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VALVE ACTUATING MECHANISM

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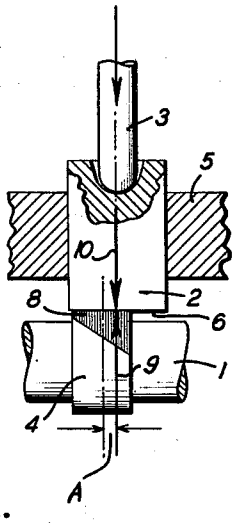


Fig. 1.

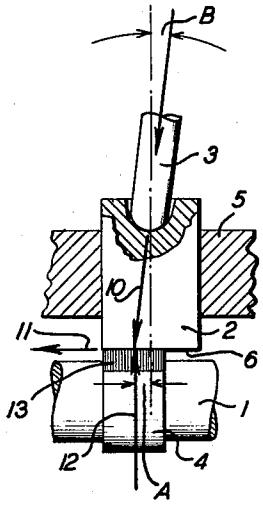
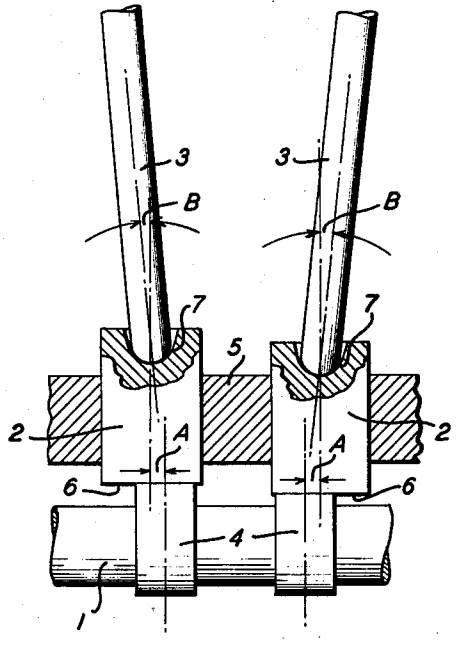


Fig. 2.

Fig. 3.



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VALVE ACTUATING MECHANISM

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The present invention relates to a valve actuating mechanism, and more particularly to an arrangement of the push rod, tappet and valve-actuating cam in which the push rod is so inclined as to provide an essentially even force distribution per unit area over the entire line of contact between the tappet and the cam, while at the same time assuring rotation of the tappet, thereby minimizing wear and tear in the materials forming the cam and tappet contact surfaces.

It is known that relatively large pressure forces occur at the contact surfaces of the cam and of the tappet of valve-controlled internal combustion engines as a result of the forces caused by acceleration and inertia during the operation of the valves. The contact surface of these parts, which is essentially rectilinear as a result of the shape of the tappet and cam, moves to and fro during the rotation of the cam along the bottom surface of the tappet whereby the high pressure peaks per unit area, i.e., the stress peaks which occur therein become effective always at the same place of the tappet bottom and of the cam surface and thereby bring about a premature wear of the tappet bottom and of the cam surface.

Various measures were suggested and carried out in the prior art to obviate these disadvantages and inadequacies. Nevertheless, such prior art measures did not prove fully satisfactory.

The sliding valve tappets in valve-controlled internal combustion engines are oftentimes arranged eccentrically with respect to the actuating cams in order to obtain a continuous rotation of the tappet during the operation thereof and to attain therewith an even loading and stressing of the tappet bottom. However, with a flat or plane configuration of the tappet bottom and of the cam disposed parallel to the axis, the resultant of the specific pressure forces, i.e., the resultant of the pressure forces per unit area, are disposed approximately at or near the tappet center, notwithstanding the displacement of the tappet eccentrically to the cam center, as an uneven distribution of the pressure forces per unit area results by reason of the eccentric application of the push rod force at the cam. As a result thereof, the moment assumed to be caused by the friction of the cam at the tappet bottom, which is intended to rotate the tappet, does not occur at all or is in effect only so slight that it is insufficient to rotate the tappet.

It is also known in the prior art that a rotation of the tappet takes place if the cam is inclined slightly and if the bottom surface of the tappet is formed in a ball-shaped or conically shaped manner.

However, as a result of such an arrangement, the contact surface of the two parts consisting of cam surface and tappet bottom is reduced and the load per unit area and stresses resulting therefrom are thereby considerably increased. In addition thereto, the parts of the valve-control arrangement become much more expensive in the manufacture thereof. The use of the so called

"roller-type tappet" also requires a great outlay and high cost of manufacture.

For purposes of achieving an even pressure distribution over the entire width of the cam and therewith for purposes of producing lower pressure forces per unit area at the tappet and cam of valve-controlled internal combustion engines provided with push rods, especially of valve-in-head internal combustion engines, the tappets of which are arranged eccentrically with respect to the actuating cams for purposes of rotation of the tappets and which are provided with a plane cam surface as well as with a support of the push rods disposed upwardly thereof, the present invention proposes an arrangement in which the push rods are inclined with respect to the tappets in such a manner that the extensions of the center axes of the push rods intersect the cam surface in the center or approximately in the center thereof. By the use of such an arrangement, the center axes of the tappet and push rods are to subtend an angle which is less than the friction angle between the materials used for each of the cams and tappets, i.e., an angle which is less than the critical friction angle depending on the friction coefficient of the particular materials used.

The present invention brings about a practically completely even distribution of the pressure forces per unit area over the entire cam width without additional parts accompanied by a simple and inexpensive manufacture of the various parts as a result of the central application of the force at the tappet-cam contact surface. Moreover, as a result of the effect of the eccentric force at the tappet bottom surface, a rotation of the tappet is also assured. Consequently, premature wear of the parts as a result of pressure peaks and uneven wear and tear are avoided.

These results are obtained in that the push rod force in line with the inclined push rod arrangement becomes effective in the center of the cam and the vertical components thereof are thereby distributed over the entire width of the cam as an even load. The horizontal components of the inclined pressure force are absorbed by the friction between the cam and tappet with an inclination of the push rod which preferably does not exceed the friction angle of the cam and tappet materials. Consequently, any additional lateral force is kept away from the tappet bearing or guide means.

It is also already known in the prior art to incline the push rods in different directions with respect to the tappet axis about a slight angle for the purposes of equalization of a different distribution and arrangement of rocker arms and cams in the longitudinal and transverse directions of the engine necessitated solely by constructive reasons. However, up to the present, no significance other than the considerations from a purely constructional or manufacturing point of view were attributed to or recognized in this push-rod arrangement; this lack of recognition in the prior art of the features underlying the present invention becomes particularly clear from the fact that oftentimes the angles of inclination of the push rods with respect to the tappets are different within one and the same engine, both as to magnitude and direction. However, the present invention is predicated on lack of recognition heretofore of the advantages and novel results obtainable in an arrangement in which the push rods are inclined with respect to the tappets which, in turn, are displaced with respect to the cams, and in which the tappets have a planar bottom surface, and which are provided with an upwardly disposed support for the push rods, especially insofar as attainment of even pressure distribution on the tappet and cam contact surfaces is concerned in such an arrangement. Accordingly, it is an object of the

present invention to provide a valve actuating mechanism with a rectilinear contact surface between tappet and cam in which the disadvantages of the prior art are avoided in both an effective and simple manner.

Another object of the present invention is the provision of an arrangement of the push rod, tappet and cam of a valve control mechanism, particularly for valve-in-head internal combustion engines, in which an even force distribution is assured so as to minimize premature wear and tear of the contact surfaces of the parts in question.

Still another object of the present invention resides in an arrangement of the push rod and tappet with respect to the actuating cam of a valve control system in which the rotary movement of the tappet is fully assured under all operating conditions without, however, necessitating complicated constructions and shapes of the various parts.

A still further object of the present invention resides in the provision of a tappet actuating mechanism for valves in which all the parts may be made and manufactured in a relatively inexpensive manner, yet which assures long life of the various parts in operation.

These and further objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein

Fig. 1 is a schematic view of a valve actuating arrangement with the push rod, tappet and cam arranged according to the prior art and in which are also indicated the pressure forces and distribution thereof which occur therein,

Figure 2 is a schematic view of a value actuating mechanism with a push-rod tappet and cam arrangement in accordance with the present invention and in which are also indicated the pressure forces and distribution thereof which occur therein, and

Figure 3 is a schematic view of another embodiment of a push-rod, tappet and cam arrangement in accordance with the present invention.

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, and more particularly to Figure 1, reference numeral 1 designates the cam shaft which is provided with a valve actuating cam 4 of any suitable shape. The tappet 2 and push-rod 3 are inserted as linking or motion-transmitting members between the cam shaft 1 with the cam 4 and the rocker arms (not illustrated) for purposes of actuating the valves suspended in the cylinder head of a valve-in-head internal combustion engine. The tappet 2, which is guided in the bearing member 5 abut against the cam 4 with the plane tappet bottom surface 6 thereof. The upper end of the tappet 4 is provided with a spherically shaped recess or ball-socket 7 for accommodating therein the push-rod 3.

The known displacement or eccentric arrangement of the tappet 2 with respect to the center of the cam 4, as shown in Figure 1, entails an uneven distribution 8 of the specific pressure forces, i.e., of the pressure forces per unit area, along the line of contact between the cam 4 and the bottom surface 6 of the tappet, such uneven distributions 8 of the pressure forces being characterized by pressure peaks. The eccentric application of the force 10 with respect to the contact line produces thereby a triangularly-spaced specific pressure distribution 8 so that the reaction force 9 resulting from the specific pressure stresses in the cam material is caused to appear opposite the primary force 10 which is caused by the force exerted by push-rod 3 on tappet 2, in the tappet center in essential alignment therewith so that the forces and moments produced thereby are in equilibrium. The expected rotation of the tappet 2 does not take place, which results in the rapid wear of the tappet 2 and cam 4, especially due to the combined effect with the pressure peaks which occur always at the same places.

In order to assure a continuous rotation of the tappet 2 during operation thereof, the tappet 2 and cam 4 according to the present invention (Figures 2 and 3) are displaced with respect to each other by an amount A in the longitudinal direction of the cam shaft and the push rods 3 are inclined with respect to the tappet 2 by the angle B. The angle of inclination B is thereby so chosen that the extended center axes of the push rods 3 intersect the cam 4 in the center or approximately in the center thereof and that the friction angle between the tappet and cam material is not exceeded.

The relationship and distribution of forces as illustrated in Figure 2, takes place in such an arrangement. The push-rod force 10 applied from the push rod 3 over the tappet 2 at an angle B extends rectilinearly over the tappet 2 up to the line contact between the bottom surface of tappet 2 and the cam 4. At that point, the force 10 is decomposed into a horizontal component 11 and a vertical component 12. The horizontal component 11 is readily absorbed by the friction between the cam 4 and the bottom surface 6 of the tappet 2 as long as the angle B does not exceed the friction angle between the materials used in connection with the cam 4 and tappet 2. The journalling or bearing 5 of the tappet 2 therefore remains essentially unloaded and is therefore relieved of the horizontal component 11. The vertical component 12 of the push-rod force 10 continues along the contact line in an even loading 13 per unit area of the line of contact without any pressure peaks. As a result of the magnitude of the vertical component 12, of the distance A thereof from the tappet center and of the friction value between the tappet 2 and cam 4, a moment is produced which rotates the tappet 2 and which in connection with the even specific force distribution 13 produces particularly favorable even loading of the bottom surface 6 of the tappet 2 and of the cam 4 with the least possible and therewith even wear of these parts.

Figure 3 shows an arrangement for the control of two valves, for example, of the inlet and exhaust valves of one cylinder of a multi-cylinder valve-in-head internal combustion engine.

While I have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of many changes and modificaions within the spirit of the present invention, and I intend to cover all such changes and modifications as encompassed by the scope of the appended claims.

I claim:

1. A valve-actuating arrangement in internal combustion engines adapted to produce an even pressure distribution to thereby prevent the occurrence of pressure peaks and therewith minimize wear and tear in the contact surfaces between the relatively movable parts thereof comprising tappet means, cam means operative during rotation thereof to reciprocate said tappet means, said tappet means being disposed eccentrically with respect to said cam means to thereby produce rotation of said tappet means, and push rod means actuated by said tappet means, said push rod means being inclined at a predetermined angle with respect to the axis of said tappet means in such a manner that the extension of the axis of said push-rod means intersects said cam means near the center thereof.

2. A valve-actuating arrangement in internal combustion engines with overhead valves adapted to produce an even pressure distribution to thereby prevent the occurrence of pressure peaks and therewith minimize wear and tear in the contact surfaces between the relatively movable parts thereof comprising tappet means, means for supporting said tappet means in the engine, cam means operative during rotation thereof to both reciprocate and rotate said tappet means, said tappet means being dis-

posed eccentrically with respect to said cam means, and push rod means actuated by said tappet means, said push rod means being inclined at a predetermined angle with respect to the axis of said tappet means in such a manner that the extension of the axis of said push-rod means intersects said cam means near the center thereof, and said angle being less than the angle of friction of the materials used in connection with said cam and tappet.

3. A valve-actuating arrangement in internal combustion engines with overhead valves adapted to produce an even pressure distribution to thereby prevent the occurrence of pressure peaks and therewith minimize wear and tear in the essentially rectilinear contact surfaces between the relatively movable parts thereof comprising tappet means having an essentially planar bottom surface, cam means disposed essentially eccentrically with respect to said tappet means and having an essentially straight outer surface parallel to the axis thereof and operative during rotation thereof to both reciprocate and rotate said tappet means by contact between said essentially straight outer cam surface and said essentially planar bottom surface, and push rod means actuated by said tappet means, said push rod means being inclined at a predetermined angle with respect to the axis of said tappet means in such a manner that the extension of the axis of said push-rod means intersects said cam means near the center thereof.

4. A valve-actuating arrangement in internal combustion engines with overhead valves adapted to produce an even pressure distribution to thereby prevent the occurrence of pressure peaks and therewith minimize wear and tear in the essentially rectilinear contact surfaces between the relatively movable parts thereof comprising tappet means having an essentially planar bottom surface, means for supporting said tappet means in the engine, cam means being disposed eccentrically with respect to said tappet means and having an essentially rectilinear outer surface parallel to the axis thereof and operative during rotation thereof to both reciprocate and rotate said tappet means by contact between said essentially rectilinear cam surface and said planar bottom surface, and push rod means actuated by said tappet means, said push rod means being inclined at a predetermined angle with respect to the axis of said tappet means in such a manner that the extension of the axis of said push-rod means intersects said cam means near the center thereof, and said angle being less than the angle of friction of the materials used in connection with said cam and tappet to thereby relieve said supporting means of any lateral forces.

5. A valve-actuating arrangement in internal combustion engines, particularly valve-in-head engines, for the even distribution of the pressure forces along the mutual contact surfaces between the valve-actuating cam and tappet comprising a tappet and a cam in operative engagement with said tappet for actuating said tappet, said tappet being displaced with respect to said actuating cam for purposes of obtaining rotation of said tappet during operation thereof, a push-rod in operative engagement with said tappet on the side opposite the side thereof in engagement with said cam, said push-rod being inclined with respect to the axis of said tappet at a predetermined angle in such a manner that the extension of the axis of said push-rod intersects said cam near the center thereof.

6. A valve-actuating arrangement according to claim 5, wherein the contact surface between said cam and tappet is essentially linear.

7. A valve-actuating arrangement in internal combustion engines, particularly valve-in-head engines, for the even distribution of the pressure forces along the mutual contact surfaces between the valve-actuating cam and tappet comprising a tappet and a cam in operative engagement with said tappet for actuating said tappet, said tappet being displaced with respect to said actuating cam for purposes of obtaining rotation of said tappet during operation thereof, a push-rod in operative engagement with said tappet on the side opposite the side thereof in engagement with said cam, and means supporting said push-rod at the upper end thereof, said push-rod being inclined with respect to the axis of said tappet at a predetermined angle in such a manner that the extension of the axis of said push-rod intersects said cam near the center thereof, and said angle being less than the angle of friction of the materials used in connection with said cam and tappet.

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