

# Design and structure of Tools for the Removal and Replacement of Engine Valve Stem Seals: A Review

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**Abstract**-For various reasons, it becomes advisable to replace or remove many components on an internal combustion engines due to automobile wear out over the time. Among these components, are the valve stem seals which are positioned on the engine cylinder heads. The traditional procedure to replace or remove these valve seals which wear out over with time, is much time consuming and tedious taking into consideration the various structures that are to be initially displaced. This paper discuss the various efforts that are taken in the past to provide a tool to facilitate the removal of valve seal from the cylinder heads of automotive engine as well as the various presently available tools. It reviews the diversity in the design and structures of the newly invented tools. Moreover this paper also emphasizes over the benefits and shortcomings of the present generation tools which are used for the same purpose.

**Key words:** *combustion engine, valve stem seals.*

## I. INTRODUCTION-

Internal combustion engines have become gradually conventional with the advent of smaller, more economical engines. They employ a number of cylinders, each of which may have two or sometimes four valves for intake and exhaust respectively. Irrespective of the engine design, each valve is operated against pressure exerted by a spring which surrounds a corresponding valve stem. The spring usually is interpolated between a valve guide within the cylinder head and a retainer cap or washer which is detachable and secured on the end of the valve stem by a retainer generally known as "keeper". Because of the reciprocating motion of the valve assemblies, the valves and valve seals and valve springs are subject to wear and fatigue thereby causing a loss of compressive force and eventual fracture. Therefore, it may be essential on occasion to have the valves, valve seals, or valve springs replaced in an automobile engine. Typically, such repairs only can be brought about by getting rid of the valve spring surrounding the valve stem. To remove the valve spring, it is mandatory to displace the washer and keeper located on the end of the valve stem. However, the washer and keeper cannot be removed until the valve spring is compressed.

One of the most difficult and tedious as well as perilous activities in the repair and replacement process of valve stem seals is the compression of these strong valve springs in order to carry out their removal and their replacement. It is obvious that if the spring is compressed manually, there are chances to accidentally release the spring and severe injury may result in. Use of lever based mechanisms for compressing the spring may be another option. But in both the cases damage to the valves may occur thereby causing the loss.

Several efforts have been made in the past to provide tools to enable the removal of valve springs from the cylinder heads of automotive engines. The traditional method involves a number

of steps which includes displacement of various components surrounding the valve seal which is not only tedious but also time consuming. Therefore, with a vision to provide an alternative and easier method for the same purpose there is a need to design equipment which will facilitate the job. The present paper reviews the various types of tools which are designed and are available to remove and replace the valve stem seals/ valve spring or spring assembly.

## II. TRADITIONAL METHODS & MODERN METHOD OF REMOVAL OF VALVE STEM SEALS:

Traditional methods	Modern method
Disconnecting the power supply and draining the coolant a series of components are removed starting from fan ring brackets, by-pass pipe bolts, crank case ventilation pipe, camshaft along with the surrounding wiring and other spring plates and bolts by making use of a lifting tool. <sup>1</sup>	By disconnecting the power supply and draining the fuel from cylinder head, without displacing it, the injector is pulled out.
By displacing the cylinder head, further desired work is carried out	The tool specifically designed to compress the valve springs is positioned in the place of injector and the desired spring is compressed one at a time. <sup>3</sup>
The process involved in displacing or removing all the surrounding components and cylinder heads for replacing the valve seal is but tedious as well as time consuming. <sup>2</sup>	The work to be carried out requires less time and is much more easier.
An alternative method is indeed needed to carry out the job.	Designing of such types of tools was a challenge.

## III. REVIEW OF LITERATURE

US. Pat. No. 3,979,811 issued to Kammeraad on Sep. 14, 1976 entitled OVERHEAD CAMSHAFT AND VALVE TRAIN

INSERTION AND REMOVAL TOOLS<sup>4</sup> shown in fig (1) gives the details of a designed tool which is used in aggregation with overhead camshaft assemblies. The tool contains a longitudinal base for attachment to the cylinder head. It projects the camshaft to a position over the valve springs. Each rocker member holds a threaded screw which when turned pivots the rocker and compresses the valve spring. This allows the removal of the camshaft or removal or replacement of valve assembly.

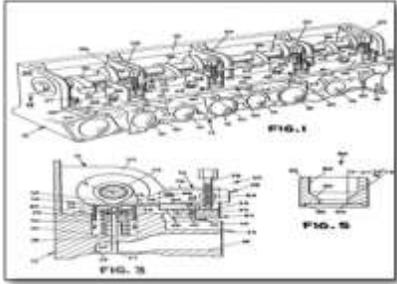


Fig (1) Overhead camshaft and valve train insertion and removal tool

US. Pat. No. 3,977,064 issued to Mote et al. on Aug. 31, 1976 entitled SITU VALVE SPRING COMPRESSION TOOL<sup>5</sup> shown in fig(2) describes a valve spring compressor tool specifically designed to use in conjunction with cylinder heads that include heavy duty double valve springs. The tool comprises of a support bridge that is bolted to the rocker housing across the valves to be compressed. A shaft is threaded into the cross arm. It is so aligned that the rotations causes it to compress down the springs and retains them in a compressed position for work on the valve assembly.

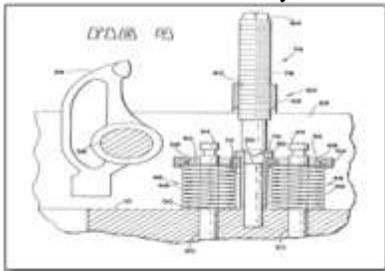


Fig (2) Situ valve spring compression tool

US. Pat. No. 4,022,453 issued to Durgan on May 10, 1977 titled CLAMP FOR ENGINE HEAD SERVICE TEST BENCH<sup>6</sup> shown in fig (3) gives details of a service bench that includes a clamp designed for compression of valve springs on an internal combustion engine cylinder head. It is primarily designed to be positioned across a pair of valves with a bridge. A threaded rod pushes on the bridge between the valves which helps compress the springs for the two valves and facilitates their removal.

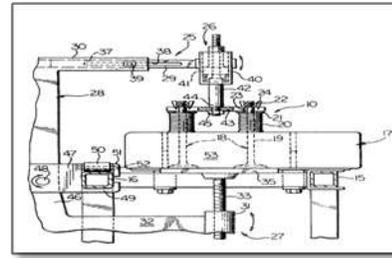


Fig (3) clamp for engine head service test bench

US. Pat. No. 4,780,941 issued to Tucker on Nov. 1, 1988 entitled QUICK MOUNT HAND VALVE SPRING COMPRESSOR<sup>7</sup> as given in fig(4) shows yet another valve spring compression tool proposed to operate in aggregation with a single valve spring at a time. The tool includes a device that is attached to a threaded rocker stud on the cylinder head. It positions a metal yoke over the discrete valve spring. The unique feature of this device is the way in which it may be attached to the threaded stud on the cylinder head and hand cranked so as to compress the valve spring.

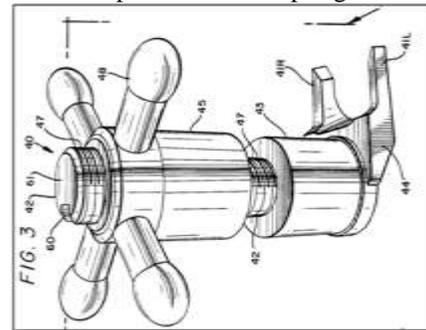


Fig (4) quick mount hand valve spring compressor

US. Pat. No. 3,984,909 issued to VelaZqueZ on Oct. 12, 1976 entitled VALVE STEM SEAL CHANGING TOOL<sup>8</sup> is directed specifically to a tool that helps the removal and replacement of valve stem seals. The best outlook of the overall tool can be seen in fig(5) in which a threaded rod with a turning handle may be located immediately over the valve spring for compression. A gliding guide rod is so positioned that it facilitate the individual placement of the spring compressor over the valve to be worked on. The tool intend to work on only a single valve at a time.

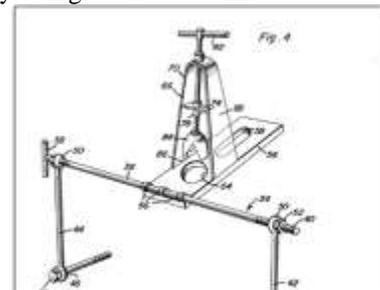


Fig (5) valve stem seal changing tool

US. Pat. No. 5,042,128 issued to Barbour on Aug. 27, 1991 named TOOL FOR REMOVING VALVE SPRING RETAINER OF A VALVE'S ASSEMBLY<sup>9</sup> shown in fig (6) describes yet another rocker plate type tool that is placed in place of the valve rocker over the valve spring assembly. The tool comprises of a threaded rod which is placed on a non-threaded seat. It is used to push rod bore of the engine cylinder head. This seat causes the threaded rod to push up on the rocker plate. When the rod is turned the rocker plate helps to compress the valve spring on the opposite end. The patent addresses the placement of the tool in conjunction with a single valve spring at a time.

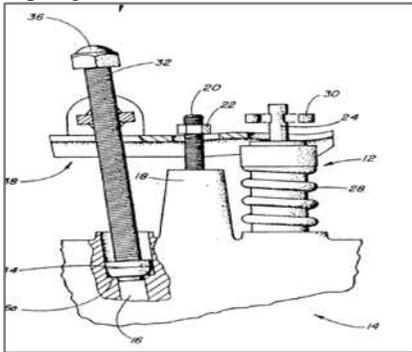


Fig (6) tool for removing valve spring retainer of a valve's assembly

US. Pat. No. 5,241,734 issued to Brackett on Sep. 7, 1993 entitled APPARATUS AND METHOD FOR REMOVING AND INSTALLING VALVE-SPRING RETAINER ASSEMBLIES<sup>10</sup> shown in the fig (7) refer to a tool that uses an existing spark plug opening for mounting. Similar to many of the previous patents, it relies on a single lever positioned on the cylinder head. The forced movement of one end of the lever causes the compression of the valve spring on the opposite end. A gang of four valve springs may be compressed through the use of an x-shaped compression tool. A similar assembly is contemplated for two side-by-side positioned valve springs also.

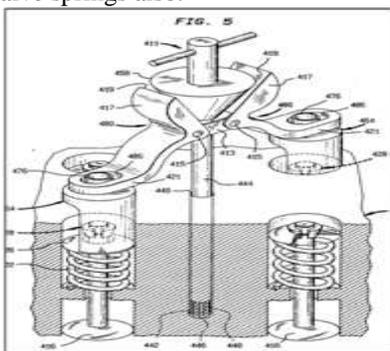


Fig (7) apparatus and method for removing and installing valve-spring retainer assemblies

US. Pat. No. 5,339,515 issued to Brackett et al.<sup>11</sup> on Aug. 23, 1994 is an extension-in-part of the earlier Brackett patent and "improves" upon the device by providing a handle for

depressing the lever. The lever handle is envisioned to speed up the process of compressing the spring versus a threaded compression screw. Moreover, the device does not help to compress multiple valve springs at the same time.

US. Pat. No. 5,371,932 issued to Bryan et al. on Dec. 13, 1994 entitled MULTIPLE VALVE SPRING COMPRESSOR<sup>12</sup> shown in fig (8) describes a bench device consisting of a rectangular base which can support an entire cylinder head assembly. The tool incorporates a longitudinal plate having a long open slit in its center. This open slit is positioned to compress the valve springs. Operation of the tool is by means of an expandable device such as a hydraulic cylinder that compresses the valve springs.

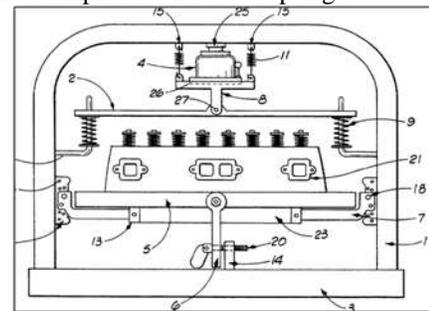


Fig (8) multiple valve spring compressor

US. Pat. No. 5,689,870 issued to Robey on Nov. 25, 1997 named VALVE SPRING COMPRESSION TOOL<sup>13</sup> give details of a comparatively simple tool. It is used in combination with a standard ratchet Wrench. The gadget comprises of a rocker plate which is placed on the valve rocker and is pushed down by the progressive threading of a special socket onto the rocker arm stud. This tool is also used to work with single spring at a time. Not more than one spring can be compressed.

#### IV. CONCLUSIONS:

Owing to the difficulty in employing the traditional method used for replacement or removal of valve seals in internal combustion engines, it became a necessity to design such kind of tool which enables the same job consuming less time and ensuring more safety. It is observed that the tool so far designed serves most of the purpose by compressing the valve spring to carry out the desired job. Many of the tools employ a puller type of arrangement in which there is a possibility of damaging the valve spring. In this case, the rocker plate types of tools are more convenient to use. This type of tool, however are used to compress a single valve spring at a time. It is also observed that a multiple valve spring replacement or removal tools are bulkier and more complicated to handle. In spite of some limitations, all the tools have satisfactorily served so far. A slight modification in the design of tools, would be more effective and definitely enhance the performance of the tool there by making the valve stem seal removal a more easier job.

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