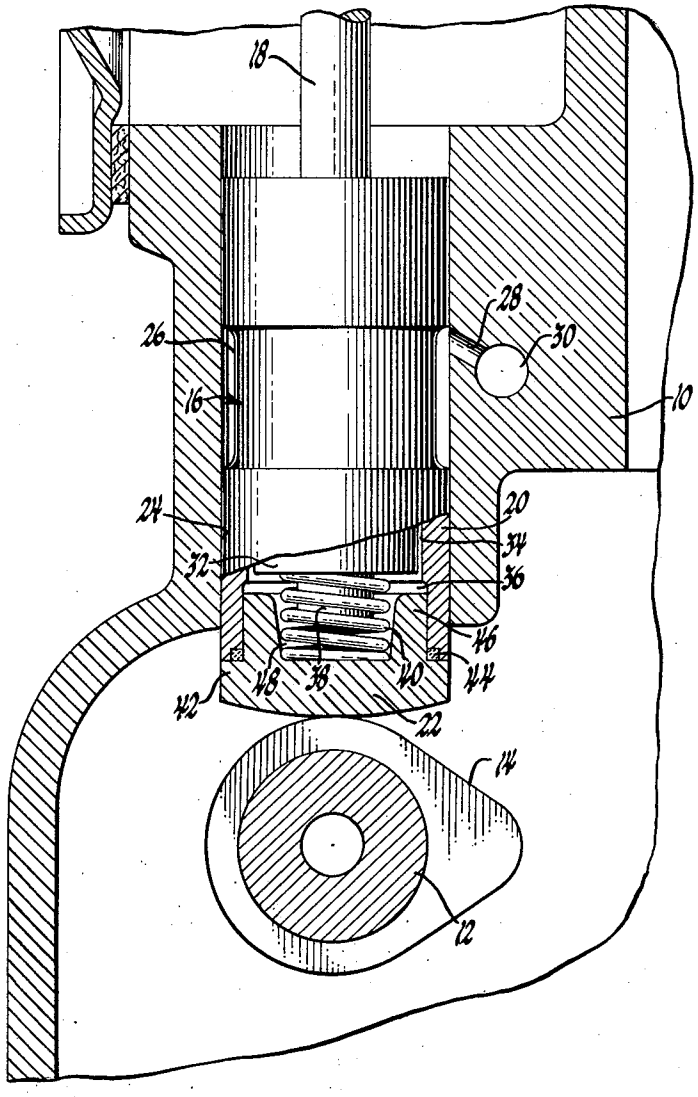
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COMPOSITE VALVE LIFTER

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COMPOSITE VALVE LIFTER

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This invention relates to valve lifters for operating poppet valves in internal combustion engines and, more particularly, to a composite hydraulic valve lifter having an alloy cast iron foot piece which is especially suitable for use with a steel camshaft.

Heat treated alloy cast irons have been employed by the automotive industry as valve lifter foot materials for a number of years. Such irons have been rather extensively used in both hydraulic and mechanical valve lifter applications in engines equipped with cast iron camshafts. Prior to the present invention, however, alloy iron valve lifter feet never proved to be successful for operation on steel camshafts.

In the past, attempts also have been made to use valve lifters having a one-piece gray iron body casting with a chilled gray iron foot portion which was produced by casting the foot surface against a chilled plate. Low speed endurance tests of engines containing these valve lifters resulted in fatigue pitting failures on the lifter foot. Such failures occurred whether the valve lifters were used in conjunction with alloy gray iron camshafts or carburized steel camshafts. Consequently, the one-piece gray iron valve lifter body castings were discarded in favor of heat-treated alloy cast irons or carburized and hardened steel. These experiences indicated that heat-treated alloy cast iron is more compatible with alloy iron camshafts than chilled gray iron, whereas the latter is suitable for use with forged steel shafts.

While valve lifters formed of certain chilled gray irons exhibit a relatively low degree of wear and a high degree of compatibility with steel camshafts, these gray irons cannot be used satisfactorily in the two-piece body valve lifter design presently employed extensively in many automobile engines. It has been found that a valve lifter foot casting formed of chilled gray iron is damaged by the necessary heat treatment of the steel lifter body tube because of the instability of the iron carbide structure at the elevated temperature. Although a two-piece valve lifter body design is highly desirable from a manufacturing standpoint, it therefore has been necessary in the past to use a one-piece body lifter when the cooperating camshaft was formed of steel.

Accordingly, a principal object of the present invention is to provide a composite valve lifter with an alloy cast iron foot piece having an iron-chromium-molybdenum carbide structure somewhat similar to the carbide structure of chilled gray cast iron and which operates satisfactorily in conjunction with a steel camshaft. A further object is to provide a valve lifter of this type which can be produced without changing present foundry practice or increasing costs.

These and other objects are attained in accordance with our invention with a composite valve lifter having a foot formed of an alloy cast iron consisting essentially of 3.2% to 3.4% total carbon, 1% to 1.4% silicon, 0.7% to 0.9% manganese, 2.4% to 2.6% chromium, 0.4% to 0.7% nickel, 0.4% to 0.7% molybdenum and the balance substantially all iron. We have found that such a valve lifter foot is heat treatable through the normal cycle used for hardening the steel sleeves or tubes which generally constitute part of the lifter body, thereby simplifying the processing procedure and correspondingly reducing production costs. A hydraulic valve lifter having a steel

tubular body portion and a foot piece formed of the aforementioned alloy cast iron composition has proved to be highly satisfactory for use with a steel camshaft because of the large percentage of complex ternary carbides in the alloy iron.

Other objects and advantages of this invention will more fully appear from the following detailed description of a preferred embodiment. The accompanying drawing is a transverse sectional view, with parts in elevation, of a portion of an internal combustion engine showing a composite hydraulic valve lifter having a foot piece in contact with a camshaft.

Referring to the drawing, the cylinder block **10** of the engine has a carburized steel camshaft **12** journaled therein and driven by a crankshaft (not shown). The cam portion **14** of the camshaft is in operative engagement with a hydraulic valve lifter **16** embodying the present invention. Lifting motion imparted to the lifter by rotation of the cam **14** is transmitted by the push rod **18** to a rocker arm and poppet valve (not shown).

The valve lifter illustrated in the drawing has an outer body or cylinder assembly comprising a steel tube or sleeve **20** and an alloy cast iron cam-engaging foot piece **22** which closes the lower end of the sleeve **20**. The exterior surfaces of the sleeve **20** are in slidable engagement with the walls of a bore **24** provided in the crankcase of the engine above the camshaft, the outer periphery of the sleeve being relieved by an annular groove **26**. This groove is sufficiently wide to maintain continuous registry with an oil port **28** served by a gallery **30** connected to the pressure lubricating system of the engine.

The inner walls of the sleeve **20** are recessed adjacent the lower end of a plunger **32** within the sleeve to provide a second annular groove **34**. The lower end of this groove is open at all times to a pressure chamber **36** between the plunger and the foot piece **22**. A generally cup-shaped cage **38** for retaining a ball-type of check valve (not shown) beneath the lower end of the plunger **32** is resiliently supported by the upper end of a coil compression spring **40**, which reacts downwardly against the foot piece to urge the plunger **32** upwardly in the sleeve **20**.

The foot piece **22** includes a disk-shaped bottom portion **42** which abuts the lower end face of the sleeve and is permanently bonded thereto. This may be accomplished by inserting a ring of brass between the sleeve and the foot piece before assembling these components and then subjecting the assembly to an elevated temperature during the subsequent carburizing or other heat treatment to fuse the brass and obtain a brazed joint **44**. Integral with the disk-shaped bottom portion **42** of the valve is an upstanding annular flange portion **46**. The outer cylindrical surface of this flange portion is tightly fitted against the inner peripheral surfaces of the sleeve **20** near its lower end to centrally pilot the foot piece during the assembly and brazing operations. This annular flange portion of the foot piece also provides a well **48** in which the lower end of the plunger return spring **40** is seated, and the upper edge of the flange portion is engageable by the plunger **32** to limit its downward movement.

As indicated above, the foot piece **22** is formed of an alloy cast iron consisting essentially of about 3.2% to 3.4% carbon, 1% to 1.4% silicon, 0.7% to 0.9% manganese, 2.4% to 2.6% chromium, 0.4% to 0.7% nickel, 0.4% to 0.7% molybdenum and the balance substantially all iron. Small amounts of various other constituents may be included in the composition, of course, without detracting from its utility. For example, phosphorus and sulphur normally will be present in amounts not in excess of approximately 0.3%, while traces (usually less than 0.1%) of copper, vanadium, etc., also will frequently be

found. A valve lifter foot composed of about 3.3% total carbon, 1.2% silicon, 0.8% manganese, 2.5% chromium, 0.5% nickel, 0.5% molybdenum and the balance iron plus incidental impurities has been found to operate in a highly satisfactory manner in conjunction with a carburized steel camshaft.

The principal difference between the typical chilled gray cast irons discussed above and the alloy irons heretofore proposed as valve lifter foot materials is that the former contain a measurably larger amount of hard carbides. For example, it has been calculated, using a 2% silicon iron as a base, that a chilled gray iron containing about 3.5% carbon, 2.5% silicon and 0.6% manganese has a carbide content of approximately 38.3% at the eutectic temperature (2100° F.) and 46.2% at the eutectoid temperature (1400° F.). On the other hand, an alloy cast iron which heretofore had been used rather extensively for valve lifter applications was calculated to have only 33.9% carbide at the eutectic temperature and 40.9% at the eutectoid temperature. This alloy iron contained about 3.1% carbon, 2.2% silicon and 1% chromium. The difference in the carbide contents of these metals is even greater than the calculated difference set forth above. The actual percentage of carbide in the alloy cast iron is lower than the calculated 40.9% because of graphitization, while the actual amount of carbide in the chilled gray iron is greater than 46.2% due to the under-cooling effect on the eutectic composition resulting from the rapid cooling of the chill plate. In general, we have found it desirable to have the foot piece contain at least 35% carbide at the eutectic temperature of the alloy cast iron and at least 43% at the eutectoid temperature.

The novel alloy cast iron valve lifter foot piece of the present invention has a microstructure in which the percentage of hard iron-chromium-molybdenum carbide present is substantially equal to the amount of carbide present in chilled gray iron. At the eutectic and eutectoid temperatures the theoretical percentages of carbide present in the former are about 37.2% and 45.4%, respectively. This high carbide content results from the relatively large amount of total carbon present in the composition in combination with the high chromium content and the specific ranges of the other elements present. The silicon content is retained within the aforementioned low range to impart the necessary thermal stability to enable the foot piece to be satisfactorily heat treated simultaneously with

the sleeve **20**. Of course, it is the particular combination of elements in the specific amounts indicated above which provides this foot piece with the properties enabling it to be successfully used in an internal combustion engine employing a carburized steel camshaft.

While our invention has been described by means of certain specific examples, it is to be understood that the scope of the invention is not to be limited thereby except as defined by the following claims.

We claim:

1. In an internal combustion engine having a cylinder block, the combination of a carburized steel camshaft journaled in said block and a hydraulic valve lifter comprising a sleeve and a foot piece secured to the end of said sleeve adjacent said camshaft, said foot piece being in engagement with a cam portion of said camshaft and being formed of an alloy cast iron consisting essentially of about 3.2% to 3.4% carbon, 1% to 1.4% silicon, 0.7% to 0.9% manganese, 2.4% to 2.6% chromium, 0.4% to 0.7% nickel, 0.4% to 0.7% molybdenum and the balance substantially all iron.

2. In an internal combustion engine having a cylinder block, the combination of a carburized steel camshaft journaled in said block and a hydraulic valve lifter comprising a generally cylindrical steel sleeve and a foot piece secured to the end of said sleeve adjacent said camshaft, said foot piece being in engagement with a cam portion of said camshaft and being formed of an alloy cast iron having an iron-chromium-molybdenum carbide content of at least 35% at the eutectic temperature and at least 43% at the eutectoid temperature, said alloy iron consisting essentially of about 3.2% to 3.4% carbon, 1% to 1.4% silicon, 0.7% to 0.9% manganese, 2.4% to 2.6% chromium, 0.4% to 0.7% nickel, 0.4% to 0.7% molybdenum, phosphorus not in excess of about 0.3%, sulphur not in excess of about 0.3% and the balance substantially all iron.

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