June 7, 1960 J. DORNBOS ET AL 2,939,442

VALVE LIFTER

Filed Aug. 13, 1958

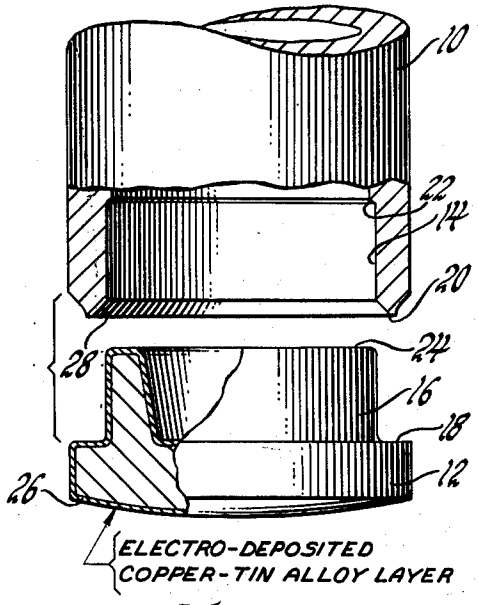


Fig. 1

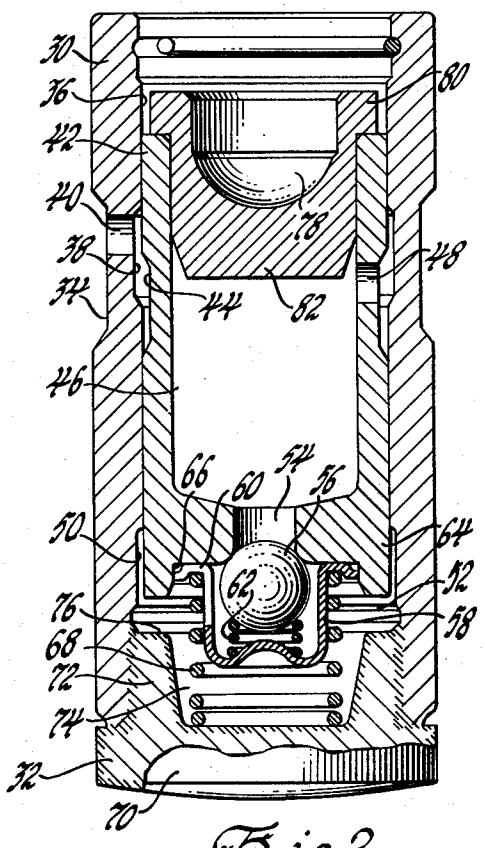


Fig. 2

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VALVE LIFTER

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13 Claims. (Cl. 123—90)

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

A specific object of this invention is to provide a valve lifter including a body member fabricated from a steel tube and an end-closing, wear-resistant foot piece having a coating thereon of a copper-tin alloy which is used to braze the foot piece in place.

Among other objects of this invention are: to provide an improved method of forming composite articles, such as valve lifter bodies and similar articles and to provide an improved method of forming composite valve lifter bodies and similar articles which lends itself to high production operation under conditions resulting in excellent metallurgical control and maximum uniformity of the product.

In accordance with the invention there is provided a composite valve lifter or similar article which has an end cap of cast iron or the like that is substantially completely enveloped by an electrodeposited copper-tin coating which functions as a bonding medium. In making valve lifter bodies, it is highly advantageous, if not essential, that the foot portion that engages the cam or other operating member be formed of a hard, wear-resistant material. By means of the present invention the foot member, if desired, can be made of a cast material that is hard and relatively unmachinable by applying a copper-tin alloy coating to the cast metal foot piece. The foot piece is then assembled with the tubular body member and the assembled parts heated to a sufficient temperature to melt the copper-tin alloy coating and bond the parts securely together.

Reference is made herewith to the accompanying drawings, in which:

Figure 1 shows a fragmentary elevational view in partial section of a tubular body member for a valve lifter or similar article and an alloy coated foot piece; and

Figure 2 shows a sectional view taken longitudinally through a valve lifter, such as can be formed in accordance with the present invention.

Referring now to Figure 1, a valve lifter generally comprises a tubular body member 10 to one end of which a cast metal foot piece or end cap 12 is secured. The end of the tubular body member has an enlarged bore 14 of suitable diameter to snugly receive the end cap 12. The end cap is a generally cylindrical member, a portion 16 of which is of a reduced diameter for insertion in a close-fitting relationship within the enlarged bore 14 of the tubular body member. The reduced diameter portion 16 gives rise to a shoulder 18 on the end cap 12 which abuts the end surface 20 of the tube when the end cap and tubular body member are assembled. Correspondingly, at the inner end of the enlarged bore 14 within the tube a shoulder 22 is formed which the end surface 24 of the end cap 12 perferably abuts upon assembly of the parts.

In a valve lifter the tubular body member 10 is formed, for example, of SAE 1020, SAE 1016, or equivalent

low carbon steel seamless tubing. Although the tubular body member can be formed in a number of ways, the known and accepted manner of making seamless tubing has provided highly satisfactory results. A length of seamless tubing is formed, sectioned into appropriate lengths and machined to the proper internal structure. The foot piece or end cap 12 for a valve lifter, on the other hand, is preferably made of a hard, wear-resistant material, such as cast iron or the like. One such material which can be used is as follows:

Manganese	.7% to .9%
Phosphorus	.20% Maximum.
Sulfur	.10% Maximum.
Silicon	2.10% to 2.40%
Nickel	.40% to .70%
Chromium	.90% to 1.10%.
Molybdenum	.40% to .70%.
Carbon	3% to 3.25%.
Iron	Balance

We have now found that an improved bonding of the end cap or foot piece 12 is obtained if the brazing alloy is applied to the binding interface as a coating 26 on the end cap. By using an alloy coating of copper and tin we have obtained a brazed joint of superior strength that can be simply and economically formed. Particularly useful in this type of application is a copper-tin alloy having an abnormally high tin content. Exceedingly satisfactory joint strength was achieved with this type of alloy which has an especially uniform melting point. Moreover, we have found that maximum uniformity of the product and excellent metallurgical control of the bonding can be achieved when the thickness of the coating and composition of the brazing alloy is accurately controlled.

We have unexpectedly found that especially accurate control of both of the above important factors can readily be achieved in commercial production by electrodepositing a coating of the brazing alloy onto the end cap. More particularly by using an electroplating bath, such as hereinafter set forth, the composition of a copper-tin brazing alloy having an unusually high tin content can easily be accurately controlled under commercial high production conditions. A copper-tin brazing alloy containing about 20% to 60%, by weight, tin and about 40% to 80%, by weight, copper has been satisfactory in producing a strongly bonded composite assembly. However, in general, it is preferable to use an alloy having a composition of about 25% to 40%, by weight, tin and about 60% to 75%, by weight, copper. This latter brazing alloy is especially preferred due to its uniform melting point temperature in the range from about 1360° F. to 1550° F. while in the former alloy the melting point temperature varies from about 1360° F. to 1650° F. It is especially desirable to employ a brazing alloy which uniformly melts to form a bond of superior strength and which provides a uniform impervious joint.

As hereinbefore mentioned, maximum uniformity of the product and excellent metallurgical control of the bonding can be achieved when the thickness of the coating and the composition of the brazing alloy is accurately controlled. The thickness of the coating is easily controlled very precisely when the coating is formed by electrodeposition. The nature of a copper-tin alloy coating of the composition, such as hereinbefore described, can be easily and precisely controlled by electrodepositing the alloy from an aqueous alkaline copper cyanide-potassium stannate bath solution. We have found such an electroplating solution can be effectively used to deposit an alloy of our preferred composition if the relative proportion by weight of free potassium cyanide to the potassium cupro cyanide in the bath is maintained at about

0.8 to 1 respectively. A cast iron foot piece of a valve lifter, for example, can be coated with a copper-tin alloy of suitable composition using a bath solution which, in operation, is as follows:

	Ounces per gallon
Free KCN	1.5–5.8
$KCu(CN)_2$	1.5–5.8
KOH	0.19–1.13
$K_2SN(OH)_6$	4.0–15.0

A wear-resistant metal foot piece is placed in the above-described plating solution and the copper-tin alloy is electrodeposited at a bath temperature of about 150° F. to 170° F. using a current density from approximately 10 amperes per square foot to 70 amperes per square foot.

The electrodeposition is continued until a sufficient plate thickness is achieved, preferably at least about 0.0008 inch. The specific depth or thickness of the electrodeposited layer of brazing alloy is dependent upon the roughness of the casting surface, the fit or clearance desired between the tubular body member and the end cap, objections to an excess of brazing alloy, etc. In general, plating thicknesses of at least about 0.0008 inch are used to form a satisfactory bonding while thicknesses in excess of 0.003 inch are undesirable. Coating thicknesses substantially greater than 0.003 inch tend to result in inferior bonds since only a relatively minor portion of the brazing alloy is diffused into the contacting surfaces in the bonding interface leaving a substantially pure bronze interjacent layer which may be deleteriously effected in subsequent hardening operations. Moreover, if an excess of brazing alloy is present, it may flow during the brazing operation into undesired areas.

We have found that the composition of the brazing alloy can more precisely be contained within the preferred limits when using a plating bath which, as formed, is as follows:

	Ounces per gallon
Free KCN	2.5–3.5
$KCu(CN)_2$	3.0–3.5
KOH	0.5–1.0
$K_2Sn(OH)_6$	5.0–8.0

A satisfactory coating is obtained when electrodepositing the bronze alloy from the above bath at a temperature of from about 155° F. to 160° F. using a cathode current density of about 10 amperes per square foot to 15 amperes per square foot.

The alloy coated end piece is assembled with the tubular body member to which it is to be secured to form a composite assembly. The assembled parts are then heated in a furnace to about 1550° F. to about 1700° F. for a duration of about 30 minutes to about 60 minutes. However, if induction heating is used, the assembly is preferably heated to a brazing temperature of approximately 1800° F. to 1900° F. for approximately 30 seconds. Higher temperatures used in the induction heating require a shorter duration of heating in order to approximate essentially the same flow and diffusion of the alloy into the parts as produced by furnace heating. An insufficient brazing temperature or duration of the treatment is characterized by a low strength bond in which there has been a non-uniform flow of the brazing alloy. In hydraulic valve lifters, for example, this tends to produce "leakers" which impair the efficiency of the valve lifter. Since high performance of a hydraulic valve lifter is dependent upon oil pressure within the lifter, any loss of oil through the brazed joint is highly undesirable.

It is especially desirable to heat the assembly to the brazing temperature under a protective atmosphere to insure statisfactory bonding and to avoid excessive scaling, spalling, etc. of the parts. Accordingly, it is desirable to provide a protective or non-oxidizing atmosphere in the brazing furnace and the chamber in which the

assembly is cooled after brazing. In some instances, it may be additionally desirable to purge the interior of the tubular member with the protective atmosphere to insure that the protective atmosphere is within the interior of the tubing during the brazing step. The atmosphere which is used to protect the interior and exterior of the assembly is preferably reducing in nature. For example, highly satisfactory results can be obtained using an atmosphere which has the following analysis: 20% carbon monoxide, 40% hydrogen and 40% nitrogen, all proportions by volume. However, substantially pure mixtures of hydrogen, carbon monoxide, nitrogen, helium, argon, etc., can also be used.

We have additionally found that the strength of the bond between the end cap **12** and the tubular body member **10** is particularly increased when the end cap is in an extremely close fitting relationship with the tubular body member. Accordingly, it is especially desirable to have the diametrically smaller portion **16** of the coated end cap be of at least about the same dimension as the diameter of the enlarged bore **114** of the tubular body member. We have found that by press fitting the alloy coated end cap **12** within the end of the tubular member, an intimate contact of the bonding surfaces is obtained which facilitates uniform distribution and flow of the brazing alloy during brazing. The intimate contact and resultant uniform flow are particularly effective in producing an imperforate joint or bond between the members. As noted above, this latter factor is particularly important in the manufacture of hydraulic valve lifters in which "leakers" are dissatisfactory. Highly satisfactory results are obtainable when the diametrically smaller portion **16** of the end cap **12** for a valve lifter having an outer diameter of about 0.875 inch is at least about 0.004 inch greater than the inner diameter of the tubular member. With this relative construction the end cap must be press fitted on the end of the tubular member in the assembly of the composite article prior to brazing. In general, the limiting dimension for the maximum diameter of the smaller portion of the end cap is determined by the strength of the tubular member. In most instances, this maximum limit is approximately 0.028 inch.

Moreover, we have found that a stronger bonding can be achieved if the end of the tubular member is chamfered on its inner edge. With this construction the shoulder **18** on the end cap **12** can be in closer contact with the end surface **20** of the tubular member. The chamfer **28** not only provides more intimate contact of the bonding surfaces to increase unit pressure at the joint during assembly, but also minimizes the surface gap between the body and foot casting.

Since this invention consistently provides a uniform imperforate joint of superior strength, it is especially useful for the commercial production of hydraulic valve lifters. A specific example of one such valve lifter is shown in Figure 2. This valve lifter has an outer cup-shaped body or cylinder assembly **30** formed of a seamless steel tube and a cast iron cam engaging foot piece **32** which constitutes an end closure member for the tube. The outer periphery of the tube **30** is relieved by an annular groove **34**. The internal periphery of the tube has a bore **36**, also relieved by an annular groove which connects with the outer groove **34** by a side wall port **40**. A cup shaped plunger **42** whose external periphery is relieved by an annular groove **44** is in close telescopically sliding fit in the bore **36** of the tube. The groove **44** in the plunger **42** is made sufficiently wide to have continuous communication with the tube internal groove **38** during relative movement and is connected to a reservoir **46** within the plunger **42** by a side wall port **48**. Oil from the engine lubricating system flows into the plunger reservoir from a gallery in a cylinder block (not shown) via the tube outer groove **34**, port **40**, tube inner groove **38**, plunger groove **44** and port **48**. The tube

inner groove 38 overlaps the upper edge of the plunger groove 44 and the latter overlaps the lower edge of the tube inner groove sufficiently so that in all relative positions of the plunger 42 and tube 30 there is communication between the ports 40 and 48. Above the lowermost or innermost end of the plunger the tube is also relieved by a second internal groove 50 which is open at all times to the pressure chamber 52 between the plunger 42 and foot piece 32.

Connecting the pressure chamber 52 with the reservoir 46 in the plunger 42 is a passage 54 whose lower end is normally closed by a check valve shown in the form of a ball 56. Enclosing the ball is a generally cup-shaped retaining cage 58 whose open end is externally flanged and slotted as at 60 to abut the plunger and accommodate passage of oil between the passage 54 and the pressure chamber 52 when the ball 56 is displaced from its seated position shown. A small biasing spring 62 between the ball 56 and the bottom of the cage 58 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 64. The internal periphery 66 of this skirt portion 64 has a tight frictional fit with the lateral extremities of the slotted cage flange to retain the cage 58 in assembly with the plunger 42 during its installation or removal from the tube 30. Seated against the cage flange is one end of a coil compression spring 68 which reacts against the foot piece 32 in urging the plunger 42 outwardly of the tube 30.

The foot piece 32 includes a bottom disk shaped portion 70 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 70 is a diametrically smaller annular portion 72 having an outer diameter sufficient to make a tight press fit with the internal periphery at the lower end of the tube. This annular portion 72 also provides a well 74 in which the bottom end of the plunger return spring 68 is socketably seated, and the upper end of this annular portion provides a shoulder 76 engageable by the plunger skirt portion 64 to limit extreme inward movement of the plunger 42.

A push rod (not shown) is supported at its lower end on the plunger by a push rod seat member 78. The push rod seat member is formed with a flange portion 80 overlying the upper open end of the plunger 42 and has its lower end 82 extending somewhat into the plunger to locate it laterally thereof.

The tubular member of a typical valve lifter, such as shown in Figure 2, has an outer diameter of approximately 0.80 inch and an enlarged bore adjacent one end of approximately 0.70 inch in diameter for receiving the end cap. The coated end cap has a diameter of between approximately 0.0008 inch and 0.0015 inch greater than the enlarged bore of the tubular member. The smaller portion of the end cap is compressed into the enlarged bore of the tubular member so that the shoulder on the end cap abuts the end surface of the tubular member. The end of the tubular member is preferably chamfered at about 45° on its inner edge to improve the contact of the shoulder with the end surface of the tubular member. Only sufficient axial spacing exists between the opposing ends of the annular end skirt portions to accommodate the normal operation range of plunger movement within the tube.

In making a valve lifter such as just described, the foot piece was cleaned prior to applying the alloy coating to remove rust, dirt, grease, etc. An initial cleaning to remove foundry sands and rust can be effected by a whell-abrate cycle of about 10 minutes using about a 500 pound load. The part can then be degreased, if necessary, in the usual way, as by means of solvents such as trichloroethylene or the like. After degreasing the part, it can then be pickled in a suitable acid solution in the known and accepted manner for such cleaning, such as by immersion for about two minutes in an aqueous solution containing 9% to 10% muriatic acid.

Following the acid treatment the part is rinsed to remove the acid adhering thereto and preferably placed in an aqueous solution containing about 2.5 ounces to 3 ounces of potassium cyanide per gallon of water. After immersion in the potassium cyanide solution for approximately 2 minutes, the part is removed therefrom and directly placed in the plating bath.

The end cap was placed in a bronze plating solution which, as formed, was compounded to deposit a bronze alloy containing about 30%, by weight, tin and about 70%, by weight, copper. This plating solution was formed with de-ionized water, as follows:

	Ounces per gallon
Free KCN	3.0
$KCu(CN)_2$	3.0
KOH	0.4
$K_2Sn(OH)_6$	13.5

Under a cathode current density of about 13 amperes per square foot and a bath temperature of approximately 155° F., using copper anodes, a bronze plate was deposited to a thickness of about 0.0001 inch in approximately one hour.

The part was thereafter immediately assembled with a clean tubular body member. If necessary, the tubular body member can be cleaned, as hereinbefore described for the end cap, before assembling the parts. Should the end cap become coated with dirt, grease, etc. after plating, it also can be cleaned, such as by degreasing or the like.

The assembly was then placed in a brazing furnace under a temperature of approximately 1600° for approximately 40 minutes under a protective atmosphere, such as hereinbefore described. It was removed from the brazing furnace and subsequently cooled under the protective atmosphere.

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 end cap to the body member must be obtained. Moreover, in commercial applications, it is of extreme importance that this bond be consistently uniformly but economically formed under production conditions. By uniformly coating the bonding surface of the end cap with the brazing alloy, it is inherently uniformly distributed throughout the bonding interface when the parts to be joined are assembled. Moreover, a separate step in the assembly operation of each composite unit is omitted, thus expediting manufacturing operations. By coating the end caps as large groups, only one coating step is necessary for a great many parts.

Although this invention has been described in connection with certain specific embodiments thereof, no limitation is intended thereby except as defined in the appended claims.

We claim:

1. A composite article comprising a tubular body member which is adapted to receive a closely fitting end cap, a portion of which is inserted within said end of said tubular body member and a copper-tin alloy coating on said end cap which bonds said end cap to said tubular body member by means of a brazed joint.

2. A valve lifter comprising a tubular body member having one end which is adapted to receive a closely fitting end cap, an end cap for said end of said tubular body member, said end cap having a diametrically smaller portion which is positioned within said end of said tubular body member and a continuous coating on said end cap of a copper-tin brazing alloy comprising about 25% to about 40%, by weight, tin and about 60% to about 75%, by weight, copper by which said end cap is brazed to said tubular body.

3. A valve lifter comprising a steel tubular body member having a chamfered inner edge at one end which is

adapted to receive a closely fitting end cap, a hard, wear-resistant end cap for said end of said tubular body member, said end cap having a diametrically smaller portion which is positioned within said end of said body member, and an electrodeposited copper alloy coating on said end cap bonding said end cap to said tubular body member, said coating having a thickness of at least 0.0008 inch which completely envelopes said cap.

4. A valve lifter comprising a steel tubular body member having a chamfered inner edge at one end which has an inner diameter adapted to receive a closely fitting end cap, a hard, wear-resistant cast metal end cap for said end of said tubular body member, said end cap having a diametrically smaller portion which is press fitted within the inner diameter of said end of said body member, and an alloy coating comprising about 25% to about 40%, by weight, tin and about 60% to about 75%, by weight, copper substantially completely enveloping said end cap, said coating having an as-formed thickness of about 0.0008 inch to about 0.003 inch and said coated smaller portion of said end cap having an as-formed diameter of at least about 0.004 inch greater than said inner diameter of said body member.

5. The method of forming a composite article which comprises forming a tubular body member having one end adapted to receive an end cap, forming an end cap to be partially inserted within the end of said tubular body member, electrodepositing a copper-tin brazing alloy onto the surface of said end cap, assembling said end cap and said tubular body member to form a composite article, heating said composite article to a brazing temperature for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite article.

6. The method of forming a valve lifter which comprises forming a tubular body member having one end adapted to receive an end cap, forming an end cap to be partially inserted within said end of said tubular body member, said end cap having a portion of smaller diameter which makes a close fit with the inner diameter of said tubular body member when placed therein, applying a coating to said end cap of a copper-tin brazing alloy comprising about 25% to about 40%, by weight, tin, and about 60% to about 75%, by weight, copper, assembling said end cap and said tubular body member to form a composite article, heating said composite article to a brazing temperature for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite article.

7. A method of forming a composite article which comprises forming a tubular body member having one end adapted to receive an end cap, forming an end cap to be partially inserted within the end of said tubular body member, electrodepositing onto the surface of said end cap a copper-tin alloy coating having a thickness of at least 0.0008 inch comprising about 25% to about 40%, by weight tin and about 60% to about 75%, by weight, copper, assembling said end cap and said tubular body member to form a composite article, heating said composite article to a brazing temperature for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite article.

8. The method of forming a valve lifter which comprises forming a tubular body member having an end adapted to receive a closely fitting end cap, forming an end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, electrodepositing onto said end cap a copper-tin brazing alloy coating having a thickness of at least 0.0008 inch, inserting said smaller portion of said end cap within the end of said tubular body member to form a composite assembly, heating said composite assembly to a brazing temperature for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite assembly.

9. The method of forming a valve lifter which comprises forming a tubular body member having one end adapted to receive a closely fitting end cap, forming an end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, electrodepositing onto said end cap a brazing alloy coating having a thickness of at least 0.0008 inch, pressing said coated smaller portion of said end cap within the end of said tubular body member to form a composite assembly, heating said composite assembly to a brazing temperature for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite assembly.

10. A method of making a valve lifter comprising forming a steel tubular body member having a chamfered inner edge at one end which is adapted to receive a closely fitting end cap, forming a cast iron end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, applying onto the surface of said end cap a copper-tin brazing alloy coating comprising about 25% to about 40%, by weight, tin and about 60% to about 75%, by weight, copper, said alloy coating having a thickness of at least about 0.0008 inch, pressing said smaller diameter portion of said alloy coated end cap within said end of said tubular body member to form a composite assembly, brazing said composite assembly to bond said end cap to said tubular body member, and cooling said composite assembly.

11. A method of making a valve lifter comprising forming a steel tubular body member having a chamfered inner edge at one end which is adapted to receive a closely fitting end cap, forming a cast iron end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, electrodepositing onto said end cap a copper-tin brazing alloy coating comprising about 25% to about 40%, by weight, tin and about 60% to about 75%, by weight, copper from a bath solution comprising potassium cyanide, copper cyanide, potassium hydroxide and potassium stannate in aqueous solution, said alloy coating being deposited to the thickness of from about 0.0008 inch to about 0.003 inch so that said smaller portion of said end cap is at least 0.004 inch larger than the inner diameter of said tubular body, brazing said coated smaller diameter portion of said coated end cap within said end of said tubular body member to form a composite assembly, heating said tubular body member to a temperature of about 1550° F. to 1900° F. for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite assembly.

12. A method of making a valve lifter comprising forming a steel tubular body member which is adapted at one end to receive a closely fitting end cap, forming a cast iron end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, electrodepositing onto said end cap a copper-tin brazing alloy coating from a bath solution containing potassium cyanide, copper cyanide, potassium hydroxide and potassium stannate in aqueous solution in which the relative proportion, by weight, of free potassium cyanide to potassium cupro cyanide in the bath is approximately 0.8 to 1, respectively, said alloy coating being deposited to a thickness of from about 0.0008 inch to about 0.003 inch so that said smaller por-

tion of said end cap is at least 0.004 inch larger than the inner diameter of said tubular body, brazing said coated smaller diameter portion of said coated end cap within said end of said tubular body member to form a composite assembly, heating said tubular body member to a temperature of about 1550° F. to 1900° F. for a sufficient duration to bond said end cap to said tubular body member by means of said brazing alloy, and cooling said composite assembly.

13. A method of making a valve lifter comprising forming a steel tubular body member having a chamfered inner edge at one end which is adapted to receive a closely fitting end cap, forming a cast iron end cap having a portion which is to be inserted within said end of said tubular body member, said end cap having a diametrically smaller portion which is generally equal to the inner diameter of said tubular body member, electrodepositing onto said end cap a copper-tin brazing alloy coating comprising about 25% to about 40%, by weight, tin and about 60% to about 75%, by weight, copper, said alloy being deposited under a cathode current density of from about 10 amperes per square foot to 70 amperes per square foot from a bath solution at a temperature of 150° F. to 170° F. which contains about 1.5 ounces per gallon to 5.8 ounces per gallon of free potassium cyanide, about 1.5 ounces per gallon to 5.8 ounces per gallon potassium cupro cyanide, about 0.19 ounces per gallon to 1.13 ounces per gallon potassium hydroxide and about 4 ounces per gallon to 15 ounces per gallon potassium stannate, said alloy coating being deposited to a thickness of approximately 0.0008 inch to 0.003 inch wherein said coated smaller portion of said end cap has a diameter of about 0.004 inch to 0.028 inch larger than the inner diameter of said tubular member, pressing said coated smaller portion of said end cap within said end of said tubular body member to form a composite assembly, heating said composite assembly under a non-oxidizing atmosphere to a temperature of approximately 1550° F. to 1900° F. to braze said end cap to said tubular body member, and thereafter cooling said composite assembly under said non-oxidizing atmosphere.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,939,442 June 7, 1960

John Dornbos et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 69, for "perferably" read -- preferably --; column 2, line 23, for "binding" read -- bonding --; column 3, line 72, for "statisfactory" read -- satisfactory --; column 4, line 21, for "114" read -- 14 --; line 63, after "groove" insert -- 38 --; column 6, line 24, for "0.0001" read -- 0.001 --.

Signed and sealed this 6th day of December 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents