July 4, 1972 E. E. REED ET AL 3,674,375

VALVE-GUIDE CORING TOOL

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Fig. 1.

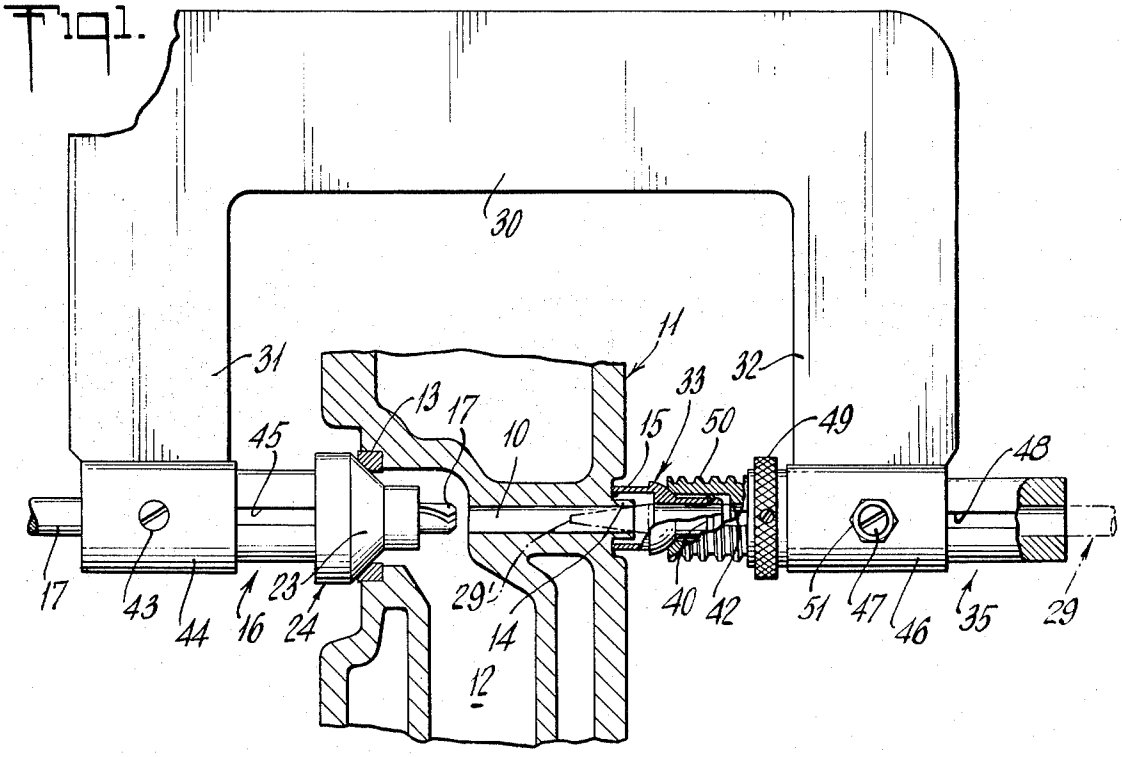


Fig. 2.

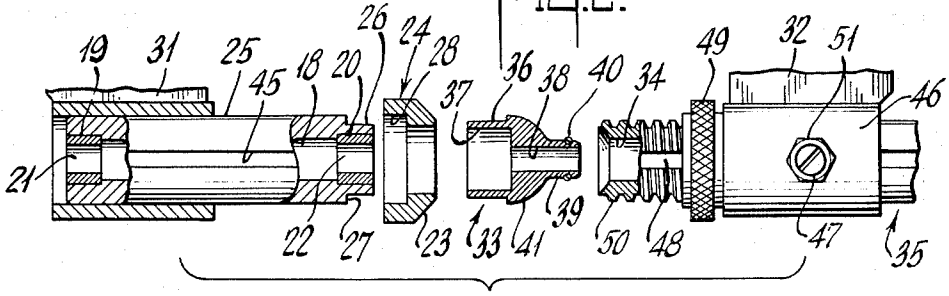
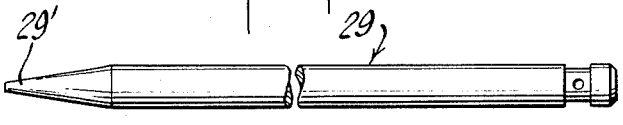


Fig. 3.



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VALVE-GUIDE CORING TOOL

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ABSTRACT OF THE DISCLOSURE

The invention contemplates a portable jig having means for establishing a reboring, reaming or coring axis for the valve-stem guide bore of a worn valve structure, by prime reliance on separate centering techniques at both the seat and actuating ends of the axis of the valve, to re-establish the axis of the valve through the center of the seat, even though the worn-seat axis at the time may be slightly offset from its original orientation. Once the axis to be cored has been thus established, clamp means of the invention retains the reference and also positions guide means for the coring tool. After finishing the expanded valve-stem guide bore, based on the new reference axis, a valve-stem guide insert is installed, and the seat is finish-machined in the customary manner, with minimum removal of seat material.

This invention relates to a portable jig, particularly adapted to guide a drilling, reaming or the like tool, for reconditioning a worn valve-stem guide, as in a cylinder head or the like body for valve mechanism.

Internal-combustion engines may initially have valve seats which are perfectly concentrically and coaxially aligned with their associated valve-stem guide bores, but wear, however slight, eventually takes its toll, resulting in poorly seating valves, with attendant loss of power, and pollution of the atmosphere by excessive release of unburned hydrocarbons. Such losses are particularly severe for the modern high-compression engine, and the poor seating is frequently attributable to the eccentricities or other misalignments which have progressively formed in the contour of the bore of the valve-stem guide. Angularity of actuating contact by an over-head rocker-arm or cam shaft system is among the causes of such uneven wear. And having thus eccentrically worn the valve-stem guide, it follows that the valve seat itself may have worn into a displaced shape in which the predominant central axis is no longer the same as it once was but is, on the other hand, offset angularly and/or radially with respect thereto.

A conventional method of reconditioning such valve-stem guide bores is to employ large, expensive and bulky drill-press machines, arbitrarily set to core out or rebore the valve-stem bores to what is hopefully the prior alignment. The expensive and cumbersome nature of such an operation precludes its use by the ordinary mechanic, and limits use to the sophisticated specialty shop. Moreover, subsequent valve-seat grinding operations may be unduly excessive, due to the fact that an arbitrarily assumed newly cored axis has no particular relation to the currently worn status of the valve seat, particularly the axis orientation thereof.

It is, accordingly, an object of the invention to provide an improved means and method for coring, drilling or reaming valve-stem guides, particularly worn guides of the character indicated.

Another object is to meet said object with means which takes its basic alignment reference from the existing valve seat and from the other end of the valve-stem guide bore.

A further object is to provide such a means and method

which are basically simple, utilize portable equipment, and are well within the reach of the individual mechanic, in business for himself.

Still another object is to provide a tool meeting the above objects and readily adaptable to a wide variety of valve body configurations, spring-seat orientations, and valve seat and guide sizes.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification, in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, a preferred form of the invention;

FIG. 1 is a view in elevation of a valve-stem coring jig of the invention, shown in application to a cylinder head, the latter being shown as a fragment, in section along one of the valve-stem bores thereof;

FIG. 2 is an exploded fragmentary view in elevation to show separable adapter parts of the jig of FIG. 1; and

FIG. 3 is a fragmentary view of another part usable in setting the jig of FIG. 1.

Briefly, the invention contemplates a portable jig having means for establishing a reboring, reaming or coring axis for the valve-stem guide bore of a worn valve structure, by prime reliance on separate centering techniques at both the seat and actuating ends of the axis of the valve, to re-establish the axis of the valve through the center of the seat, even though the worn-seat axis at the time may be slightly offset from its original orientation. Once the axis to be cored has been thus established, clamp means of the invention retains the reference and also positions guide means for the coring tool. After finishing the expanded valve-stem guide bore, based on the new reference axis, a valve-stem guide insert is installed, and the seat is finish-machined in the customary manner, with minimum removal of seat material.

In FIG. 1, the invention is shown in application to one of the valve-stem guide bores **10** of an automotive cylinder head **11**. The bore **10** is seen to extend through solid cast metal, from its opening at the manifold passage **12** (near the region of valve seat **13**) to the spring-pad region, comprising an annular and axially outward projection or spring-guide portion **14** and an adjacent annular spring-seat region **15**. In the initial manufacture of the cylinder head **11**, all guide bores will have been precision-bored in large special floor-mounted machines, and such operation will have unquestionably established the necessary concentric and coaxial relation of the conical flare of seat **13** with respect to the axis of the bore **10**. The new engine, thus fabricated, is well sealed to operate with high-compression and to achieve its designed high-efficiency performance.

The problem solved by the invention is presented by a worn cylinder head **11**, that is, by a head in which the valve-stem guide bore(s) **10** and/or the valve seat(s) **13** are worn, to the extent that the guide bore **10** is no longer able to assure purely axial guidance of the valve stem and accurate seating of the valve face at **13**. For example, the wear in bore **10**, due to slight angularity or offset in valve-actuating thrust by a rocker arm or by overhead cam, may have developed an eccentricity in the bore, and such eccentricity may be of different magnitude and at different angle about the original valve-stem guide axis, as a function of position along the valve-stem guide axis. At the same time, the valve face or its seat **13** may have asymmetrically worn, with resulting adaptation to a slightly eccentrically or otherwise offset relation to the original valve-stem guide axis.

The jig of the invention is primarily an elongated guide **16** for a rotatable coring tool **17**, of size selected to rebore, core or otherwise refinish the bore **10** to accept a

valve-stem guide insert or sleeve (not shown). The guide member **16** is provided with an elongated guide bore **18** for the tool **17**, a preference being indicated for the provision of sleeve inserts **19–20** at the respective ends of bore **18**. The inserts **19–20** may be of suitable hard material, such as high-speed steel, precision-finished at their respective bores **21–22**, to a diameter which establishes a close but free guided orientation of the coring axis of the tool **17** inserted therein.

To establish the desired coaxial reference to the worn valve seat **13**, the front or work-engaging end of the guide member **16** is precision-finished with a tapered convex surface **23**, truly concentric to the tool-guide axis established by bores **21–22**. The taper at the front surface **23** is selected according to the design taper of the valve seat **13**. To make the guide member **16** more universally applicable to various engine designs, the tapered front surface **23** is formed on a first part or adapter **24**, and the precision tool-guide elements **19–20** are parts of a second part or body **25**. A reduced cylindrical forward surface **26** on body **25** establishes a shoulder **27**, and a correctly tapered selected adapter **24** is appropriately bored and counterbored (at **28**) to achieve firm axial and coaxial reference to the body guides **19–20**, upon detachable telescoped assembly thereto.

To further establish the axis of the tool (element **16**) and to resist the tendency of surface **23** to dislodge from seated relation at **13** in the course of cutting with tool **17**, the invention provides means whereby a centering reference may be taken for the remote end of the bore **10**, and whereby the guide element **16** may be positively held or clamped in its correct orientation. Such clamp structure relies upon a centering pin **29** (FIG. 3) of diameter larger than bore **10** and having a conical tip **29**; and the clamp structure may comprise a rigid frame **30** with spaced arms **31–32** sized to span the largest of the anticipated valve-body or cylinder-head structures to be cored. The described tool-guide member **16** may be viewed as valve-seat engaging means carried by one of these arms (**31**); and further work-engaging means, accommodating pin **29** and including prefrably another removable adapter part **33** is carried by the other of these arms (**32**). As shown, the adapter **33** is axially insertable in and removable from the counterbore **34** of an elongated rugged tubular member **35**, carried by the arm **32**.

In the form shown, adapter **33** includes a cylindrical skirt **36** projecting toward the work **11** and counterbored at **37** to a depth and diameter which allows relatively great axial and radial clearance with the projection **14** which forms part of the valve-spring support. Adapter **33** further includes a body integral with the base of skirt **36** and with a guide bore **38**, of diameter exceeding that of the alignment pin **29**. The adapter body is externally contoured to provide a reduced neck **39**, projecting loosely within the counterbore **34** and externally grooved to carry friction means, such as an elastomeric O-ring **40**, for yieldable friction engagement with the counterbore **34**. Finally, a truncated convex spherical surface **41** completes the outer profile of adapter **33**, accounting for the bulge from neck **39** to skirt **36**.

The convex spherical surface **41** interferes with the adjacent end of the tubular support member **35**, at a concave spherical flare at the end of counterbore **34**. The spherical centers of these convex and concave surfaces should be the same, the convex surface **41** being on the axis of guide bore **38**, and the mating concave surface of member **35** being on the axis of bore **42** and counterbore **34** thereof. The bore **42**, unlike the bore **38**, has a diameter to closely match the diameter of pin **29**, thus aligning the same, for centering reference of the tool axis at the adjacent end of bore **10**.

Having established means whereby the desired seat-axis reference may be taken at one end of bore **10** and work-engagement and axis centering may be achieved at the other end of the valve-stem guide bore, means is provided whereby the frame **30** is utilized to clamp both work-engaging means **16–33**, in secure axial compression. This may be done using a jack between telescoped, mutually guided halves of the frame **30**; alternatively, a jack mechanism may be interposed between one of the arms **31–32** and the related one of the work-engaging means (**16**, and **33–35**, respectively). The form shown adopts the latter of these alternatives. Thus, the seat-engaging means **16** is adjustably fixed, at set screw **43** in the collared end **44** of arm **31**; set screw **43** preferably seats in the bottom of a keyway **45** in the cylindrical periphery of body **26**, which otherwise receives extensive support at the bore of collared end **44**. Preferably, the bottom of keyway **45** is a ramp, sloping from a shallow end near fitting **23**, to a greater radial depth at the end remote from valve-seat engagement; thus, a clamped setting of screw **43** strongly resists dislodgment, however strong the axial force of clamping. The end **46** of the other arm **32** is similarly collared, and a set screw **47** locates in a keyway **48** in the tubular support member **35**; the key fit at **47–48** should, however, be loose, to afford longitudinally jacked displacement of member **35**, by selective manipulation of a nut **49** on the threaded portion **50** of member **35**. Preferably, a lock nut **51** secures screw **47** in such keying position.

In use, a valve-seat-engaging adapter **24** is first selected, depending upon the particular seat configuration of the head **11**. The selected adapter **24** is telescopically assembled to the reduced end **26** of body **25**, and set screw **43** is clamped, as the span for the worn block **11** may dictate. An appropriate self-aligning work-engaging means or adapter **33** is also selected for the particular design of head **11**, and it is assembled with friction fit to counterbore **34**. The jig, thus assembled, is applied to span the work (**11**), with adapter surface **23** firmly planted at the seat **13**. Next, nut **49** is manipulated to project adapter skirt **36** into light contact with the work (**11**) at **15**. The alignment pin **29** (FIG. 3) with cylindrical contour sized for precise guidance by the bore **42**, is inserted in the tail end of bore **42**, until its tapered front end **29'** engages and determines its centering reference from the bore **10**, as shown by phantom outline in FIG. 1 at **29'**; a light hammer tap on the projecting end of pin **29** will assure that it positively references to the bore **10** and thus assures final determination of the tool axis. The nut **49** is then tightened, by wrench or spanner means, to establish a secure, compressionally loaded hold of the now located guide member **16**, seated and oriented as well as is possible, at **13**; in this clamping process, the self-aligning feature at **41** has enabled the work reference to adapt to various orientations of the spring-pad surface **15**. Pin **29** can be removed, and drilling, reaming and the like coring can then proceed, using a portable drill to which the tool **17** has been chucked. Having finished the enlarged bore **10** to the necessary enlarged diameter (and possibly slightly reoriented axis), the tool **17** and jig are removed, and a valve-stem guide sleeve insert is installed. Finally, the valve seat **13** is ground, using the bore of the new insert as the basic reference.

The described embodiment of the invention will be seen to have achieved the stated objects with a basically simple but highly accurate tool which is portable and adaptable to various valve-body, cylinder head, and like configurations in which a guide is to be cored. The clearances in the counterbore **37** and bore **38** of adapter **33** permit the greatest freedom for seat **13** to adapt to the particular orientation of spring seat **15**; this feature is so significant in the use of the tool that I have called adapter **33** a "spring-seat avoider," or "spring-seat compensator."

While the invention has been described in detail for the preferred forms shown, it will be understood that modifications may be made without departing from the scope of the invention.

We claim:

1. A work-mounted rotary-tool jig for use in reconditioning a worn valve assembly, comprising a rigid frame with spaced arms adapted to span a valve body having a valve-stem guide bore and a tapered concave valve-disc seat at one end of the bore, valve-seat engaging means carried by one of said arms and having a tapered convex surface facing the other of said arms and conforming to and adapted to locate on said seat, said valve-seat engaging means having an elongated bore open at both ends and finished at least at two spaced axial regions thereof to provide an accurate cylindrical tool-support guide on an axis that is strictly concentric with that of said tapered convex surface, and work-engaging means on the other of said arms and having an elongated alignment bore aligned with the axis of said valve-seat engaging means, said work-engaging means including self-aligning connecting means, said connecting-means being distributed about the axis of the alignment bore and in clearance relation with said valve-stem guide bore, said connecting means having a bore of larger diameter than that of said alignment bore, elongated centering means guided by said alignment bore and projecting through said connecting means for centering engagement with the valve-stem guide bore, and adjustable means for selectively relatively axially spacing said seat-engaging means and said work-engaging means, whereby upon axially adjusting said last-defined means for compressional embrace of the valve body at the seat and valve-stem guide bore thereof, said valve-seat engaging means will be accurately and concentrically referenced, to the center of the seat and to the center of the remote end of the valve-stem guide bore, so that a rotary tool may be guided via the bore of said valve-seat engaging means, to enlarge and possibly offset the prior-existing valve-stem guide axis, thereby conditioning the enlarged bore to receive a valve-stem guide insert.

2. The jig of claim 1, in which said work-engaging means is generally annular with a bore diameter exceeding the bore diameter of said cylindrical tool-support guide, whereby the rotary tool will assuredly clear the bore of said work-engaging means, upon emergence through the work.

3. The jig of claim 2, in which said self-aligning connecting-means includes a truncated convex spherical formation on said work-engaging means and concentric with the bore thereof.

4. The jig of claim 1, in which said centering means includes an element that is selectively removable through the bore of said self-aligning connecting means.

5. The jig of claim 3, in which said work-engaging means includes a reduced neck projecting axially beyond the region of said truncated spherical formation and a tubular member carried by said other arm and having a bore in which said neck is insertable, and yieldable friction means carried by said neck for selective engagement with and retention by the bore of said tubular member.

6. The jig of claim 1, in which said adjustable means includes a lead-screw and nut connection between said self-aligning connecting-means and said other arm.

7. The jig of claim 1, in which said valve-seat engaging means includes concentric head and body elements having a selectively engageable telescopic fit, said body element having the bore with the cylindrical tool-support guide, and said head element having said tapered convex surface and being annular, with a bore diameter exceeding that of said cylindrical tool-support guide.

8. The jig of claim 1, in which said elongated centering means is a rod guided by said alignment bore and having a conical end for work engagement.

9. A work-mounted rotary-tool jig for use in reconditioning a worn valve assembly, comprising a rigid frame with spaced arms adapted to span a valve body having a valve-stem guide bore and a tapered concave valve-disc seat at one end of the bore, self-centering valve-seat engaging means carried by one of said arms and adapted to locate on said seat, said valve-seat engaging means having an elongated central bore open at both ends and finished at least at two spaced axial regions thereof to provide an accurate cylindrical tool-support guide on an axis that is strictly concentric with that established by self-centering action upon valve-seat engagement by said valve-seat engaging means, and work-engaging means on the other of said arms and having an elongated alignment bore aligned with the axis of said valve-seat engaging means, said work-engaging means including self-aligning connecting means, said connecting means being distributed about the axis of the alignment bore and in clearance relation with said valve-stem guide means, said connecting means having a bore of larger diameter than that of said alignment bore, elongated centering means guided by said alignment bore and projecting through said connecting means for centering engagement with the valve-stem guide bore, and adjustable means for selectively relatively axially spacing said seat-engaging means and said work-engaging means, whereby upon axially adjusting said last-defined means for compressional embrace of the valve body at the seat and valve-stem guide bore thereof, said valve-seat engaging means will be accurately and concentrically referenced, to the center of the seat and to the center of the remote end of the valve-stem guide bore, so that a rotary tool may be guided via the bore of said valve-seat engaging means, to enlarge and possibly offset the prior-existing valve-stem guide axis, thereby conditioning the enlarged bore to receive a valve-stem guide insert.

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