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VALVE LIFTER

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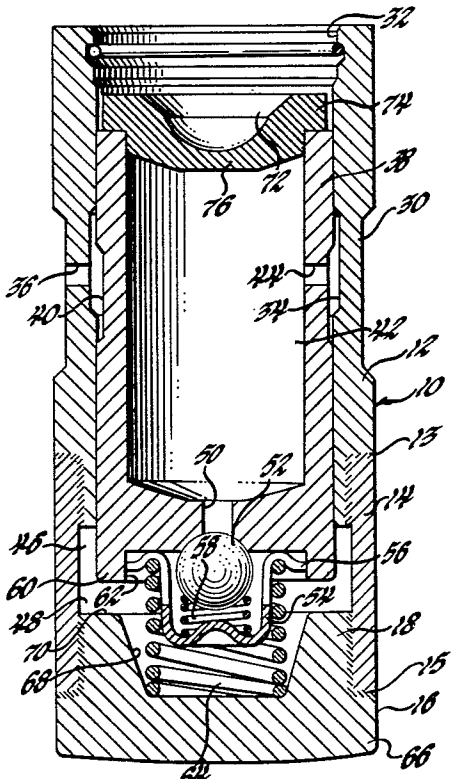


Fig. 1

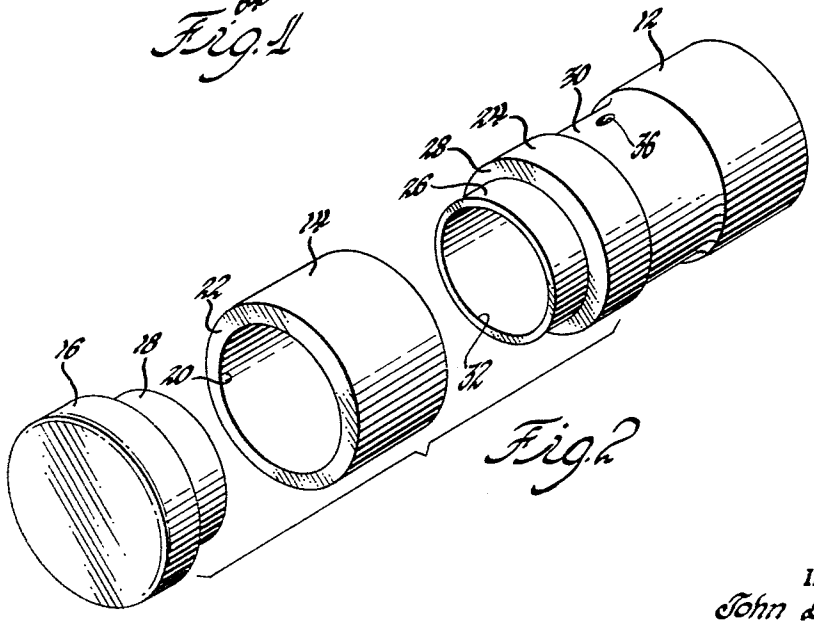


Fig. 2

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VALVE LIFTER

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This invention relates to a composite valve lifter and similar articles and to an improved method of making same.

It is well known that valve lifters, both mechanical and hydraulic, are operated under conditions which are corrosive to the metals used in making the lifters. The effect of the corrosive conditions does not create an especially critical problem with regard to mechanical lifters. Hydraulic valve lifters, on the other hand, can be particularly deleteriously affected by these corrosive conditions. Corrosion of the inner wall of the body of the hydraulic lifter, as well as the outer mating wall of the plunger results in increasing the space therebetween to such an extent as to permit rapid leakdown of the lifter which, of course, renders the lifter functionally inoperative.

The outer surface of the plunger and inner surface of the body are in sliding contact with one another. Corrosion products accumulating on these surfaces are wiped off during operation of the lifter yielding a fresh surface which can be corroded. As this process is continuous during operation of the lifter, it is readily seen that an extremely large gap can be acquired between the mating surfaces of the body member and the plunger due to corrosion.

Attempts to produce a more corrosion-resistant valve lifter by merely making the plunger out of stainless steel only reduces the corrosion problem by one half. Corrosion of the inner surface of the body member still remains a problem. Forming the plunger and the body member out of stainless steel would virtually eliminate the aforesaid corrosion problem. Unfortunately, heretofore there was no commercially practical means for securing the cast iron foot piece to the stainless steel member.

Due to the continuous succession of shocks and various dynamic stresses to which a valve lifter is subjected, it is readily apparent that an exceptionally strong bonding of the cast iron end cap to the stainless steel tubular body member must be obtained. Moreover, for commercial use it is of extreme importance that this strong bond be consistently but economically obtained under the comparatively wide tolerances inherently involved with commercial production conditions.

Although various methods of bonding stainless steel to cast iron have been proposed, no such method alone, under commercial production conditions, will consistently yield a valve lifter having the required reliability demanded for commercial applications. I have found that the criticalities and inherent expenses involved in bonding stainless steel to cast iron can be materially reduced by employing my valve lifter structure. My valve lifter construction obviates the usual problem inherently involved in securing the cast iron foot piece to a stainless steel body by forming a two-piece body for the valve lifter of a specific construction.

Accordingly, a primary object of the invention is to

provide an improved valve lifter construction and method of forming same.

Other objects, features and advantages of the invention will become more apparent from the following description of a specific example thereof and from the drawing, in which:

FIGURE 1 shows a sectional view taken longitudinally through a valve lifter, such as can be formed in accordance with the present invention; and

FIGURE 2 shows an exploded elevational view in perspective of an end cap and two-piece body member used to produce a valve lifter, such as shown in FIGURE 1.

As previously indicated, the invention comprehends forming a two-piece body for the valve lifter in which a major portion of the body is formed of a stainless steel tubular member while a minor portion of the body is formed of a low alloy steel tubular member. In assembly the low alloy steel portion of the body is interposed between the stainless steel portion and an alloy cast iron foot piece of the valve lifter.

Although interposing the low alloy steel between the alloy cast iron and the stainless steel provides some advantages from a metallurgical standpoint, it has been found that a satisfactory valve lifter cannot be formed unless the outer diameter of the stainless steel portion of the valve lifter is brazed to the inner diameter of the low alloy steel tubular member. Moreover, an extremely tight fitting relationship must exist between the mating surfaces of these two portions of the body member.

A more detailed description of the invention can be made clearer by reference to a specific example of the valve lifter construction contemplated by the invention. For this reason, attention is directed to the drawing which shows a hydraulic lifter that is made in accordance with the invention. The valve lifter generally comprises a two-piece tubular body 10 having a stainless steel portion 12 and a low alloy steel portion 14 to which an alloy cast iron foot piece or end cap 16 is secured. The stainless steel part 12 and the low alloy steel part 14 are brazed together as shown at 13. The alloy cast iron foot piece 16 is brazed to the low alloy steel part 14 as shown at 15.

The end cap 16 is a generally cylindrical member, a portion 18 of which is relieved, of a reduced diameter, for insertion in a close fitting relationship with the inner circumference 20 of the low alloy steel portion 14 of the tubular body. The alloy cast iron end cap abuts the end surface 22 of the low alloy steel portion of the body when the end cap and the body 10 are assembled. The outer periphery 24 of the stainless steel portion 12 of the body is relieved, of a reduced diameter 26 at one end, for insertion within the low alloy steel portion 14 of the body 10. This reduced diameter portion 26 gives rise to a shoulder 28 which preferably abuts the end of the low alloy steel member 14 opposite to end 22.

The outer periphery of the tube 12 is also relieved by an annular groove 30. The bore 32 of the tube 12 is relieved by an annular groove 34 which connects with the outer groove 30 by a side wall port 36. A stainless steel cup-shaped plunger 38 whose external periphery is relieved by an annular groove 40 is in close telescopic sliding fit in the bore 32 of the tube 12. The stainless steel plunger 38 is preferably carburized in any suitable manner to improve its wear resistance. The groove 40 in the plunger 38 is made sufficiently wide to have continuous

communication with the tube internal groove 34 during relative movement therebetween, and is connected to a reservoir 42 within the plunger 38 by a side wall port 44.

Oil from the engine lubricating system flows into the plunger reservoir from a gallery in a cylindrical block (not shown) via the tube outer groove 30, port 36, tube inner groove 34, plunger groove 40 and port 44. The tube inner groove 34 overlaps the upper edge of the plunger groove 40 and the latter overlaps the lower edge of the tube inner groove sufficiently so that in all relative positions of the plunger 38 and tube 12 there is communication between the ports 36 and 44. The plunger 38 is spaced from the tube 14 to provide a groove 46 which is open at all times to the pressure chamber 48 between the plunger 38 and foot piece 16.

Connecting the pressure chamber 48 with the reservoir 42 in the plunger 38 is a passage 50 whose lower end is normally closed by a check valve shown in the form of a ball 52. Enclosing the ball is a generally cup-shaped retaining cage 54 whose open end is externally flanged and slotted as at 56 to abut the plunger and accommodate passage of oil between the passage 50 and the pressure chamber 48 when the ball 52 is displaced from its seated position shown. A small biasing spring 58 between the ball 52 and the bottom of the cage 54 tends to maintain the ball seated. The bottom end wall of the plunger is recessed to receive the cage flange within a depending annular skirt portion 60. The internal periphery 62 of this skirt portion 60 has a tight frictional fit with the lateral extremities of the slotted cage flange to retain the cage 54 in assembly with the plunger 38 during its installation or removal from the tube 12. Seated against the cage flange is one end of a coil compression spring 64 which reacts against the foot piece 16 in urging the plunger 38 outwardly of the tube 12.

The alloy cast iron foot piece 16 includes a bottom disk-shaped portion 66 which abuts the bottom end face of the tube and is permanently bonded thereto in a manner described herein. Integral with the disk-shaped portion 66 is the diametrically smaller annular portion 18 having an outer diameter sufficient to make a tight press fit with the internal periphery 20 of the tube 14. This annular portion 18 also provides a well 68 in which the bottom end of the plunger return spring 64 is socketably seated, and the upper end of this annular portion provides a shoulder 70 engageable by the plunger skirt portion 60 to limit extreme inward movement of the plunger 38.

A push rod (not shown) is supported at its lower end on the plunger by a push rod seat member 72. The push rod seat member is formed with a flange portion 74 overlying the upper open end of the plunger 38 and has its lower end 76 extending somewhat into the plunger to locate it laterally thereof.

Satisfactory results are attainable when the relieved area 26 of the stainless steel tube 12 has a diameter at least the same as the inner diameter of the low alloy steel tube 14. Best results under commercial production conditions are attainable when the diameter of the relieved area 26 is up to 0.005 inch greater than the inner diameter of the low alloy steel tube 14. The reduced diameter portion 18 of the end cap also should have a greater diameter than the inner diameter of the tube 14. The portion 18 of the end cap preferably has a diameter between approximately 0.004 inch to 0.03 inch greater than the inner diameter of the tube 14.

In making a valve lifter, such as hereinbefore described, a stainless steel seamless tube is suitably relieved at one end to a diameter about 0.0005 inch greater than the inner diameter of a low alloy steel seamless tube. The outer periphery of the tubes can be of any suitable diameter, as this surface of these tubes is subsequently machined to the proper dimensions.

The parts preferably are cleaned to remove dirt, grease, etc. in the normal and accepted manner as by degreasing in trichloroethylene or the like. The relieved area of the stainless steel tube is then press fitted into the low alloy steel tube and a suitable copper brazing compound applied to the inner circumferential joint formed therebetween. The assembly is heated in a hydrogen atmosphere for approximately 40 minutes to effect the braze and then cooled under a protective atmosphere to room temperature.

The alloy cast iron foot piece is preferably joined to the two-piece body by brazing in the following manner. The foot piece is cleaned to remove rust, dirt, grease, etc. by wheel-abrading and degreasing in the normal and accepted manner. After degreasing, the part is pickled in a suitable acid solution, such as immersion for about two minutes in an aqueous solution containing about 10%, by weight, muriatic acid.

After pickling, the part is rinsed to remove the acid adhering thereto and placed in an aqueous solution containing about 2.5 ounces to 3 ounces potassium cyanide per gallon of water. After immersion in the potassium cyanide solution for about two minutes the end piece is removed therefrom and directly placed into an aqueous bronze plating bath which is as follows:

	Oz./gal.
Free KCN	3.0
$KCu(CN)_2$	3.0
KOH	0.4
$K_2Sn(OH)_6$	13.5

A layer of a bronze alloy containing about 30%, by weight, tin and about 70%, by weight, copper, approximately 0.001 inch in thickness is deposited. The layer is formed under a cathode current density of approximately 10 amperes per square foot and a bath temperature of about 155° F., using copper anodes.

The bronze plated foot piece is rinsed in water, dried and press fitted into the open end of the low alloy steel portion of the previously brazed two-piece body. The three-piece assembly is heated to a temperature of approximately 1650° F. under a hydrogen atmosphere for about 40 minutes to braze the foot piece to the body. It is then cooled in the hydrogen atmosphere to room temperature.

The brazed three-piece assembly is then ground and finish machined. It is then carburized at a temperature of approximately 1650° F. for about 2½ hours, oil quenched, and tempered at about 300° F. for one hour.

It is not only essential to the successful production of a corrosion-resistant valve lifter in accordance with my invention that the two-piece body be formed with a low alloy steel and stainless steel, it is imperative that the low alloy steel portion of the body be interposed between the stainless steel portion and an alloy cast iron foot piece. It is also essential that the inner circumference of the low alloy steel portion be brazed to an outer circumference of the stainless steel member to attain consistent satisfactory results under commercial production conditions.

For purposes of this invention the term "stainless steel" is intended to encompass all those ferrous alloys (alloys having more than 50% iron) containing in excess of 10%, by weight, chromium. Especially satisfactory stainless steels for commercial applications are found in the SAE 300 and SAE 400 series stainless steels. The term "low alloy steel," as used herein, refers to various ferrous alloys in which the total alloy content, alloying ingredients other than iron, is less than about 8%, such as is normally understood by the term, and in which the carbon content is less than about 0.8%, by weight. Especially satisfactory low alloy steels for commercial applications are found in the SAE 1010 to SAE 1020 series steels. The term "alloy cast iron," as used herein, comprehends those cast irons (ferrous alloys having a carbon content of about 1.7% to 4.5%, by weight), which contain about 2.8% to 3.3%, by weight, carbon along with appropriate amounts of silicon and significant amounts of alloying ingredients in addition to carbon and silicon. The addi-

tional alloying ingredients frequently involve one or more from the group including nickel, chromium and molybdenum.

As specific examples, the following table lists the composition of a suitable alloy of each of the above-mentioned types of ferrous alloys:

	Alloy cast iron, percent	Low alloy steel, percent	Stainless steel, percent
Manganese	.7–.9	0.30–0.60	[1] 1.00
Phosphorus	[1] .20	[1] 0.040	[1] 0.04
Sulfur	[1] .10	[1] 0.050	[1] 0.03
Silicon	2.10–2.40		[1] 1.00
Nickel	.40–.70		
Chromium	.90–1.10		11.50–13.50
Molybdenum	.40–.70		
Carbon	2.8–3.25	0.18–0.23	[1] 0.5
Iron	Balance	Balance	Balance

[1] Maximum.

It is to be understood that although the invention has been described in connection with certain specific examples thereof, no limitation is intended thereby except as defined in the appended claims.

I claim:

1. A method of making a valve lifter which comprises relieving the outer periphery of a stainless steel tubular member to form an annular shoulder adjacent one end thereof, said relieved area suitably corresponding to an inner periphery of a low alloy steel tubular member, press fitting said relieved area of said stainless steel member within one end of said low alloy steel tubular member to abut said shoulder against the end of the alloy steel member, brazing the contacting surfaces of said members together, press fitting an end cap within the other end of the low alloy steel member, said end cap having a cylindrical portion the diameter of which suitably corresponds to the inner diameter of said low alloy steel tubular member, and brazing said cylindrical portion of said end cap to said low alloy steel tubular member.

2. A method of making a valve lifter which comprises relieving the outer periphery of a first tubular member to form an annular shoulder adjacent one end thereof, said tubular member being formed of a ferrous alloy containing at least about 10%, by weight, chromium, placing said relieved area of said tubular member within one end of a second tubular member to abut said shoulder against the end of the second tubular member, said second tubular member being formed of a ferrous alloy having less than about 8%, by weight, total alloy content and less than about 0.8%, by weight, carbon, brazing the contacting surfaces of said members together, placing a cylindrical portion of an alloy cast iron end cap within the other end of said second tubular member, said cylindrical portion having the diameter which suitably corresponds to the inner diameter of the second tubular member, and brazing said end cap to said second tubular member.

3. The method of making a valve lifter which comprises relieving the outer surface of one end of a stainless steel tubular member to suitably correspond to an inner surface of one end of a low alloy steel tubular member, said relief forming an annular shoulder on said member adjacent one end thereof, assembling said tubular members by inserting said relieved area of said stainless steel member within the corresponding end of said low alloy steel member and abutting said shoulder against the end of said alloy steel member, bonding said relieved area to said inner surface, and securing a cast iron end closure on the other end of said low alloy steel tubular member.

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