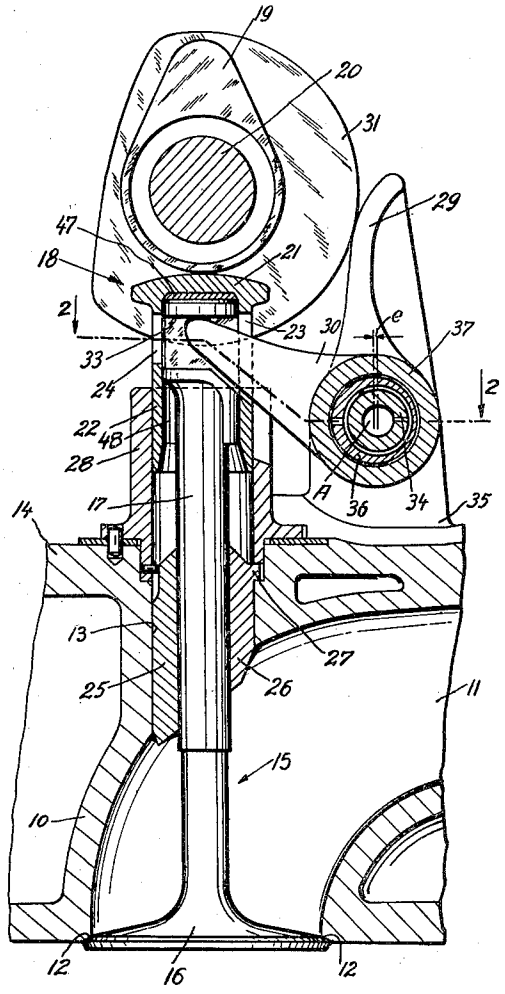
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VALVE CONTROL MECHANISM, PARTICULARLY FOR HIGH SPEED INTERNAL COMBUSTION ENGINES

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Fig. 1




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Fig. 4

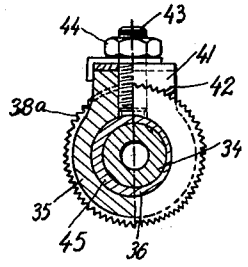



Fig. 2

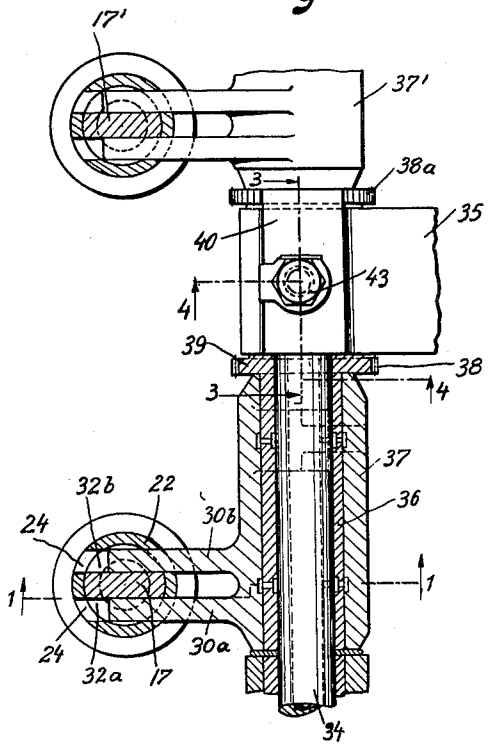
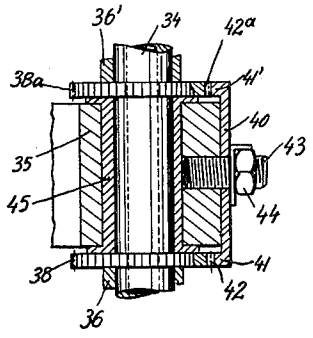



Fig. 3




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# VALVE CONTROL MECHANISM, PARTICULARLY FOR HIGH SPEED INTERNAL COMBUSTION ENGINES

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13 Claims. (Cl. 123—90)

Our invention relates to a valve control mechanism, particularly for high speed internal combustion engines, in which the valve is positively actuated in both the lifting direction and the closing direction by cams.

It is the object of the present invention to provide an improved valve control mechanism of the chartcter indicated in which springs are eliminated, since the use of springs introduces a source of trouble at very high speeds of operation because springs are susceptible to breakage under the influence of vibration.

It is another object of the present invention to provide a valve control mechanism of the kind stated hereinabove in which the actuation of the valve in closing direction is positively effected by a cam through the intermediary of a bell crank, the latter being so adjustable that undue lost motion may be readily eliminated.

Further objects of our invention are to provide an eccentric sleeve for the adjustment of the cam-actuated bell crank and improved detent means for retaining the eccentric sleeve in adjusted position, and to provide the valve stem with lateral shoulders for cooperation with the cam-actuated lever, such shoulders being adapted to be coated with a wear-resistive material.

Finally it is an object of the invention to so coordinate and organize the various elements of the valve control mechanism that the length of the valve stem and the consequent weight of the latter may be reduced to a minimum without jeoardizing a reliable guidance of the valve in axial direction, that the number of the elements of the valve control mechanism will be reduced to a minimum, and that such elements may be readily assembled and disassembled.

Further objects of our invention will appear from a detailed description of a preferred embodiment of our invention described hereinafter with reference to the drawings, and the features of novelty will be pointed out in the claims. We wish it to be clearly understood, however, that the detailed description following hereinafter serves the purpose of illustrating the invention rather than that of restricting or limiting the same. In the accompanying drawings,

Fig. 1 is a vertical section of a valve control mechanism embodying our invention, the section being taken along the line 1—1 of Fig. 2,

Fig. 2 is a partial plan view, partly in section, of the valve control mechanism shown in Fig. 1, the cam shaft being omitted showing the valve stems of two adjacent valves and the associated bell cranks and the means for mounting the same, the section being taken along the broken line 2—2 of Fig. 1,

Fig. 3 is a partial sectional view of the means for mounting the bell cranks, the section being taken along the line 3—3 of Fig. 2, and

Fig. 4 is a cross section taken along the broken line 4—4 of Fig. 2.

The cylinder head 10 of an internal combustion engine is provided wih a passageway 11 for the intake or the



exhaust of a gaseous medium, with a valve seat 12 at the inner end of the passageway, with a bore 13 coaxially disposed with respect to the valve seat 12, and with a cooling jacket 14 integral with the cylinder head 10. A poppet valve 15 controls the passageway 11, the head 16 of the poppet valve cooperating with the valve seat 12, and the composite stem of the poppet valve extending through the bore 13 and being axially guided therein for reciprocation between the closed position shown in Fig. 1 and a depressed or open position not shown. The stem of the poppet valve 15 is composed of a rod 17 and of a cup-shaped guiding member 18 seated on the end of rod 17 for engagement by a primary cam 19 fixed to or integral with a cam shaft 20 which extends transversely to and is intersected by the axis of the stem 17, 18 of the valve. The cup-shaped guiding member 18 has a bottom portion 21 located between the primary cam 19 and the end of the rod 17 and a shirt portion 22 surrounding the rod 17 and provided with registering diametrical apertures 23 and 24.

Hence, it will appear that the stem of valve 15 is provided at its end with a guiding portion of increased diameter formed by member 18 and is provided between its end and the head 16 of the poppet valve with a portion 17 of reduced diameter, stationary guiding bushings being provided for each of the portions 18 and 17. The bushing for the guidance of portion 17 of reduced diameter is divided lengthwise into two sections 25 and 26 which are inserted in bore 13. Each of the bushing sections 25, 26 is provided with a flange, such as 27, at its top engaging an internal shoulder of the bore 13, such shoulder facing upwardly.

The valve stem guiding portion of increased diameter constituted by the member 18 is slidable in a flanged bushing 28 which coaxially surrounds the valve stem and is mounted on the cooling jacket 14 of the cylinder head and fixed in position by suitable bolts not shown.

A bell crank having rigidly connected arms 29 and 30 is mounted for rocking movement about a fulcrum axis A (Fig. 1) which extends substantially parallel to the cam shaft 20 laterally of the valve stem and spaced therefrom. The arm 29 engages a secondary cam 31 fixed to or integral with the cam shaft 20 adjacent to the cam 19 thereof. The arm 30 is preferably bifurcated, as shown in Fig. 2, and its sections 30*a* and 30*b* extend through the apertures 23 formed by parallel, axially extending slots provided in the shirt portion 22 of member 18. The ends of arms 30*a* and 30*b* straddle the upper end of rod 17 engaging opposite lateral recesses 32*a* and 32*b* thereof, as will appear from Figs. 1 and 2. The recesses 32*a* and 32*b* form shoulders 33 (Fig. 1) which are preferably coated with a wear-resistive material, such as tungsten carbide. For this purpose, a thin plate of tungsten carbide may be welded to each shoulder 33. From Fig. 1 it will appear that the top of bottom portion 21 of member 18 constitutes the end face of the composite valve stem, and that the shoulders 33 constitute a second face of the valve stem disposed in opposite relationship to the end face, and that the bell crank 29, 30 engages such second face 33 of the stem for restoring the valve to, and keeping it in, its seated condition.

The two cams 19 and 31 are so profiled that when the primary cam 19 commences by acting on the bottom portion 21 of member 18 to depress the valve stem, the secondary cam 31 will permit the bell crank to rock in anti-clockwise direction with reference to Fig. 1. When the primary valve cam 19 has fully depressed the valve stem and then permits it to rise again, the secondary cam 31 will rock the bell crank in clockwise direction causing its arm 30 bearing against the shoulders 33 to positively raise the valve 15 to its closed position. Throughout such operation the lost motion that may exist

between the elements 19, 21, 17 and 30 must be kept at a minimum. This is ensured by a suitable adjustment of axis A with respect to the cam shaft 20.

The means for mounting the bell crank 29, 30 include means for adjusting the position of the fulcrum axis A. Preferably, such adjusting means are formed by a rotatable eccentric, as will be described hereinafter.

A shaft 34 is rigidly mounted in a bracket 35 secured to the top of the cylinder head 10 and extends from the bracket in a direction parallel to axis A. Adjacent to the bracket 35 an eccentric sleeve 36 is rotatably mounted on the shaft 34. This sleeve constitutes the fulcrum for the bell crank, the latter having a hub portion 37 of considerable length rockably mounted on the eccentric sleeve 36, as will appear from Fig. 2. The eccentricity *e*, i. e. the distance between the axis A of the cylindrical outer peripheral surface of the sleeve and the axis of the cylindrical inner surface of the sleeve, amounts preferably to about .2 inch or less. It has been found that this small eccentricity is sufficient to take up any lost motion in the valve control mechanism.

Adjacent to the bracket 35 the eccentric sleeve 36 is preferably provided with circumferentially distributed detent teeth 38. As shown in Figs. 2 and 3, the teeth may be provided on the periphery of a flange 39 of the eccentric sleeve. A stationary detent 40 is mounted on the bracket 35 so as to releasably engage the teeth 38. In the embodiment shown, the detent is formed by a plate having a flange 41 provided with complementary detent teeth 42 and having a hole through which a threaded bolt 43 passes, such bolt being screwed into a tapped bore of the bracket 35 and bearing a nut 44.

When it is desired to alter the location of axis A, the operator will unscrew nut 44 to an extent permitting detent plate 40 to be lifted an amount sufficient to disengage the teeth 38 and 42, whereupon the operator may grasp the flange 39 and turn the eccentric sleeve 36 through the required angle to thereby effect the desired adjustment, whereupon the nut 44 is tightened again causing the teeth 42 of the detent plate 40, 41 to engage the detent teeth 38 of the eccentric sleeve.

While shaft 34 may be secured to the bracket 35 in a definite non-adjustable position, we prefer to interpose an eccentric sleeve 45 between the shaft 34 and the bore of bracket 35, as shown in Fig. 3, such eccentric sleeve 45 being held in any desired adjusted position by engagement with the threaded bolt 43.

In the embodiment illustrated in Fig. 2, a single bracket 35, a single detent plate 40, and a single shaft 34 are coordinated to the bell cranks of adjacent valves. Thus, Fig. 2 shows a pair of spaced parallel valve stems 17 and 17' and associated bell cranks having hub portions 37 and 37'. The shaft 34 extends through the bracket 35 and a pair of eccentric sleeves 36 and 36' is mounted on the shaft 34 at either side of the bracket adjacent thereto. Each of the sleeves 36, 36' constitutes the fulcrum of the associated bell crank in the manner described. The single detent member 40 has two toothed flanges 41 and 41', one flange cooperating with the detent teeth of eccentric sleeve 36 and the other toothed flange 41' cooperating with the detent teeth of eccentric sleeve 36'.

For disassembling the valve control mechanism illustrated in Fig. 1 the operator will first remove the cam shaft so as to expose the valve stem. He will then withdraw shaft 34 in axial direction, whereupon the eccentric sleeves and the bell cranks carried thereby may be removed. Thereupon the cup-shaped members 18 may be pulled off the valve stems and the guiding bushings 28 may be detached from the cylinder head and removed. It will be noted that the stem rod 17 is provided at its end with a portion of increased diameter carrying the cup-shaped member 18. The stem projects from the cylinder a distance which is just so dimensioned that when the valve is closed, the portion of increased diameter of the rod 17 is spaced from the cylinder head 10, 14 a distance sufficient to permit withdrawal therethrough of section 25 of the bushing. When section 25 has been withdrawn, the section 26 may be turned about rod 17 through an angle of 180° and may then be likewise withdrawn. This turning of section 26 is necessary because on the right hand side with reference to Fig. 1 the section of rod 17 of increased diameter has a greater axial length than it has at the left side. The axial length of the section of reduced diameter has been made shorter at the left for the sole purpose of permitting the removal of the bushing sections 25 and 26. In this manner, the length of the valve stem may be made a minimum consistent with a possibility of disassembling the elements conveniently.

An exchangeable disk 47 is inserted between the end face of the rod 17 and the bottom 21 of the cup-shaped member 18. By substituting another disk of increased or reduced thickness, the proper adjustment of the lost motion by angular adjustment of the eccentric sleeve 36 may be facilitated.

From the foregoing description it will appear that the present invention relates to a valve control mechanism, particularly for high speed internal combustion engines, in which the valve is positively actuated in both directions of its reciprocation by means of two cams, such as 19 and 31, one of which actuates the valve in one direction through the intermediary of a two-armed lever, such as bell crank 29, 30, while the other cam actuates the valve in the opposite direction, preferably by direct action on the valve stem.

Moreover, it will be noted that springs are neither inserted between the arms 29 and 30, nor between the arm 30 and the valve stem, nor between the valve stem and the cam 19. Such springs are susceptible to excessive vibration when the engine is operated at a very high speed and are thereby liable to break. According to the present invention, such springs are eliminated and the arms 29 and 30 of the two-armed lever are rigidly connected with each other, any lost motion that might exist between the cams, such as 19 and 31, and the two-armed lever being adjustable by means of the eccentric sleeve 36 and/or 45. Since, as a rule, the lost motion is of the order of the allowance observed in profiling the cams 19 and 31, the eccentricity *e* may be very small, for instance .2 inch or less. For adjusting the eccentric element which is preferably formed by a sleeve, the same is provided with the detent teeth 38 cooperating with the stationary detent 40, whereby the eccentric sleeve may be released for adjustment and subsequently arrested and maintained in the adjusted angular position. Preferably, the detent is formed by a flat member, such as 40, secured to the bracket 35. This bracket has detent teeth, such as 42 or 42*a*, engaging those of the eccentric element. Preferably, the same detent is used for detaining a pair of eccentric elements coordinated to adjacent valves.

For the actuation of the valve the two-armed lever preferably extends through an aperture of the valve stem, such as 17, 18, the valve-actuating arm, such as 30, being preferably bifurcated and adapted to cooperate with opposite lateral shoulders of the valve stem, such as shoulders 33. Because of the lateral disposition of the shoulders, the same may be provided in a very simple manner with a wear-resistive layer.

Moreover, the present invention envisages the provision of the valve stem at its end with a section of increased diameter, such section serving to guide the valve stem and to constitute the shoulders for engagement by the two-armed lever. A two-part guide bushing, such as 25, 26, is provided to guide the portion of reduced diameter of the stem between the head 16 and the section of increased diameter. In order that the length of the valve stem may be reduced to a minimum, the section of increased diameter may be spaced from the cylinder head a distance which at one side is rendered smaller by a recess 48

facing the sections 25, 26 and at the other side may be at least as long as the bushing sections, such as 25, 26. As a result, each section of the bushing may be disassembled, one of the sections being turned about the valve stem rod for such purpose. Owing to this design the weight of the valve may be reduced to a minimum.

The structure of the valve and of its guiding means described hereinabove is applicable independently of the particular kind of valve control mechanism used in the embodiment described.

While the invention has been described in connection with a preferred embodiment thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as fall within the scope of the invention or the limits of the appended claims.

What we claim is:

1. In a valve control mechanism of the character described, the combination comprising a poppet valve, a cam shaft extending transversely to and being intersected by the axis of the stem of said poppet valve, a primary cam fixed to said cam shaft in position for engagement with said stem for lifting said poppet valve from its seat, a secondary cam fixed to said shaft, a rigid bell crank having rigidly connected arms and mounted for rocking movement about a fulcrum axis extending substantially parallel to said cam shaft, one arm of said bell crank engaging said secondary cam and the other arm of said bell crank engaging said stem for restoring the valve to and keeping it in its seated condition, and means for mounting said bell crank including means for adjusting the position of said fulcrum axis with respect to said cam shaft and said valve stem.

2. In a valve control mechanism of the charactcer described, the combination comprising a poppet valve having a stem provided with an end face and with a second face disposed in opposite relationship to said end face, a cam shaft extending transversely to and being intersected by the axis of the stem of said poppet valve, a primary cam fixed to said cam shaft in position for engagement with said end face for lifting said poppet valve from its seat, a secondary cam fixed to said shaft, a bell crank having rigidly connected arms and mounted for rocking movement about a fulcrum axis extending substantially parallel to said cam shaft, one arm of said bell crank engaging said secondary cam and the other arm of said bell crank engaging said second face of said stem for restoring the valve to and keeping it in its seated condition, and means for mounting said bell crank including a rotatable eccentric for adjusting the position of said fulcrum axis with respect to said cam shaft and said valve stem.

3. In a valve control mechanism of the character described, the combination comprising a poppet valve, a cam shaft extending transversely to and being intersected by the axis of the stem of said poppet valve, a primary cam fixed to said cam shaft in position for engagement with said stem for lifting said poppet valve from its seat, a secondary cam fixed to said shaft, a bell crank having rigidly connected arms and mounted for rocking movement about a fulcrum axis extending substantially parallel to said cam shaft, one arm of said bell crank engaging said secondary cam and the other arm of said bell crank engaging said stem for restoring the valve to and keeping it in its seated condition, a stationary shaft, an eccentric sleeve rotatably mounted thereon and constituting a fulcrum for said bell crank, and means for keeping said sleeve in any desired angular position.

4. In a valve control mechanism of the character described, the combination comprising a poppet valve, a cam shaft extending transversely to and being intersected by the axis of the stem of said poppet valve, a primary



cam fixed to said cam shaft in position for engagement with said stem for lifting said poppet valve from its seat, a secondary cam fixed to said shaft, a bell crank having rigidly connected arms and mounted for rocking movement about a fulcrum axis extending substantially parallel to said cam shaft, one arm of said bell crank engaging said secondary cam and the other arm of said bell crank engaging said stem for restoring the valve to and keeping it in its seated condition, and means for mounting said bell crank including a bracket, an eccentric sleeve rotatably mounted therein, and a shaft extending through said sleeve, said shaft supporting said bell crank.

5. The combination claimed in claim 2 in which said rotatable eccentric has an eccentricity of less than .2 inch.

6. In a valve control mechanism of the character described, the combination comprising a poppet valve, a cam shaft extending transversely to and being intersected by the axis of the stem of said poppet valve, a primary cam fixed to said cam shaft in position for engagement with said stem for lifting said poppet valve from its seat, a secondary cam fixed to said shaft, a bell crank having rigidly connected arms and mounted for rocking movement about a fulcrum axis extending substantially parallel to said cam shaft, one arm of said bell crank engaging said secondary cam and the other arm of said bell crank engaging said stem for restoring the valve to and keeping it in its seated condition, a stationary shaft, an eccentric sleeve rotatably mounted thereon and constituting a fulcrum for said bell crank, said sleeve being provided with circumferentially distributed detent teeth, and a stationary detent releasably engaging said teeth.

7. The combination claimed in claim 2 in which said means for mounting said bell crank comprises a bracket, a shaft rigidly mounted therein and extending therefrom, an eccentric sleeve rotatably mounted on said shaft adjacent to said bracket and provided with circumferentially distributed detent teeth, and a detent detachably mounted on said bracket and engaging said teeth to keep said sleeve in any desired angular position, said bell crank being rockably mounted on said sleeve.

8. In a valve control mechanism of the character described, the combination comprising a pair of spaced parallel valve stems, a cam shaft having primary cams adapted to engage and actuate said stems in valve-lifting direction and having secondary cams for restoring said valves to and keeping them in closed condition, a pair of bell cranks each having rigidly connecting arms, one arm of each bell crank engaging the associated one of said secondary cams and the other arm engaging said valve stem for actuation in valve-closing direction, a bracket, a shaft extending through and rigidly mounted in said bracket to extend substantially parallel to said cam shaft, a pair of eccentric sleeves mounted on said shaft at either side of said bracket adjacent thereto, each sleeve constituting the fulcrum of one of said bell cranks and being provided with circumferentially distributed detent teeth adjacent to said bracket, and a single detent member releasably mounted on said bracket and engaging the detent teeth of both of said sleeves.

9. The combination claimed in claim 2 in which said valve stem is composed of a rod integral with the valve and of a cup-shaped guiding member seated on the end of said rod for engagement by said primary cam, said rod and said guiding member being provided with registering diametrical apertures for engagement by said bell crank, said cup-shaped guiding member having a bottom portion and a shirt portion, the bottom portion being located between said primary cam and said end of said rod and said shirt portion surrounding said rod and being provided with said apertures.

10. The combination claimed in claim 2 in which said other arm of said bell crank is bifurcated and straddles said valve stem, the latter being provided with opposite lateral recesses between its ends for engagement by said arm.

11. The combination claimed in claim 2 in which said other arm of said bell crank is bifurcated and straddles said valve stem, the latter being provided with opposite lateral recesses between its ends, said recesses forming shoulders for engagement for said arms, said shoulders being coated with a wear-resistive material.

12. The combination claimed in claim 2 in which said valve stem is provided at its end with a portion of increased diameter and between its end and the head of said poppet valve with a portion of reduced diameter, stationary guiding bushings being provided for each of said portions, the bushing for the guidance of said portion of reduced diameter being divided lengthwise into two sections.

13. In a valve control mechanism of the character described, the combination comprising a poppet valve having a head and a stem, the latter being provided at its end with a portion of increased diameter and between the latter and said head with a portion of reduced diameter, a cylinder head provided with a valve seat and with a bore axial thereto, and a split bushing composed of two sections mounted in said bore and surrounding said stem in contact with said portion of reduced diameter thereof for guiding said valve for cooperation with said valve seat, said stem projecting from said cylinder head a distance causing said portion of increased diameter, when said valve is closed, to be spaced from said cylinder head a distance shorter than the length of said sections of said bushings, said portion of increased diameter having a lateral recess facing said sections and dimensioned to permit withdrawal of same.



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