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INJECTOR OPERATING MECHANISM FOR INTERNAL-COMBUSTION ENGINES

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Fig. 1.

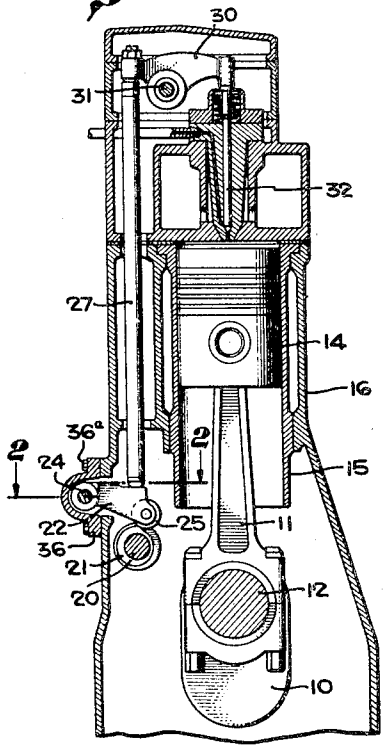


Fig. 3.

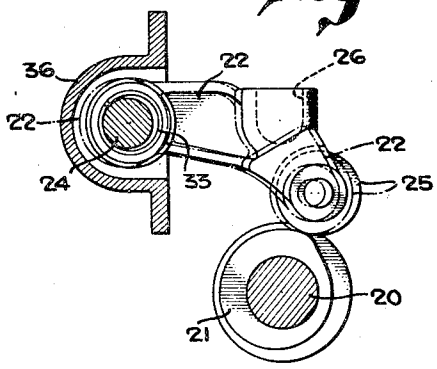


Fig. 4.

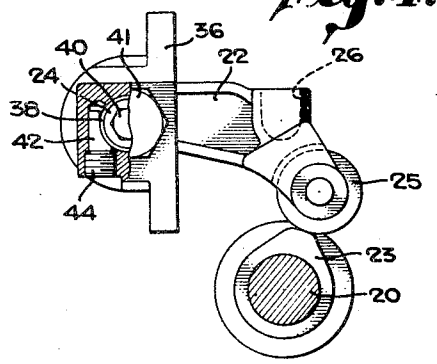
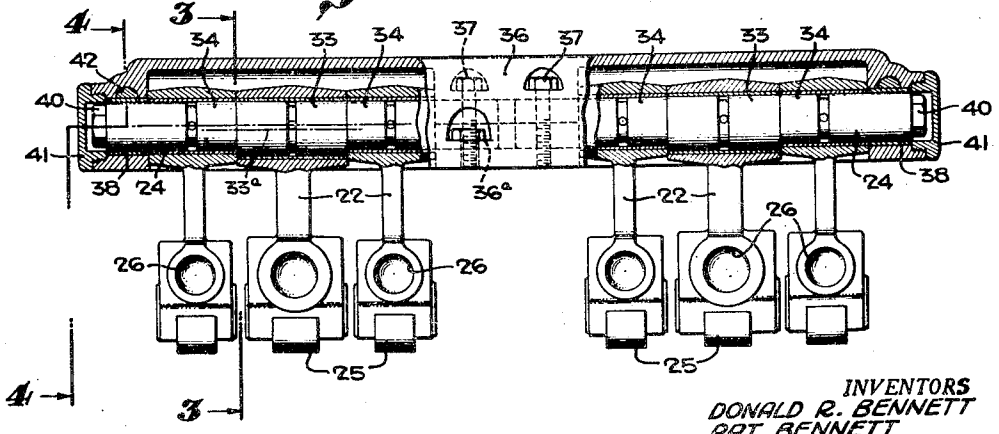


Fig. 2.



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INJECTOR OPERATING MECHANISM FOR INTERNAL-COMBUSTION ENGINES

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4 Claims. (Cl. 123—90)

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The present invention relates generally to internal combustion engines, and more especially to improvements in the construction of fuel injector operating mechanisms such as are commonly found in Diesel engines.

In engines of this kind it is conventional construction to have a plurality of cam rocker levers which are oscillated by individual cams on a rotating cam shaft and which, by their oscillations, individually reciprocate push rods which are operatively connected to valves and fuel injectors. The lever and push rod assemblies normally occur in multiples of three since the intake and exhaust valves and fuel injector for each cylinder are operated individually by a separate lever and push rod. The rocker levers are mounted at one end on a shaft about which the levers oscillate; and the shaft is mounted in a separate housing on the frame of the engine.

After an engine has run for a considerable length of time, the cams become worn and lose their original shapes so that the operation of the engine becomes impaired. It is common practice at this stage to recondition the cam shaft by regrinding badly worn cams to restore them to their original shape, but they are then somewhat smaller since a portion of the metal is ground or worn away. The wear on all cams is not equal, wear on the injector cam normally being considerably greater than on the valve operating cams because of the much higher operating pressure involved. The valve cams may not require grinding at all, even though the injector cams are reshaped.

When the reconditioned cam shaft is placed in the engine, difficulties are encountered in properly timing the engine. Although the cams are similar in outline to their original shape, they are ordinarily somewhat smaller and the change in size is not necessarily uniform between all of the cams on the shaft. As a result of this situation there has occurred a change in the time in which the cam shaft operates any given rocker lever with respect to the position of the crank shaft and to the time of operation of other rocker levers. Since reconditioning of this type has not ordinarily been contemplated by the manufacturer, there is no provision built into the engine to compensate for or adjust the timing after the engine is reconditioned.

The usual method of improving the timing of a reconditioned cam shaft is by placing shims between the engine block or frame and the housing enclosing the stationary bearing for the rocker levers, thus causing the housing to be

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shifted bodily away from the block, taking with it the rocker levers mounted on a shaft within the housing. This causes all of the rocker levers to be shifted longitudinally with respect to the cam shaft; and, by trial and error, it is possible to approximate the correct timing of at least one, and sometimes more, of the rocker levers. However, assuming that the proper timing of the valve injector rocker lever of a cylinder has been achieved, it usually occurs that the timing of the rocker levers for the intake and exhaust valves has been made incorrect. This occurs in any given cylinder because there is no provision for differential movement between the rocker levers for the injector and the levers for the valves. Likewise, since a shift in the housing moves all the rocker levers for two or more cylinders, inability to provide differential movement between the group of rocker levers for each individual cylinder means that one cylinder may be properly timed but at the expense of the timing of an adjoining cylinder.

Timing an engine by this method of trial and error is very time-consuming because the results of adding or removing any given shim cannot be predicted accurately in advance and it is very laborious to change the shims since the fixed shaft housing must be removed each time a thicker or thinner shim is inserted. It will be seen that this method of timing can result only in an approximation to correct timing since a compromise must often be effected between the several cylinders of an engine, as well as between the elements of a single cylinder. The end result is that the engine cannot be timed correctly and in such a way as to produce maximum operating efficiency.

Thus it is a general object of our invention to provide a valve operating mechanism for an internal combustion engine which includes means permitting accurate timing of the valves and fuel injectors in order to obtain maximum efficiency and performance from the engine, especially after the cam shaft has been worn or reconditioned and no longer has exactly its original size and shape.

It is also a general object of our invention to provide means, in the valve operating mechanism for an internal combustion engine, which makes it possible easily and accurately to adjust the cam rocker levers for each individual cylinder relative to the crank shaft without affecting the position of the levers associated with another cylinder.

It is a further object of our invention to pro-

vide means in the valve actuating mechanism of an engine which permits relative movement of the rocker lever arm operating the fuel injector of a cylinder with respect to the lever arms operating the valves of that cylinder.

These objects of our invention have been attained by providing in an engine having a plurality of rocker levers oscillated by a rotating cam shaft, one or more stationary shafts each of which is provided with three bearings upon which rocker levers are mounted to oscillate. The shaft is mounted on the engine frame by means which permit the shaft to be turned to selected positions about its longitudinal axis. Two of the bearings on the shaft have their axes concentric with the main axis of the fixed shaft, while one bearing axis is eccentric thereto. As a result of this construction, the shaft can be rotated about its axis to move the rocker lever mounted on the eccentric bearing with respect to the cam shaft.

The eccentric bearing is preferably the bearing upon which is mounted the rocker lever for the fuel injector. Since this bearing is eccentric with the shaft axis, the associated rocker lever shifts longitudinally as the shaft is rotated; but the levers on either side of it, which actuate the exhaust and intake valves of the cylinder, remain unchanged with respect to the cam shaft. When adjusted to the desired positions, the shaft is locked to hold it fixed in position.

By providing separate fixed shafts mounted concentrically in end-to-end relation for each of two adjoining cylinders, each cylinder can be timed in this manner, independently of the other. Thus each cylinder can be timed properly to obtain maximum performance without in any way compromising with the timing of the adjoining cylinder.

How the above objects and advantages of our invention, as well as others not specifically referred to herein, are attained, will be more easily understood by reference to the following description and to the annexed drawings, in which:

Fig. 1 is a fragmentary vertical section through a typical internal combustion engine constructed according to our invention;

Fig. 2 is an enlarged fragmentary horizontal section on line 2—2 of Fig. 1 showing two fixed shafts upon which rocker levers are mounted, the two shafts being mounted in a single housing upon the cylinder block;

Fig. 3 is a fragmentary vertical section on line 3—3 of Fig. 2 showing the range of movement of a rocker lever with respect to the cam shaft as a result of rotation of the eccentric bearing; and

Fig. 4 is a fragmentary vertical section on line 4—4 of Fig. 2 showing a form of locking means employed at one end of the fixed shaft to hold it in a selected rotational position.

Fig. 1 is a vertical cross section through a typical Diesel engine, and shows a crank shaft 10 which is driven by a plurality of connecting rods 11 attached to cranks 12 on the crank shaft. Each connecting rod 11 is attached to a piston 14 which reciprocates within a cylinder 15. The other cylinders and positions are similar to the one shown; For ease of construction, we prefer to make our invention in units for two cylinders, and we shall now describe an arrangement embodying this construction; but it will be realized that our invention is in no may limited thereto, nor is it limited to any particular number of cylinders.

At one side of and parallel to crank shaft 10 is cam shaft 20 which is driven from the crank shaft by the usual gear train, not shown. Cam shaft 20 has a plurality of axially spaced cams of suitable outline, there being shown in Fig. 1 a cam 21 for actuating the fuel injector. As cam shaft 20 rotates, it actuates a plurality of cam rocker levers 22 which are all generally similar to the one shown in Fig. 1 and are spaced lengthwise of cam shaft 20. Rocker levers 22 are mounted in groups of three at one end on bearings on a stationary shaft 24 and oscillate about the axis of the bearing; and at the other end of each rocker lever there is provided a roller follower 25 which engages a cam on shaft 20. As is conventional, certain of the cams, as cam 21, operate the fuel injectors, while other cams 23 (Fig. 4) operate the valves. Though the two kinds of cams have different shapes, all cam rocker levers 22 are the same except that those for the injectors are made stronger.

As shown in Fig. 2, each rocker lever 22 has a socket 26 on its upper side near the inner or free end which receives the lower end of push rod 27 which is connected at its upper end to top rocker arm 30 mounted on shaft 31. Each rocker arm 30 is mounted to oscillate about its bearing, on shaft 31, which is intermediate the ends of the arm. One end of each rocker arm 30 is operatively connected to the stem of an exhaust or inlet valve (not shown) or to the stem of a fuel injector as shown in Fig. 1. Through this linkage just described, the upward motion of rocker levers 22 induced by cams 21 and 23 respectively raises push rods 27 to periodically cause the fuel injector 32 to introduce a quantity of fuel into the combustion chamber, or open a valve in the cylinder head above piston 14.

Each bearing shaft 24 is made long enough to accommodate the three rocker levers for one cylinder; thus each shaft 24 is provided with two concentric bearings 34 and one intermediate eccentric bearing 33, as shown in Fig. 2.

The shafts 24 may be mounted upon the engine block in any convenient manner. In the drawings, two shafts 24 are mounted in end-to-end relation within a single housing 36 which is bolted at 36a to the side of the engine block or frame slightly above and at one side of cam shaft 20. This construction is used because it is desired to have easy access to one end of each shaft 24, and it is simple and economical to mount the shafts in units of two. As shown particularly in Fig. 2, each shaft 24 is rotatably mounted in housing 36 by means of simple journal bearings at each end of the shaft.

Housing 36 is open along one side, as shown in Fig. 1, except at its ends. For this reason, the inner adjacent ends of the two shafts 24 are held by split bearings, half of each of the two bearings being held in a single bearing block which can be tightened around the ends of shafts 24 by means of bolts 37. At their outer ends, housings 36 completely surrounds shafts 24, which fit inside a split bushing 38 which forms the bearing for the shaft. Each shaft 24 is provided with some means by which it can be engaged by a wrench or the like to rotate the shaft about its longitudinal axis. For this purpose, we have provided the outer end of each shaft 24 with a hexagonal head 40 adapted to receive a standard socket wrench or the like. This hexagonal head is normally covered by cap 41 screwed into the open end of the housing, but which may be removed to provide access to the shaft.

It will be evident that when a shaft **24** has been turned to a selected position in order to obtain the proper adjustment of the injector rocker lever that it requires means to hold it in the adjusted position. For this purpose, any suitable locking means can be provided. At the inner end of the shaft, such locking action is supplied by tightening bolts **37** to clamp the end of the shaft in the bearings. At the other end of the shaft, frictional locking means is provided by plug **42** which engages split sleeve **38** in order to compress the sleeve and clamp it around the end of the shaft. This locking action of plug **42** is controlled by set screw **44** threaded into the housing. Set screw **44** may be turned by a socket wrench to advance or retract plug **42** and thus clamp or release the fixed shaft.

From the foregoing description of the construction of our invention, it will be evident that, by rotating a shaft **24** and its eccentric bearing **33**, the fuel injector rocker arm **22** may be moved in a substantially longitudinal direction. The range of this movement is equal to twice the eccentricity of axis **33***a* of bearing **33**, as shown in Fig. 3 in which the rocker arm is shown in the fully advanced position by full lines and in fully retracted position by dot-dash lines. This longitudinal movement of the rocker arm changes the point in its revolution at which cam **21** commences to lift the free end of the rocker arm. In other words, this adjustment in position of the rocker arm makes it possible to regulate the angular position of the cam shaft at which the fuel injector is operated, thus timing the fuel injection with respect to the revolution of the crank shaft of the engine.

This timing is accomplished in a very simple manner, after all of the parts of the engine have been assembled, merely by turning the shaft **24** for each cylinder until proper timing for each cylinder has been obtained. The proper adjusted position of shaft **24** is then maintained by tightening bolts **37** and set screws **44** to clamp the ends of shafts **24**, locking them in the adjusted positions. This timing operation can be carried out simply and in a relatively short time as it does not require any dismantling or reassembly of parts of the engine during the timing procedure. Each cylinder is timed independently of every other cylinder so that each cylinder operates under conditions of maximum performance.

Having described a preferred embodiment of our invention, it will be evident that various changes may be made in the arrangement and construction of the various parts without departing from the spirit and scope of our invention; and consequently we wish it to be understood that the foregoing description is considered illustrative of, rather than restrictive upon, the appended claims.

We claim:

1. In an internal combustion engine, the combination comprising: a rotatable cam shaft; a stationary shaft having two concentric bearings and a third bearing intermediate the first two, the third bearing having its axis eccentric with respect to the other bearings and the axis about which said shaft can be turned; a rocker lever mounted on each of the bearings and oscillated by the cam shaft; a push rod reciprocated by each of the rocker levers; and mounting means for said stationary shaft in which the shaft can be turned to selected positions about the axis of said concentric bearings, in order to shift said third rocker lever with respect to the cam shaft substantially longitudinal of said rocker lever, the other two rocker levers remaining unchanged in position when the third one is shifted.

2. In an internal combustion engine, the combination comprising: two cylinders each having a fuel injector; a pair of stationary shafts concentrically mounted in end-to-end relation, one at each cylinder; mounting means for the stationary shafts in which each shaft can be turned about the shaft axis to selected positions; a bearing on each stationary shaft having its axis eccentric to the shaft axis; a rotatable cam shaft; a plurality of rocker levers oscillated by the cam shaft and mounted one on each of the bearings on the stationary shaft; and a plurality of push rods, each reciprocated by one of the rocker shafts and operatively connected to one of the injectors; whereby the rocker lever associated with one cylinder can be shifted relative to the cam shaft in a direction substantially longitudinal of the rocker lever and independently of the rocker lever associated with the other cylinder to permit independent timing of the cylinders.

3. In an internal combustion engine as in claim 2, the combination that also includes locking means for each of the fixed shafts adapted to lock the shafts in selected rotational positions.

4. In an internal combustion engine as in claim 2, the combination that also includes: a second bearing on each stationary shaft concentric with the shaft axis; a second rocker lever for each cylinder mounted on each said second bearing and oscillated by the cam shaft; and a push rod reciprocated by each of said second rocker levers and operatively connected to a valve for a cylinder; said second rocker lever remaining unchanged in position when the first mentioned rocker lever on the same shaft is shifted longitudinally by rotation of the stationary shaft.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,509,262	Royce	Sept. 23, 1924
1,799,549	Evans	Apr. 7, 1931
1,936,653	Almen	Nov. 28, 1933
2,218,575	Griswold	Oct. 22, 1940

FOREIGN PATENTS

Number	Country	Date
486,191	Great Britain	May 31, 1938