ABSTRACT

A drill guide for enlarging the valve stem guides of internal combustion engines when said guides become worn, in order to permit the insertion of a shim sleeve of the desired accurate internal bore, consisting of a guide bar adapted to be positioned over a line of said guides, a series of at least three blocks carried by the bar for adjustable movement therealong, and fixable thereon at any desired position, and a pilot rod carried by each of the blocks, the pins being parallel with each other and normal to the bar, and adapted to be received in the valve stem guides, at least one of the pilot rods being carried removably in a drill bushing fixed in its associated block.

8 Claims, 7 Drawing Figures
DRILL GUIDE FOR ENLARGING ENGINE VALVE STEM GUIDES

This invention relates to new and useful improvements in overhaul accessories for internal combustion engines, and has particular reference to a guide for enlarging worn valve stem guides of an engine by means of drilling, in order to permit the installation of shim sleeves having internal bores accurately sized to receive the valve stems, whereby to repair the engine.

This type of engine repair is common, but has always been subject to the problem that it is difficult to align the enlarging drill accurately with the original axis of the stem guide when the guide is badly worn and hence irregularly enlarged. The difficulty applies both to providing accurate concentricity of the drill to the original guide axis, and also to providing accurate parallelism of the drill to the original guide axis. Pins or pilot rods inserted into the worn guides, which are usually utilized for providing drill alignment, may tilt and rock in the guide, and may also be disposed off-center with respect to the original guide axis, when the guide is badly worn, so that the drilling is not accurately coaxial with the original guide axis, with the result that the shim sleeve itself is inaccurately installed. This inaccuracy results in misalignment both of the valve heads with their seats, and also of the valve stems with the rocker arms which reciprocate said stems in said sleeves, causing inefficient operation of the repaired engine.

Accordingly, the principal object of the present invention is the provision of a drill guide device which insures coaxiality of the drilling with the original guide axis within acceptable limits of accuracy, regardless of the degree or contour of wear to which the guides may have been subjected. Generally, this object is accomplished by the provision of a device consisting of a guide bar adapted to be positioned over a line of the valve stem guides of an engine head, and three pilot rods projecting normally therefrom in parallel relation, at least one of said pilot rods being carried removable in a drill bushing of the desired size. The three rods are first inserted in three relatively unworn guides of either the same engine head or an identical but new head, and fixed relative to the guide bar. The removable pilot rod is then removed, and the bar positioned with the drill bushing over the guide to be drilled, with the other two pilot rods inserted in adjacent guides bearing the same relation to the guide to be drilled as those engaged by these two rods in the original combination bore to the rod carried by the drill bushing. The drill may then be inserted through the bushing to enlarge the worn guide with full assurance of accuracy within acceptable limits. The two pilot rods are omitted at this time are of course engaged in guides of the engine head which may also be worn to some extent thereby introducing some inaccuracy in the positioning of the drill bushing, but acceptable accuracy is virtually assured by the fact that significant wear of more than one or two stem guides in a head is most unusual, so that virtually always there will be a sufficient number of only slightly worn guides to provide for acceptably accurate placement of the drill bushing. Also, it is nearly always the guides of the exhaust valves which show wear first, due to the relatively high temperature of the exhaust gases, while the guides of the intake valves remain relatively unworn and hence can be used to index the present device.

Other objects are extreme simplicity and economy of construction, efficiency and dependability of operation, and ready adaptability of the device for use with engine heads having different valve guide spacings.

With these objects in view, as well as other objects which will appear in the course of the specification, reference will be had to the accompanying drawing, wherein:

FIG. 1 is a top plan view of a drill guide embodying the present invention.

FIG. 2 is a sectional view taken on line II—II of FIG. 1 with parts left in elevation.

FIG. 3 is a fragmentary sectional view taken on line III—III of FIG. 2.

FIG. 4 is a sectional view taken on line IV—IV of FIG. 2.

FIG. 5 is a fragmentary sectional view taken on line V—V of FIG. 2.

FIG. 6 is a fragmentary sectional view of the head of an internal combustion engine, showing the drill guide of the present invention in two different positions relative thereto occupied in the two stages of the use of said guide, and

FIG. 7 is an enlarged fragmentary view similar to FIG. 2, but showing a slight modification of structure.

Like reference numerals apply to similar parts throughout the several views, and FIG. 6, shows generally the head of an internal combustion engine. Formed in said head are a series of parallel, in-line valve stem guides 4 constituting bores formed therein. Said guides are formed in pairs, the bores of each pair projecting outwardly of said head through necks 6 of said head, and communicating respectively at their inner ends with an intake valve chamber 8 having a port 10 to the intake manifold, and an exhaust valve chamber 12 having a port 14 to the exhaust manifold. As is well understood in the art, the valve chambers 8 and 12 of each pair communicate with a single cylinder of the engine, and each valve chamber carries a valve member, not shown, having a head member movable toward and away from a valve seat 16 formed at the outer end of the chamber, and having a stem member slidable in the associated stem guide 4. The stems project outwardly from the head through necks 6, and are operated by suitable timing gear to provide opening and closing of the valves in proper sequence. The valve guides for four cylinders are shown. Assume that the leftmost exhaust valve stem guide 4 in FIG. 6, further designated as 4A, is badly worn, and requires enlargement by drilling to permit the insertion of a shim sleeve. The block may be supported on the work table of a drill press, with necks 6 uppermost, and levelled to bring guides 4 into vertical position to be parallel with a drill bit 18 carried by the drill press head. This set-up adjustment may be accomplished by means of a spirit level or the like mounted on a pin inserted in a relatively unworn guide 4.

The drill guide forming the subject matter of the present invention includes a straight guide bar 20 of inverted U-shape, in cross sectional contour, having a top wall 22 and depending parallel side walls 24. A slot 26 is formed longitudinally in top wall 22, extending nearly the full length thereof. The slot is somewhat narrower than the spacing between side walls 24.

Carried between side walls 24 are three rectilinear blocks 28, 30, and 32 which fit snugly but slidably between said side walls. Each block is secured in the guide bar by a cap screw 34 threaded therein, said screw extending upwardly through slot 26, and through
a washer 36 seated against the top surface of the bar, the head of the screw being disposed above said washer. By tightening each of said screws, the associated block may be drawn tightly against the inner surface of top wall 22 of the bar, and clamped immovably in said bar. By loosening each of said screws, the associated block may be moved freely in a direction longitudinal to the bar.

In block 28, there is affixed a tubular cylindrical drill bushing 38 the axis of which is vertical and accurately normal to guide bar 20, the lower end thereof being flush with the bottom surface of the block, and the upper end of which projects above said block into slot 26. The internal diameter of said bushing is equal to the diameter to which stem guide 4A must be bored to receive a shim sleeve. Carried removably in the bushing is a pilot rod 40 having an upper end portion 42 of a diameter to engage slidably and snugly in the bushing, and a coaxial lower end portion 44 having a diameter equal to the nominal diameter of stem guides 4. Portion 44 is of such length as to extend completely through a stem guide 4 when portion 42 thereof is engaged in bushing 38 and guide bar 20 is disposed above the head in position A of the device as shown in FIG. 6. Affixed permanently and respectively in blocks 30 and 32 are a pair of pilot rods 46 and 48 projecting downwardly from their respective blocks in accurately parallel relation to pilot rod 40, and both of the same diameter as lower portion 44 of rod 40. The downward projection of pilot rod 46 is preferably equal to that of rod 40, but pilot rod 48 may be substantially shorter, as shown. Also, as shown, pilot rods 40 and 48 are the end rods of the series of three, and pilot rod 46 is disposed intermediate rods 40 and 48, but as will appear this is a matter to be affected by the circumstances of each particular job.

In the operational use of the species of the invention shown in FIGS. 1–6, as just described, block 28, carrying pilot rod 40, may be secured tightly in guide bar 20 at all times, by tightening of its screw 34. Then, with screws 34 of blocks 30 and 32 loosened, the device is placed in the A position of FIG. 6, relative to the engine head, so that pilot rods 40, 46, and 48 enter relatively unworn stem guides 4 of the block, the slidability of blocks 30 and 32 in guide bar 20 resulting from loosening of their screws 34 permitting the pilot rods to adjust themselves to the spacing of the stem guides in any particular engine. As previously stated, it is generally possible to find three relatively unworn stem guides in most engine heads, since it is unlikely that more than one or two guides will become badly worn before the engine requires repair, and further since the guides of the exhaust valves generally wear much more rapidly than those of the intake valves. Also, the spacing of the pilot rods obtained at the A position of FIG. 6 could be obtained by application of the device to an identical but new and unworn engine head.

Screw 34 of block 30 is then tightened to fix the spacing of pilot rods 40 and 46 relative to guide bar 20. Screw 34 of block 32 could also be tightened at this time, but preferably is not, since as will appear it is not necessary, and since a later stage of use requires that rods 46 and 48 be withdrawn simultaneously from their guides 4, and it has been found that this withdrawal is facilitated if rod 48 is loose and movable slightly relative to the guide bar. It is also for the purpose of facilitating this removal that rod 48 is shorter than rod 46.

Pilot rod 40 may then be removed by sliding it upwardly through bushing 38, and guide bar 20 is then lifted to withdraw pilot rods 46 and 48 from their guides 4. The device is then moved to the B position of FIG. 6, with drill bushing 38 positioned above the stem guide 4A to be bored out, and pilot rods 46 and 48 are inserted into two relatively unworn guides 4 bearing the same relation to guide 4A that the guides in which they were inserted in the A position bore to the guide receiving pilot rod 40 in the A position. Screw 34 of block 30, if it was not tightened when the device was in the A position, is tightened at this time. The previous fixing of block 30 insured the proper lateral spacing between the axes of drill bushing 38 and pilot rod 46, so that bushing 38 will then be disposed accurately at its proper position longitudinally of the line of stem guides, and the fixing of block 32 corrects any lateral offset of the bushing from the line of stem guides. The axis of drill bushing 38 is then disposed, within reasonably acceptable limits of accuracy, coaxially with the original axis of stem guide 4A, and said guide may be bored and enlarged accurately coaxially with its original axis by using bushing 38 to guide and direct drill bit 48, regardless of any irregular or off-center contour imparted to said guide by wear thereof, in order that the shim sleeve subsequently seated in the enlarged bore will be accurately placed.

Of course, accuracy of placement of drill bushing 38 cannot be absolute, since its placement is indexed by pilot rods 46 and 48 in nearby stem guides 4 of the same engine head, which naturally is a used head, so that the guides used for indexing purposes, while perhaps relatively unworn as compared to guide 4A, nevertheless will show some wear, and permit some slight inaccuracy of indexing drill bushing 38. However, it has been fully demonstrated that the present device provides accuracy well within acceptable limits, much greater than that obtainable by present equipment, and sufficient to prevent any material adverse effect on efficiency of engine operation. To increase the accuracy of the present device, it is obvious that guide bar 20 could be made of any desired length, and that the three pilot rods could be distributed in any desired sequence and spacing therealong, in order to take advantage of the least worn stem guides for indexing purposes. Also, the pilot rods may be of somewhat greater diameter than the nominal stem guide diameter, in order to compensate for general engine wear.

FIG. 7 shows a slight modification of structure, the device shown therein being identical to that shown in FIGS. 1–6 except that pilot rods 46 and 48, instead of being permanently affixed in their respective blocks 30 and 32, are each provided with an enlarged upper portion, 50 and 52 respectively, carried slidably in tubular bushings 54 and 56 fixed in the respective blocks, in the same manner as pilot rod 40. This modification possesses certain advantages. It permits the pilot rods to be inserted separately into the stem guides in the A step of FIG. 6, and the guide bar subsequently applied therewith, and also permits removal of the guide bar before pilot rods 46 and 48 are transferred to other stem guides for use in the B step of the operation. This is considered advantageous in increasing the ease and facility with which the pilot rods may be inserted into and removed from the stem guides. Also, this arrangement facilitates the interchangeable use of pilot rods the lower guide-engaging portions of which are of
finely graduated diameters, in order to provide the most accurate possible fit in stem guides which may be somewhat worn. With the species of FIGS. 1–6, selective use of pilot rods of graduated diameters would require an entire additional tool, or at least separate blocks 30 and 32, for each pilot rod of different diameter. However, the species of FIGS. 1–6 provides accuracy of a degree fully acceptable under most circumstances, and is generally preferable to that of FIG. 7 in view of its relative simplicity, and of the relatively short time required for its use as described.

While I have shown and described a specific embodiment of my invention, it will be readily apparent that many minor changes of structure and operation could be made without departing from the spirit of the invention.

What I claim as new and desire to protect by Letters Patent is:

1. A drill guide for guiding a drill bit in enlarging a worn valve stem guide of an internal combustion engine to receive a shim sleeve having an internal diameter equal to the nominal diameter of said valve stem guide and a larger outside diameter, said drill guide comprising:
   a. a straight, rigid guide bar adapted to be positioned above and in line of stem guides of the head of said engine normally to the axes of said stem guides,
   b. a tubular drill bushing carried by said guide bar normally to the longitudinal extent thereof and adapted to guide a drill bit coaxially therein, said bushing having an internal diameter sized to receive a drill bit for drilling a hole in the engine head for receiving said shim sleeve,
   c. at least two pilot rods carried adjustably by said guide bar for movement relative to said guide bar in a direction parallel to the longitudinal extent of said guide bar, said pilot rods projecting normally from said guide bar parallel to but spaced apart from said drill bushing, said pilot rods being insertable simultaneously into certain stem guides of said engine head whereby to position said drill bushing relative to another of said stem guides,
   d. means operable to affix each of said pilot rods immovably to said guide bar at any desired point of said adjustable movement, and
   e. a third pilot rod having a portion having a diameter engageable snugly and removably in said drill bushing, and a portion reduced in diameter to a size insertable snugly into a stem guide of said engine head.

2. A drill guide as recited in claim 1 wherein said drill bushing is carried adjustably by said guide bar for movement thereof relative to said guide bar in a direction parallel to the longitudinal extent of said guide bar, and with the addition means operable to affix said drill bushing immovably to said guide bar at any desired point of said adjustable movement.

3. A drill guide as recited in claim 2 wherein said drill pushing and said pilot rods are detachably connected to said guide bar whereby they may be detached therefrom and re-attached thereto in any desired sequence.

4. A drill guide as recited in claim 1 wherein each of said first pilot rods is connected to said guide bar by means including:
   a. a rectilinear block fitting closely and slidably in a rectangular longitudinal groove of said guide bar, said pilot rod being mounted in said block, and
   b. clamp means operable to affix said block immovably in said groove.

5. A drill guide as recited in claim 4 wherein said drill bushing is connected to said guide bar by means including:
   a. a rectilinear block fitting closely and slidably in a longitudinal groove of said guide bar, said drill bushing being affixed in said block, and
   b. clamp means operable to affix said block immovably in said groove.

6. A drill guide as recited in claim 2 wherein said guide bar is of generally inverted U-shape in cross-sectional contour, having a groove formed in the lower surface thereof, and a longitudinal slot formed through its top wall and communicating with said groove, said slot being transversely narrower than said groove; and wherein said pilot rods, and said drill bushing, are connected to said guide bar by means comprising:
   a. a series of at least three blocks carried slidably in the groove of said guide bar, said drill bushing and said pilot rods each being mounted in one of said blocks, with said drill bushing opening upwardly through said slot, and
   b. a series of cap screws each having a washer beneath the head thereof slidably abutting the top surface of said guide bar in bridging relation to said slot, each of said screws extending downwardly through said slot and being threaded into one of said blocks.

7. A drill guide as recited in claim 6 wherein said drill bushing and said pilot rods are permanently affixed in their associated blocks.

8. A drill guide as recited in claim 6 with the addition of a tubular pilot rod bushing affixed in each of the blocks associated with the said at least two pilot rods, in parallel relation to said drill bushing, and wherein each of the said at least two pilot rods has a portion engaged slidably and removably in the associated pilot bushing.