May 3, 1955 L. W. KIRKPATRICK ET AL 2,707,462

VALVE ASSEMBLY

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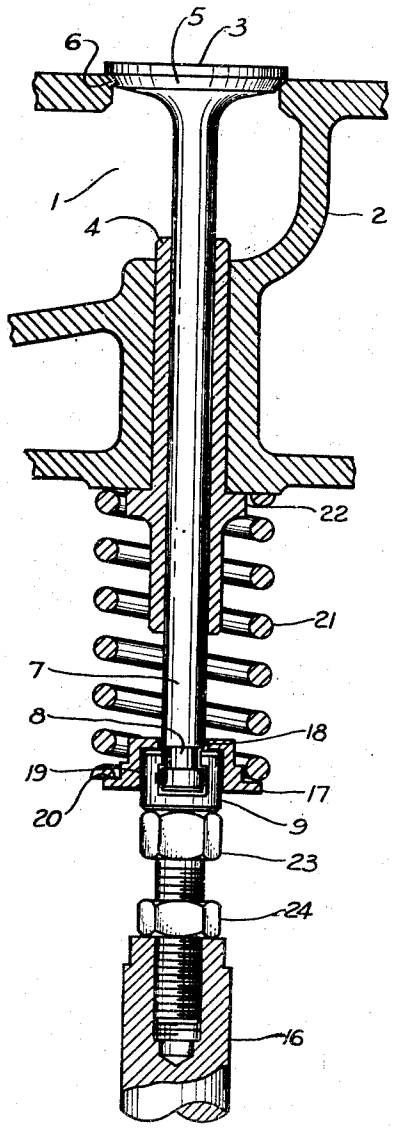


Fig. 1

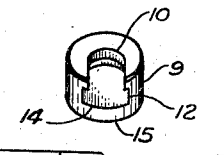


Fig. 2

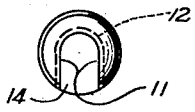


Fig. 3

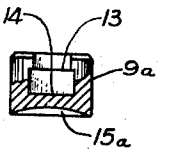


Fig. 4

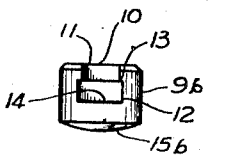


Fig. 5

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VALVE ASSEMBLY

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3 Claims. (Cl. 123—90)

The present invention relates broadly to a poppet valve assembly particularly suited for use in internal combustion engines, and in its specific phases to a special valve assembly wherein the valve is freely rotatable continuously in either direction when it is not seated.

The present day practice which is commonly used in connection with the mounting of poppet valves in internal combustion engines, such as automobile engines, involves single or multiple grooving of the lower end of the valve stem, and engaging these grooves with removable semi-circular inserts having internal ribs adapted to tightly fit the valve stem. The outer face of these inserts is uniformly tapered with the small end at the valve head end of same. A valve spring retainer cup with a correspondingly tapered bore is adapted to fit over these semi-circular inserts so that under the force exerted by the valve spring during conventional use, the spring retainer cup is rigidly gripped onto the valve stem. With this type of construction, the friction of the ends of the compressed valve spring on the motor block and on the rigidly gripped spring retainer cup effectively locks the valve against rotation. This causes so-called "grunt grabbing," promotes uneven wear of the valve seat and block seat, tends to produce "hot spots" on the valve head and the spot building up of carbon and lead deposits on the seating area, and stem breakage directly under the valve head due to fatigue caused by what is known as "spring wind pressure."

The rigidly gripped parts of the valve assembly described above are seldom perfectly produced, and neither are the ends of the valve springs perfectly parallel nor uniform in their loading action on the valve. As a result the plane of the upper or spring supporting face of the rigidly gripped spring retainer cup is commonly out of true perpendicular to the axis of the valve stem. This condition, in combination with spring wind pressure and the rigid grip of the spring retainer cup on the valve stem, eccentrically loads the valve stem so that it almost invariably wears on one side at one end of the valve guide and on the other side at the opposite end of the valve guide. The friction on the valve stem in the valve guide caused by this eccentric loading also requires that the valve spring be heavier than otherwise necessary, with more operating power required, and after considerable wear, is commonly the cause of the valve not seating properly, as well as being out of alinement, which in turn promotes valve burning as well as the building up of carbon and lead in the seating area.

In an attempt to avoid the above situation, several forms of positive drive valve rotators utilizing one-way clutch assemblies and the like have been proposed. Those constructions are not only expensive to produce, but are also subject to wear and breakage with inherent expense for repairs and replacement. Another plan has been to free the valve, when it is lifted from its seat, and then give the spring retainer cup an oscillatory motion of reversing spiral pattern through a sidewise projecting dog on the retainer cup adapted to engage a spiral slot in a sleeve within the valve spring, the retainer cup having a tapered

bore engaging a pair of semi-circular inserts which loosely fit an elongated groove in the lower end of the valve stem. This construction is also impractical due to the substantial impossibility of the dog following a spiral pattern groove under conditions of present day conventional high engine speeds, the wear inherently involved in the dog and groove, and the need of a much stronger valve spring to force the valve to close even under moderate engine speeds. Another plan which has been proposed involves taper boring the valve spring retainer from its bottom and slotting same sidewise slightly wider than the smallest diameter of the valve stem, which in turn is provided with an enlarged tapered end having a portion fitting the taper of the valve spring retainer, such valve stem being adapted to be directly engaged by the valve operating pushrod during the lifting and lowering of the valve. This procedure is subject to wearing the end of the valve stem as well as the inaccuracies inherent in producing a taper bore in a valve spring retainer and a matching taper on the lower end of the valve stem, which in turn cause eccentric loading and the difficulties caused by same. A more feasible construction is shown in the George R. Rich Patent No. 2,647,501, of which the present invention is an improvement. It was a recognition of the above difficulties, as well as other problems and difficulties in this field, and the need of a satisfactory solution for same, which led to the conception and development of the present invention.

Accordingly among the objects of the present invention is the provision of a new type of valve assembly wherein the engine push rod actuates the valve by direct contact with the underface of a one-piece member which connects the valve spring retainer loosely to the valve through an annular groove near the lower end of the latter in manner promoting automatic continuous free rotation of uni-directional type or indexing of the valve in use, and in doing so extends the life of the valve due to (1) constantly wiping the valve face and valve seat clean thus leaving no deposits to flake off and start the valve guttering, (2) minimizing the effects of distortion due to thermal and/or mechanical factors, (3) preventing local hot spots in the valve face which are the starting points of valve burning, (4) promoting even wear of the valve stem all around in the valve guide, and in doing so this prevents deposits on the valve stem which would cause the valve to stick in its guide and to be held open and thus inoperative, (5) facilitates more uniform valve stem lubrication and substantial elimination of scuffing, (6) stopping valve stem breakage directly under the valve head caused by fatigue induced by spring wind pressure, (7) permitting moderately increased operation speeds above the current maximum, (8) eliminating wear on the end of the valve stem which would take place if the actuating push rod or rocker arm directly contacted same, and (9) making possible longer valve operation before valve grinding becomes necessary.

Another object is to provide a new form of valve assembly wherein spring wind pressure is relieved and the valve is freely rotatable when lifted from its seat under normal operating conditions, both of which are facilitated by the direct lifting of the assembly through the special form of one-piece, closed bottom, valve engaging member.

Another object is to provide a valve assembly wherein the valve stem is annularly grooved, perpendicular to its longitudinal axis, above but adjacent its end for the engagement with a special one-piece member having a closed bottom, said member having a sidewise extending slot in its upper face, the lower portion of said slot being undercut to a width and depth exceeding the diameter and length of the end of the valve stem below said groove therein, the portion of said member above said undercut being of a thickness slightly less than the width of the

groove in said valve stem, and adapted to engage and actuate said valve through the latter.

Another object is to provide a member for engaging a grooved valve stem, said member having a concentric opening in its upper face, and a solid lower face, said concentric opening being joined by a parallel-sided slot which extends full size to one side of said member, said slot having an undercut portion slightly wider than the thickness of said valve stem with its inner end also concentric with said member, said upper face concentric opening and slot being of a size slightly larger than the groove in said valve stem, and the distance from the upper face to said undercut portion being slightly less than the length of said stem groove, with the distance from said stem groove to the end of the valve stem being less than the depth of said undercut portion so that when said valve stem engaging member is mounted on the valve stem the end of the valve cannot contact the bottom of said undercut portion, and a valve spring retainer cup having a central opening therethrough slightly larger than said valve stem, said valve spring retainer cup being concentrically counterbored on its under face to receive said valve stem engaging member and center said valve stem in the concentric opening in the upper face of said valve stem engaging member.

A further object is to provide a simplified valve assembly which is self-alining and self-centering and which holds its seating and alinement better than usual even after considerable wear, and due to its freeness of action does not require as heavy a spring as is now commonly used on like size valve assemblies, with resultant increase in the engine's power when this assembly is used.

A further object is to provide a valve assembly which is free from "grunt and grab" when seating, eliminates the use of split washers, uses only one part to join the valve stem to the valve spring retainer cup, is efficient, easy to install and remove, and yet permits free rotation of the valve when it is not seated.

Still further objects and advantages of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the valve means hereinafter fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail certain means for carrying out the invention, such disclosed means illustrating, however, but several of the various ways in which the principle of the invention may be used.

In the annexed drawing:

Figure 1 shows a partially sectioned assembly view of a preferred form of the present invention.

Figure 2 shows a perspective view of the valve stem connecting member of the present invention.

Figure 3 shows a top view of the valve stem connecting member illustrated in Figure 2.

Figure 4 shows a partially sectioned view of a modified form of the valve stem connecting member illustrated in Figure 2, said modification involving a recessed lower face particularly adapted for engagement by a rocker arm for actuating the valve assembly.

Figure 5 shows a front view of a modified valve stem connecting member having a rounded bottom.

Referring more particularly to Figure 1 of the drawing, valve port **1** of the motor block **2** is shown with the head of valve **3** closing same. This valve is of the type adapted to be reciprocated endwise through valve guide **4** in conventional manner with seat **5** of the valve engaging with block seat **6** when the valve is in closed position as shown.

Adjacent the lower end of valve stem **7** there is provided an accurately machined annular groove **8**, the upper and lower edges of which are in parallel planes perpendicular to the longitudinal axis of the valve stem. Mounted in engagement with this groove is a valve stem connecting member **9** which is preferably of circular disc form, as shown more particularly in Figure 2. This connecting member has a center opening **10** of a diameter just slightly larger than the diameter of annular groove **8** in valve stem **7**. Extending from this center opening **10** to the outer edge of valve stem connecting member **9** is a groove **11**. The sides of this groove are preferably parallel and spaced apart a distance equal to the diameter of center opening **10**. Directly beneath center opening **10** and groove **11**, Figures 2 and 3, there is provided an undercut portion **12** which, at the central portion of connecting mmeber **9**, is co-axial therewith and of a diameter slightly larger than the diameter of valve stem **7**. This undercut portion **12** then extends outward to the edge of connecting member **9** with the sides of same parallel to each other and symmetrical with the sides of groove **11**. The upper face **13** of undercut portion **12** is preferably parallel to the top face of connecting member **9**, with the two spaced apart a distance just slightly less than the length of annular groove **8** in valve stem **7**. Lower face **14** of undercut portion **12** is preferably spaced a distance below upper face **13** an amount in excess of the length of the end of valve stem **7** below annular groove **8** plus the amount that the length of annular groove **8** exceeds the distance between the top of connecting member **9** and upper face **13** of undercut portion **12** of same. Under these conditions the lower end of valve stem **7** cannot contact lower face **14** of undercut portion **12** of the valve stem connecting member **9**, and the valve is solely joined to valve stem connecting member **9** through the portion of the latter above undercut portion **12** which fits into groove **8** of valve stem **7**. The bottom **15** of connecting member **9** is thus solid and adapted to stand long wear under conditions of actuation through tappet **16**, or the like.

Mounted on the lower end of valve **3** is a spring retainer cup **17** which has a center bore **18** which is slightly larger than the diameter of valve stem **7** to avoid binding thereon. The lower face of the spring retainer cup **17** is provided with a counterbore **19** which is coaxial with center bore **18** and closely fits but is slightly larger than the outside diameter of valve stem connecting member **9**, the inner face of said counterbore being in a plane perpendicular to the axis of said center bore **18**. Spring retainer cup **17** is provided on its upper face with a shouldered groove **20** which is coaxial with center bore **18** and of suitable size to support and center the lower end of valve spring **21** on cup **17**, said groove also being in a plane perpendicular to the axis of said center bore. The upper end of valve spring **21** may be held in suitable position by shoulder **22** of valve guide **4**.

Valve tappet **16** is actuated in any conventional manner (not shown) and the upper end of same is preferably bored and threaded for the reception of a stud **23**, which, to facilitate adjustment, may have a hexagon head, and has mounted thereon a lock nut **24** for holding stud **23** after adjustment to desired operating position. The head of this stud **23**, which is preferably co-axial with valve stem **7** and normally moves in alinement with same, is adapted to actuate valve **3** through valve stem connecting member **9**. Stud **23** is preferably hardened to a suitable degree and its upper face accurately ground in a plane perpendicular to its axis for direct engagement with the lower face of valve stem connecting member **9** which is also preferably hardened and ground to facilitate accurate adjustment while allowing relative movement between them.

One convenient way to set the operating clearance, for a valve mounted in accordance with the present invention, is to first determine with a feeler (not shown) the space between the top of connecting member **9** and the upper edge of annular groove **8** when connecting member **9** is in its lowermost position and resting on the lower shoulder of annular groove **8**. This clearance should be less than the amount of clearance for which the valve is to be set. Then the remainder of

the desired clearance is set by adjusting stud **23** so that when tappet **16** is in its lowermost position, such remainder will be between the bottom of connecting member **9** and the head of stud **23**. After this adjustment has been made, lock nut **24** is tightened to maintain the clearance setting.

With the valve in its seated position, as shown in Figure 1, the valve spring **21** will exert downward pressure on the upper face of spring retainer cup **17** and in turn the latter will hold connecting member **9** in contact with the lower face of groove **8** in valve stem **7**. In this position the minimum operating valve spring pressure is exerted in holding the valve seated on block seat **6**. After the tappet **16** starts to rise, the upper end of stud **23** will move upward into contact with the lower face **15** of connecting member **9**. Then as the tappet continues to move upward, upper face **13** of the undercut portion **12** of connecting member **9** will leave the lower face of groove **8**, and connecting member **9** will continue to move upward until the top face of same engages the upper face of groove **8** in stem **7**, during which time valve **3** will hang free. Further movement of the tappet in upward direction will, through connecting member **9**, carry valve **3** upward to the top of its travel, during which time the valve will freely rest and be rotatable on the upper face of valve stem connecting member **9**, and will not be affected by the increasing spring pressure caused by the compression of valve spring **21**. Valve tappet **16** then starts moving downward and the spring continues to hold the bottom of connecting member **9** in contact with the upper end of stud **23**, the valve still remaining free to rotate. When the valve reaches the lower end of its travel and the spring is holding connecting member **9** against the lower edge of valve stem groove **8**, tappet **16** will move away from connecting member **9** to the extent of the preset clearance between them, thus allowing the spring tension to once more clamp the valve head into seated position against block seat **6**. It is thus to be seen that the valve, throughout its entire cycle of operation except when seated, is entirely free of valve spring pressure. This it has been found, eliminates "grunt grabbing" and grooving of the valve stem on diametrically opposite sides at the top and bottom of the valve guide, and makes possible the exceeding of 4600 R. P. M. of the valve containing motor, which has been the commonly considered limit practical in the past due to the difficulties encountered in connection with the valve head breaking from the the valve stem on account of spring wind pressure when the valve is rigidly gripped to the spring retainer cup. It has been found by actual tests that the valve, when assembled in accordance with the present invention, gradually rotates substantially in one direction under conditions of operation so as to wear uniformly and at the same time almost completely avoids building up of carbon on the valve seat as well as the valve burning encountered in the past, while permitting thousands of hours of extra operation before valve grinding becomes necessary.

From the above it will be noted that means have been provided for accomplishing the objects set forth, but attention is again invited to the fact that variations may be made in the construction set forth without departing from the spirit of the invention. The directional terms "upper," "lower," "top," "bottom," et cetera, have been used for convenience in describing the invention in its position shown in the drawing and likewise are not to be considered as a limitation on the invention.

Other modes of applying the principle of our invention may be employed instead of those explained, change being made as regards the mechanism herein disclosed, provided the means stated by the following claims, or the equivalent of such stated means, be employed.

We therefore particularly point out and distinctly claim as our invention:

1. A valve assembly comprising a valve spring, a poppet valve with head and stem, said stem having an external annular groove adjacent its end remote from said head, a valve stem connecting member, said connecting member being of thick disc form with a central opening and undercut sidewise extending slot in its upper face adapted to receive and hold the slotted end of said valve stem substantially centered on said connecting member while allowing said valve limited endwise movement and free rotation when in unseated position, a valve spring retainer cup having a central opening slightly larger in diameter than the diameter of said valve stem and a counterbore on its lower face of a size to receive and hold said connecting member, and a valve opening means adapted to solely engage said connecting member on the side of same opposite to that in contact with said valve spring retainer cup and being the sole means for actuating said valve, said valve opening means first moving said connecting member from contact with the bottom of said valve stem groove and upon further movement forcing the upper portion of said connecting member against the upper part of said groove to lift said valve, said valve then being free for rotation with respect to said connecting member.

2. A valve asembly as set forth in claim 1, wherein the central opening of said connecting member is of a slightly larger diameter than that of said annular groove in said valve stem, said sidewise extending slot being of substantially the same width as the diameter of said opening, said undercut portion below said central opening and slot being of a size a little larger than the diameter of said valve stem and spaced below the upper face of said connecting member a distance slightly less than the length of said annular groove in the valve stem and of a depth substantially greater than the length of the end portion of said valve stem below said groove so that said connecting member can be slid sidewise onto the end of said valve stem and freely center on same.

3. A connecting member for a poppet valve with head and stem, said stem having an external annular groove adjacent but spaced from its end remote from said head, the sides of said groove being in parallel planes perpendicular to the longitudinal axis of said valve stem, said connecting member being in the form of a thick disc having in its upper face a central opening and slot extending sidewise to one edge of said disc, said central opening and slot being of a size slightly larger than the diameter of the groove in said valve stem, said connecting member being undercut below and concentric with said central opening and having an undercut slot extension with sides substantially parallel to the sides of said first named slot, said undercut portion being of a size slightly larger than the diameter of the end portion of said valve stem and spaced below the upper face of said connecting member a distance slightly less than the length of said annular groove in the valve stem, said undercut portion also being of a depth substantially greater than the length of said valve stem end portion below said groove therein, said connecting member having a closed bottom, and when slid sidewise onto the end of said valve stem, same will be freely rotatable thereon.

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