

4-stroke horizontal FJ series engine delivers lower vibration at lower cost



The 4-stroke horizontal general-purpose engine FJ series has been developed afresh and released to the market as the successor to the FE series, which has been popular with OEMs for over 20 years to drive all sorts of machines.

The FJ series maintains the best-in-industry low vibration that sets us apart from competitors technically, while reducing cost through a development process in which almost all parts are procured in China from the prototype stage.

Preface

We have developed the 4-stroke horizontal general-purpose engine FJ series for the commercial market (e.g. agricultural equipment, carts and other work equipment, lawn equipment), especially for professional applications in OEMs' work machines, and also for the residential market (e.g. generators, power sprayers), especially for general users.

The preceding FE series has been popular with OEMs and users for over 20 years, set apart by its best-in-industry low vibration which has given Kawasaki a reputation for low-vibration engines.

The development objective of our new FJ series has been to modify the structure from the FE series to maintain its low vibration while reducing cost, allowing us to hold our own in price competition, to expand our market share in 4-stroke horizontal general-purpose engines.

To fulfill the paradox of low vibration and low cost, we established a new production base in China, CK&K*, and managed to procure almost all parts in China from the prototype stage.

*CK&K: Changzhou Kawasaki and Kwang Yang Engine Co., Ltd.
A general-purpose engine manufacturing company set up by 50:50 investment between KYMCO (Kwang Yang Motor Co., Ltd.) and Kawasaki.

1 Main specifications

As the development policy for the horizontal general-purpose engine FJ series (FJ130/180/220D) in general, we used the bore-up and bore-down method, while keeping in mind to keep parts shared throughout the series, to speed

Table 1 Main specifications

Item \ Model	FJ130D	FJ180D	FJ220D
Engine	Air-cooled, horizontal, 4-stroke OHV, 1-cylinder		
Displacement (cm ³)	133	179	220
Bore × Stroke (mm)	56 × 54	65 × 54	72 × 54
Maximum output (kW/rpm)	2.8/3,600	4.1/3,600	4.8/3,600
Maximum torque (N·m/rpm)	7.9/2,800	11/3,200	13.7/3,200
External dimensions (mm)	L302 × W360 × H353	L304 × W365 × H370	L304 × W365 × H370
Dry mass (kg)	16.5	18.6	19.0

up development and design and to reduce workload. The FJ series' main specifications are shown in Table 1.

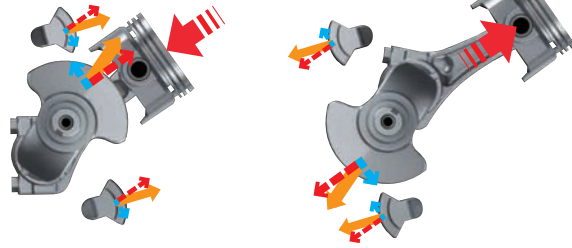
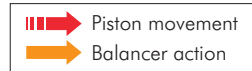
In particular, the basic FJ180D model inherited the basic specs of our vertical engine for lawnmowers, which boasts about 650,000 units of sales, and at the same time reduced cost by sharing basic parts such as the piston and intake and exhaust valves. Also, we gave our horizontal output engine the new features of a 2-axis balancer and a V-valve spherical combustion chamber, obtaining the lowest vibration in the industry, while also conforming to strict exhaust gas regulations.

2 Features

(1) Low vibration (adoption of a 2-axis balancer)

In the FJ180/220, we adopted a 2-axis balancer to cancel out vibration from the vertical movement of the piston, dramatically reducing the vibration felt. A conceptual diagram of the 2-axis balancer is shown in Fig. 1. Levels of

Balancers work in direction opposite piston's to reduce vibration



(a) Piston lowering

(b) Piston rising

Fig. 1 Conceptual diagram of 2-axis balancer

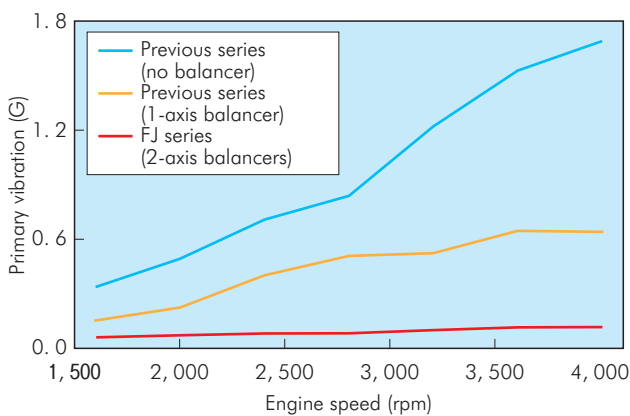


Fig. 2 Comparison of vibration levels

vibration are compared in Fig. 2.

Thus, we achieved a vibration level that compares favorably to the preceding FE series, making a product that secures the industry's lowest vibration, to uphold Kawasaki's reputation for low-vibration engines.

(2) Achieving a competitive price range

The following design methods and approaches were introduced to improve price competitiveness.

- ① We worked with vendors to advance low-cost design, with design methods suitable for procurement and manufacturing in China and compatible with Chinese vendors' production methods.
- ② We reduced part cost by sharing parts within the series.
- ③ We promoted part preparation from the prototype stage of the mass production process, helping to identify mass production problems at an early stage and to grasp non-obvious problems.

(3) Product design considerate of customer needs

(i) Light startability

We achieved top-class light startability by improving the precision of the auto-decompressor (a mechanism that

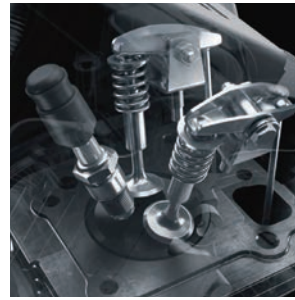


Fig. 3 Kawasaki V-valve

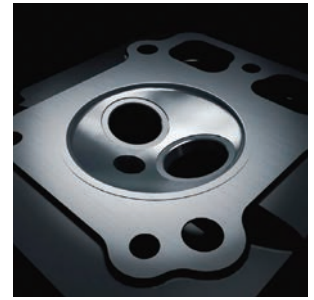


Fig. 4 Spherical combustion chamber

reduces the power needed to start the engine by opening the exhaust valve when the engine starts to prevent compression pressure from the piston rising) and using ball bearings to reduce bearing friction.

(ii) Low noise

We improved the muffler to reduce explosive noise and make the engine sound powerful, but not unpleasant.

(iii) High performance and output

We placed the intake and exhaust valves in a V shape (Kawasaki V valves) (Fig. 3), adopted a spherical combustion chamber with the spark plug in the center (Fig. 4), and used a high-lift, large-diameter cam to raise output and torque yet another step higher compared to the previous model.

(iv) High durability and reliability

We used iron gears, a forged crankshaft, and a cast-iron cylinder liner and ball bearings to secure excellent durability.

(v) Appearance

We gave the engine compact external dimensions for easy installation, along with a sharp, advanced appearance design that is easy to handle and maintain.

Postscript

CK&K, as Kawasaki's first general-purpose engine plant in China, has been assembling the 2-stroke engine TJ and TK series in addition to the FJ series, altogether reaching a total production of about 320,000 units in the period from FY 2010 to FY 2012.

With the completion of the FJ series, with its best-in-industry low-vibration high performance and the price competitiveness of Chinese procurement, we have confidence that OEMs will choose our 4-stroke horizontal general-purpose engines.

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