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Kammeraad et al.

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[45] **Aug. 13, 1974**

[54] **METHOD AND APPARATUS FOR REBUILDING VALVE GUIDES**

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[21] Appl. No.: **214,261**

Related U.S. Application Data

[63] Continuation of Ser. No. 847,927, Aug. 6, 1969, abandoned.

[52] **U.S. Cl.**..... **123/188 GC,** 29/156.4 WL, 29/401

[51] **Int. Cl.**..... **F01l 3/08,** B23p 7/00

[58] **Field of Search** ..... 29/213, 235, 157.1, 401, 29/451, 525, 156.4 WL; 123/188 P, 188 VA, 188 GC, 188 SA, 90.67; 308/5 V, 237 R

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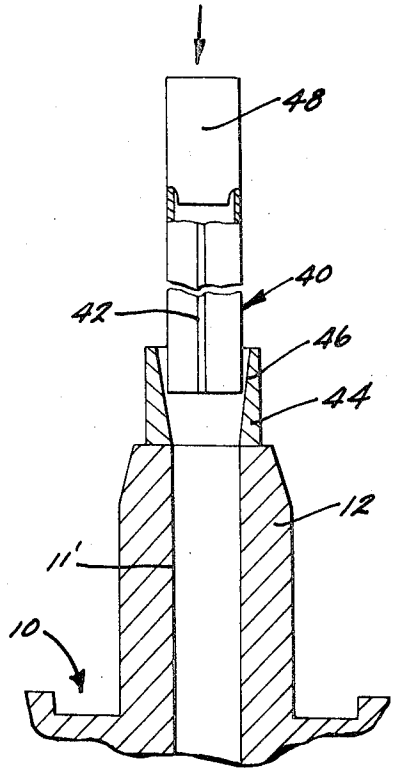
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[57] **ABSTRACT**

This disclosure relates to a method and system for rebuilding valve guides for internal combustion engines wherein the old worn guides are first reamed and then have slitted tubular members forced into the reamed guides. The tubular member inserts can then be reamed to size. The operation can also include knurling and broaching of the tubular members after insertion of the tubular member into the reamed valve guide. The tubular member has an outer diameter greater than the inner diameter of the reamed guide so that a press fit between the tubular member and the guide results.

4 Claims, 8 Drawing Figures



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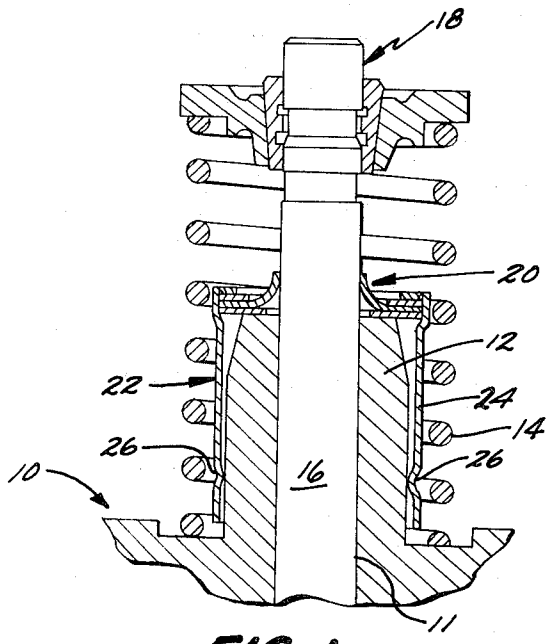


FIG. 1.

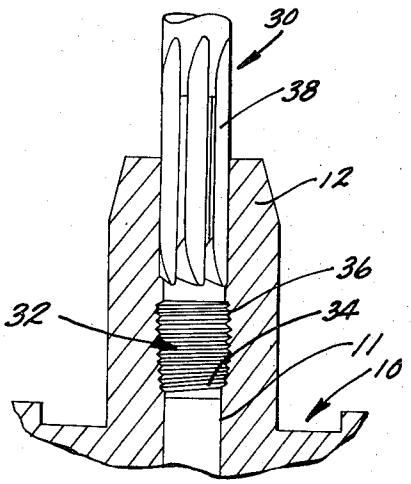


FIG. 2.

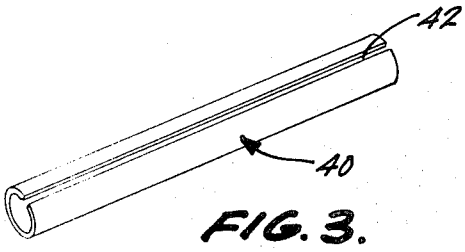


FIG. 3.

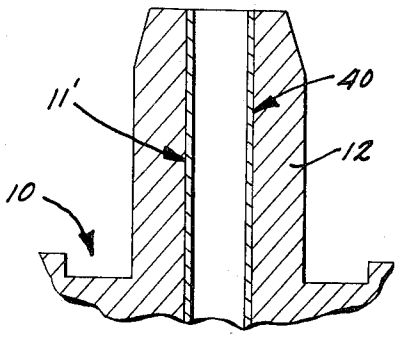


FIG. 5.

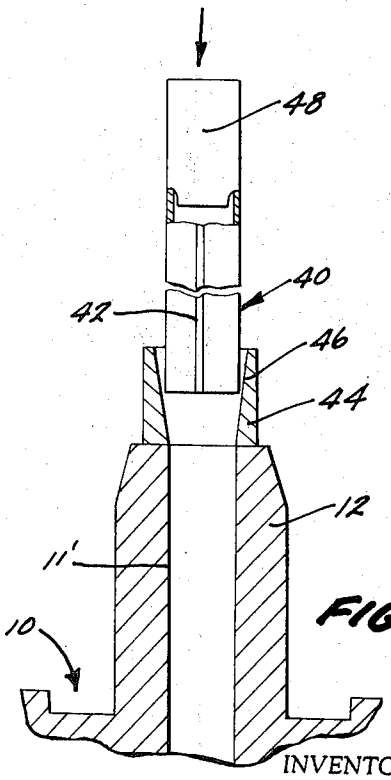


FIG. 4.

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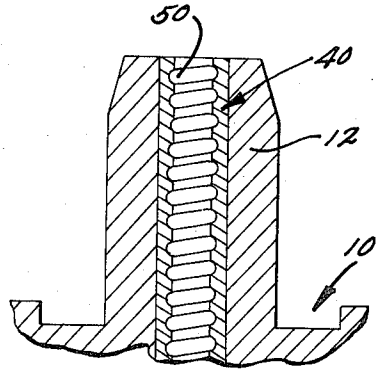


FIG. 6.

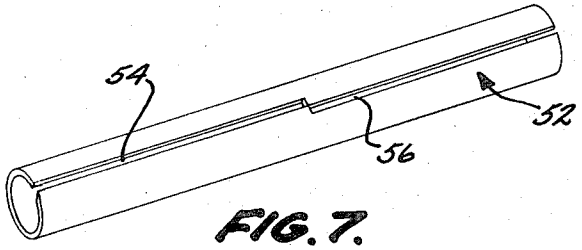


FIG. 7.

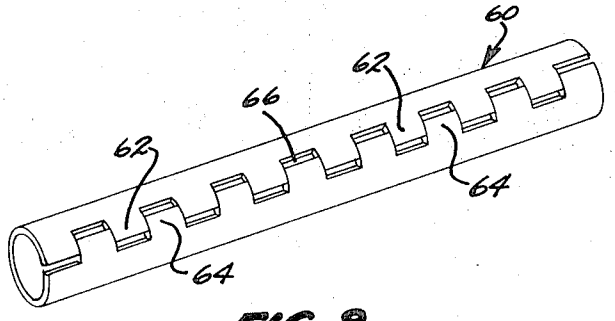


FIG. 8.

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METHOD AND APPARATUS FOR REBUILDING VALVE GUIDES

This application is a continuation of co-pending application Ser. No. 847,927 entitled METHOD AND APPARATUS FOR REBUILDING VALVE GUIDES filed Aug. 6, 1969, now abandoned.

This invention relates to rebuilding valve guides. In one of its aspects, it relates to rebuilding valve guides wherein the old guides are first reamed and slitted tubular members are then forced into the reamed guides.

In another of its aspects, the invention relates to a system for rebuilding valve guides in which a reaming means is provided to ream out the old valve guide, a tubular member having a longitudinal slit is provided, and means are provided for forcing the tubular member into a reamed valve guide to provide a press fit between the reamed valve guide and the tubular member.

Valve guides for internal combustion engines become worn through extended use. It is necessary for the valve guide to have close tolerances between the valve stem and the valve guides in order for the engine to operate efficiently.

Tools have been devised for effectively reducing the diameter of a hole such as valve guides. In U.S. Pat. No. 3,097,426, for example, there is disclosed a tool for reducing the effective diameter of a hole by forming flat crested threads within the hole. This tool cannot always be used for rebuilding valve guides, however, because in many instances the valve guides are so badly worn that there is insufficient metal to form the desired inner diameter of the guide.

Other systems have been developed for rebuilding valve guides. One such system drills and reams out valve guides and then inserts a tubular cast iron cylinder into the reamed out hole. The excess portion of the cylinder is then trimmed off. The thickness of the cast iron cylinder is necessarily about seventy-five to one-hundred thousands of an inch. Substantial amounts of metal must be removed from the valve guide necessitating the use of precision drilling equipment. Numerous jigs, dies, guides and leveling devices, and special power units are required with the system. As a result a large capital investment is required to use the same. Further, the wearability of the new valve guide is about the same as that of the original valve guide.

Another system first drills an anchor hole in a valve guide. Then a self-piloting tap is threaded into the valve guide. A phosphor bronze spiral bushing is then threaded into the threaded valve guide with a special tool. Excess material is removed from the ends of the bushing and a broach is forced through the guide to set the bushing in place. The valve guide is then reamed to size. The tapping of the valve guide is a complicated operation and the insertion of the spiral bushing is difficult.

I have now discovered still another system and method for rebuilding valve guides wherein the use of a slotted tubular member as a valve guide permits a simple system of tools to be used to quickly, easily and effectively rebuild the guides.

By various aspects of this invention one or more of the following, or other, objects can be obtained.

It is an object of this invention to provide a system and method for rebuilding valve guides wherein a few simple tools are employed.

It is another object of this invention to provide a system and method for quickly and easily rebuilding valve guides wherein the rebuilt valve guides have improved wear characteristics.

It is a further object of this invention to provide a system for rebuilding valve guides in which durable inserts used in the system are inexpensively and quickly made to the proper size needed for the job.

It is still another object of this invention to provide a system and method for rebuilding valve guides in which the valve guides are first reamed but said reaming operation requires only simple and inexpensive tools.

It is yet another object of this invention to provide a method and system for rebuilding valve guides wherein the rebuilt guides have maximum heat transfer properties to minimize wear of the rebuilt guides.

It is another object of this invention to provide an improved rebuilt valve guide having improved wear characteristics and closer tolerances for more efficient engine operation.

Other aspects, objects, and the several advantages of this invention are apparent to one skilled in the art from a study of this disclosure, the drawings, and the appended claims.

According to the invention there is provided a method for rebuilding valve guides comprising the steps of reaming said valve guides so as to expand the diameter thereof, forcing a tubular longitudinal insert into the reamed valve guides to provide a new surface for the guide. The inserts have an outer diameter greater than the inner diameter of the reamed hole and have a longitudinal slit extending the length thereof so that the tubular member conforms in a press fit to the inner diameter of the reamed valve guide.

Further according to the invention, the metal of the insert is flowed to join the slit thereby preventing the oil from flowing through the slit within the valve guides. Preferably the tubular insert is made from phosphor bronze for greater wearability of the rebuilt guides.

Further according to the invention, the tubular member is formed by progressively forming cut blanks from sheet stock into a tubular shape. The longitudinal slit in the tubular member can be formed by offset portions such that the slit is nonlinear, or can be formed by interengaging finger portions which abut each other at the circumferential edges thereof.

Still further according to the invention there is provided a system for rebuilding valve guides comprising a means for reaming the valve guide, a tubular member having a slit extending longitudinally from one end to the other and adapted to fit coextensively within said valve guide. The outer diameter of the tubular member is slightly greater than the outer diameter of the reaming means. Means are also provided for forcing the tubular member into a reamed valve guide, thereby making a press fit between the tubular member and the reamed valve guide.

Still further according to the invention a valve guide for an internal combustion engine has a valve guide formed from a cylindrical hole in the cylinder head, a cylindrical thin wall tubular member is firmly secured in the cylindrical hole, the tubular member having a longitudinal seam from one end to the other. The wall thickness of the tubular member is preferably in the range of ten to twenty-five thousands of an inch and the

tubular member is preferably made from a phosphor bronze.

The invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a partial side elevational view in section of a typical valve guide and valve stem in operating position;

FIG. 2 is a view of the valve guide similar to FIG. 1 illustrating a first step of the method of the invention;

FIG. 3 is a perspective view of a tubular insert used in practicing the invention;

FIG. 4 is a side elevational view of the valve guide like FIG. 2, but showing a second step of the process;

FIG. 5 is a side elevational view of the valve guide illustrated in FIGS. 2 and 4 showing a further step in the process;

FIG. 6 is a view similar to FIG. 5 showing the rebuilt valve guide after a knurling operation;

FIG. 7 is a perspective view of a modified tubular member; and

FIG. 8 is a perspective view of still another modified tubular member.

Referring now to the drawings, and to FIG. 1 in particular, an overhead valve engine head **10** has machined therein a valve guide **11** with an exposed shoulder portion indicated generally by the reference numeral **12** through which the valve stem **13** is passed during assembly. Ordinarily, the exposed shoulder **12** will be integrally cast with the remainder of the head and thereafter machined to proper dimensions. A valve spring **14** encircles exposed shoulder portion **12** of the valve guide assembly and the valve is conventionally retained with respect thereto by a pair of valve keepers **18.** While not shown, of course, the valve stem **13** extends downwardly and terminates in a valve portion having a suitable seat machined into the lower surface of the head **10.** The valve spring **14** retains the valve in closed position with respect to the seat except when forced downwardly by a rocker arm (not shown) or the like in proper operational sequence. An oil seal **20** prevents oil from flowing between the valve stem **16** and the valve guide **11** and into the combustion chamber of the engine.

The seal **20** is retained in compressive abutment by means of the retaining boot assembly **22** which has a tubular base member **24** adapted to telescopically engage the outer diameter of the valve guide **12** through indent **26.** The seal structure is more fully described and claimed in United States Patent Application Ser. No. 675,586, filed Oct. 16, 1967.

Referring now to FIG. **2,** there is shown a first step in the valve rebuilding guide method. The valve stem **16** and its associated components are removed from the shoulder portion **12.** A reamer tool **30** having a threaded section **32** with a tapered leading portion **34** and a sizing portion **36** is forced through the valve guide. The reamer tool **30** is a self-piloting tool so that the axis of the reamed valve guide is the same as the original axis of the guide. The reamer tool **30** has a reamer section comprised of longitudinal flutes **38** which cuts away and thereby expands the diameter of the valve guide.

Referring now to FIG. **3** a tubular member **40** is stamped from a blank of phosphor bronze and pregressively formed into a tubular shape, leaving a longitudinal slit **42.**

Referring now to FIG. **4,** the tubular insert **40** is forced into the reamed valve guide **11'** by means of an adaptor **44** having a tapered inner diameter **46.** The outer diameter of the tubular member **40** is greater than the reamed valve guide **11'** so that the tubular insert **40** must be radially compressed in order to force the same into the reamed valve guide **11'.** The adaptor **44** is annular shaped. At the upper portion, the inner diameter of the adaptor is greater than the outer diameter of the tubular insert **40.** At the lower portion, the inner diameter of the adaptor **44** is equal to or less than the inner diameter of the reamed valve guide **11'.**

A forcing tool **48** is positioned in the upper portion of the tubular insert **40** and is struck at the top portion thereof to force the tubular insert through the adaptor **44** and into the reamed valve guide **11'.** The forcing tool **48** may have a lower circumferential rim as illustrated in the drawing or may be flat.

The tubular insert **40** can be cut from a blank so as to be exactly the length of the valve guide. Alternately standard size blanks can be used with an excess length trimmed off when the tubular members have been inserted into the valve guides. Thus, when the tubular insert **40** is completely within the valve guide as illustrated in FIG. **5,** with the top portion of the tubular insert **40** even with the top surface of the shoulder portion **12,** the tubular insert **40** will be coextensive with the reamed valve guide **11'.** Further, the blanks are so dimensioned that the slit **42** is closed forming a longitudinal seam as the tubular insert is forced into the reamed valve guide. The slit **42** is thereby held closed by the circumferential pressure from the valve guide **11'** on insert **40.** The wall thickness of the tubular inserts can be in the range of ten to twenty-five thousands of an inch and preferably in the range of fifteen to twenty thousands of an inch. Preferably the tubular inserts are made from phosphor bronze for maximum wearability

At this point, the valve guide is ready for use. However, additional steps can also be performed to improve still further the rebuilt valve guide structure.

For example, as illustrated in FIG. **6,** the inner surface of the tubular insert **40** can be knurled as at **50** to flow the metal of the tubular insert. This knurling process flows the metal of the tubular insert **40** so as to seal off the passage through slit **42.** By this step, the oil within the engine is prevented from seeping through the valve guide **11.** In addition, the knurling operation more firmly seats the insert **40** within the reamed valve guide. Many tools are available for this knurling operation. One such tool is disclosed in U.S. Pat. No. 3,038,253.

After the knurling operation, the valve guide can then be reamed again to a predetermined size diameter if necessary. The rebuilt valve guide will then be as good as or better than the original valve guide of the engine.

In a modified procedure, the rebuilt valve guide illustrated in FIG. **5** can be broached with a common broaching tool in order to flow the metal in the same manner as was done with the knurling tool.

The modified tubular insert **52** illustrated in FIG. **7** has circumferentially offset slits **54** and **56** which are contiguous and form a longitudinal slit in the tubular insert. This modified tubular insert **52** can be formed

in the same manner as the tubular insert **40**, ie., stamped from tubular stock and progressively formed in dies into a tubular shape.

Another modified tubular insert **60** is illustrated in FIG. **8**. This modified insert has interlocking finger **62** and **64** which form in the tubular insert longitudinal slit **66** having a tortuous path. The interlocking fingers **62** and **64** abut at the circumferential edges thereof so that when the tubular member **60** is inserted within the valve guide, oil will not be able to flow through the longitudinal slit **66** from one end to another. However, oil pockets can be left at the open slit portion **66** to provide oil retaining means for lubricating the valve stem within the valve guide.

This modified tubular insert **60** is formed in the same manner as the tubular insert **40**, i.e., by stamping the same out of blanks of metal, preferably phosphor bronze, and then progressively forming the stamped blanks into a tubular shape as illustrated.

The use of the longitudinal slits facilitate the insertion of the tubular member into the reamed valve guide so that a press fit is maintained between the tubular insert **40** and the reamed valve guide. Further, the formation of the tubular inserts are simple and inexpensive with the stamping and forming operations. By the nature of the interlocking relationship of the tubular inserts **52** and **60**, no material is wasted in the stamping operation.

The stamping operation is very precise and precision parts can be formed thereby. The tubular inserts formed by such process can be precisely formed from thin gage phosphor bronze or other similar material. The thinner the material is, the better the operation of the valve guides. The interface between the insert and the engine block retards the heat flow away from the valve guides during operation. It has been found that as the wall thickness of the inserts decreases, the retarding effect of the interface decreases. Therefore, it is desirable to use a thin a material as possible without mitigating the wearability of the valve guide. By the use of the blanks, the wall thickness can be reduced to about ten thousands ot an inch.

Further, with the use of the sheet stock to form the tubular inserts, the final inner diameter of the valve guide cam be controlled with far greater accuracy than if the tubular inserts were cast or reamed.

A still further advantage of the use of the thin wall material is that only small amounts of material need be removed from the worn valve guides. This small amount of material can be removed with a single pass of a self-piloting reaming tool disclosed above. In the prior art systems, it is sometimes necessary to make multiple passes with reaming tools in order to remove enough material from the valve guide. When substantial amounts of material are removed from the valve guide, as with prior art systems, the alignment of the reaming tools is more critical and must be controlled with more complicated equipment and more complicated procedures.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, the drawings, and appended claims without departing from the spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an internal combustion engine having a plurality of valve guides within which a series of valves are reciprocally mounted, at least some of said valve guides including a sleeve-like member positioned within an elongated cylindrical bore in said engine, the improvement in said member comprising said member being thin-walled and formed from phosphor bronze, said member, when installed, being substantially coextensive with said bore such that said member terminates substantially flush with the axial extremities of said bore and having the form of a cylinder having a substantially straight longitudinal exterior surface which contacts said bore and a substantially straight longitudinal interior surface which contacts the stem of the valves, said member including an offset longitudinal slit formed therealong and extending the length thereof, said longitudinal slit comprising at least two interengaging finger portions which abut each other at the circumferential edges of said member; said member, in relaxed condition prior to insertion in said bore, being expanded in cross section larger than the diameter of said bore with the sidewall portions bounding said longitudinal slit being separated from one another, said member, in confined condition after axial insertion into said bore, being radially compressed by and in tight abutment with the inner diameter of said bore so that said member is generally circular in cross section with the sidewall portions bounding said slit being in abutment with one another, said sidewall portions being retained in such abutment and said member being retained within said bore by the radial compression of said bore.

2. The structure as set forth in claim **1** wherein the wall thickness of said member is in the range of ten to twenty-five thousandths of an inch.

3. The structure as set forth in claim **1** wherein said member is formed by progressively forming cut blanks of sheet stock into a tubular shape.

4. The structure as set forth in claim **1** wherein said longitudinal slit is formed of a plurality of interengaging finger portions which abut each other at the circumferential edges of said member.

* * * * *