May 21, 1968 E. C. KIEKHAEFER ETAL 3,384,058

OVERHEAD CAMSHAFT ENGINE

Filed April 21, 1967 2 Sheets-Sheet 1

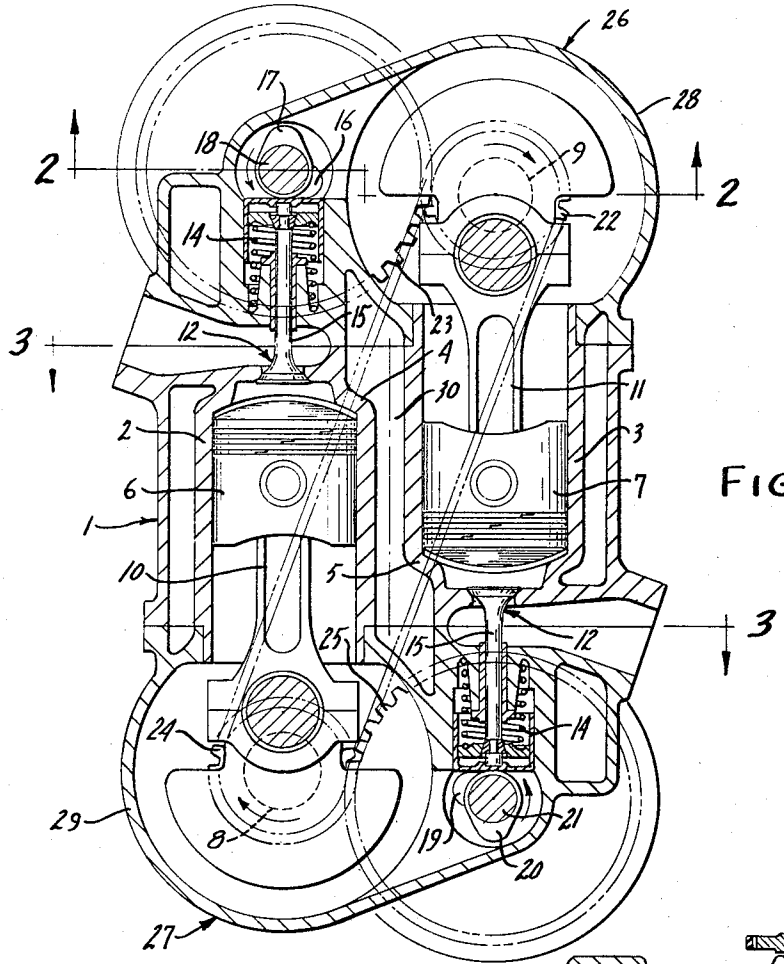


FIG. 1.

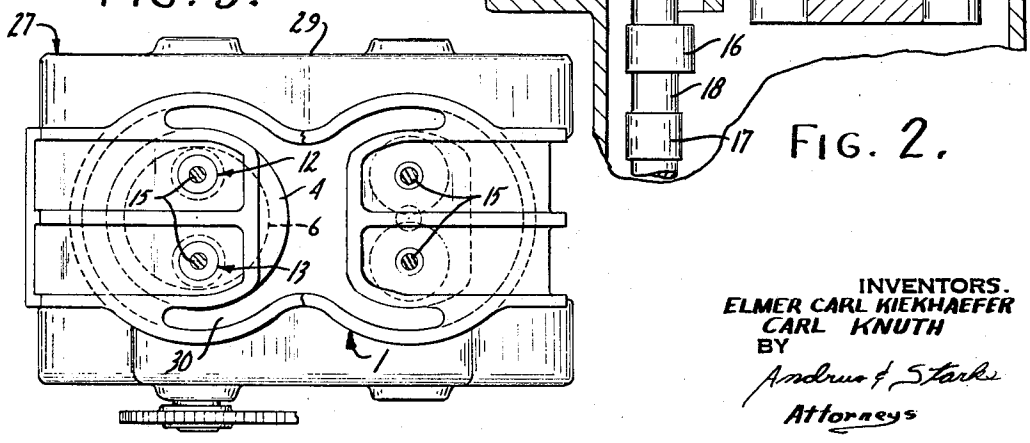


FIG. 3.

FIG. 2.

INVENTORS.
ELMER CARL KIEKHAEFER
CARL KNUTH
BY
Andrus & Starke
Attorneys

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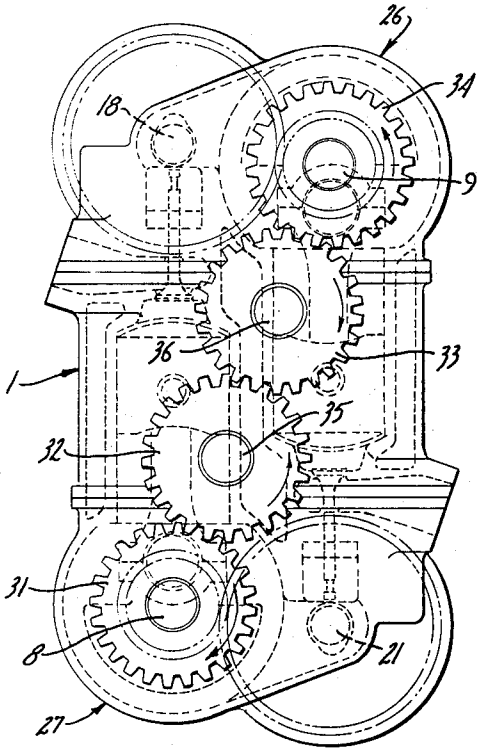


FIG. 4.

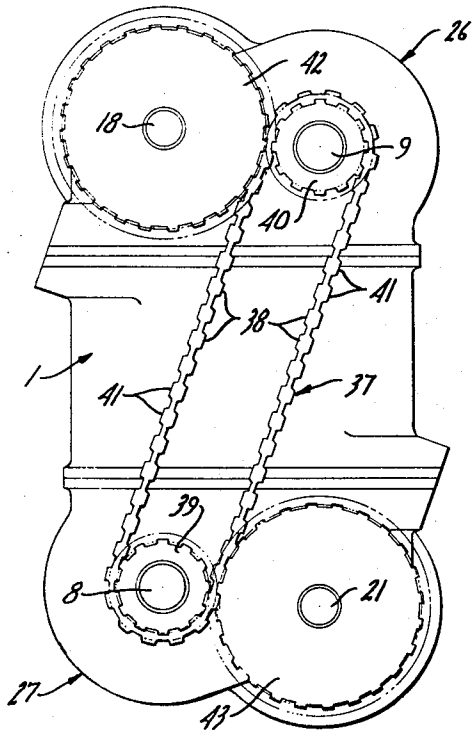


FIG. 5.

INVENTORS.
ELMER CARL KIEKHAEFER
CARL KNUTH
BY
Andrus & Starke
Attorneys

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OVERHEAD CAMSHAFT ENGINE

Elmer Carl Kiekhaefer, Winter Haven, Fla., and Carl Knuth, Fond du Lac, Wis., assignors to Brunswick Corporation, Chicago, Ill., a corporation of Delaware

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7 Claims. (Cl. 123—52)

ABSTRACT OF THE DISCLOSURE

A four-cycle internal combustion engine has its cylinders arranged in Siamese pairs with two separate crankshafts at opposite ends of the block, synchronized in operation either by a train of gears or a positive drive belt, and having overhead camshafts for actuating intake and exhaust valves in the heads of the corresponding cylinders. Each camshaft is driven directly from the adjacent crankshaft.

This invention relates to an overhead camshaft engine of the four-cycle internal combustion type.

The invention is applicable to engines having two cylinders and multiples of two cylinders.

The advantages of overhead camshaft actuation of the valves for four-cycle internal combustion engines have long been known. Nevertheless, practical engines employing such overhead camshafts have awaited developments in various types of drive connections between the crankshaft at one end of the cylinders and the camshaft at the other end.

The use of long belts and chains for driving overhead camshafts has presented problems in noise, in oiling and maintenance, in wear and stretching and thereby destroying the timing, and in overall life. Gears have been used but require substantial oiling which becomes a problem for the height needed.

The present invention proposes to arrange the cylinders in Siamese pairs wherein the head of one cylinder for each pair is adjacent the crank end of the opposite cylinder and vice versa. In this way there are two crankshafts and two camshafts for the engine, there being a crankshaft and a camshaft at each end of the cylinders. With this construction the drive connection is between the crankshaft of one cylinder and the camshaft of the adjacent cylinder and is short so that any one of the drive connections will be suitable without encountering the problems previously referred to.

The invention further contemplates the positive synchronizing of the crankshafts by means of gears or a timing belt or other suitable means. Where it is desired to drive counter rotating propellers for marine purposes it is preferable to synchronize the crankshafts by gear means providing for counter rotation of the crankshafts. Where it is desired to provide a common output shaft driven from the two crankshafts the synchronizing is preferably accomplished by a timing belt which may be of the general type described and claimed in the copending application of Elmer Carl Kiekhaefer, Ser. No. 432,676, filed Feb. 15, 1965, now Patent No. 3,338,107 and assigned to a common assignee with the present application.

The accompanying drawing illustrates the best mode presently contemplated by the inventors for carrying out the invention.

In the drawings:

FIGURE 1 is a schematic sectional view of an engine taken partially axially of a pair of Siamese arranged cylinders;

FIG. 2 is a schematic section taken generally on line 2—2 of FIG. 1;

FIG. 3 is a schematic section taken generally on line 3—3 of FIG. 1;

FIG. 4 is a detail schematic view of the synchronizing connection between the several shafts utilizing gearing; and

FIG. 5 is a similar view utilizing a timing belt.

The internal combustion engine illustrated has its cylinders arranged in Siamese pairs, only one pair of which is illustrated and comprises a cylinder block **1** having the spaced parallel cylinders **2** and **3** disposed with their corresponding heads **4** and **5** opposed in direction.

Pistons **6** and **7** operate in the corresponding cylinders **2** and **3** and are connected to individual crankshafts **8** and **9**, respectively, by suitable connecting rods **10** and **11**.

The cylinder heads **4** and **5** contain the necessary fuel inlet valves **12** and exhaust valves **13** for each cylinder. The valves **12** and **13** illustrated are of the poppet type with the valves held seated by suitable springs **14** disposed to bias the valve stems **15** outwardly.

Inward movement of each valve **12** and **13** for cylinder **2** is effected by cams **16** and **17**, respectively, on a camshaft **18** extending across the closed end of the cylinder in a direction parallel to crankshafts **8** and **9**.

Similarly, inward movement of each valve **12** and **13** for cylinder **3** is effected by cams **19** and **20**, respectively, on a camshaft **21** extending across the closed end of the cylinder in a direction parallel to crankshafts **8** and **9**.

Camshaft **18** for cylinder **2** is driven by a suitable connection such as the gears **22** and **23** from crankshaft **9** for cylinder **3**. Likewise, camshaft **21** for cylinder **3** is driven by a suitable connection such as the gears **24** and **25** from crankshaft **8** for cylinder **2**.

Gears **22** and **24** on the corresponding crankshafts **9** and **8** are one-half the pitch diameter of gears **23** and **25** on the corresponding camshafts **18** and **21** to provide the necessary 2:1 speed reduction between the camshafts and the crankshafts of the engine.

Suitable end housings **26** and **27** enclose the opposite ends of block **1** and provide the necessary crank cases **28** and **29** and the closed water cooling passage **30** around the cylinders.

It will be observed that by driving camshaft **18** of cylinder **2** directly from the adjacent crankshaft **9** of cylinder **3** a short drive connection is obtained which can be maintained accurate for a long period of time. The same is true of the direct drive connection between camshaft **21** of cylinder **3** and the adjacent crankshaft **8** of cylinder **2**.

Synchronization of the two crankshafts **8** and **9** is provided by a suitable power connection between the same.

Where it is desired to provide a dual counter rotating shaft output the synchronizing means may comprise the gear train illustrated in FIG. 4 and consisting of gears **31**, **32**, **33** and **34** in series mesh with gear **31** on shaft **8** and gear **34** on shaft **9**. The counter rotating output shafts may comprise either the crankshafts **8** and **9** or the shafts **35** and **36** upon which the corresponding gears **32** and **33** are secured. If it is desired to have a single output shaft it is possible to utilize any one of the shafts **8**, **9**, **35** or **36**.

Preferably, where counter rotation of the crankshaft **8** and **9** is not required, the synchronizing means illustrated in FIG. 5 may be employed. It comprises a timing belt **37** having internal cogs **38** which interlock with a gear **39** on shaft **8** and a gear **40** on shaft **9**. By providing cogs **41** on the outer surface of belt **37** it may additionally interlock with a gear **42** on camshaft **18** and with a gear **43** on camshaft **21** as the belt passes between the gears **39** and **43** at one end and between gears **40** and **42** at the other end.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. A four cycle internal combustion engine comprising a pair of synchronized crankshafts, at least one pair of cylinders disposed in opposite Siamese arrangement with the head of one cylinder adjacent the crankshaft of the other cylinder in each instance, inlet and exhaust valves in the head for each cylinder, an overhead camshaft for each cylinder with cams thereon for actuating the corresponding valves for the cylinder, and separate means driving each said camshaft from the adjacent crankshaft.

2. The engine of claim 1 in which each of said separate drive means comprises directly intermeshing gears on the adjacent camshaft and crankshaft.

3. The engine of claim 1 in which said crankshafts are synchronized by a gear train therebetween.

4. The engine of claim 3 in which said gear train comprises an even number of gears providing for counter rotation of said crankshafts.

5. The engine of claim 3 in which said gear train comprises an odd number of gears providing for unidirectional rotation of said crankshafts.

6. The engine of claim 1 and a timing belt connecting said crankshafts to synchronize the rotation thereof.

7. The engine of claim 6 in which said timing belt comprises cogs on the inner surface thereof meshing with gears on the opposite crankshafts, and cogs on the outer surface of the belt meshing with gears on the opposite camshafts.

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WENDELL E. BURNS, *Primary Examiner.*