the orifice is substantially greater than the flow area defined between the upper portion of the pin and the orifice, the proportioning and dimensioning of the housing, pin, spring and orifice being such that the pin is out of contact with the orifice under all load conditions.

9. For use in an engine crankcase ventilating system wherein a conduit communicates between the crankcase and the air intake for the cylinders, a valve structure adapted to be positioned in the conduit to control the flow of crankcase vapors therethrough, a freely supported flow control pin in the valve structure, a spring supporting the pin therein so that the pin is normally out of contact with the walls of the valve structure other than through its spring support such that the air pressure differential through the valve structure operates the pin and spring, the spring being dimensioned such that in its free length, the pin is normally out of contact with the housing of the valve structure, an orifice in the valve structure downstream from but closely adjacent to the pin and defining an effective flow passage therewith so that as the air pressure differential varies through the passage, causing differential movement of the pin, the effective flow passage between the pin and orifice will be varied in accordance with pin movement, the effective flow passage being tailored to provide various flow areas between the pin and orifice in response to various air pressure differentials through the valve structure so that the flow area is coordinated to the blow-by characteristics of the engine.

10. The structure of claim 9 further characterized in that the pin is of a length in relation to the free length of the spring such that in the at-rest position of the

pin and spring, the downstream end of the pin will be generally within the confines and laterally aligned with the orifice.

11. The structure of claim 9 further characterized in that the spring is in the form of a coil compression spring disposed about the pin and in engagement with a portion of the pin upstream from the orifice, the dimensioning of the coils of the spring being such that compression and extension of the spring due to variations in air pres-

sure differential cause the coils to effect a self-cleaning action with the walls of the valve structure.

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