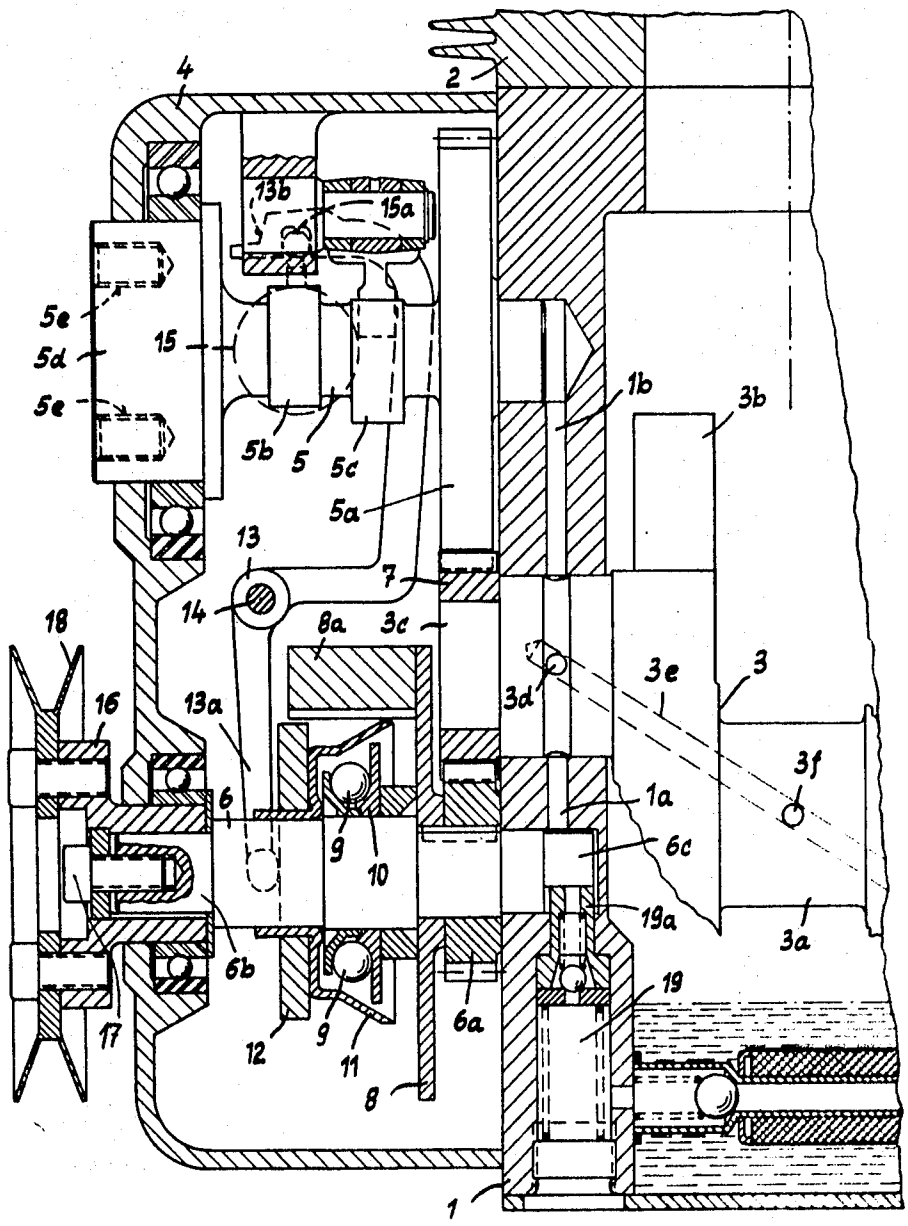
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INTERNAL COMBUSTION ENGINE

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# INTERNAL COMBUSTION ENGINE

Ernst Hatz, Ruhstorf, Germany, assignor to Motorenfabrik Hatz KG., Ruhstorf, Germany

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## ABSTRACT OF THE DISCLOSURE

An internal combustion engine, particularly a single cylinder diesel engine, has a crank shaft which drives, on the control side of the engine, two axially-parallel shafts, one of which is a valve control shaft and the other an imbalance shaft. The crank shaft terminates immediately adjacent the main bearing in a short spindle or the like for a pinion which drives both the other shafts. These shafts are arranged on opposite sides of the crank shaft axis and are provided at their ends which project out of the housing with means for driving accessory apparatus or equipment. The imbalance weight on the imbalance shaft is so arranged that the movable elements of a centrifugal regulator occupy the free space within the path of movement of the weight. One end of the imbalance shaft is arranged to drive a lubricating-oil piston pump.

## FIELD OF THE INVENTION

This invention relates to an internal combustion engine, in particular a single cylinder diesel engine, having a crank shaft which drives, on the control side of the engine, two axially-parallel shafts, one of which serves as a valve control shaft and the other as an imbalance shaft.

## BACKGROUND AND SUMMARY OF THE INVENTION

It is already known to provide, in addition to the balance weights on the crank shaft, an additional compensating weight for the moving masses by mounting an additional imbalance weight on a shaft which is axially parallel to the crank shaft. The imbalance shaft is driven from the crank shaft in the opposite rotational direction but at the same speed. Usually, the crank shaft extends outwardly at the control side to permit a direct power take-off here.

However, prior arrangements of this kind have serious disadvantages. Firstly, the fact that the end of the crank shaft rotates closely adjacent the imbalance shaft limits the space available for the imbalance weight, so that only by employing complicated gearing arrangements for the drive of the imbalance shaft is sufficient additional weight compensation possible. Moreover, the power take-off means on the crank shaft often prevent the addition of further power take-off means to the outer end of the imbalance shaft so that, in many cases, it is impossible to provide an additional power take-off from the imbalance shaft adjacent the power take-off on the crank shaft.

It is an object of the present invention to avoid these disadvantages of the known constructions and to provide an arrangement which not only considerably increases the room available for movement of the imbalance weight, but which also makes possible unhindered simultaneous power take-offs at two positions on the same side of the internal combustion engine, by a simple addition or arrangement of drive gears between all three shafts.

This problem is solved in accordance with the invention by the fact that, on the control side, the crank shaft terminates immediately adjacent the main bearing in a short spindle or the like for the pinion driving both the other shafts, and that both of these shafts are arranged on opposite sides of the crank shaft axis and are provided at their ends which project out of the housing, with means for driving accessory apparatus, additional equipment or the like. In a preferred embodiment of the invention there is provided on the cam shaft adjacent the drive pinion, at least one valve control cam, a drive cam for an injection pump, and a shaft end provided with fixing means. Also, there is arranged on the imbalance shaft adjacent the drive pinion at one side, a carrying plate for the imbalance weight, a centrifugal regulator for an injection pump as well as a shaft end provided with fixing means and, on the other side, the drive means for a lubricating-oil feed pump.

An advantageous arrangement of the centrifugal regulator, in accordance with another feature of the invention, resides in that the imbalance weight is arranged on the periphery of the carrying plate and extends substantially in the axial direction, and that the central area of the carrying plate is formed as the support for the centrifugal regulator. In this event, it is proposed to arrange the imbalance weight and the centrifugal regulator on the same side of the carrying plate so that the movable elements of the regulator occupy the free space within the path of movement of the weight. A particularly advantageous arrangement of the lubricating-oil pump, according to a further feature of the invention, is produced by the fact that the end of the imbalance shaft adjacent the crank shaft is formed with a drive eccentric for the lubricating-oil pump.

## DESCRIPTION OF THE DRAWING

One embodiment of the invention is described in the following description with reference to the drawing, which shows in section only so much engine structure as is necessary to an understanding of a preferred embodiment of the invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrated, by way of example, in the drawing is an internal combustion engine having a crank case **1**, a vertically mounted cylinder **2**, and a non-illustrated cylinder head which are connected to one another. The crank shaft **3** mounted in the crank case **1** has a crank journal **3***a* which is coupled to the big end bearing of a non-illustrated connecting rod. The piston which moves up and down in the cylinder is coupled to the other end of the connecting rod. The webs of the crank shaft **3** are each provided, in known manner, with a compensating weight **3***b*.

Fitted to the side of the crank case **1** is a casing **4** in which are mounted the outer ends of a camshaft **5** and of an imbalance shaft **6**. The inner ends of these shafts are mounted in the crank case wall so that both shafts **5** and **6** extend parallel to the crank shaft **3** and are also driven therefrom. For this purpose, a toothed pinion **7** is fixed to the end **3***c* of crank shaft **3** and drives, at one side, a gear wheel **5***a* on the camshaft **5** and a gear wheel **6***a* on the compensating shaft **6**. The gear ratio between shafts **5** and **6** is 1:2, shaft **6** turning in the opposite direction to the crank shaft. The camshaft **5** carries two cams **5***b*, **5***c* which operate the inlet and outlet valves through known intermediate members. The outer end **5***d* of the camshaft **5** is formed with a fixing flange, to which power take-off drive means, for example, for an electric current generator, can be fixed by means of tapped holes **5***e*.

The imbalance shaft **6** has a carrying plate **8** fixed thereto to turn with it. A segmental block **8***a* is fixed to the periphery of plate **8** as a supplementary imbalance weight. In this way, it is possible to accommodate a centrifugal regulator within the annular path of the weight

8*a*. This regulator employs a plurality of ball weights **9** which, on the one hand, rest on an axially-immovable track **10** which is mounted to turn with the shaft **6** and, upon rotation of the shaft **6**, press against a hopper-form track **11** which is axially adjustable on shaft **6** and move in known manner further, or less far, to the left. Engaged with an abutment plate **12** on track **11** is the forked end **13***a* of a regulating lever which is mounted on a transverse bolt **14** in the casing **4**. The opposite end **13***b* of this regulating lever **13** engages the control lever **15***a* of a fuel injection pump **15** indicated only in dotted lines, which is mounted on the side of the casing **4** and the piston of which is driven from cam **5***b*. Thus, the control lever **15***a* is arranged to turn about an axis at right angles to the axis of shaft **5**.

The outer end **6***b* of the imbalance shaft is coupled to a fixing flange **16**, e.g. by a screw **17**. Drive means, for example, a pulley wheel **18**, for additional apparatus of the engine, e.g. a cooling air blower, can be fixed to flange **16**.

The inner end of the shaft **6** is constructed to form a drive eccentric which drives the feed piston of a lubricating-oil pump **19**. This pump is mounted in the wall of the crank case **1**, sucks lubricating oil from the sump of the crank case and feeds it to various lubrication points through bores **1***a*, **1***b*, **3***d*, **3***e*, **3***f*.

It can be clearly seen that crank shaft **3** does not project from the control casing **4**, but terminates immediately adjacent the main bearing in a short spindle or extension or the like **3***c* for pinion **7**. Thus, the crank shaft, according to the arrangement of the invention does not serve to directly transfer the take-off forces. Moreover, both shafts **5** and **6** are mounted on opposite sides of the axis of the crank shaft so that their outer ends, which project from the control casing **4**, can be provided with means for driving apparatus, additional equipment or the like, without these means interfering with one another, even during simultaneous operation. In the illustration, the shafts **5** and **6** are mounted at exactly diametrically-opposed locations about the axis of the crank shaft **3**. One or both of these shafts could, however, be displaced by a selected angular amount from the vertical plane through the crank shaft to suit drive conditions.

As a result of the positioning of the shafts **5** and **6** on opposite sides of the crank shaft **3**, the space occupied by the additional weight **8***a* can be of a larger diameter. In this way, it is possible to accommodate a further centrifugal regulator within the annular path of movement of the compensating weight. Moreover, the inner end of the imbalance shaft can also be shaped as a drive eccentric for a lubricating oil pump or the like.

The arrangement of the invention brings, along with the facility for two simultaneously-operable power take-off points on the engine, the further advantage of accommodating the camshaft and imbalance shaft in minimum space, as well as that of the devices or apparatus driven from these two shafts. It is to be understood that the illustrated construction shows only one of the possible arrangements of control and power take-off drives, variations from the disclosed arrangement being possible without further information.

Having thus described a preferred embodiment of my invention in the manner required by the patent statutes, I claim:

**1.** In an internal combustion engine, a crank case, a main bearing in one wall of the crank case, a crank shaft in said crank case and journalled at one end in said main bearing, a casing fitted to said wall and forming therewith a control housing, a valve control shaft in said housing with one of its ends journalled in the casing so as to be axially parallel to the crank shaft, an imbalance shaft



in said housing with one of its ends journalled in the casing so as to be axially parallel to said crank shaft, said valve control shaft and said imbalance shaft being arranged on generally opposite sides of the crank shaft axis and projecting at their said one ends through the casing and outside of the housing and being provided at their projecting ends with means adapted for driving accessory apparatus, said crank shaft terminating at its said one end immediately adjacent said main bearing in a short spindle in said housing, and drive train means mounted in said housing on said spindle and on the other two shafts for transmitting rotary drive power from said crank shaft to the other two shafts.

**2.** In an internal combustion engine as claimed in claim **1**, wherein said drive train means comprises a pinion mounted on said spindle and gear wheels mounted on the other two shafts in meshing engagement with said pinion.

**3.** In an internal combustion engine as claimed in claim **2**, wherein said pinion and said gear wheels are disposed immediately adjacent said wall of the crank case.

**4.** In an internal combustion engine as claimed in claim **2**, wherein said valve control shaft is a cam shaft having cams for actuating valves and an injection pump for the engine.

**5.** In an internal combustion engine as claimed in claim **2**, wherein there is arranged on the imbalance shaft adjacent its gear wheel at one side, a carrying plate for an imbalance weight, a centrifugal regulator for an injection pump, and said projecting end of the imbalance shaft, and, on the other side of the gear wheel, drive means for lubricating-oil feed pump.

**6.** In an internal combustion engine as claimed in claim **5**, wherein an imbalance weight is arranged on the periphery of the carrying plate and extends substantially in the axial direction, and the central area of the carrying plate is formed as the support for the centrifugal regulator.

**7.** In an internal combustion engine as claimed in claim **6**, wherein the imbalance weight and the centrifugal regulator are so arranged on the same side of the carrying plate that movable elements of the regulator occupy the free space within the path of movement of the weight.

**8.** In an internal combustion engine as claimed in claim **5**, wherein the drive means on the end of the imbalance shaft adjacent the crank shaft comprises a drive eccentric for the lubricating-oil pump.

**9.** In an internal combustion engine as claimed in claim **2**, wherein said imbalance shaft and said valve control shaft are each journalled at one end in the casing wall and at the other end in the crank case wall.


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