PTO SYSTEM
for CI engine

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CONTENTS

NOTES

This document is applied for Kubota CI engines for OEM.
This document is intend to provide installation guide for the engine to the application.
The information in this document subject to change without notice.
The latest document is available on the AM website. Printed copies are for reference only.

PTO SYSTEM

1. GENERAL

Power can be taken off a Kubota engine from the following points within a certain range indicated by total engine output.

Power can be taken from the engine at several points. The amount of power that can be taken at a position may be 100% (Full engine power) or less than that.
This depends on strength of engine components (Example: At fuel camshaft parts are smaller), type of drive component and direction of power take-off.

To ensure proper engine performance and long life the drive system must be carefully designed.
A review by Kubota is recommended.

Table 1 PTO

PTO Position	Application	Connecting method	SM	05	03	07	V3	09
Front of crankshaft	Auxiliary power	Rotation transmission by concentric shaft	✓	✓	✓	✓	✓	✓
		Belt drive by pulley						
Rear of crankshaft	Main power	Flange direct-coupling	✓	✓	✓	✓	✓	✓
		Belt drive by pulley						
Governor shaft	Hydraulic pump	Oldham	-	✓	-	-	-	-
Rear of fuel camshaft	Hydraulic pump	Spline or Oldham	✓	-	✓	-	-	-
Front of fuel camshaft	Tachometer	Oldham	✓	✓	✓	-	-	-
Rear of gear case	Hydraulic pump	Spline	-	-	✓*	-	✓	-
Front of gear case	Hydraulic pump	Spline	-	-	-	-	✓	-
Rear of flywheel housing (Intake side)	Hydraulic pump	Spline	-	-	-	-	-	✓
Rear of flywheel housing (Exhaust side)	Hydraulic pump	Spline	-	-	-	✓	-	✓*
Front of flywheel housing (Exhaust side)	Hydraulic pump	Spline	-	-	-	✓	-	✓*

■ **NOTE**

1. *marked: Depending on engine specifications.
2. The transmissible power slightly varies with models and positions.
3. Contact Kubota for available power.

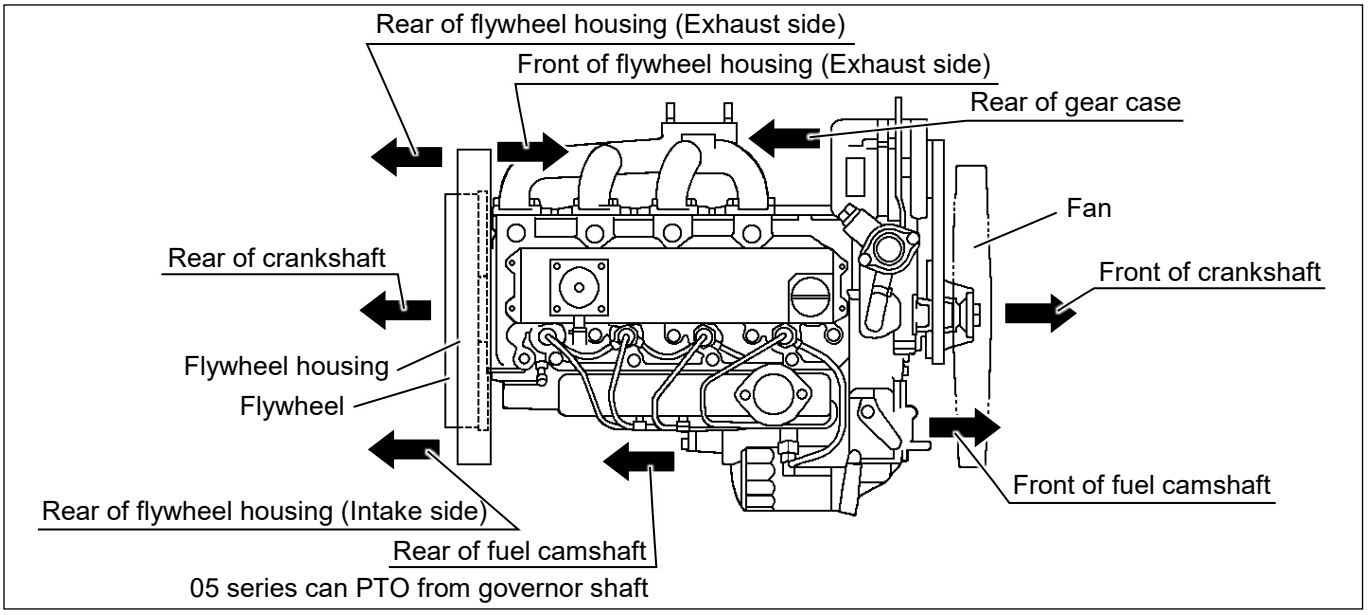


Figure 1

2. REAR OF CRANKSHAFT (Flywheel side)

(1) For direct connection with housing

1) Housing

Connect flange faces and tighten bolts (by pilot dia. or knock pin).

2) Rotating body

Connect flywheel mounting face with flange face and tighten bolts (by dowel).

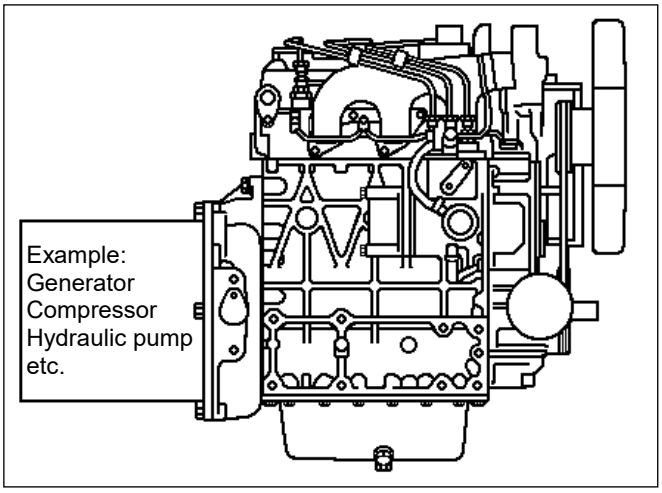


Figure 2

3) Precision of case and rotating body

Rigid connection of the PTO, marine gear or transmission to the engine flywheel housing can make the system compact. Special attention should be paid to the assembly precision for this type of connection.
Improper assembly will result in excessive power loss premature parts failure.

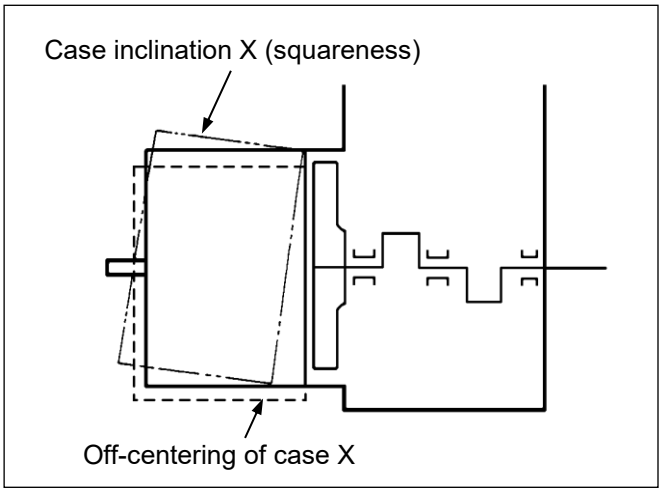


Figure 3

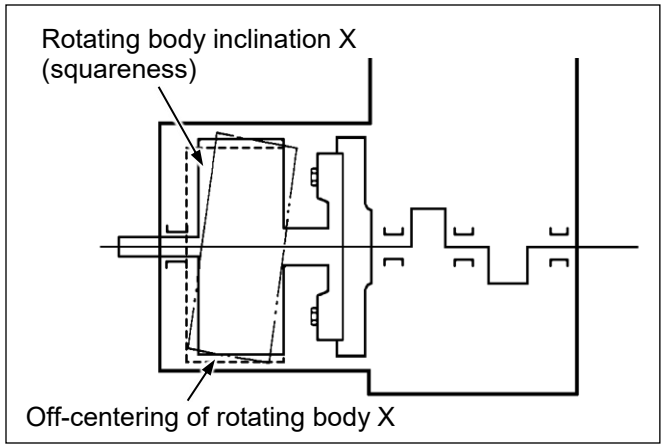


Figure 4 Precision of rotating body

(2) For using belt

1) Direction

a) When taking power off in two directions, arrange so that tension is offset.

b) When taking motive power off in one direction, take it off downward. Ensure that side load is within Kubota's specifications.

2) Available load

Determine by referring to Figure 5 and details in page 5 to 8.

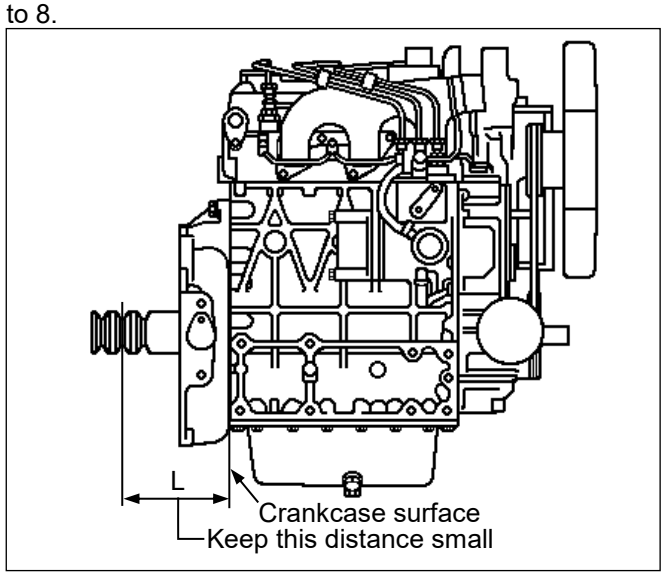


Figure 5

3) When using belt

When belt driving is used, careful consideration must be given to the amount of overhang and size of load, allowable load must be strictly observed, belt tension also greatly influences load. Belt must be tightened as specified.

■ **NOTE**

If the long or heavy parts plan to be attached to REP/FWH (Example: Using two hydraulic pumps in series.), please consult Kubota at the design stage.

3. FRONT OF CRANKSHAFT (Radiator side)

(1) Taking off in axial direction

a) Take off from the same shaft center via a flange coupling (concentric).

■ NOTE

1. PTO should be able to be dismounted easily when replacing the fan belt.

2. Since spline is formed at the crankshaft end, an adapter suitable to the spline required. (03 series)

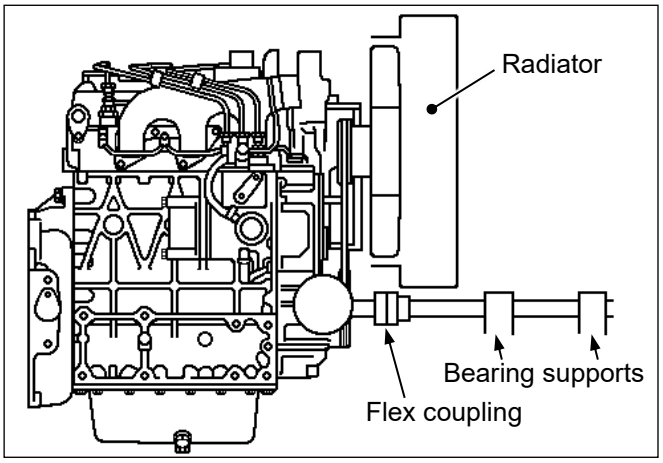


Figure 6

b) An example of front PTO for 03 series.

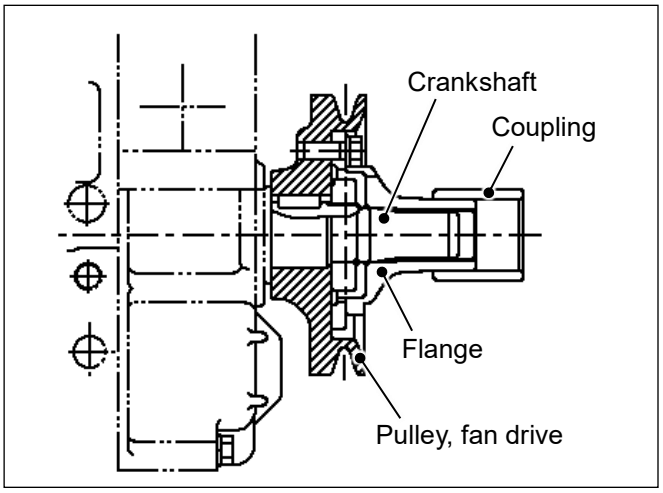


Figure 7

(2) For using belt

1) Direction

a) When taking power off in two directions, arrange so that the tension is offset.

b) When taking power off in one directions, take it off downward. Ensure that side load is within Kubota's specifications.

2) Available load

Determine by referring to Figure 8 and details in page 5 to 8.

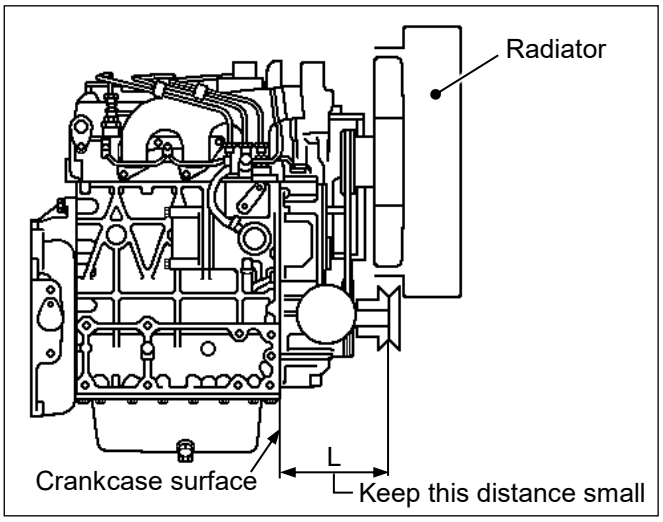


Figure 8

4. POWER TAKE-OFF RECOMMENDATIONS

(1) Common Considerations

1. If PTO shaft length are too long, an outboard bearing must be added.
2. Flexible couplings allow a little miss alignment between engine and drive device.
   They also dampen inertial loads, they must be used, along with outboard bearing, for front PTO drives.
3. Power disconnects (Clutches, Hydraulic unloader valve, etc.) reduce the load on the engine when being started.
   Using them may eliminate the cost of adding a heavy duty starter.
4. SAE housings allow direct coupling of industry standard generators, clutches and pumps.
5. To minimize the possibility of excessive overhang when driving two separate loads through two separate belts, it is best to place the two loads as directly opposite each other as possible.
6. To reduce overhang, belt drive pulleys must be as close to the engine as possible.

(2) Side load calculation for V-belt drive application

When V-belt pulley is used for PTO according to the following procedure, confirm that the position of the pulley is within the allowable limit.
Even if it is located within the limit, minimize the overhang as much as possible to avoid any side load problems.
Also, tension of the belt is very important for the life of the bearing of the engine and the belt.
Follow the recommendation of the belt manufacture for tensioning the belt.
The following calculation method is only a reference for designing. Therefore, it is important to eventually carry out the actual operation test or the endurance test using the actual machine to check for problems.

(3) Procedure to determine the allowable side load

1) Find the design power Pd

a) Select the service factor Ks from Table No.1 depending on the type of the driven machine and the service cycle.
   If cannot find your machine on Table No. 1 use 1.3 as the service factor.

b) Calculate the Design power according to Formula No.1.

$$Pd = Ks \times Pr \quad \cdots \text{(Formula No. 1)}$$

Pd: Design power (kW)
Pr: Required machine power (kW)
Ks: Service factor

2) Find the shaft load

a) Calculate Ψ or (D-d) / c

$$\Psi = 180 - 57 \times (D-d) / c \quad \cdots \text{(Formula No. 2)}$$

Ψ: Arc of contact on small pulley (degree)
D: Large pulley diameter (mm)
d: Small pulley diameter (mm)
c: Center distance between both pulleys (mm)

b) Find the Arc correction factor KΨ from Figure 9.

c) Calculate the belt speed.

$$V = (Dr \times N) / 318.3 \quad \cdots \text{(Formula No. 3)}$$

V: Belt speed (m/min)
Dr: Drive pulley diameter (mm) ⋯ small or large pulley
N: Drive input speed (rpm)

d) Calculate the shaft load Fd.

$$Fd = 4500 \times [(2.5 - K\Psi) / K\Psi] \times [(Pd/0.7355) / V] \times 9.80665 \quad \cdots \text{(Formula No. 4)}$$

Fd: Shaft load (N)

(3) Find the allowable overhang from the engine according to Figure 10 and design the position within the allowable limit.

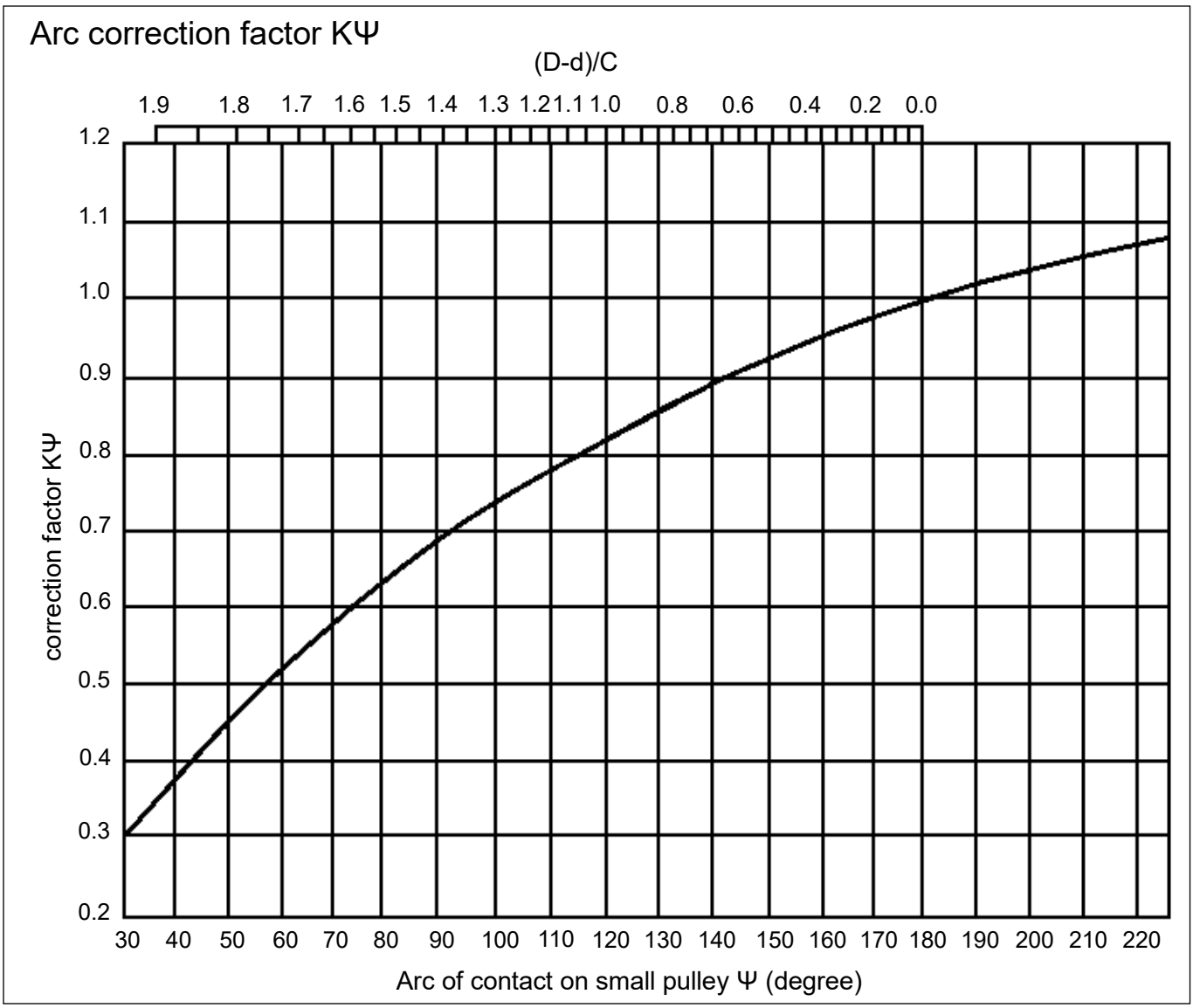

Arc correction factor KΨ
(D-d)/C
1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.8 0.6 0.4 0.2 0.0
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
correction factor KΨ
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
Arc of contact on small pulley Ψ (degree)

Figure 9

Table 2 Service factors

Driven machine	Type of service		
	Ⅰ	Ⅱ	Ⅲ
Liquid agitators	1.0	1.1	1.2
Blowers and exhausters			
Centrifugal pumps & compressors			
Fans up to 7.4 kW			
Light duty conveyors			
Belt conveyors for sand, grain, etc.	1.1	1.2	1.3
Fans over 7.4 kW			
Generators			
Line shafts			
Machine tools			
Punches - presses - shears			
Printing machinery			
Positive displacement rotary pumps			
Removing and vibrating screens			
Brick machinery	1.2	1.3	1.4
Bucket elevators			
Piston type compressors			
Hammer mills			
Piston pumps			
Positive displacement blowers			
Pulverizers			
Saws, mills, and woodworking machineries			
Crushers	1.3	1.4	1.5
Mills			
Hoists			

Table 3 Type of service

Ⅰ: Intermittent service	3-5 hours daily or seasonal
Ⅱ: Normal service	8-10 hours daily
Ⅲ: Continuous service	16-24 hours daily

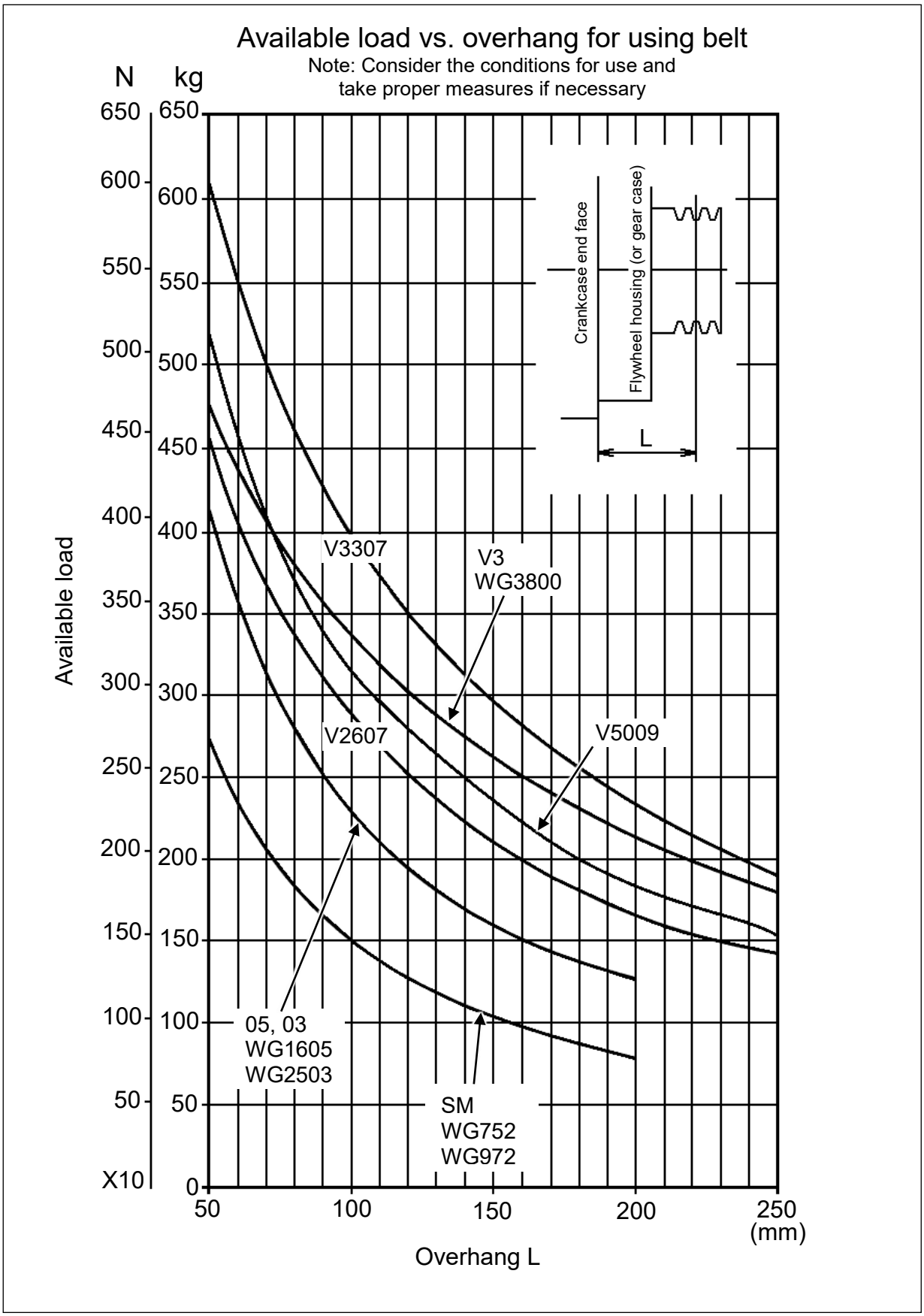

Available load vs. overhang for using belt
Note: Consider the conditions for use and
take proper measures if necessary
N
kg
650
600
550
500
450
400
350
300
250
200
150
100
50
X10
Available load
Crankcase end face
Flywheel housing (or gear case)
L
V3307
V3
WG3800
V2607
V5009
05, 03
WG1605
WG2503
SM
WG752
WG972
50
100
150
200
250
(mm)
Overhang L

Figure 10

5. FRONT AND REAR OF FUEL CAMSHAFT

(1) Front of fuel camshaft or camshaft
Driving a tachometer or small pump, the small amount of power required can be taken off by making a connection with slot fitting of camshaft's end face.
Connect with bolts at the flange joint face.

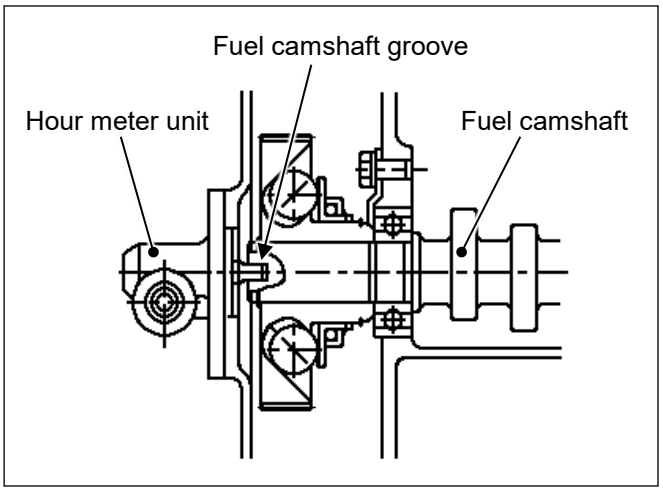


Figure 11

(2) Rear of fuel camshaft
The hydraulic pump is mounted here by a holder and driven by an arrangement of gears.

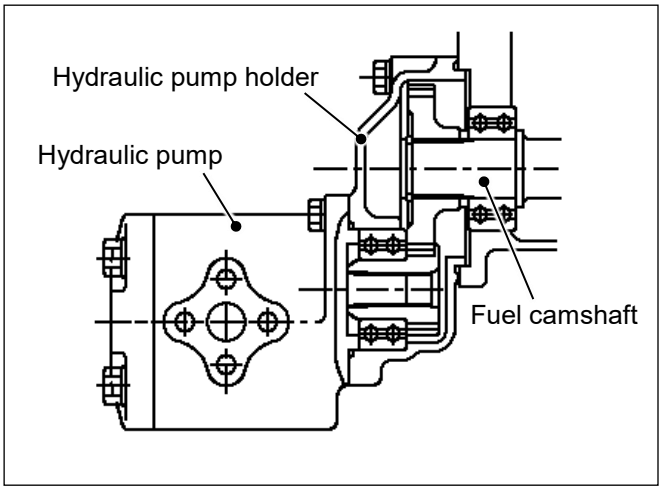
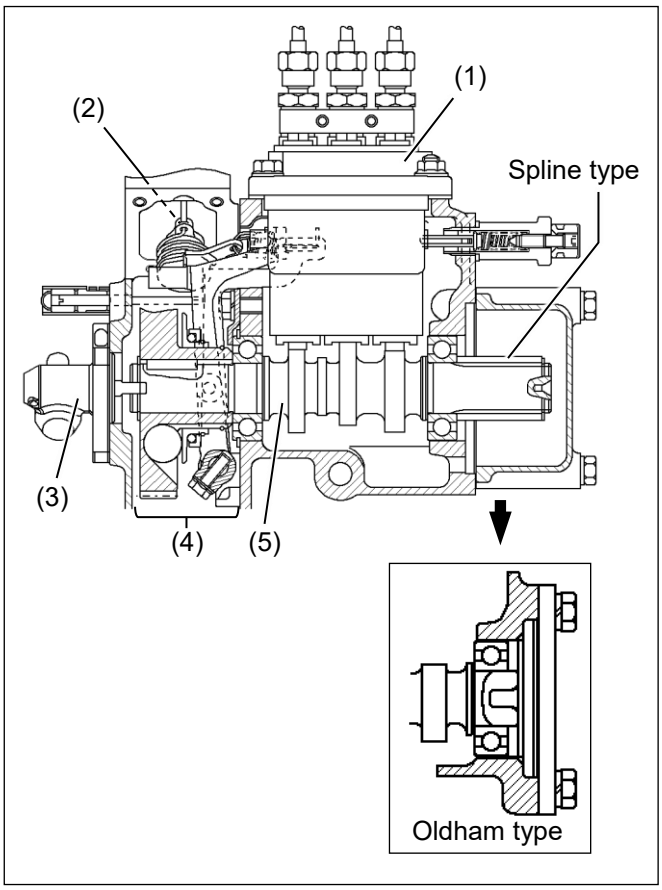


Figure 12



(1) Injection pump
(2) Speed control lever
(3) Hour meter unit
(4) Governor system
(5) Fuel camshaft

Figure 13

6. GOVERNOR SHAFT FOR 05 SERIES

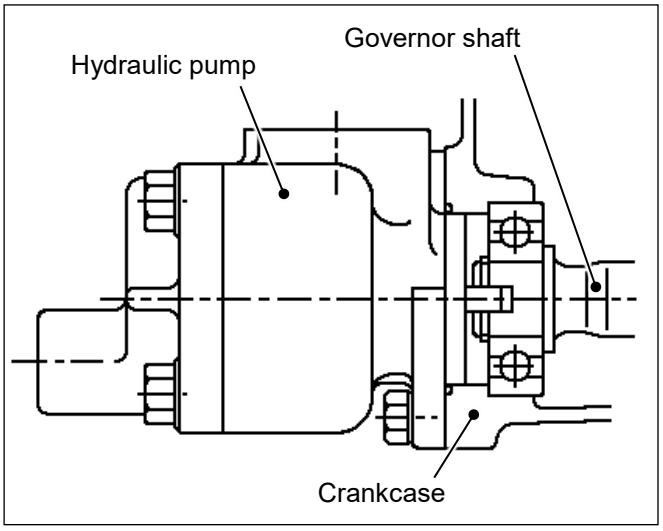


Figure 14

7. SIDE PTO FOR 03 SERIES (Option)

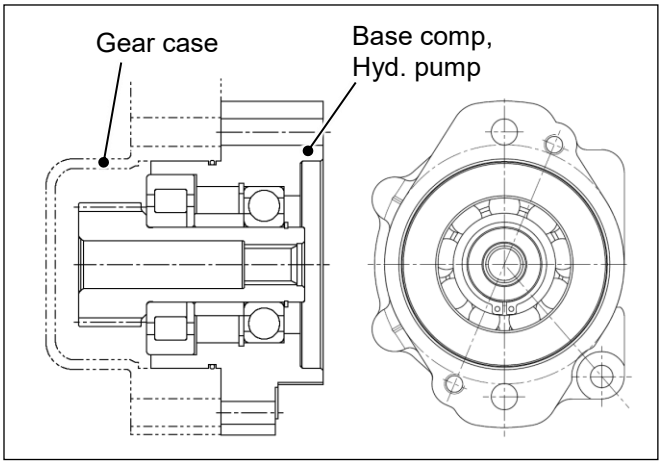


Figure 15

8. SIDE PTO FOR 07 SERIES (Option)

(1) V2607

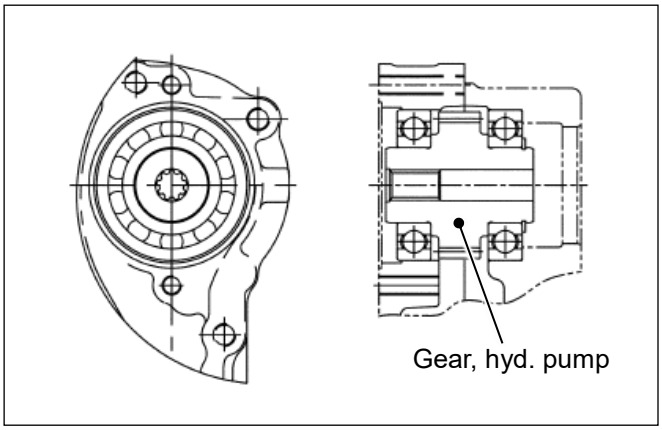


Figure 16

(2) V3307

A Type PTO

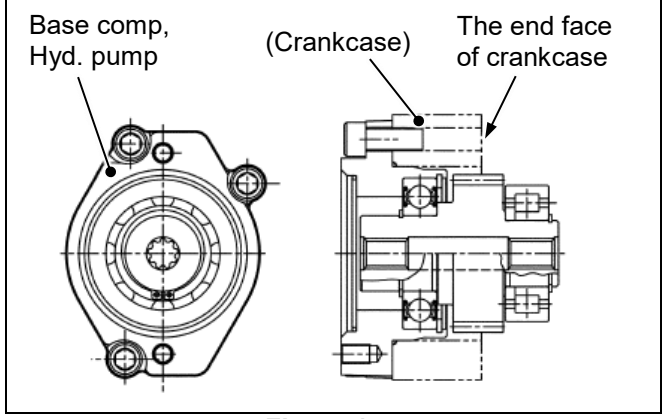


Figure 17

B Type PTO

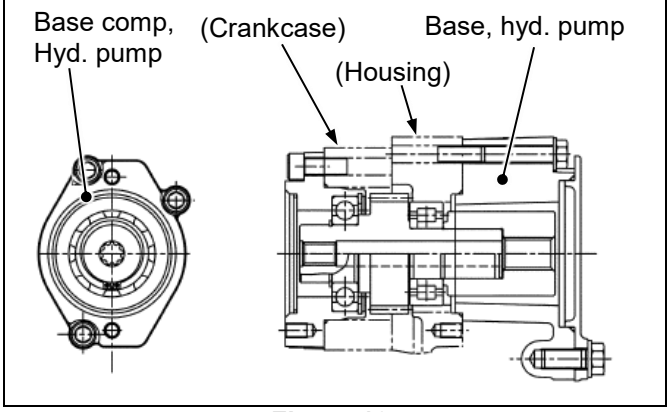


Figure 18

9. GEAR CASE DRIVE KIT FOR V3 SERIES (Option)

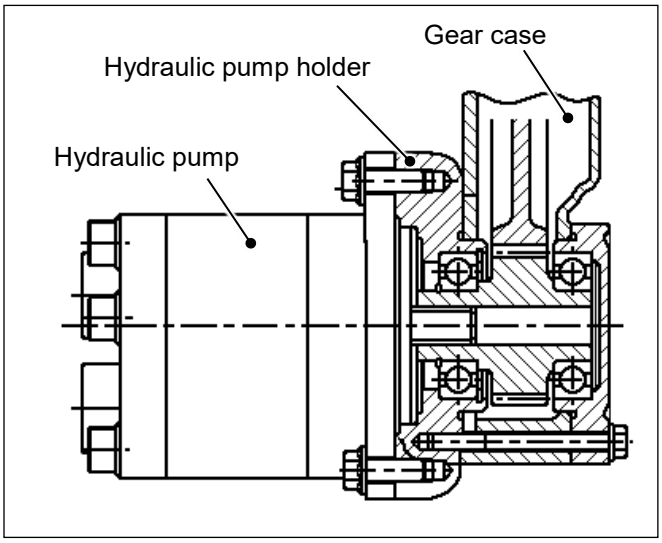


Figure 19

10. SIDE PTO FOR 09 SERIES (Option)

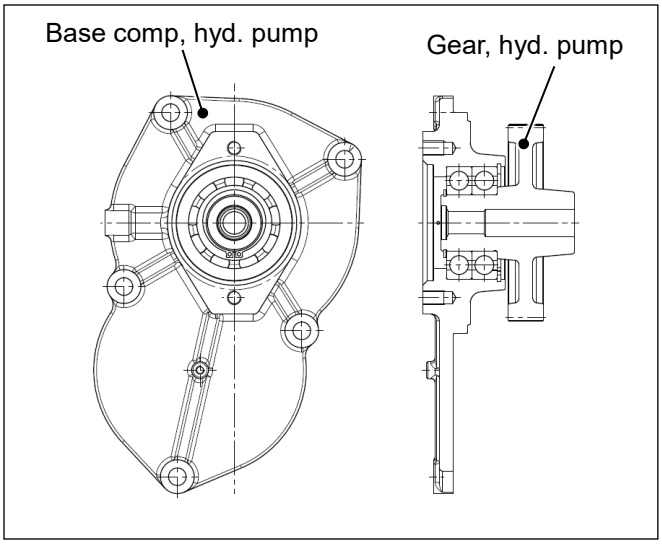


Figure 20

REVISION HISTORY

File Name	Remarks	Date
KORD3_16-059_10_pto_system.pdf	Document style standardization	Jun. 8, 2016
KORD3_20-077_PTO_SYSTEM.pdf	- Typo correction - Document style standardization	Apr. 23, 2020
KORD3_21_038_ PTO_system_for_CI_engine.pdf	Add NOTE at page 4	Apr. 16, 2021
KORD3_22_205_ PTO_system_for_CI_engine.pdf	- Add 09 series specification - Add figure for 03 PTO	Jun. 29, 2022