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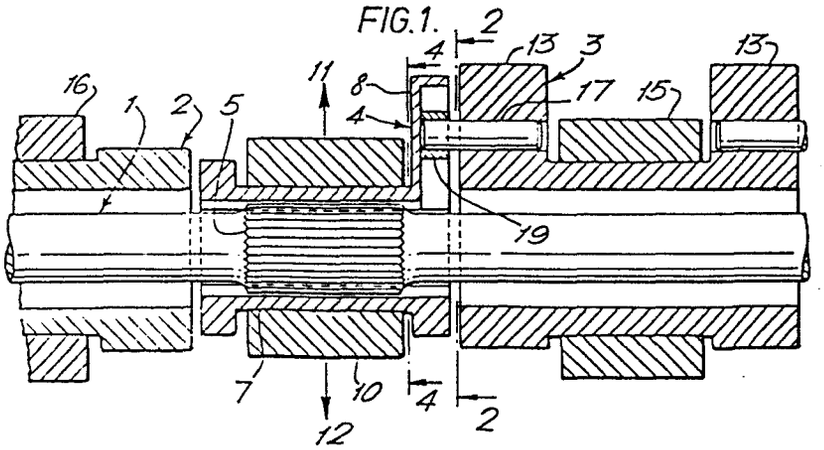
(54) **Variable valve timing mechanism.**

(57) A variable valve timing mechanism uses the known principle of an eccentric drive to the camshafts 2, 3. The drive is by means of a shaft 1 which extends through the sleeves and can be moved by means of a bearing 11 in a translational sense with respect to the axes of rotation to the cams. The shaft 1 has lateral projections 8, 9 which couple to the cam lobes.

When the shaft is moved in the direction of arrows 11 or 12 the eccentricity of the drive to the cams is varied and the valve timing is altered.

FIG.1.



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VARIABLE VALVE TIMING MECHANISM

This invention relates to variable valve timing mechanisms for internal combustion engines.

As is well known, the opening and closing of exhaust and inlet valves can be varied to achieve certain desired advantages. For example, increased power at high speeds can be obtained by advancing the opening and delaying the closing of inlet valves, and by advancing the opening of the exhaust valves. At low speeds, delaying the opening of the exhaust valves to reduce valve overlap achieves the same effect while also reducing exhaust emissions.

United Kingdom Patent Specification No. 1 522 405 describes one prior proposal for varying the valve timing. In that proposal separate camshafts are provided for each cylinder and they are driven eccentrically with variable eccentricity to vary the valve timing. The camshaft drive is provided by a gear located between the centre two camshafts, which results in an undesirable increase in the height of the valve gear cover.

United Kingdom Patent Specification No. 2 066 361 describes another proposal for varying the valve timing. In this

proposal, separate camshafts for each cylinder are coupled to a driveshaft which runs the length of the cylinder head through the hollow camshafts and which is movable in a translational sense to drive the camshafts whith varying eccentricity. The camshaft is driven by a gear located outside the valve gear cover so that the height of the valve gear cover can be reduced since the driving gear is not within the valve gear cover but the means coupling the camshafts to the driveshaft nevertheless adds to the length of the cylinder head.

The invention provides a variable valve timing mechanism for an internal combustion engine comprising a valve actuating cam on a rotatably mounted hollow camshaft, and a shaft for driving the camshaft, which shaft extends through the hollow camshaft and is movable in a translational sense relative to the axis of rotation of the cam, the shaft having a lateral projection so coupled to the cam lobe as to drive the camshaft with varying amounts of eccentricity as the shaft is moved, in order to vary the valve timing.

The use of the cam lobes as part of the means coupling the drive shaft and individual camshafts permits a reduction in the length of the cylinder head while still enabling the height of the valve gear cover to be reduced compared to the first prior proposal referred to above.

Advantageously, the camshaft carries two cams, and the bearing for the camshaft is located between the two cams.

Advantageously, there is a separate camshaft for each cylinder. Although each camshaft could have a single cam for varying the timing of a single valve (inlet or exhaust), preferably each camshaft carries two cams, either for operating both an inlet and an exhaust valve, or for operating a pair of exhaust valves. In the latter case, additional separate camshafts could be provided for each cylinder so that there is one for a pair of inlet valves and one for a pair of exhaust valves.

Advantageously, there is a slot in the cam lobe or preferably in the lateral projection which slot is engaged by a slider connected to the cam lobe or lateral projection, respectively, which transmits the drive in a rotary direction while allowing the necessary radial relative movement to take place freely.

The lateral projection may be on an arm which extends from a sleeve fixed on the shaft. The sleeve may have projections at each end, each connected to a cam lobe for a valve of a different cylinder.

The invention is applicable to spark ignition or compression

ignition engines.

A valve timing mechanism for a spark ignition internal combustion engine will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an axial cross-section through a part of the valve timing mechanism;

Figure 2 is a section taken on the lines 2-2 in Figure 1;

Figure 3 is an exploded view of some of the parts shown in Figure 1; and

Figure 4 is a section taken on the lines 4-4 in Figure 1, but on a smaller scale than Figure 1.

Referring to the drawings, the engine is a four cylinder in-line engine with two inlet valves and two exhaust valves per cylinder. A variable valve timing camshaft mechanismm is provided for all the inlet valves and a separate variable valve timing camshaft mechanism is provided for all the exhaust valves.

The drawings show part of the mechanism for the inlet valves, and the one for the exhaust valves is identical.

The mechanism for the inlet valves commprises a drive shaft indicated generally by the reference numeral 1, hollow camshafts for two adjacent cylinders indicated generally by the

reference numerals 2, 3, and an intermediate driving member indicated generally by the reference numeral 4 for driving the camshafts from the drive shaft. The cam lobes of the camshafts operate tappets (not shown) in the usual way.

The drive shaft has a serrated portion 5, and the interior of the intermediate driving member 4 is also internally serrated at 6, so keying the two together.

The intermediate driving member 4 consists of a sleeve 7 bearing the internal serrations and two integral lateral projections 8, 9 which extend radially from the shaft 1. The sleeve 7 is mounted in a bearing 10 which is movable by means to be described hereinafter in the direction of the arrows 11, 12.

Each hollow camshaft 2, 3 has an internal diameter wide enough to allow the lateral movement of the driving shaft 1 to take place. Each has a pair of identical cam lobes 13, 14 respectively (the lobes 14 are not visible in the drawings) and each is rotatably mounted in a fixed bearing housing 15, 16 respectively.

The cam lobes 13, 14 are coupled respectively to the lateral projections 8, 9 by pin and slot couplings, only one of which

is shown in the drawings. Thus, the cam lobe 13 has pin 17 pressed into an aperture in it, which pin engages in aperture 18 in a square-sectioned slider 19 which is freely slideable in a radial slot 20 recessed in one face of lateral projection 8, (Figure 3). In addition, the slider 19 can oscillate relative to the pin 17 about the axis of the pin 17.

When the axis of the drive shaft 1 coincides with the axes of the camshafts 2, 3, the angular velocity of the camshafts will keep in step with that of the driving shaft 1. When the bearing 10 is moved in the direction of the arrows 11, 12, the axis of the drive shaft 1 will no longer coincide with the axes of rotation of the camshafts. The angular velocities of the camshafts will then no longer be in step with that of the drive shaft 1 and the valve timing will be varied.

Referring to Figure 4, the bearing housing 10 is mounted in a pivotable housing 21. A fixed shaft 22 runs through an aperture in one end of the housing, and a notch 23 is cut out of the other end. The notch 23 containing an eccentric 24 mounted on a fixed shaft 25. The housing 10 moves in the direction of the arrows 11, 12 when the shaft 25 is turned and the eccentric acts on the notch.

Although only one intermediate driving member 4 has been shown,

it is apparent that one other will be needed for a four cylinder engine, to be located between the camshafts for the other two cylinders. The other is mounted in an indentical bearing housing 10 which is in turn mounted in an identical pivotable housing 21. The shafts 22, 1 and 25 extend the full length of the cylinder head through both bearing housings and pivotable housings, and it will be apparent that twisting of control rod 25 causes both bearing housings to move in the same direction 11, 12 in step with each other.

The drive shaft 1 is driven at one end (not shown) by means of a pulley driven by a belt.

It will be noted that the lateral projections 8, 9 of the intermediate driving member 4 lie within the profiles of the cam lobes 13, 14, thereby permitting the use of bucket tappets.

It will also be noted that, as compared with United Kingdom Patent Specification No. 2 066 361, the length of the cylinder head can be reduced since cam lobes form part of the means coupling to the camshafts to the drive member 1.

The intermediate driving member 4 is made of metal; the slider 19 may be of metal or of synthetic material.

As has been stated hereinbefore, a similar arrangement to that which has been described is provided for the exhaust valves.

Various modiciations may of course be made without departing from the scope of the invention. Thus, for example, a third intermediate driving member could be provided between the centre two cylinders so that camshaft 3 could be driven by an appropriate pin and lateral projection at each lobe, instead of only at one lobe as illustrated. If desired each cam lobe of each camshaft could be driven by a separate pin in order to reduce stresses on the camshaft.

Also, the cam lobes could act via rockers if desired.

The arrangement is applicable to any number of in-line or opposed cylinders, or to banks of cylinders of V-configuration, or indeed to any arrangement of cylinders. Further, if desired, the variable valve timing mechanism could be provided for inlet valves only, or for exhaust valves only, and is applicable to a single inlet or a single exhaust valve per cylinder as well as to pairs thereof.

Also, instead of the camshafts 2, 3 bearing pairs of inlet, or exhaust cams for each cylinder they may each bear one inlet and one exhaust valve for a respective cylinder, that is, two

valves per cylinder.

Finally, the invention is applicable to compression injection as well as to spark ignition engines.

CLAIMS

1 A variable valve timing mechanism for an internal combustion engine comprising a valve actuating cam on a rotatably mounted hollow camshaft, and a shaft for driving the camshaft, which shaft extends through the hollow camshaft and is movable in a translational sense relative to the axis of rotation of the cam, the shaft having a lateral projection so coupled to the cam lobe as to drive the camshaft with varying amounts of eccentricity as the shaft is moved, in order to vary the valve timing.

2 A mechanism as claimed in claim 1, wherein the camshaft carries two cams, and the bearing for the camshaft is located between the two cams.

3 A mechanism as claimed in claim 2, wherein one of the cams is for operating an inlet valve and the other is for operating an exhaust valve.

4 A mechanism as claimed in claim 2, wherein both of the cams are for inlet, or for exhaust, valves.

5 A mechansims as claimed in any one of claims 1 to 4, wherein there is a separate camshaft for each cylinder.

6 A mechanism as claimed in claim 5, wherein there are two camshafts for each cylinder, to vary the valve timing of inlet and exhaust valves separately.

7 A mechanism as claimed in claim 5 or claim 6, wherein adjacent camshafts are driven by an intermediate driving member comprising a sleeve surrounding the driving shaft with which the respective lateral projections are formed integrally.

8 A mechanism as claimed in any one of claim 1 to 7, wherein there is a slot in the lateral projection or in the cam lobe which slot is engaged by a slider connected to the cam lobe or lateral projection, respectively.

9 A mechanism as claimed in claim 8, wherein the slider engages a pin which extends through the lateral projection or the cam lobe.

10 A variable valve timing mechanism substantially as hereinbefore described with reference to the accompanying drawing.

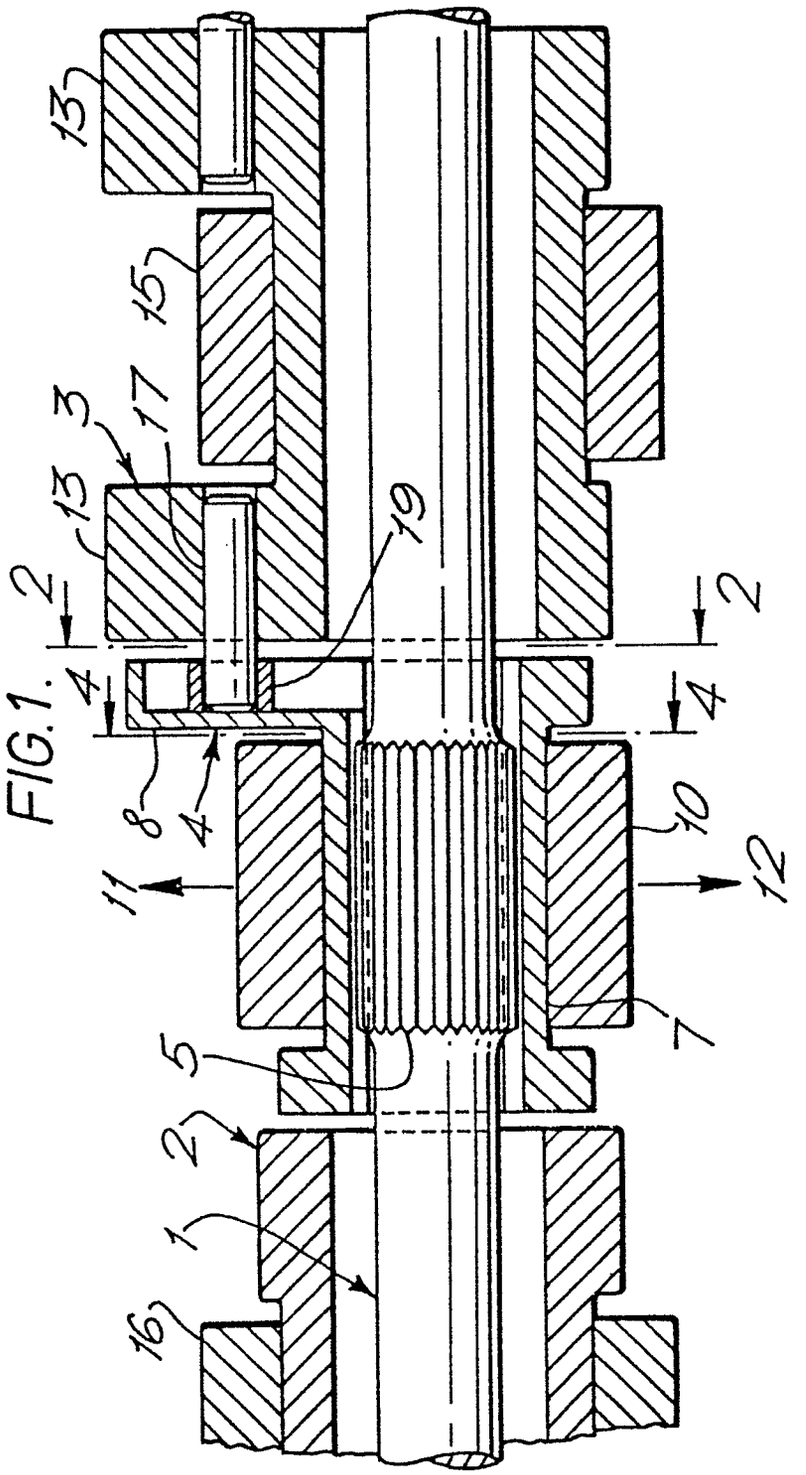

FIG.1.

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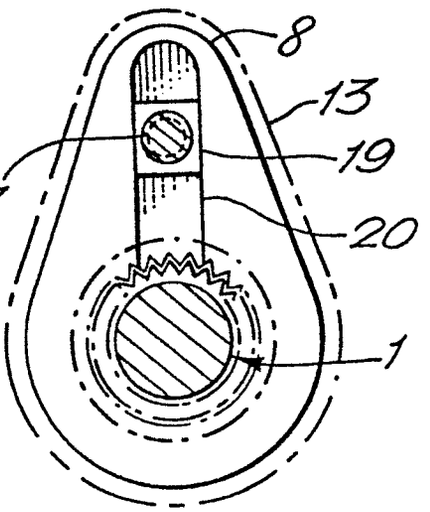
FIG.2.



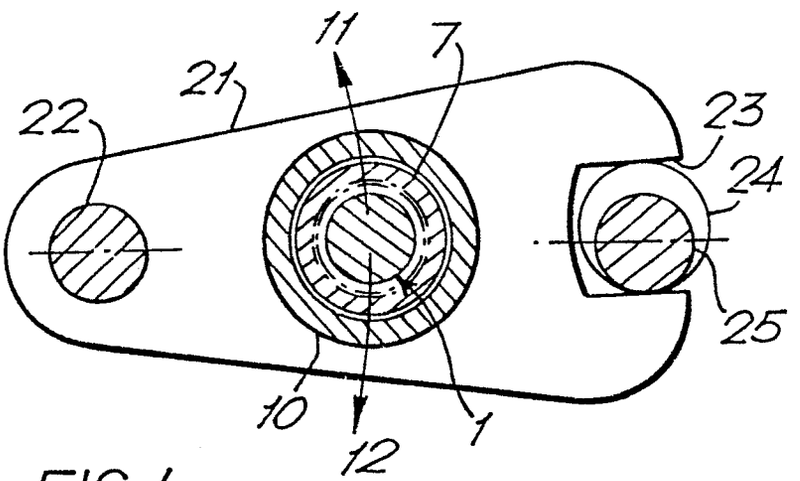


FIG.4.

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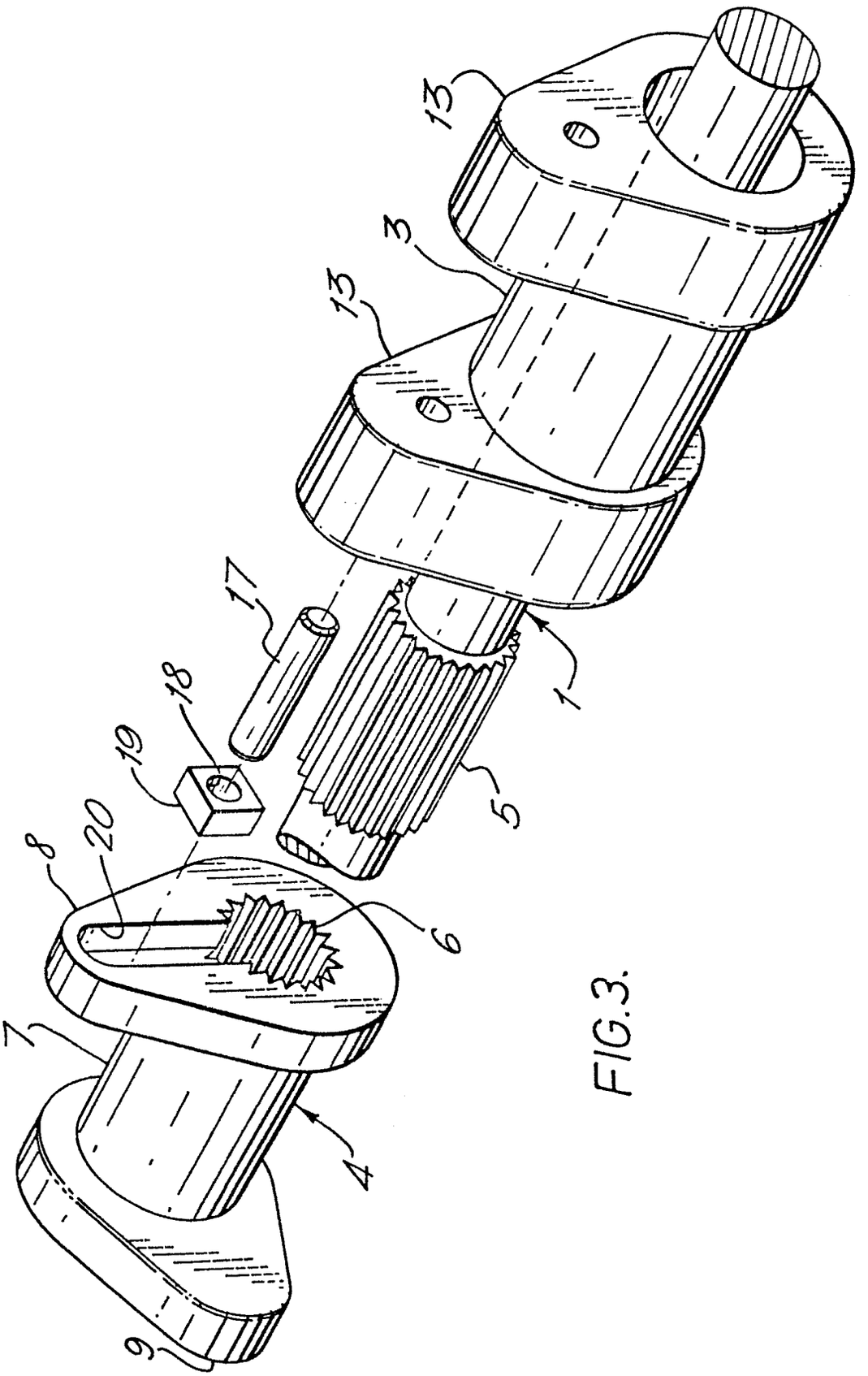

FIG.3.