April 21, 1959 J. W. HUMPHREYS 2,882,878

SELF-ALIGNING TAPPET

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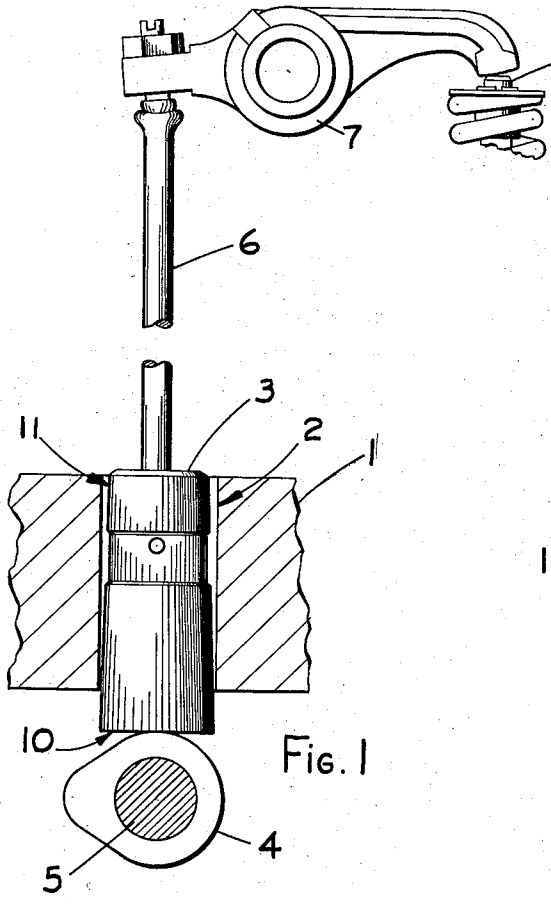


Fig. 1

Fig. 2

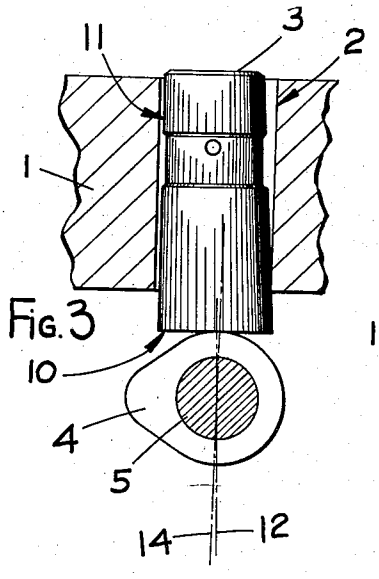


Fig. 3

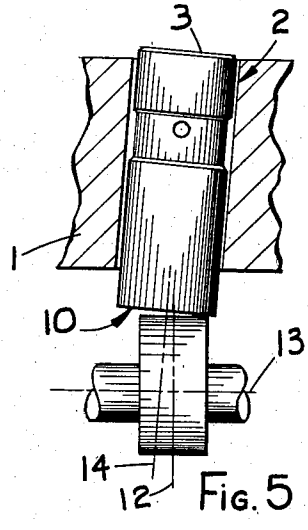


Fig. 5

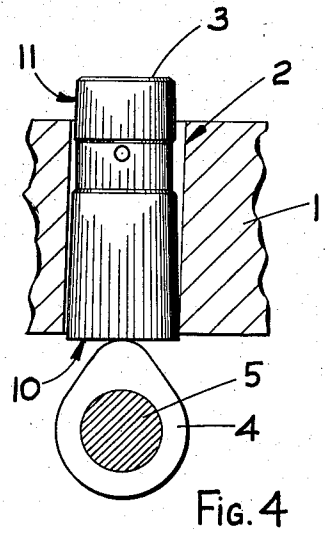


Fig. 4

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SELF-ALIGNING TAPPET

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6 Claims. (Cl. 123—90)

This invention relates to tappets and more particularly to a tappet structure specifically designed to meet the problem of misalignment between the cam and the opening for the tappet in the supporting structure.

Tappets are normally seated in closely fitting openings machined in the walls of the motor block. Under ideal circumstances of tolerance control, these openings are perfectly aligned with and normal to the center line of the cam shaft. The alignment of the cam shaft is determined by holes machined at a remote point in the engine block. As a result slight misalignment occurs frequently. Misalignment also occurs from wear of the tools and jigs controlling the machining of these openings.

When proper alignment exists, the tappet rests squarely on the cam and contact between the tappet and the cam exists across the full width of the cam.

Where slight misalignment exists the tappet tends to ride on one edge of the cam. This causes excessive wear on both the tappet and the cam. Further, it causes the tappet in both raised and lowered positions to be slightly elevated. Misalignment permits rocking of the tappet at the beginning and end of each stroke. This sometimes results in delayed opening of the valve and interference with its seating. This adversely affects the timing of the engine.

This problem has been recognized for many years and various solutions have been proposed. One of the more common solutions is to so machine the walls of the tappet from top to bottom that they are slightly convex with a greater diameter at the center than at either end. In other cases it has been proposed to machine the opening in the tappet support in a similar fashion but with a minimum diameter at the center and maximum diameter at either end. Another proposal involves using a combination of these two expedients. While these solutions are reasonably effective, the cost of machining such convex and concave surfaces is excessive. It requires complex, expensive precision machinery. This is particularly true since the tolerances must be closely held and the machining of any convex or concave surface makes this exceedingly difficult.

This invention is designed to overcome this difficulty by providing a tappet having a straight tapered wall from one end to the other. The machining of a tapered tappet involves a much simpler tooling operation and a much less expensive machining operation. Further, the holding of the tappets to precise external dimensions is substantially easier. The machining operations can be carried out more expeditiously and the number of unacceptable or rejected tappets is materially reduced.

These and other objects and advantages of this invention will be understood by those acquainted with tappet use and manufacture upon reading the following specification and the accompanying drawings.

In the drawings:

Fig. 1 is a somewhat schematic elevation view of a tappet incorporating this invention and illustrating the tappet mounted in a perfectly aligned opening.

Fig. 2 is an elevation view taken from the side of the cam shaft, illustrating the tappet in lowered position with the bore for the tappet slightly misaligned with respect to the cam.

Fig. 3 is an elevation view, sectioning the cam shaft and illustrating the invention where the bore for the tappet is tipped with respect to the cam.

Fig. 4 illustrates the same tappet situation as shown in Fig. 3 but with the tappet raised.

Fig. 5 illustrates the result produced by a tipped tappet opening where no provision is made for correction.

The numeral **1** indicates a tappet guide having a bore **2** for the tappet. Received through the bore **2** is a tappet **3** seated at its lower end on the cam **4**. The cam **4** is mounted on the cam shaft **5**. The tappet **3** seats the lower end of the push rod **6**. The upper end of the push rod **6** engages one end of the rocker arm **7**. The other end of the rocker arm is in operative engagement with the valve **8**. The push rod **6**, rocker arm **7** and valve **8** are conventional structure. The tappet together with the push rod **6** and rocker arm **7** constitute the valve train by which motion is transmitted from the cam to the valve. The tappet **3** serves as both a guide for the lower end of the push rod **6** and in many engines as a means of adjusting the length of the valve train as the engine heats and cools. Such tappets also compensate for wear.

When the bore **2** is perfectly aligned with and perpendicular to the cam shaft **5**, a tappet of constant diameter throughout its length will operate quite satisfactorily. A tapered tappet incorporating this invention will also operate with complete satisfaction. The necessity for this invention does not arise unless there is some misalignment of one type or another between the bore **2** and cam shaft.

The tappet **3** has a cam contacting surface **10** on its lower end. This surface is precisely machined to be normal to the center line of the tappet body. The outer surface **11** of the tappet in accordance with this invention is straight but tapered so that its greatest diameter is at the lower end adjacent the cam contacting surface **10** and its minimum diameter is at the top of the tappet. The decrease in diameter from one end of the tappet to the other is constant. Thus the tappet's outer wall is straight rather than curved. The taper is such that the difference in diameter is in the range of 0.002 to 0.009 of an inch and preferably in the range of 0.004 to 0.007 of an inch. While slight, this taper is sufficient to permit the tappet to assume a position normal to the center line of the cam shaft. The lower end of the tappet has a diameter approximately 0.001 less than the diameter of the bore **2**.

Where the bore **2** is perfectly aligned the tappet will seat centrally in the bore with the lower end of the raised tappet having sufficient clearance to slide without binding with the walls of the bore. The upper end of the tappet will have additional clearance with the side walls, and will be centered between them.

Fig. 2 illustrates a cam **3** seated in a bore **2** which is slightly misaligned or inclined with respect to the center line of the cam shaft. Due to the tappet's tapered walls **11**, the tappet will assume a position perpendicular to the center line of the cam shaft even though the center line of the bore **2** is slightly tipped. This is illustrated by the fact that the tappet center line **12** is perpendicular to the center line **13** of the cam shaft **5** whereas the center line **14** of the bore is inclined at a slight angle.

By reason of the smaller diameter of the upper end of the tappet the inclination of the bore will not force the tappet into an inclined position where it is rocked with respect to the cam (Fig. 5). Thus the lower contact surface **10** of the cam makes contact with the cam surface across the entire width of the cam (Fig. 2). Where the upper end of the tappet is not free to adjust to the cam

with a misaligned bore **2**, the bore will force the tappet to one side, causing it to ride on one edge of the cam.

As illustrated in Fig. 5 such a relationship causes the center of the end **10** of the tappet to be spaced from the face of the cam. The result is a raised tappet which prevents seating of the valve. This misalignment is illustrated by the divergence of the tappet-bore centerline **14** from the cam centerline **12**. This results in malfunctioning of the valve because the valve can neither seat properly nor will its operation be precisely timed to the movement of the piston within the explosion chamber or cylinder. It also causes excessive wear on both the tappet and the cam because all forces between the tappet and cam are concentrated along a narrow line of contact.

As the tapered tappet **3** is raised by the cam **4** the lower end of the tappet will cause it to center in the guide opening **2**. The force exerted on the tappet by the valve spring causes bottom contacting surface **10** of the tappet to seat squarely on the cam (Fig. 4). It will be noted that in both Figs. 3 and 4 the tappet maintains contact only with one edge of the misaligned bore **2**. The upper end of the tappet does not contact the walls of the bore in either position. The fact that the tappet may have a few ten thousands of an inch lateral movement as it rises, due to its contact with the lower edge of the walls of the bore **2**, is immaterial. This slight lateral travel will not adversely affect the timing of the valve operation nor will it otherwise interfere with the tappet's proper functioning. The effect of the taper of the tappet walls **11** is to allow the tappet freedom to maintain a position normal to the cam even though the bore is not perfectly aligned.

Where the tappet is ground to provide hyperbolic walls or is seated in a similarly shaped guide hole, the tappet rocks about a point midway between its ends. This rocking motion occurs both at the start and finish of the valve actuation and is of such magnitude that it results in serious impairment of timing and causes the engine to produce rattling noises. This rocking motion causes the tappet to rock on the cam, changing the effective length of the valve train sufficiently to interfere with the valve's operation.

By comparison, the lateral travel produced in the rise and fall of the tapered tappet is slight. It is no more than the increase in radius occurring in a minor portion of the tappet's overall length. Further, the tappet being firmly supported against rocking motion always maintains contact with the cam across the full width of the cam.

The inclination or taper on the walls **11** of the tappet may be produced by any suitable machining operation such as grinding. A straight taper of this type is comparatively simple to machine as compared to a curved surface. Further, it is easier to check for accuracy. Being easier to machine and requiring less complex machining equipment, the likelihood of the production of units which do not meet tolerance requirements is substantially less.

Having described a preferred embodiment of my invention, it will be understood that modifications of this invention may be made without departing from the principles of the invention. Such modifications are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. A tappet having an upper end and a lower cam contacting end, said tappet comprising: a main body; said body being tapered throughout its length with its greatest diameter at its lower end.

2. A tappet received within an engine block bore and having an upper end and a lower cam contacting end, said tappet comprising: a main body; the sides of said body being straight and converging toward the upper end thereof throughout the length thereof received within said bore and whereby the lower end of said tappet has the greatest diameter for maintaining said lower end in full seating engagement on an actuating cam during the reciprocation thereof.

3. A self-aligning tappet having a body; said body having a planar surface on one end normal to the axis of said body; the exterior walls of said tappet body converging inwardly away from said planar surface whereby said planar end of said body is of greater diameter than the other end thereof.

4. A self-aligning engine tappet having a planar surface on one end thereof normal to the axis of said tappet and a straight peripheral surface converging toward the other end of said tappet whereby said other end is of lesser diameter than said one end.

5. An internal combustion engine valve operating mechanism comprising: a stationary guide having a bore therethrough and a tappet supported for reciprocation in said guide bore; a cam for reciprocating said tappet adjacent one end of said guide bore; the side walls of said tappet at the one end thereof adjacent said cam having a close sliding fit with said guide bore; said side walls being straight and converging toward the other end of said tappet whereby said other end is of lesser diameter than said one end.

6. An internal combustion engine valve operating mechanism, comprising: a stationary guide having a bore provided therethrough, a tappet member supported for reciprocation within said guide bore, a cam engaging one end of said tappet member for reciprocating actuation thereof, and the side walls of one of said bore and tappet member being cylindrical and the other thereof having a straight taper throughout the length thereof to provide a larger clearance space between said guide wall forming said bore and said tappet member at the other end of said tappet member for maintaining said tappet member disposed for full seating engagement with said cam irrespective of misalignment of the axis of said tappet and the center line of said cam.

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