Feb. 26, 1957 R. J. TIEMAN 2,782,518

VALVE TAPPET AND CAM LOBE CHECKING DEVICE

Filed May 19, 1954 2 Sheets-Sheet 1

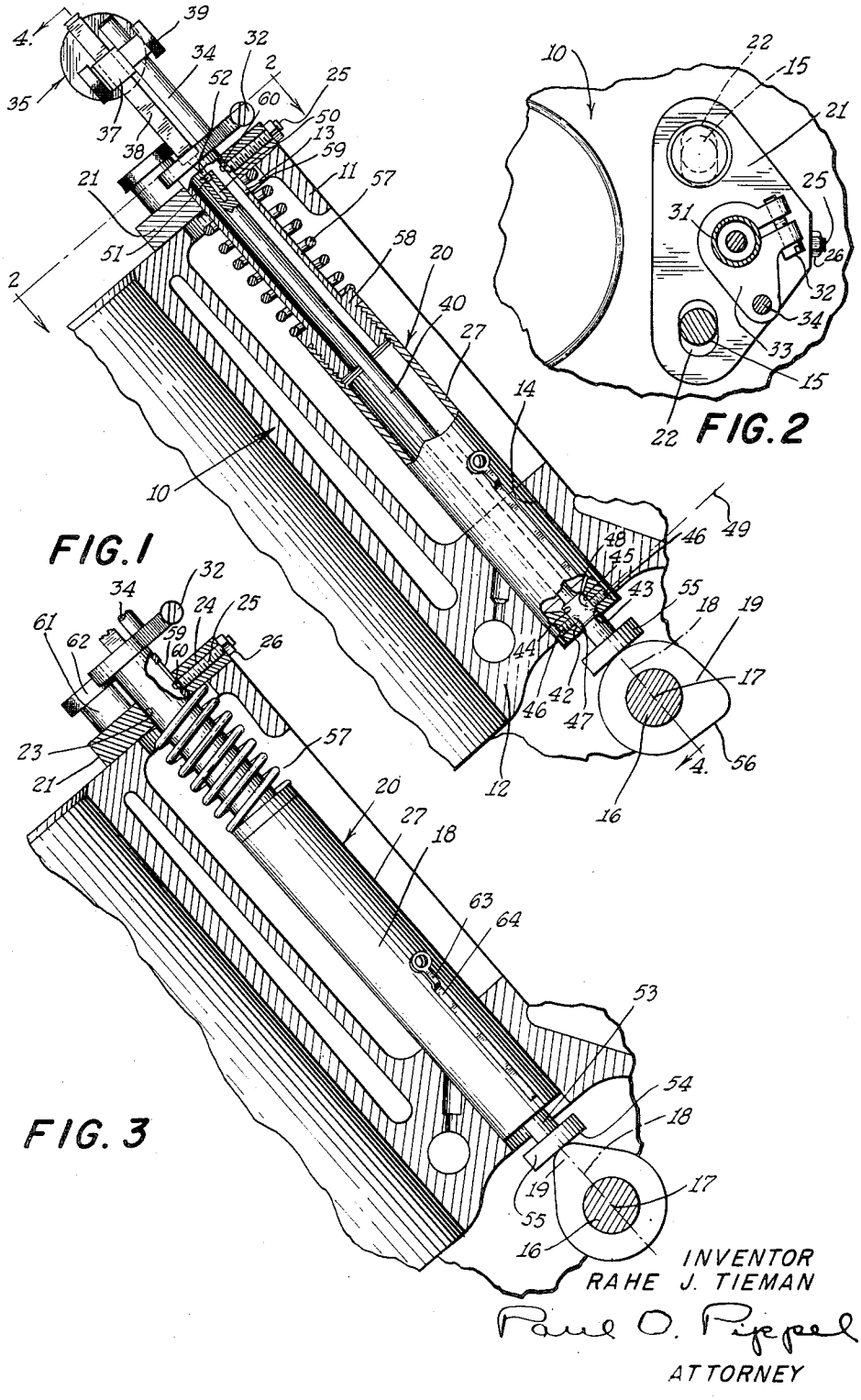


FIG. 1

FIG. 2

FIG. 3

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Filed May 19, 1954 2 Sheets-Sheet 2

FIG. 4

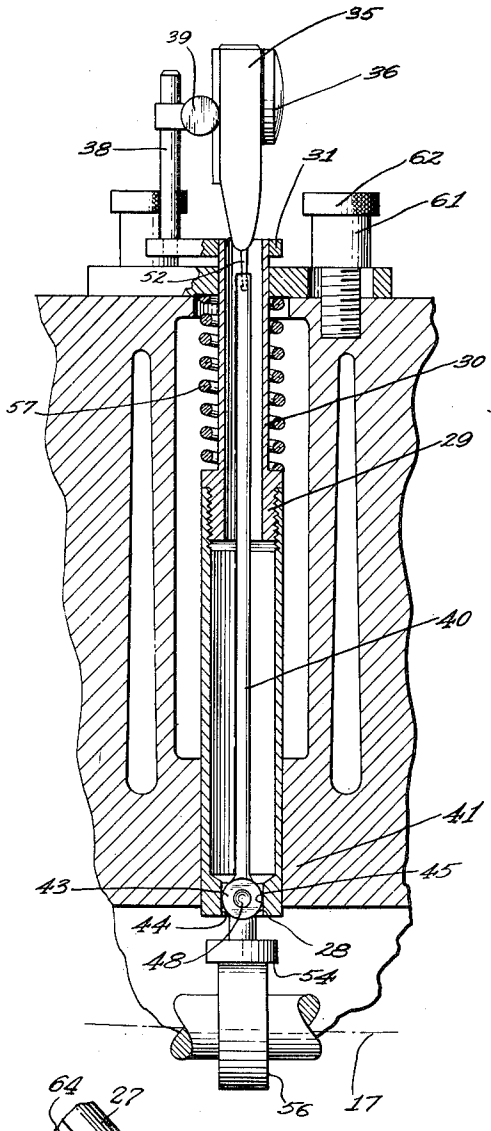
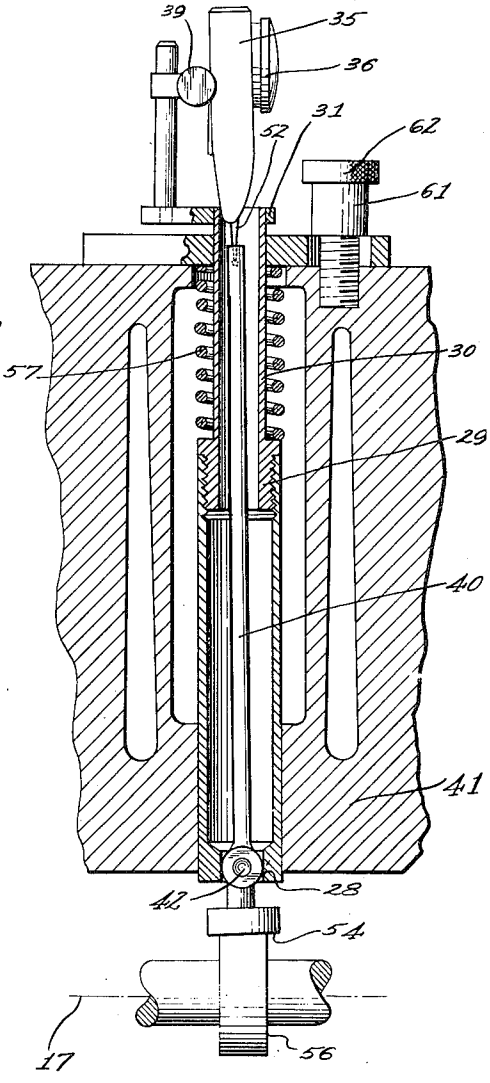


FIG. 5



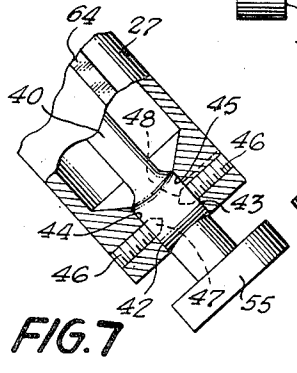


FIG. 7

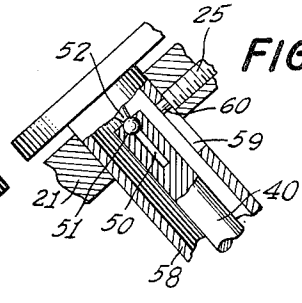


FIG. 6

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VALVE TAPPET AND CAM LOBE CHECKING DEVICE

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Application May 19, 1954, Serial No. 430,773

12 Claims. (Cl. 33—181)

This invention relates to internal combustion engines and more particularly to a tappet bore and cam lobe checking device.

Exhaustive tests have fairly well established that excessive wear and ultimate failures of the engaging surfaces of internal combustion engine valve tappets and cam lobes are oftentimes due to the pitting of the contacting surfaces. Pitting is caused primarily by the development of abnormally high contact surface stress areas on the mating surfaces and ultimately results in a failure of the tappet or cam lobe or both when the stresses exceed the safe limit of the material of which the parts are made.

The localized high surface stress areas are developed by non-uniformly transmitting the driving force of the cam lobe to the tappet face. Assuming that full and uniform line contact, as distinguished from joint contact, always existed between the tappet face and the entire width of the cam face, it is unlikely that pitting would occur. However, this ideal contact relationship between the cam and tappet is difficult to achieve and is commercially impossible to obtain where the engines are manufactured in large volumes inasmuch as production processes may, from time to time, deviate from the desired tolerances. Practically speaking, it is impossible to machine the camshafts and cam lobes whereby the contact surfaces of the cam lobes are perfectly parallel to the camshaft rotation axis. Furthermore, because of bearing inaccuracies and misalignments the longitudinal axes of the tappets are not perpendicular to the camshaft axis and the tappet cam-engaging surfaces are not parallel to the camshaft axis and the contact surfaces of the cam lobes. Hence, the cam surface is inclined from the tappet face and, as a result, if the degree of inclination is substantial, only a portion of the cam surface engages a corresponding portion of the tappet face causing a high surface stress to be developed in the region of the engaging portions.

It will be appreciated that if the degree of inclination or misalignment between the tappet cam-engaging surfaces and the cam lobe surfaces can be accurately determined during assembly of the various engine components and before the engine is placed in operating service, many engine breakdowns due to tappet and cam failures which occur by reason of the degree of misalignment therebetween unknowingly exceeding a permissible limit can be avoided. Heretofore, it was commercially impossible to check the degree of misalignment of the tappets and cam lobes of each production engine because of the unavailability of gauges and instruments which could be employed quickly and conveniently. Furthermore, the time required to test each engine accurately with the prior art devices was of such length that the test was commercially impractical. It is, therefore, the primary objective of the present invention to provide a tappet bore and cam lobe checking device which is convenient and easy to use and which will quickly and accurately indicate the

degree of misalignment between a tappet bore and cam lobe.

Oftentimes, due to manufacturing inaccuracies, a portion only of a cam lobe surface will be misaligned with the valve tappet in the assembled engine and a single test made of the alignment of only one section of the cam lobe profile in relation to the tappet bore will not necessarily reveal the misaligned cam surface portion. It is, therefore, another object of the invention to provide a checking device which is capable of quickly indicating the degree of misalignment of the tappet bore with respect to the entire cam lobe tappet-engaging surface.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention, together with many of the purposes and uses thereof, will become readily apparent from a reading of the ensuing description in conjunction with the annexed drawings, in which:

Figure 1 is a fragmentary cross-sectional view of an internal combustion engine cylinder block and camshaft showing a tappet bore and cam lobe checking device embodying the invention in position for indicating the misalignment between a cam lobe and tappet bore;

Figure 2 is a sectional view taken substantially along line 2—2 of Figure 1;

Figure 3 is a view similar to Figure 1 with exception that a different section or portion of the cam lobe surface is shown contacting the checking device;

Figure 4 is a sectional view taken substantially along line 4—4 of Figure 1; and

Figure 5 is a view similar to Figure 4 with the exception that the cam lobe surface contacting the checking device is not parallel to the camshaft rotation axis.

Referring to the drawings in detail, wherein like reference characters represent like elements throughout the various views, there is shown a portion of one bank of the cylinder block 10 of a V-type, overhead valve internal combustion engine. While the invention is shown and will be described in conjunction with a V-type, overhead valve engine, it is to be understood that the invention could be applied to engines other than those of the V-type. However, in the engine illustrated, the top and bottom walls 11 and 12, respectively, of the cylinder block 10 are provided with a plurality of pairs of aligned bores 13, 14. One pair is shown in the drawings. The lower bore 14 is adapted to slidingly receive a valve tappet (not shown) and is generally referred to as a tappet bore. While the cylinder block head and the engine valves which are mounted in the head are not shown, it will be appreciated that the valves are actuated by reciprocation of the valve tappets through the media of linkage extending from the tappets through the bores 13 to the valves as in conventional engines. The cylinder head is secured to the cylinder block 10 by means of bolts which are threaded into a plurality of threaded apertures 15, two of which are shown in Figure 3, formed in the top wall 11 of the cylinder block.

A camshaft 16, partially shown in the drawings, is rotatably journaled in the cylinder block 10 and is disposed below the bottom wall 12. The rotational axis 17 of the camshaft 16 is perpendicular to the longitudinal axis 18 of the tappet bore 14 in an engine having accurately machined tappet bores and a perfectly aligned camshaft. A plurality of cam lobes 19 (only one is shown) are formed on the camshaft 15 along the rotational axis 17 thereof. A cam lobe 19 is disposed below each tappet bore 14 and in normal operation, upon rotation of the camshaft 16, the valve tappets contacting the cam lobes are reciprocated to actuate the intake and exhaust valves of the internal combustion engine.

In the production of internal combustion engines in

large volumes, it is commercially impossible to absolutely manufacture each engine exactly like every other engine and to manufacture each engine perfectly wherein the tappet bore axes are perpendicular with respect to the camshaft axis and to the tappet-contacting surfaces of the cam lobes. The present invention contemplates the provision of a device for rapidly checking tappet bores in relation to the camshaft axis and cam lobes and for indicating the degree of deviation from a perfectly aligned, ideal engine construction. The device, designated generally by numeral **20**, is applied to the engine to be gauged after the camshaft **16** is mounted in the cylinder block **10** but prior to the assembly of the valve tappets therein. The device **20** includes a mounting plate **21**, triangularly-shaped in plan as shown in Figure 2. A pair of spaced, elongated slots **22** are formed in the plate **21** for a purpose which will be explained hereinafter. The plate **21** is also provided with a centrally located circular aperture **23** and a relatively small bore **24** leading from one edge of the plate and opening into the aperture **23**. The bore **24** is threaded and is adapted to receive a set screw **25**. The set screw **25** is adjustable within the bore **24** whereby the length of the set screw projecting into the aperture **23** can be varied. A lock nut **26** is threaded on the end of the set screw **25** exteriorly of the plate **21** and is used to maintain the set screw in its adjusted positions.

As best shown in Figures 1, 4 and 5, the device **20** includes a cylindrical hollow member **27** having a relatively small rectangular opening **28** at its lower end. The outer diameter of the cylindrical member **27** is slightly less than the diameters of the tappet bores **14** of the engines to be checked. The upper end of the cylindrical member **27** is provided with an internal screw thread and is adapted to receive the lower, threaded end **29** of an open-ended sleeve **30**.

A bracket **31** is clamped to the upper end of the sleeve **30** by means of a bolt **32**. The bracket **31** is provided with an arm **33** to which one end of a rod **34** is fixed. The rod **34** serves as a supporting post for a conventional dial indicator gauge, designated generally by numeral **35**. The dial indicator gauge **35** is of the type that is provided with a needle pointer (not shown) for indicating on a dial face **36** the degree of rotation of a bracket **37** about an axis perpendicular to the plane of the paper as viewed in Figure 4, from a zero position. As in conventional dial indicator gauges, the gauge **35** will register plus or minus readings depending upon the direction the bracket **37** rocks from the zero position. A rod **38** is adjustably clamped to the bracket **37** and depends therefrom. The gauge **35** as a whole is similarly adjustably clamped to the supporting rod **34** by means of a bolt **39** whereby the spacing of the gauge above the bracket can be varied.

Extending longitudinally within the cylindrical member **27** and sleeve **30** is a slender rod **40**. The lower end **41** of the rod **40** is enlarged and is substantially in the form of a flat circular disk. The parallel sides **42, 43** of the disk portion **41** are adapted to slidingly engage walls **44, 45**, respectively, partially defining the rectangular opening **28** formed through the lower end of the cylindrical member **27**. A pair of pivot pins **46**, carried by the lower end of member **27**, extend diametrically toward each other. The innermost ends **47** of the pins **46** are cone-shaped and are positioned in cone-shaped bearings **48** formed in the disk portion **41** to thus support the rod **40** for pivotal movement about an axis **49** extending through the pins and perpendicular to the plane of the paper as viewed in Figures 4 and 5. The uppermost end or end opposite the disk portion **41** is provided with a longitudinally extending, cone-shaped recess **50** which is adapted to receive a ball portion **51** integrally formed with a depending, reduced diameter section **52** of the rod **38**. By virtue of the above described structure it will be appreciated that pivotal movement of the rod **40** in one direction about its pivotal axes **49** causes the rod **38** and the bracket **35** to rock in the opposite direction.

A stem **35** is rigidly secured to the disk portion **41** in longitudinal alignment with the rod **40** and on the opposite side of the pivotal axis **49**. Integrally formed with the stem **53** and having a flat cam-engaging surface **54** lying in a plane perpendicular to the longitudinal axis of the rod **40** is an enlarged, circular head **55**. The diameter of the head **55** is substantially equal to the diameters of conventional tappets which is larger than the width of the cam lobe tappet-engaging surfaces **56**.

A helically-wound spring **57** encircles the sleeve **30** and has one end abutting the underside of the mounting plate **21**. The opposite end of the spring bears against a radially extending shoulder **58** formed on sleeve **30**. From the foregoing, it will be appreciated that the cylindrical member **27**, sleeve **30**, and dial indicator gauge **35** are slidable in a longitudinal direction with respect to the mounting plate **21** and the spring **57** yieldably urges the head **55** downwardly, as viewed in the drawing, or away from the plate **21**. An elongated, longitudinally extending slot **59** is formed in the sleeve **30** adjacent its upper end. The inner end **60** of the set screw **25** is in the form of a reduced diameter section and is adapted to project into the slot **59**. By virtue of the set screw **25** and the slot **59**, the sleeve **30** is permitted to move longitudinally with respect to the mounting plate **21** a distance equal to the length of the slot but is prevented from rotating with respect to the mounting plate.

In order to check the perpendicular relationship between the longitudinal axis of a tappet bore and the rotational axis of the camshaft or the cam lobe tappet-engaging surface associated with the particular tappet bore of a partially assembled engine, the device **20** is lowered into the cylinder block **10** through the aligned bores **13** and **14** until the head **55** abuts the cam lobe tappet-engaging surface **56**. Inasmuch as the spring **57** tends to urge the reduced diameter section **60** of the set screw **25** into engagement with the uppermost end of the slot **59**, the mounting plate **21** which carries the set screw is spaced from the upwardly facing surface of the top wall **11**. A securing bolt **61** having an enlarged, knurled knob **62** on one end thereof is then inserted in one of the slots **22** of the mounting plate **21** and threaded into one of threaded apertures **15**. The mounting plate **21** is moved longitudinally downwardly with respect to the sleeve **30** against the resilient action of the spring **57** until it abuts the top wall **11** and the bolt **61** is then employed to maintain the mounting plate firmly in abutting engagement with cylinder block **10** and prevent relative movement therebetween. Since the cylindrical member **27** is yieldably urged toward the camshaft axis **17** and since the head **55** is carried by the member **27** and is free to pivot about axis **49** relative thereto, the head assumes a position wherein the flat cam-engaging surface **54** of the head is parallel to the cam lobe surface **56**. It will be appreciated that if the particular section of the cam lobe surface **56** engaged by the head surface **54** is not perpendicular to the longitudinal axis **18** of the tappet bore **14**, as shown in Figure 5, because the cam surface **56** is inclined to the camshaft axis **17** or the camshaft axis **17** per se is inclined to the tappet bore axis **18** or both, the head **55** and the rod **40** fixed thereto pivot from the normal position wherein the longitudinal axis of the rod substantially coincides with the tappet bore axis **18** to an adjusted position wherein the head surface **54** is parallel to the section of the cam lobe surface **56** engaged. Such movement causes the rod **38** and the bracket **37** to rock in an opposite direction an amount directly proportionate to the pivotal movement of the head **55**. As stated hereinbefore the degree and direction of rocking movement of the bracket **37** from its zero position is indicated on the dial face **36** of the gauge **35**. It will be appreciated that the spring **57** main-

tains the head surface 54 in engagement with the cam lobe surface 56 and the spring force is sufficient to cause the head 55 to continually adjust itself so that the surface 54 is parallel to the cam lobe surface 56. Inasmuch as the device 20 as a whole with the exception of the mounting plate 21 is capable of reciprocating with respect to cylinder block 10 and the camshaft 16, the dial indicator gauge 35 will indicate the alignment of the tappet bore 14 with respect to the entire cam lobe surface 56 when the camshaft 16 is rotated 360°. As an example, Figure 1 shows the lowest part of the cam lobe surface 56 presented to the head surface 34 and in Figure 3 the highest section of the cam lobe surface is shown engaging the head surface. In order to prevent any looseness between the cylindrical member 27 and the tappet bore 14 and to compensate for any undesirable play therebetween which could result in inaccurate readings, a pair of leaf springs 63 (only one is shown) are provided. The leaf springs 63 are spaced 120° apart and are disposed in longitudinally extending slots 64. One end of each spring 63 is suitably secured to the cylindrical member 27 and portions of the springs are yieldably urged outwardly of the slots 64 and are adapted to engage the tappet bore 14.

The embodiment of the invention chosen for the purposes of illustration and description herein is that preferred for achieving the objects of the invention and developing the utility thereof in the most desirable manner, due regard being had to existing factors of economy, simplicity of design and construction, and the improvements sought to be effected. It will be appreciated, therefore, that the particular structural and functional aspects emphasized herein are not intended to exclude, but rather to suggest such other adaptations and modifications of the invention as fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A device for indicating the angular relationship between the longitudinal axes of a valve tappet bore formed in the cylinder block of an internal combustion engine and the tappet-engaging surface of a cam lobe, comprising: a flat mounting plate adapted to be firmly secured to the cylinder block; an elongated, cylindrical hollow body having a portion thereof adapted to slide longitudinally within the tappet bore; means for interconnecting said body to said mounting plate for limited relative longitudinal movement therebetween; a dial indicator gauge secured to said body including a pivotally supporting rod adapted to pivot about an axis extending substantially perpendicular to said tappet bore axis, said gauge being capable of indicating the direction and degree of pivoting of said rod from a zero position wherein said rod is disposed in longitudinal alignment with said tappet bore axis; a head pivotally supported at one end of said body for rocking movement about an axis perpendicular to said tappet bore axis and parallel to the pivoting axis of said rod, said head having a flat cam-engaging face; means operatively interconnecting said head and said rod whereby rocking movement of said head effects a corresponding pivoting of said rod; and yieldable means for continually urging said cam-engaging face of said head into engagement with the cam lobe tappet-engaging surface.

2. A device substantially as set forth in claim 1, in which, said means operatively interconnecting said head and said rod includes a second rod integrally formed with said head and disposed on the diametrically opposite side of said cam-engaging face, and means connecting the free ends of said first mentioned and second rods.

3. A device for indicating the angular relationship between the longitudinal axis of a valve tappet bore formed in the cylinder block of an internal combustion engine and the tappet-engaging surface of a cam lobe, comprising: a cylindrical hollow body including a member having an outer diameter slightly smaller than the diameter of the tappet bore and a reduced diameter sleeve attached to one end of said member, the end portion of said member opposite said sleeve being adapted to slide longitudinally within the tappet bore; a head pivotally supported by said member and depending from the end portion of said member opposite said sleeve, said head being capable of pivoting about an axis perpendicular to said tappet bore axis and having a flat cam-engaging face; a bracket attached to said sleeve; an indicating mechanism supported by said bracket exteriorly of the cylinder block; means operatively interconnecting said indicating mechanism and said head whereby said indicating mechanism indicates the direction and degree of pivoting of said head from a zero position wherein said cam-engaging face is disposed in a plane perpendicular to said tappet bore axis; and spring means encircling said sleeve and engaging a radial shoulder on said sleeve for continually urging said cam-engaging face into line contact engagement with the cam lobe tappet-engaging surface.

4. A device substantially as set forth in claim 3, in which, said means operatively interconnecting said indicating mechanism and said head includes a first elongated rod disposed within said member and said sleeve, said rod having one end fixed to said head on the diametrically opposite side of said cam-engaging face and its opposite end provided with a longitudinally extending cone-shaped recess to form a bearing; and a second rod pivotally supported by said indicating mechanism and having a ball-like extension at one end thereof adapted to be journaled in said cone-shaped bearing.

5. A device substantially as set forth in claim 4, which further includes a flat mounting plate adapted to be firmly secured to the cylinder block; and means for interconnecting said body to said mounting plate for limited relative longitudinal movement therebetween, said spring means being adapted to abut one side of said mounting plate.

6. A device for indicating the angular relationship between the longitudinal axis of a valve tappet bore formed in the cylinder block of an internal combustion engine and the tappet-engaging surface of a cam lobe, comprising: a hollow body having a cylindrical end portion adapted to slide longitudinally within the tappet bore; a head pivotally supported by one end of said body and depending from said end portion, said head being capable of and constrained for pivoting about a single axis perpendicular to said tappet bore axis, said head having a flat cam-engaging face; an indicating mechanism attached to said body exteriorly of the cylinder block; means operatively interconnecting said indicating mechanism and said head whereby said indicating mechanism indicates the direction and degree of pivoting of said head from a zero position wherein said cam-engaging face is disposed in a plane perpendicular to said tappet bore axis including structure disposed within said hollow body; and spring means encircling said body and engaging a portion of said body for continually urging said cam-engaging face into line contact engagement with the cam lobe tappet-engaging surface.

7. A device for indicating the angular relationship between the longitudinal axis of a valve tappet bore formed in the cylinder block of an internal-combustion engine and the tappet-engaging surface of a cam lobe, comprising: a hollow body having a cylindrical end portion adapted to slide longitudinally within the tappet bore; a head pivotally supported by said body and depending from said end portion, said head being capable of pivoting about an axis perpendicular to said tappet bore axis, said head having a flat cam-engaging face; an indicating mechanism attached to said body exteriorly of the cylinder block; means operatively interconnecting said indicating mechanism and said head whereby said indicating mechanism indicates the direction and degree of pivoting of

said head from a zero position wherein said cam-engaging face is disposed in a plane perpendicular to said tappet bore axis including a first elongated rod disposed within said body, said rod having one end fixed to said head on the diametrically opposite side of said cam-engaging face and its opposite end provided with a longitudinally extending, cone-shaped recess to form a bearing; and a second rod pivotally supported by said indicating mechanism and having a ball-like extension at one end thereof adapted to be journaled in said cone-shaped bearing; and spring means engaging said body for continually urging said cam-engaging face into line-contact engagement with the cam lobe tappet-engaging surface.

8. A device for indicating the angular relationship between the longitudinal axis of a valve tappet bore formed in the cylinder block of an internal combustion engine and the tappet-engaging surface of a cam lobe, comprising: a body having a cylindrical end portion adapted to slide longitudinally within the tappet bore; a head pivotally supported by one end of said body and depending from said end portion, said head being capable of and constrained for pivoting about a single axis perpendicular to said tappet bore axis, said head having a flat cam-engaging face; indicating means operatively connected to said head and attached to said body exteriorly of the cylinder block at the end thereof opposite said head for indicating the direction and degree of pivoting of said head from a zero position wherein said flat cam-engaging face is disposed in a plane perpendicular to said tappet bore axis; and spring means encircling said body for continually urging said cam-engaging face into line contact engagement with the cam lobe tappet-engaging surface.

9. A device for indicating the angular relationship between the longitudinal axis of an engine valve tappet bore and the tappet-engaging surface of a cam lobe, comprising: a head capable of sliding longitudinally with respect to said tappet bore, said head being further capable of and constrained for pivoting about a single axis perpendicular to said tappet bore axis, said head having a flat cam-engaging face adapted to engage said cam lobe tappet-engaging face; and indicating means operatively connected to said head for indicating the direction and degree of pivoting of said head from a zero position wherein said cam-engaging face is disposed in a plane perpendicular to said tappet bore axis.

10. A device for indicating the angular relationship between the longitudinal axis of an engine valve tappet bore and the tappet-engaging surface of a cam lobe, comprising: a head capable of sliding longitudinally with respect to said tappet bore, said head being further capable of and constrained for pivoting about a single axis perpendicular to said tappet bore axis, said head having a flat cam lobe tappet-engaging face; an indicating mechanism; and means operatively interconnecting said indicating mechanism and said head whereby said indicating mechanism indicates the direction and degree of pivoting of said head from a zero position wherein said cam-engaging face is disclosed in a plane perpendicular to said tappet bore axis.

11. A device for indicating the angular relationship between the longitudinal axis of an engine valve tappet bore and the tappet-engaging surface of a cam lobe, comprising: a head capable of sliding longitudinally with respect to said tappet bore, said head being further capable of pivoting about an axis perpendicular to said tappet bore axis, said head having a flat cam lobe tappet-engaging face; an indicating mechanism; and means operatively interconnecting said indicating mechanism and said head whereby said indicating mechanism indicates the direction and degree of pivoting of said head from a zero position wherein said cam-engaging face is disposed in a plane perpendicular to said tappet bore axis including a first elongated rod having one end fixed to said head on the diametrically opposite side of said cam-engaging face and its opposite end provided with a longitudinally extending, cone-shaped recess to form a bearing; and a second rod pivotally supported by said indicating mechanism, said second rod having a ball-like extension at one end thereof adapted to be journaled in said cone-shaped bearing.

12. A device substantially as set forth in claim 11, in which, spring means are provided for continually urging said cam-engaging face into line contact engagement with the cam lobe tappet-engaging surface.

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