BAD BOY TRACTORS

30 & 20 SERIES TRACTOR

3026H, 2024H
SERVICE MANUAL

Before ordering parts please check for the latest Parts Manual update on the Tractor tab of the Bad Boy Mowers Dealer Zone.

PREFACE

This manual is to provide servicing personnel with extensive information on the structure, service procedure, removal and installation procedure, disassembly, troubleshooting and more for the **2024H/3026H TRACTOR** with high-end technology to ensure precise and rapid service.

Most accidents are resulted from negligence in safety precautions and directions, so it is very necessary to follow such precautions and directions to avoid any safety accident beforehand. Service technicians should provide quality service to prevent any safety accident and enhance customer satisfaction so they should fully understand the service procedure, methods, inspection points and safety precautions for accurate service.

To ensure optimum condition of your tractor, it is highly recommended to use only **BBT** genuine parts which are manufactured under strict quality assurance policy for premium quality, durability and reliability. **BBT** is always committed to provide best quality products through extensive research, study and development.

Information in this manual is subject to change without notice for improvement of the product.

Please keep this manual in a safe place. If there is any typo, incorrect information or question about this manual, feel free to contact **BBT**.

(Oct. 2020)

BAD BOY TRACTORS Co. Ltd.

※ Remark

- **This manual does not contain all accidents and preventive measures that can occur during service. Make sure to have this tractor serviced only by professional technicians with care.**
- **Use only genuine parts, including engine oil and transmission fluid, specified in this manual. Otherwise, it can affect the tractor's performance seriously.**
- **Never attempt to duplicate contents and figures in this manual without prior approval by BBT.**

MEANINGS OF SAFETY SYMBOLS

Precautions and instructions described in this manual and safety decals, such as DANGER, WARNING and CAUTION decals, are important for you and your machine's safety. If these instructions are not followed, you and the vehicle can be severely injured and damaged. Read such precautions and instructions carefully for your safety.

If any DANGER, WARNING or CAUTION decal is damaged or missing, order it from your dealer and have it attached to the original position.

Important safety instructions are described with various symbols throughout this manual. Make sure to follow such instructions. Their design and meanings are as follows:

DANGER	**This symbol indicates potentially hazardous situation which, if not observed, may result in death or moderate injury.**
WARNING	**This symbol indicates the most serious hazardous situation which, if not observed, may result in death or serious injury.**
CAUTION	**This symbol indicates potentially hazardous situation which, if not observed, may result in minor or moderate injury. Also, this can be used as a warning for an unstable action.**
IMPORTANT	**This symbol indicates important procedures or information to perform work with more ease and skills.**
Notes	**This symbol indicates information useful to users.**

HOW TO USE THIS MANUAL

1. Target readers

This manual is intended for technicians with mid to high level of service knowledge and skills for **BAD BOY TRACTORS**. Make sure to understand this manual fully for rapid and accurate inspection and service.

2. Order of contents

This manual is a single book for the **2024H/3026H TRACTOR** and contains several useful chapters such as General Information, Engine, Clutch, Transmission, Front Axle, Hydraulic System, Electric System. Information and diagrams in this manual are described based on the standard model so they may be different from your vehicle due to different specifications by models. However, the same instructions should be followed for service.

3. Body structure of this manual

This manual is structured as follows:

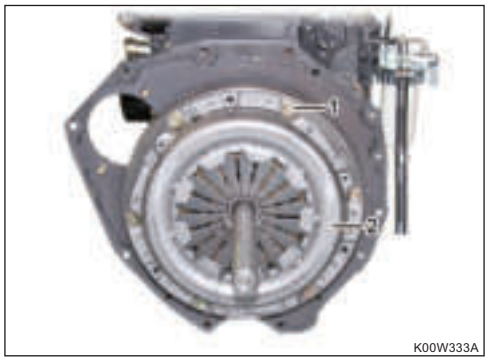
〈 Upper section 〉

3. DISASSEMBLY

3.1 CLUTCH HOUSING REMOVAL

1. Park the tractor on level ground and apply the hand brake.
2. Disconnect the negative battery cable.
3. Drain the transmission fluid.
4. Remove the hood and propeller shaft.
5. Disconnect the hydraulic hose, wiring connector and various cables between the vehicle body and engine.
6. Place a stand under the clutch housing and a portable jack under the engine oil pan.

3.2 CLUTCH DISASSEMBLY



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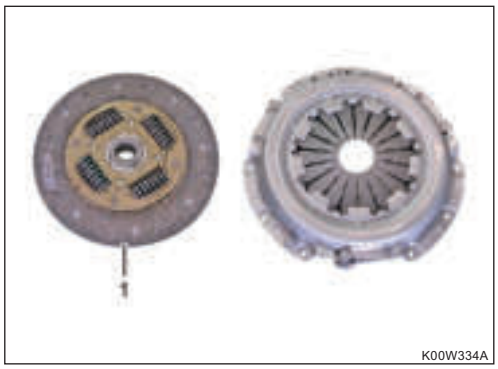
〈 Lower section 〉

8. Unscrew the mounting bolt (1) from the clutch housing and engine mounting flange. Then, push the front axle section to separate it from the clutch housing.

ITEM	TORQUE VALUE
M8 bolt	2.4 ~ 2.8 kgf.m (17.4 ~ 20.2 lbf.ft)
M10 bolt	4.9 ~ 5.7 kgf.m (35.5 ~ 41.2 lbf.ft)

9. For more detailed disassembly procedures, refer to the instructions for engine removal in Chapter 2.



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2. Remove the clutch disc (1).

1 2 3 4 5

HOW TO USE THIS MANUAL

① **Chapter**

This indicates the current chapter.

② **Body**

Generally, figures and diagrams are placed in the upper section of a page while information and description are set in the lower section. However, a large table or diagram may take a whole page. Each figure is assigned with a figure number and a large figure may be set in a A3-size page like a circuit diagram.

③ **Model name**

This indicates the corresponding model.

④ **Publication classification**

This indicates the publication category and date of this manual.

⑤ **Page number**

Each page is given with the corresponding number:

Example: 3-8

4. Other information

The component names used in this manual are set to reflect their functions so they may not be consistent with the ones in other materials, such as the part list and user's manual, labels and decals.

Also, as the figures and diagrams in this manual are based on the product at the time of its publication, so they may differ from your actual product. The specification and other information in this manual are subject to change without notice for design change or improvement of the product.

TABLE OF CONTENTS

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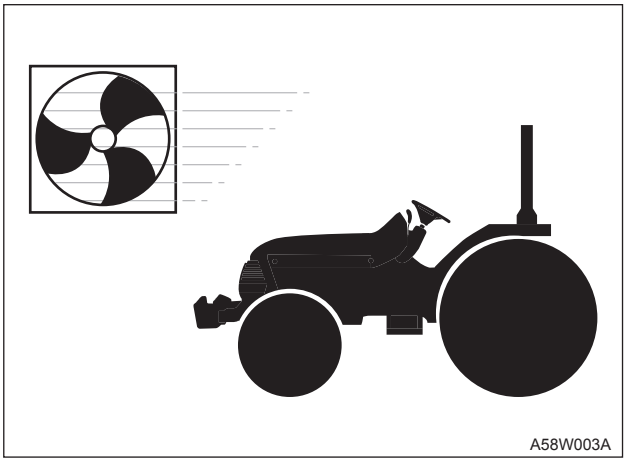
CHAPTER 1 GENERAL INFORMATION

TABLE OF CONTENTS

1. GENERAL INFORMATION FOR SERVICE

1.1 FOR SAFE OPERATION

1.1.1 WORK PLACE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⚠ DANGER

Sufficient ventilation:

- **When grinding or sanding a painted surface or working near the exhaust gas pipe, the work area should be sufficiently ventilated to avoid inhalation of hazardous gas and particles. [Otherwise] the battery can explode, resulting in a burn.**

[Otherwise] You can inhale toxic gas, leading to an injury.

⚠ CAUTION

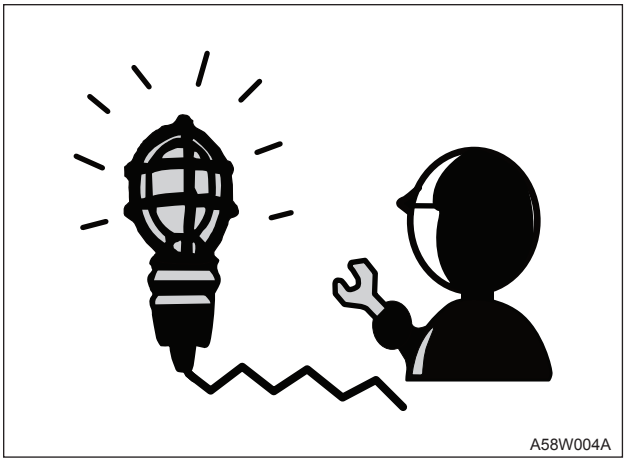
Sufficient working area:

- **To prevent an injury, secure a sufficient working area for service.**

  [Otherwise] it can lead to rollover.

⚠ CAUTION

- **Have your work place neat and clean.**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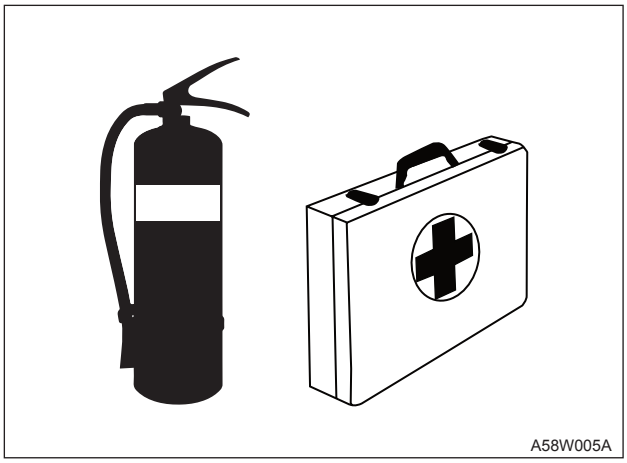
⚠ CAUTION

- **The work place should be properly illuminated.**

When working in or under the machine, make sure to have a protected lighting equipment.

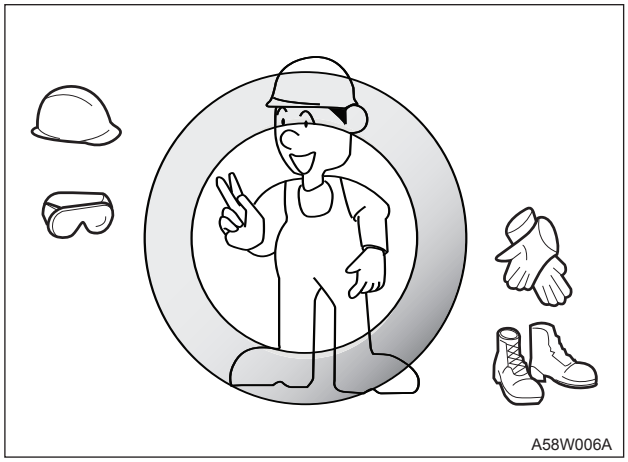

A58W005A

⚠ CAUTION

- **Have a fire extinguishing system ready in your work place.**

Have a fire extinguisher in your work place.

1.1.2 WORKING CLOTHES AND OTHER SAFETY GEARS

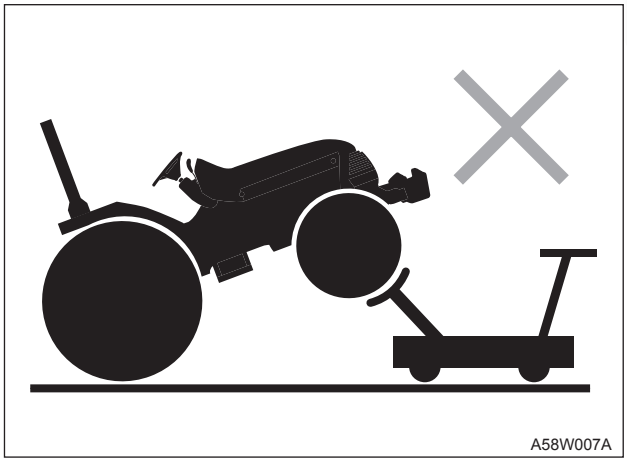


⚠ CAUTION

- **Wear proper working clothes to ensure your safety.**

Make sure to wear working clothes, safety hat, safety gloves, safety goggles and other safety gears for your safety.

1.1.3 TOOL

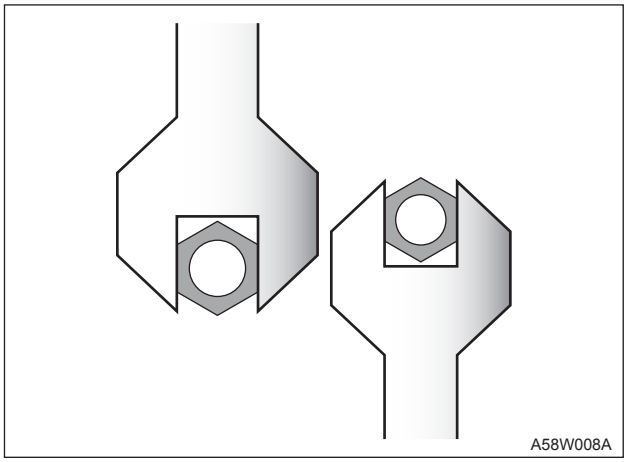


⚠ DANGER

- **Have a proper support and lifting equipment ready always.**

Never work on the tractor only with a wood support or other type of block or jack.

Do not use any lift or crane with insufficient rated load capacity.



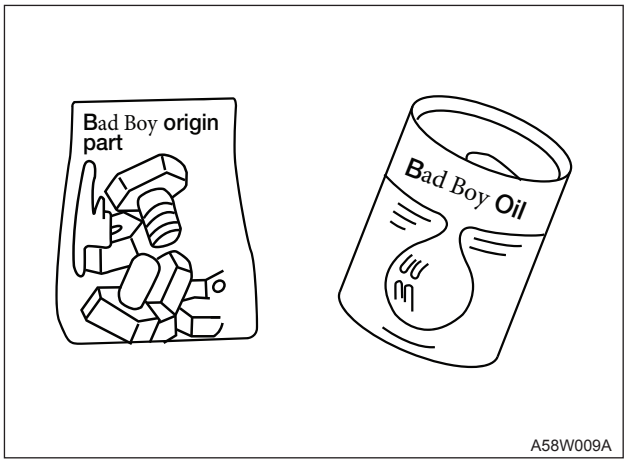
⚠ WARNING

- **Use a proper tool.**

Use the specified tools for disassembly and assembly.

[If working on the machine without sufficient knowledge or skills], it can lead to an injury or damage to equipments and parts.

1.1.4 STANDARD PARTS, LUBRICANT, GREASE AND OIL



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⚠ CAUTION

Use only the specified standard parts.

[Otherwise] It can shorten the service life and cause an unexpected problem to the vehicle.

1.1.5 FINISHING UP AND CHECKING

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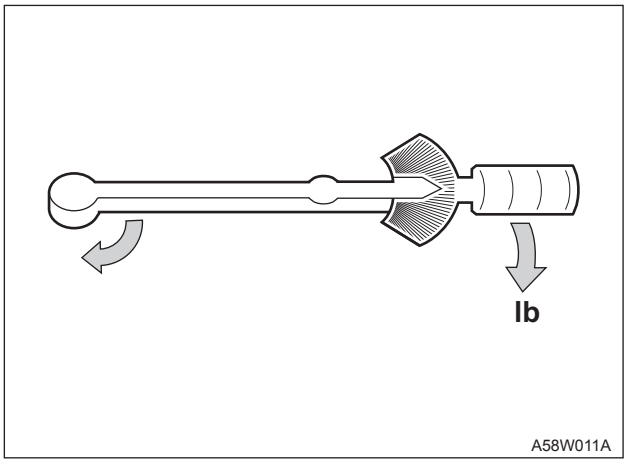
⚠ CAUTION

- **Before delivering the machine to your customer, make sure to inspect it according to the inspection list.**

1.1.6 TORQUE PART



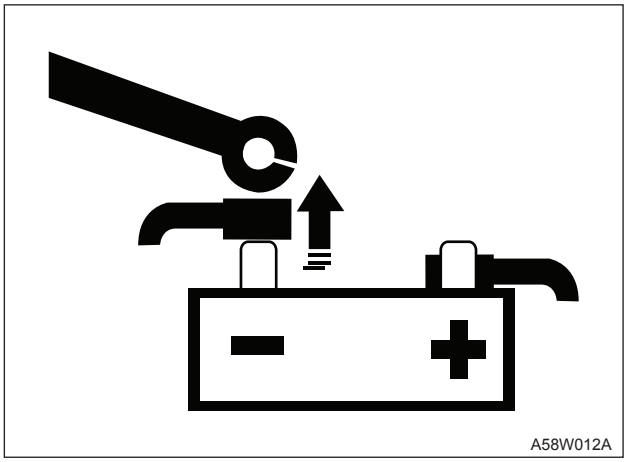
A58W011A

⚠ WARNING

Follow the torque specified in this manual.

[Otherwise] It can cause a serious accident.

1.1.7 ELECTRIC SYSTEM


A58W012A

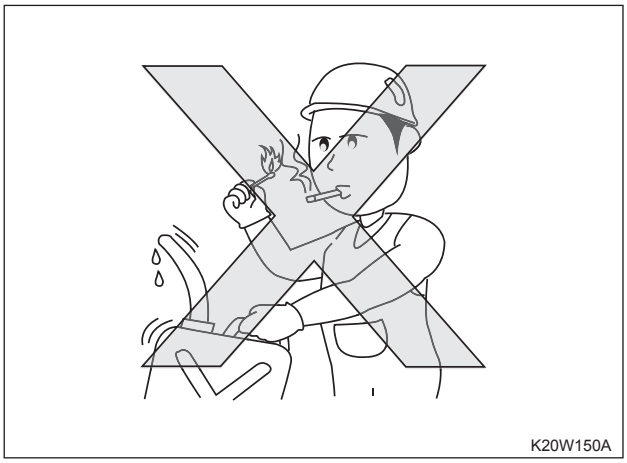
⚠ WARNING

Shorted line:

- **To prevent the battery from discharging, disconnect the negative battery cable during inspecting the electric system.**

[Otherwise] It can cause a serious accident.

1.1.8 SAFETY DURING SERVICE

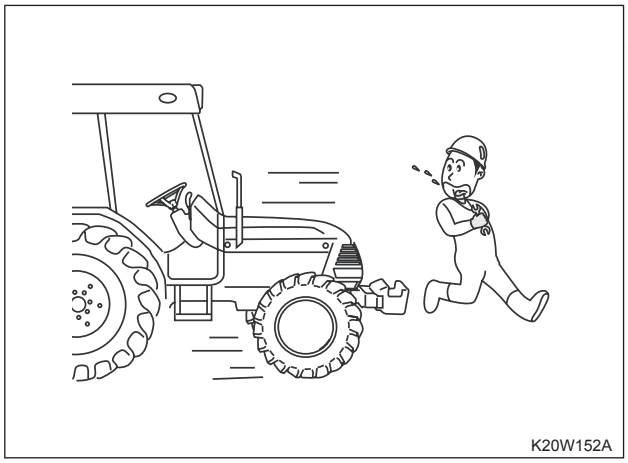


⚠ WARNING

Keep flammables away during fueling

- **Keep flammables, such as a cigarette, match and lighter, away from the vehicle during fueling.**

[Otherwise] it can cause a fire, leading to a burn.

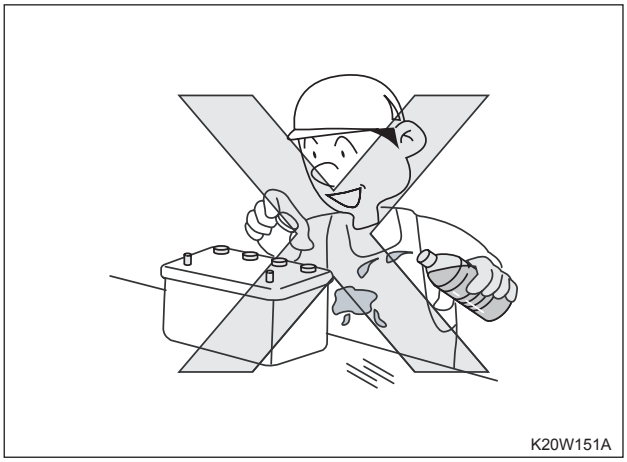


⚠ CAUTION

Stop the engine during inspection and service

- **Make sure to stop the engine during inspection, service, repair or cleaning.**

[Otherwise] it can lead to an injury or accident.

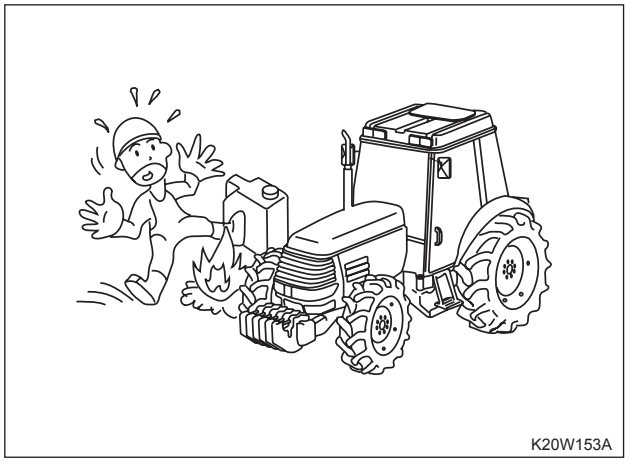


⚠ DANGER

Do not allow the battery fluid to contact your skin.

- **If battery fluid is on your skin or clothing, rinse it with water immediately.**

[Otherwise] you can get burnt or clothing can be damaged.

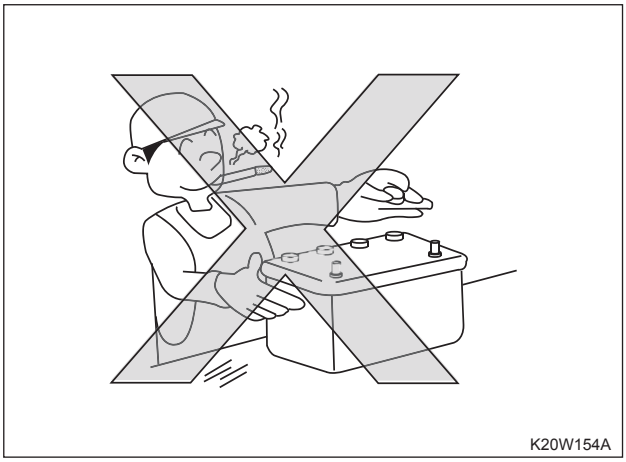


⚠ DANGER

Add fuel or oil only after the engine is sufficiently cooled down.

- **Never add fuel or oil while the engine is running or hot.**

[Otherwise] Hot fuel or oil can cause a fire.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DANGER

Keep flammables away during battery inspection

- **Keep flammables away from the vehicle while checking and charging the battery.**

[Otherwise] the battery can explode, resulting in a burn.


K20W155A

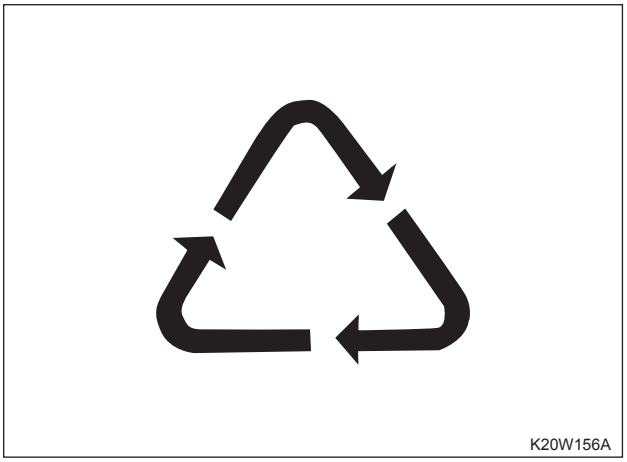
CAUTION

Follow the correct procedures for battery connection and disconnection.

- **When connecting the battery, connect its positive cable first. When disconnecting it, disconnect its negative cable first.**

[Otherwise] it can cause a short circuit, leading to burn, fire or electric shock injury.

1.1.9 WASTE DISPOSAL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WARNING

If waste is not disposed properly, it can pollute the environment and destroy the ecosystem. Make sure to dispose waste according to the applicable law.

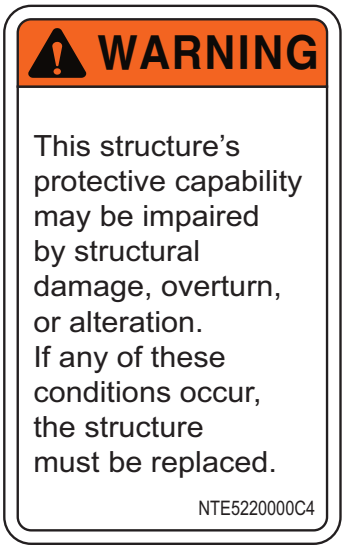
- **When draining fuel or oil, store it in a proper container and put a label on it to prevent anyone from accidentally drinking it.**
- **When fueling or draining oil, be careful not to spill it around to prevent soil or water pollution.**
- **There are various types of hazard waste produced from the tractor, including fuel, coolant, brake fluid, oil, filter, battery and etc.**
- **Have harmful waste disposed by a specialized refuse disposal company according to the applicable law and regulations.**

2. LOCATION OF DECALS

To ensure safe work, check the location of the safety decals and always keep the safety precautions.

Keep the safety decals intact. If any decals is damaged or missing, attach a new decal.

(1) No.: NTE5220000C4



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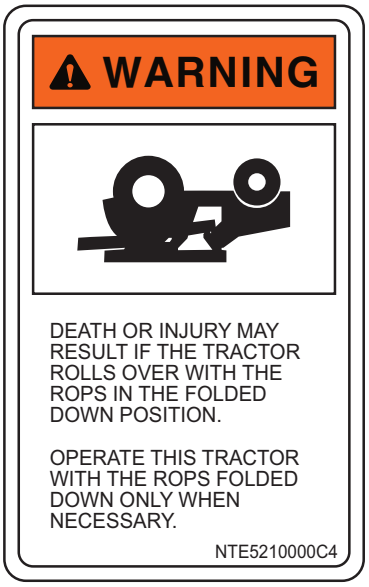

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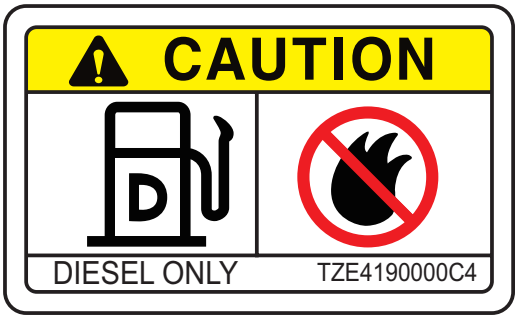

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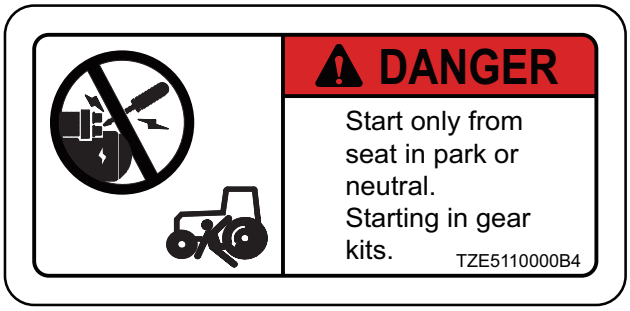

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(6) No.: TZE5130000B4

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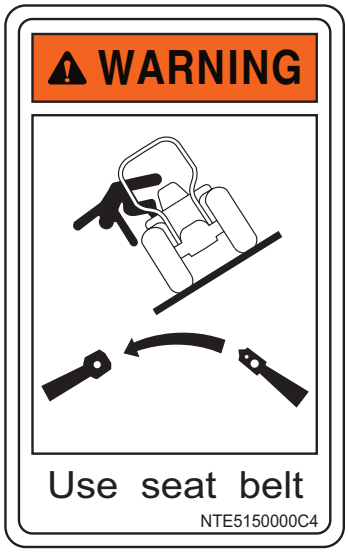

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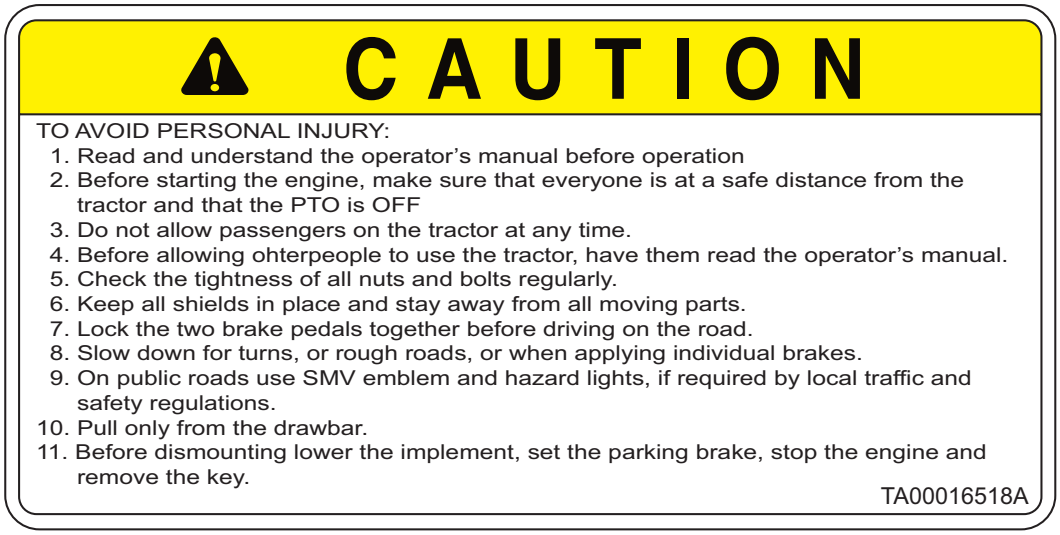

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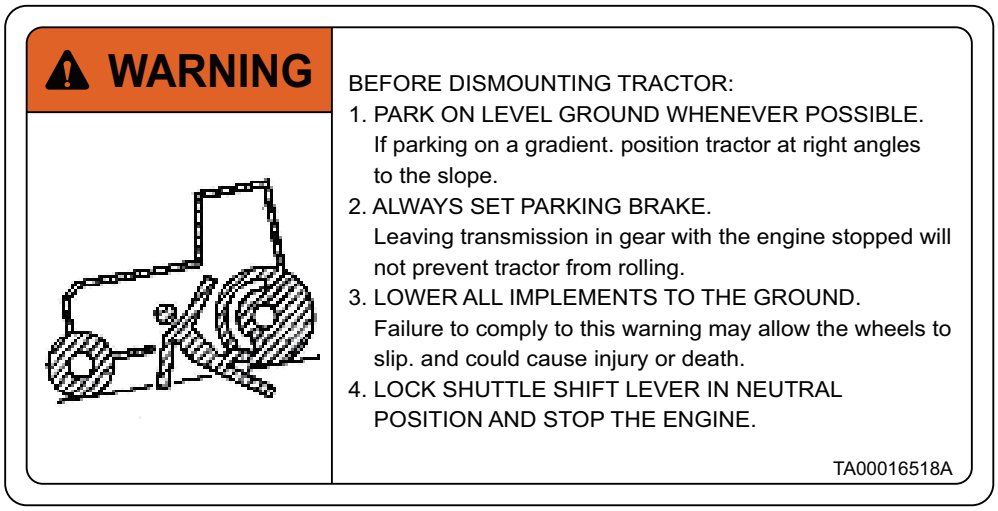

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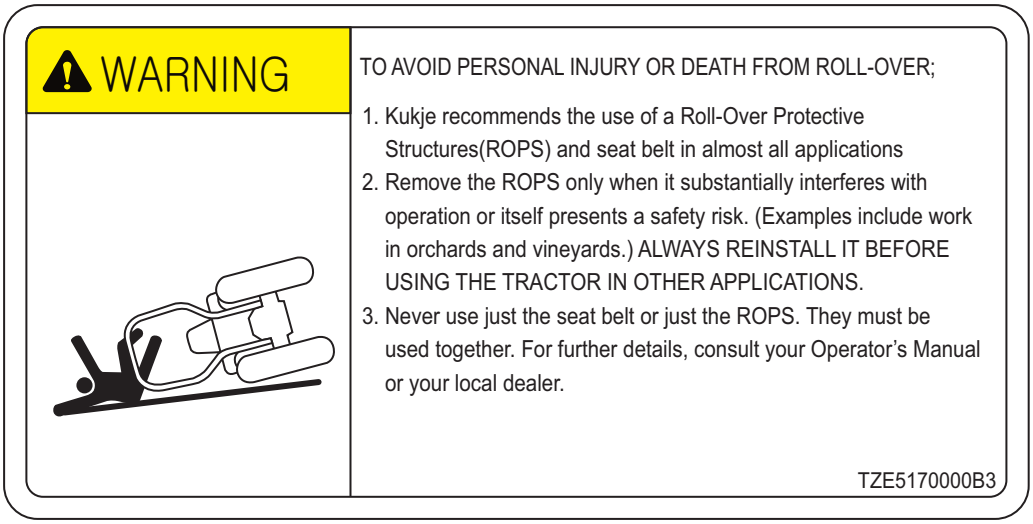

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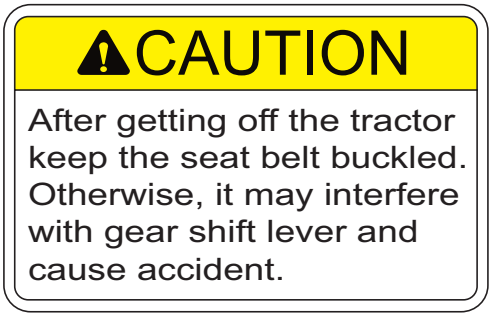

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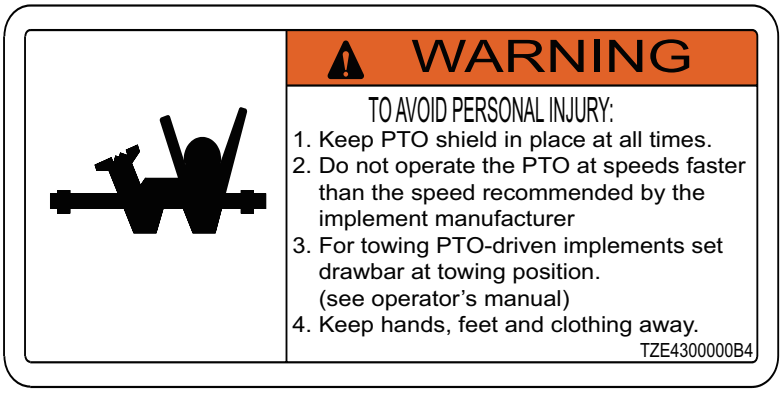


3. GENERAL INFORMATION FOR MAINTENANCE

3.1 TIGHTENING TORQUE

3.1.1 HEX. BOLT

Unit: N.m (kgf.m) [lbf.ft]

ITEM	NO GRADE OR 4 T	7T	9 T	8.8 T	10.9 T	12.9 T
M6	8.8 (0.9) [6.4]	11 (1.1) [8.1]	-	9 (0.9) [5]	13 (1.3) [10]	14 (1.4) [9]
M8	20 (2.0) [14.7]	25 (2.6) [18.4]	14 (1.4) [10.3]	23 (2.3) [17]	33 (3.3) [25]	40 (2.9) [29]
M10	42 (4.3) [30.9]	52 (5.3) [38.3]	28 (2.9) [20.6]	45 (4.5) [33]	65 (6.5) [50]	70 (7.0) [50]
M12	68 (6.9) [50.1]	84 (8.6) [61.9]	44 (4.5) [32.4]	80 (8.0) [60]	115 (11.5) [85]	125 (12.5) [95]
M14	120 (12) [88.5]	140 (14) [103.2]	-	125 (12.5) [90]	180 (18.0) [133]	195 (19.5) [145]
M16	180 (18) [132.2]	220 (22) [162.2]	-	195 (19.5) [140]	280 (28.0) [200]	290 (29.0) [210]
M18	260 (27) [191.7]	290 (30) [213.9]	-	280 (28.0) [200]	390 (39.0) [285]	400 (40.0) [290]
M20	360 (27) [265.5]	400 (41) [295.0]	-	400 (40.0) [290]	550 (55.0) [400]	-

3.1.2 STUD BOLT

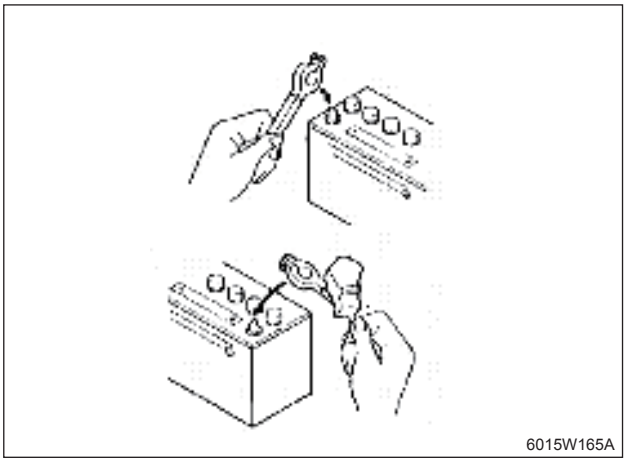
ITEM	BASE			TOLERANCE		
	N.m	kgf.m	lbf.ft	N.m	kgf.m	lbf.ft
M8	11.8 ~ 15.6	1.2 ~ 1.6	8.68 ~ 11.5	8.82 ~ 11.8	0.90 ~ 1.2	6.51 ~ 8.67
M10	24.6 ~ 31.3	2.5 ~ 3.2	18.1 ~ 23.1	19.7 ~ 25.4	2.0 ~ 2.6	14.5 ~ 18.8
M12	29.5 ~ 49.0	3.0 ~ 5.0	21.7 ~ 36.1	31.4	3.2	23.1

3.2 OIL, GREASE, FUEL AND COOLANT SPECIFICATIONS

ITEM	CAPACITY	SPECIFICATION	REMARKS
Fuel	23 ℓ (6.08 u.s. gal)	Diesel fuel (KS 2)	Summer: S, Winter: W
Engine oil	3.0 ℓ (0.79 u.s. gal)	15W-40	Grade CJ or higher
Grease	Small amount	High load No. 2 of KSM 2130	Multi-purpose
Coolant	Radiator : 4.6 ℓ (1.21 u.s. gal) Reservoir tank : 0.45 ℓ (0.12 u.s. gal)	**BBT** genuine anti-freeze	ASTM D4985 Extended Lift antifreeze
Transmission fluid and steering oil	10 ℓ (2.64 u.s. gal)	TF500	Texaco TDH oil, 1893 Chevron tractor hydraulic fluid
Front axle oil	3.0 ℓ (0.79 u.s. gal)	SAE 80W90	Gear oil

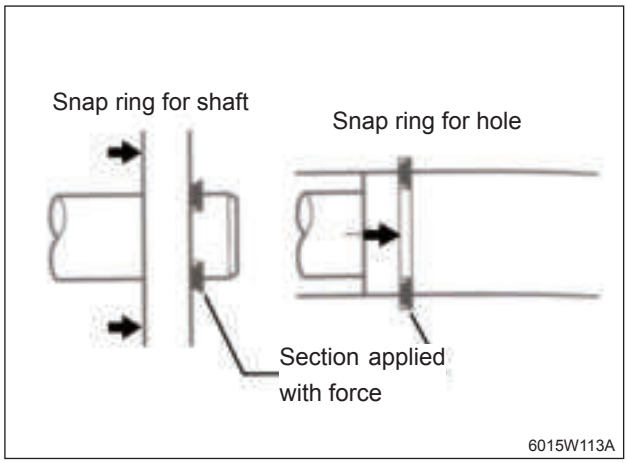
※ If the ambient temperature is below 50°F (10°C), use diesel fuel for winter season.

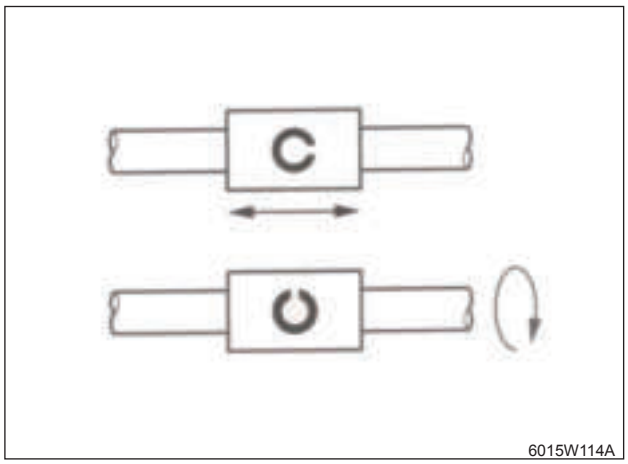
3.3 ELECTRIC DEVICE SERVICE



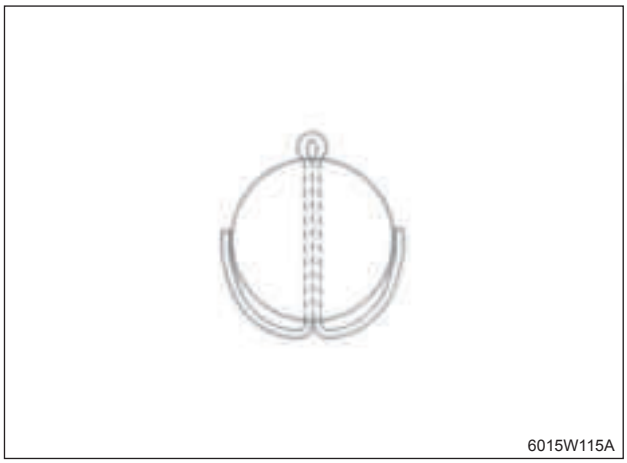
1. When disassembling or repairing any part applied with voltage, disconnect the negative battery cable first.
2. When disconnecting the battery cables, disconnect the negative cable first. When connecting them, connect the positive cable first.
3. Apply grease to the battery terminals and cover them securely after connecting the battery cables.
4. When charging the battery, it produces hydrogen gas and chlorine. Therefore, disconnect the battery and move it to an isolated well-ventilated area with no flammables and flame before charging.

3.4 USING STANDARD PART AND ADHESIVE

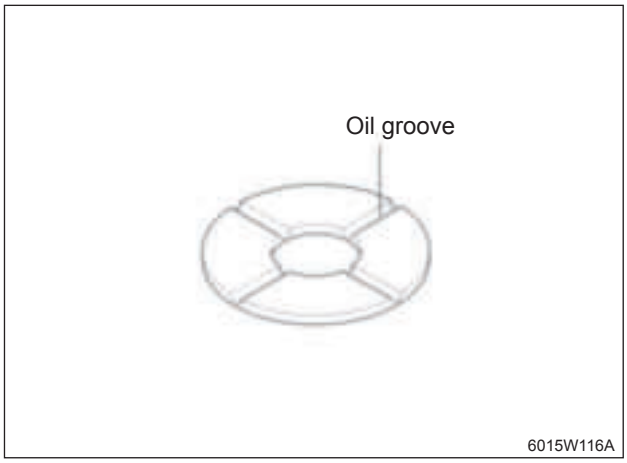




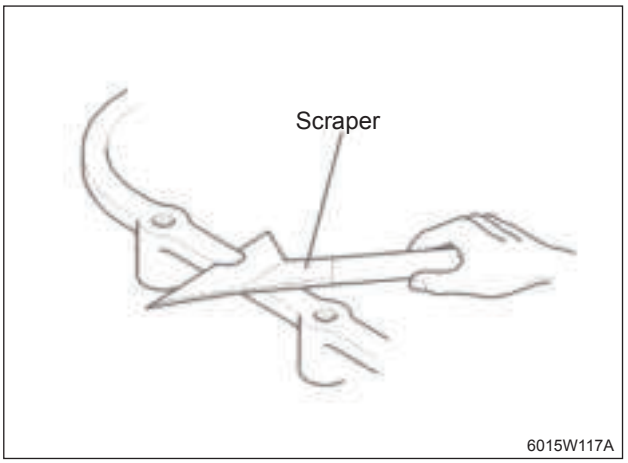
1. When replacing a worn or damaged part, use a new part that meets the international standard.
2. When replacing a packing or O-ring, fit a new one. Before installation, apply grease to the O-ring or oil seal ring.
3. When assembling a snap ring on a shaft or in a hole, ensure its sharply angled side to point the direction of force as shown in the first figure.
4. When installing a spring pin, insert its split portion in the direction to be forced as described in the second figure above.



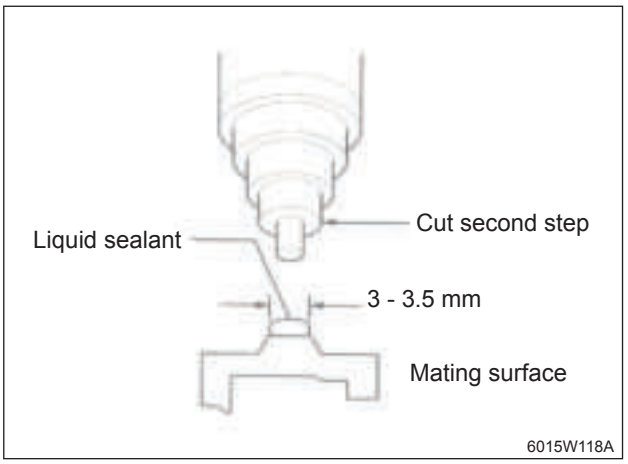
5. Replace the split pin with a new one and fix it firmly.



6. When the oil grooves are engaged with the thrust washer, be careful with assembly.



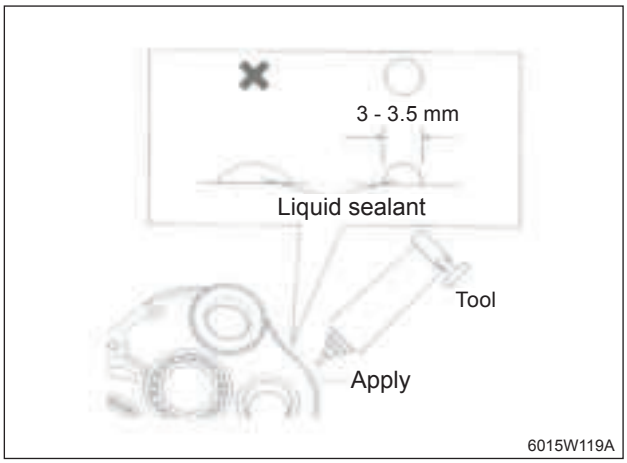
7. Use a liquid sealant removal scraper (flat) to remove any sealant left on the case. Make sure not to make any scratch bigger than 0.3 mm (0.012 in). If the surface is scratched, grind it with an oil grinder.



⚠ CAUTION

Do not use kerosene, heavy oil or diesel oil.

- **Before applying sealant: Use a proper cleaner to remove any oil and stain left on the surface. Never use gasoline.**
- **Cut the second step of the nozzle so that it can drop beads 3 to 3.5 mm wide.**
- **Fit the tube to the tool and use this tool to apply liquid sealant onto the mating surface.**



⚠ CAUTION

Spread liquid sealant. Otherwise, it can leak.

- **Apply sealant to the inner side of the attached surface.**
- **Assemble within 15 minutes after applying liquid sealant.**
- **After assembly, tighten the bolts in a diagonal order.**
- **When oiling the part, run the machine 30 minutes after oiling it.**

4. INSPECTION AND CORRESPONDING ACTION

⚠ CAUTION
• **To inspect or service the tractor, stop the engine on level ground, apply the parking brake and chock the wheels in advance.**

4.1 DAILY INSPECTION

To prevent any future problem, it is important to be aware of the condition of the tractor. Therefore, check the followings before starting the engine:

4.1.1 CHECKING WORK PLACE

- Check that the work place hasn't had any problem.

4.1.2 CHECKING CONDITION AROUND TRACTOR

- Check the tires for inflation pressure, wear and damage.
- Check for leakage.
- Check the engine oil level.
- Check the transmission fluid level.
- Check the coolant level.
- Check the condition of the seat belt.
- Check the radiator screen and grill.
- Check the bolts and nuts on the tires are firmly tightened.
- Check the license plate and SMV emblem for damage. When necessary, clean or replace them.
- Follow all the instructions in the Danger, Warning and Caution decals.
- Clean the area around the exhaust manifold and engine muffler.

4.1.3 CHECKING WHEN SEATING ON DRIVER'S SEAT

- Check the brake and clutch pedals.
- Check the parking brake.
- Check the steering wheel.

4.1.4 CHECKING WHEN TURNING IGNITION SWITCH

- Check the function of the lamps and indicators on the instrument cluster.
- Check the head lamps, tail lamps and hazard warning flasher. When necessary, clean them.
- Check the performance of the instrument cluster and gauges.

4.1.5 CHECKING WHEN STARTING ENGINE

- Check if the lamp on the easy checker is not turned off.
- Check the color of exhaust gas.
- Check that the brake operates properly.

5. GENERAL INFORMATION FOR SERVICE

5.1. MACHINE HISTORY AND INFORMATION

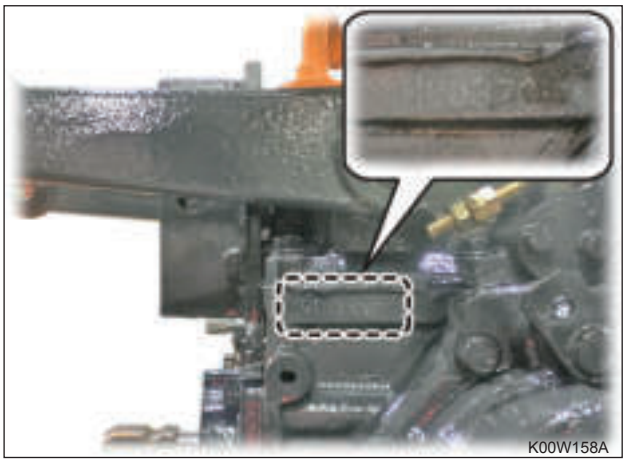
If you have any question or want to ask for service, check the operating hours, serial number, engine number and engine model of the tractor.

5.1.1 SERIAL NUMBER

Example : FD4H00003

It is specified on the serial number decal which is attached on the front right side of the front axle bracket.

5.1.2 TRANSMISSION SERIAL NUMBER



Example : H00370

It is stamped on the right side surface of the hydraulic cylinder.

5.1.3 ENGINE NUMBER

Example : TY6H00184

The engine number is stamped on the cylinder block and is specified on the decal which is attached to the cylinder block on the left side of the engine. Also, the decal indicating the engine model and standards is attached on the top of the engine cylinder head cover.

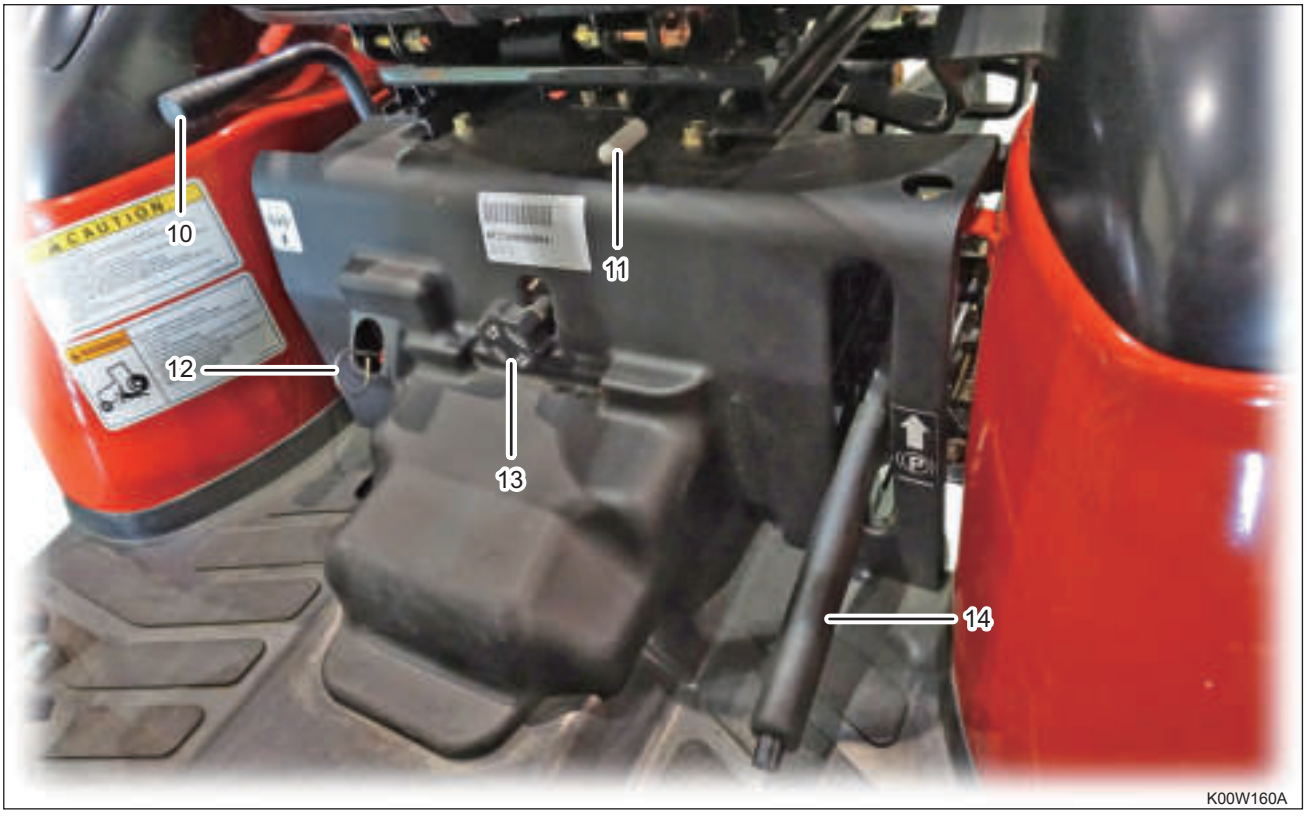
5.1.4 HOURMETER

6. COMPONENTS OF TRACTOR

6.1 FRONT AND REAR EXTERIOR VIEW

(1) Head lamp
(2) Steering wheel
(3) Side step
(4) Seat
(5) Lower frame
(6) Draw bar
(7) Top link hinge
(8) Tail lamp assy

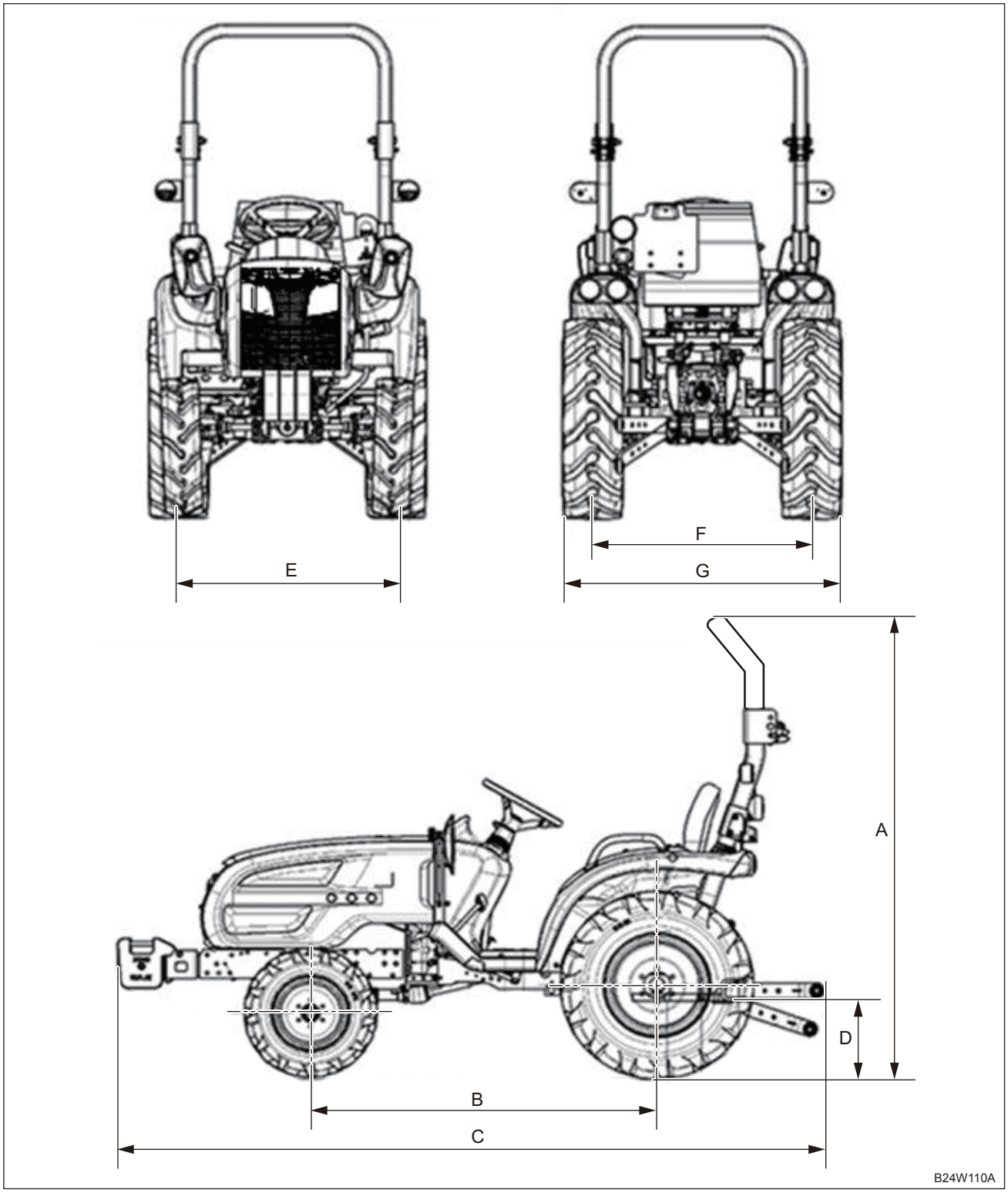
6.2 INTERIOR VIEW



(1) Turn signal light switch
(2) Clutch pedal
(3) Range gear shift lever
(4) Emergency switch
(5) Cruise switch
(6) Accelerator lever
(7) Brake pedal
(8) HST pedal (Forward)
(9) HST pedal (Reverse)
(10) Differential lock lever
(11) Seat adjust lever
(12) Oil gauge
(13) Stop valve knob
(14) Parking brake lever

7. TRACTOR SPECIFICATIONS

7.1 EXTERIOR DIMENSIONS



SIZE mm (in.)

MODEL	A	B	C	D	E	F	G
2024H	2,216 (87.2)	1,502 (59.1)	3,066 (120.7)	349 (13.7)	853 (33.6)	880 (34.6)	1,124 (44.3)
3026H	2,312 (91.0)	1,670 (65.7)	3,122 (122.9)	417 (16.4)	-	-	1,369 (53.9)

7.2 MAJOR SPECIFICATIONS

MAJOR ITEMS				2024H	3026H
Engine	Model			A1100N2	
	Type			Vertical, water cooled 4-cycle, diesel engine	
	Emission regulation			Final Tier4	
	Number of cylinders			3	
	Bore and stroke		mm (in.)	78 X 82 (3.07 X 3.23)	
	Total displacement		cc (in^3)	1,175 (71.70)	
	Rated speed		(rpm)	2,600	
	Power at rated engine rpm		kW(HP)	18(24)	
	Intake type			Naturally	
	Battery		(V)	12	
	Fuel			Diesel	
Capacity	Fuel tank		ℓ(u.s. gal)	23 (6.07)	
	Engine crankcase		ℓ(u.s. gal)	3.0 (0.79)	
	Coolant		ℓ(u.s. gal)	4.6 (1.21)	
	Transmission case		ℓ(u.s. gal)	10(2.64)	
	Front axle		ℓ(u.s. gal)	3.0 (0.79)	
Dimension	Overall length (with F/weight)		mm (in.)	3,066 (120.7)	3,122 (122.9)
	Overall width		mm (in.)	1,124 (44.3)	1,369 (53.9)
	Overall height		mm (in.)	2,216 (87.2)	2,312 (91.0)
	Wheel base		mm (in.)	1,502 (59.1)	1,670 (65.7)
	Min. ground clearance		mm (in.)	349 (13.7)	417 (16.4)
	Tread	Front	mm (in.)	853 (33.6)	45 (1,142)
		Rear	mm (in.)	880 (34.6)	43.2 (1,097)
Transmission	Tire size (Agri)	Front wheel		6.0-12 4PR	7.0-16 6PR
		Rear wheel		9.5-16 6PR	11.2-20 8PR
	Steering system			Hydrostatic	
	Main shifting			HST	
	Gear shifting			2 Range shift	3 Range shift
	Brake system		Driving	Wet disc type	
			Parking	Hand brake lever type	

MAJOR ITEMS				2024H	3026H
Hydraulic oil	Hydraulic lift control			Position control	
	Pump flow capacity		LPM	29	
	3-point hitch			CAT.1	
	Max. lift force (at lifting point)		kg	650	
PTO	PTO (hydraulic)			Ø 35 mm - 6 splines	
	Revolution (rpm)		1st	540	
			2nd	960	
			Mid	2,500	
Draft system				Pin mounting type	
Driving speed		Forward	km/h(MPH)	0 ~ 19.5 (0 ~ 12.1)	0 ~ 23.9 (0 ~ 14.9)
		Reverse	km/h(MPH)	0 ~ 19.5 (0 ~ 12.1)	0 ~ 23.9 (0 ~ 14.9)
Weight (with F/W)			kg(lbs.)	830 (1,829)	956 (2,107)

※ 1. Rated engine speed: 2,600 rpm

2. Tire dynamic load radius (only for pneumatic tire): 423 mm (9.5 - 16)

3. Notes: The specifications are subject to change without notice.

7.3 DRIVING SPEED

2024H

SHIFT POSITION	SPEED			
	FORWARD DRIVING		REVERSE DRIVING	
RANGE SHIFT	km/h	MPH	km/h	MPH
L	6.1	3.9	6.1	3.9
H	19.5	12.1	19.5	12.1

3026H

SHIFT POSITION		SPEED (FORWARD AND REVERSE)	
TIRE SIZE	RANGE SHIFT	km/h	MPH
7.0-16 / 11.2-20	L	7.0	4.3
	M	13.0	8.0
	H	23.9	14.9

8. PERIODIC INSPECTION

8.1 PERIODIC MAINTENANCE SCHEDULE TABLE

NO.	RUNNING HOURS / ITEMS		OPERATING HOUR (HOUR OR YEAR)															
			50	100	150	200	250	300	350	400	450	500	550	600	650	700	1YR	2YR
1	Engine oil	R	⊙				●					●						
2	Engine oil filter	R	⊙				●					●						
3	Transmission fluid	R	⊙						●						●			
4	Transmission fluid filter	R	⊙						●						●			
	HST filter																	
5	Front axle fluid	R	⊙						●						●			
6	Radiator cleaning	CL	At the time the coolant is replaced															
7	Fuel oil filter and element	C		●		●		●		●		●		●		●		
		R										●						
8	Coolant	R	Check before every work (Replace every year)															
9	Air cleaner element	CL	●	●	●	●	●	●	●	●	●		●	●	●	●		
		R										●						
10	Fan and radiator cleaning	CL	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
11	Battery solution	R	Replace every two years															
12	Battery (specific gravity)	C		●		●		●		●		●		●		●		
13	Fuel pipe and connection	C	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
		R																●
14	Steering wheel hose	C	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
		R																●
15	Radiator hose	C				●				●				●				
		R																●
16	Hydraulic fluid hose	C		●		●		●		●		●		●		●		
		R															●	
17	Fuel hose	C		●		●		●		●		●		●		●		
		R															●	
18	Electric cables	C	●	●	●	●	●	●	●	●	●	●	●	●	●	●		

NO.	RUNNING HOURS / ITEMS		OPERATING HOUR (HOUR OR YEAR)															
			50	100	150	200	250	300	350	400	450	500	550	600	650	700	1YR	2YR
19	Greasing	C	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
20	Tightening handles	C		●		●		●		●		●		●				
21	Tightening bolts&Nuts	C	●	●		●		●		●		●		●		●		
22	Cooling fan belt	A	●	●		●		●		●		●		●		●		
23	Clutch	A		●		●		●		●		●		●		●		
24	Brake	A		●		●		●		●		●		●		●		
25	Engine breed pipe	C	●	●		●		●		●		●		●		●		
26	Engine crankcase cleaning	CL						●						●				
27	Intake/exhaust valves	C												●				
28	Fuel injection valve	C												●				
29	Generator motor	C	●	●				●				●						
30	Hydraulic system	C	●	●				●				●						

※ The jobs indicated by ◉ must be done after the first 50 hours of operation

※ Meanings of symbols=R: Replace C: Check A: Adjust CL: Clean

※ Inspection should be done every 50 hours. If the tractor is not used much, inspect every year.

※ Replace parts every two years regardless of running hours.

8.2 INSPECTION DESCRIPTION

⚠ CAUTION

- **Before working on this machine, lower any attachment or implement on the ground and apply the parking brake (1).**

8.2.1 FUELING INTO FUEL TANK

⚠ CAUTION

- **When fueling, be careful not to spill fuel and watch out for any smoke or flame around. Make sure to fuel only with the engine stopped.**

1. Check the fuel level through the instrument cluster with the engine running.
2. When the pointer on the fuel gauge is on the first quarter zone, add fuel to the fuel tank (1).

FUEL TANK CAPACITY	23 ℓ (6.07 u.s.gal.)

⚠ CAUTION

- **Make sure that no dust enters the fuel filler hole.**
- **If the fuel tank becomes empty, air may enter the fuel system, causing an engine starting problem. Add fuel to the tank before it becomes empty.**
- **When fueling, be careful not to spill it. If spilled, wipe it out thoroughly.**
- **After daily work, top up the fuel tank to prevent any foreign material from entering the tank.**

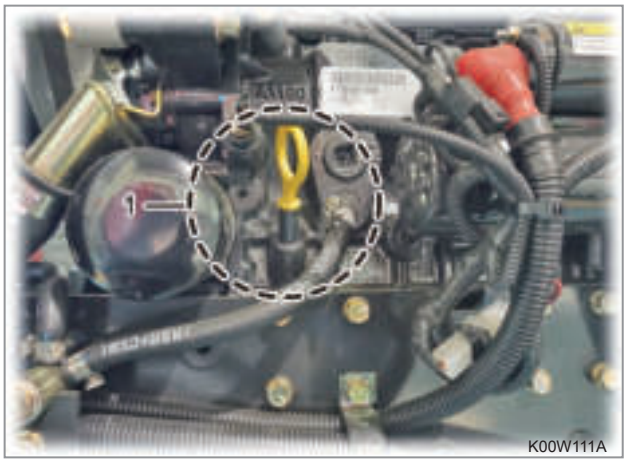
8.2.2 CHECKING ENGINE OIL

⚠ WARNING

- **Never mix different types of oil, but use the only engine oil specified by BBT. (SAE 15W-40, Final Tier4: grade CJ or higher)**
- **Never attempt the start the engine without sufficient engine oil.**

⚠ CAUTION

- **Make sure to stop the engine before checking the engine oil level.**



1. Make sure that the machine is parked on level ground.
2. Remove any dust around the dipstick inlet.
3. Pull out the dipstick (1), wipe its mark, insert it and pull it out again to check the oil level and oil condition.
4. The oil level should be between the min. and max. lines and the oil color should not be too dark or too light.
5. If not normal, add engine oil up to the max. line on the dipstick. (Refer to 8.2.8 Changing engine oil in this chapter.)

8.2.3 CHECKING COOLANT AMOUNT

⚠ CAUTION

- **Hot coolant or steam from the pressurized cooling system can be surged leading to a serious scald. Make sure to stop the engine before checking the coolant level. Remove the filler cap only when it is cooled down enough to touch by a hand. At this moment, release residual pressure in the system and then unscrew the cap slowly to remove it.**

1. Check the coolant level in the reservoir (1).
2. The coolant level should be between the lower and upper limits while the engine is running.
3. If the coolant level is below the min. level, add coolant up to the max. limit into the reservoir.

RESERVOIR CAPACITY	0.45 ℓ (0.12 u.s.gal.)

8.2.4 CHECKING LAMPS

1. Check the head lamps, turn signal lamps and brake lamps.
2. If any lamp is malfunctioning or damaged, replace it with a new one.

8.2.5 CHECKING SEAT BELT

1. Inspect the seat belt (1) and its anchor at least every year. Check the belt for looseness of its anchor, cut, excessive wear or abnormal wear. If a damage is found, replace the seat belt with a new genuine **BBT** seat belt.

8.2.6 CLEANING RADIATOR DUST GRILL

⚠ CAUTION

- **Check and clean the dust grill after stopping the engine.**

1. Check the front of the hood or side grill for dust, and clean them accordingly.
2. Open the hood and remove the intake tube(1), and then pull out the dust grill (2) to upward to remove. Then, remove dust from the dust grill.

⚠ CAUTION

- **Clean the grill and dust grill to prevent the engine from overheating and let sufficient air flow into the air cleaner.**

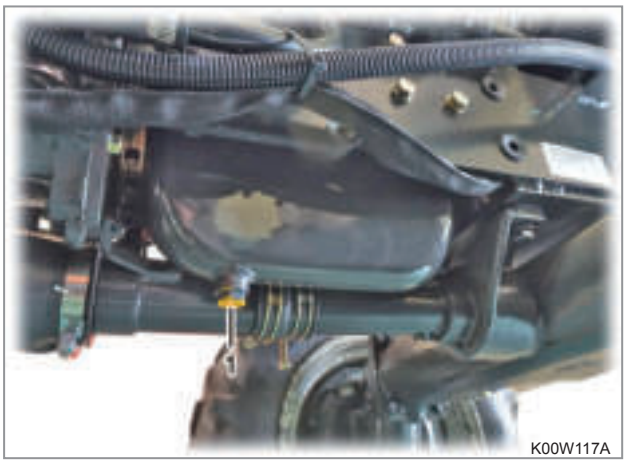
8.2.7 CHECKING INSTRUMENT CLUSTER SIGNALS

1. Turn the ignition switch to the START position.
2. Check that the gauges and signals are working properly.
3. If not, check the corresponding lamp and electric circuit.
4. If necessary, replace the part with a new one.

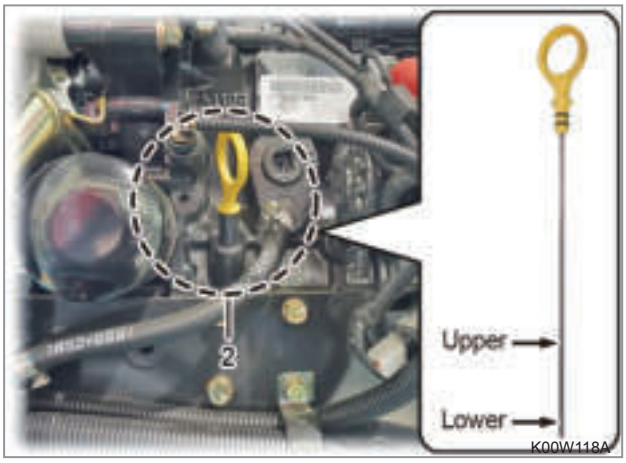
8.2.8 CHANGING ENGINE OIL

⚠ CAUTION

- **Make sure to stop the engine before changing engine oil.**
- **Make sure that the engine is sufficiently cooled down enough to touch by a hand.**



1. Remove the drain plug (1) to drain engine oil.
2. Fit the drain plug and tighten it to 50 N.m (37 lbf.ft).
3. Add clean oil with proper viscosity to the crankcase.



4. Wait for 15 minutes and check the oil level. The oil level should be up to the upper limit on the dipstick (2).

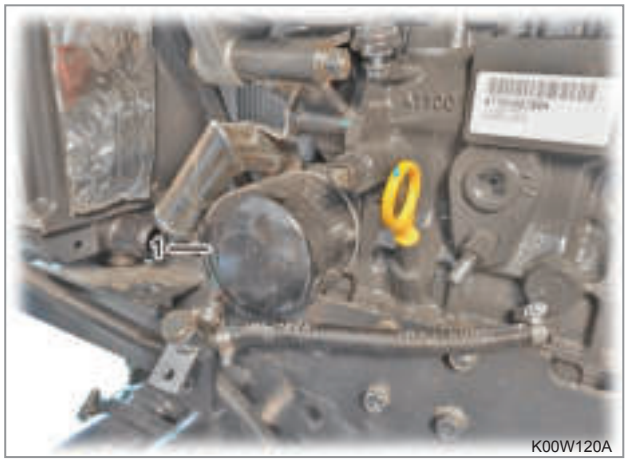
5. Run the engine for a while and check the oil filler hole (3) and drain plug for oil leakage.

SPECIFIED AMOUNT OF ENGINE OIL	3.0 ℓ (0.79 u.s.gal.)
LUBRICANTS	15W-40 Grade CJ or higher

8.2.9 REPLACING ENGINE OIL FILTER

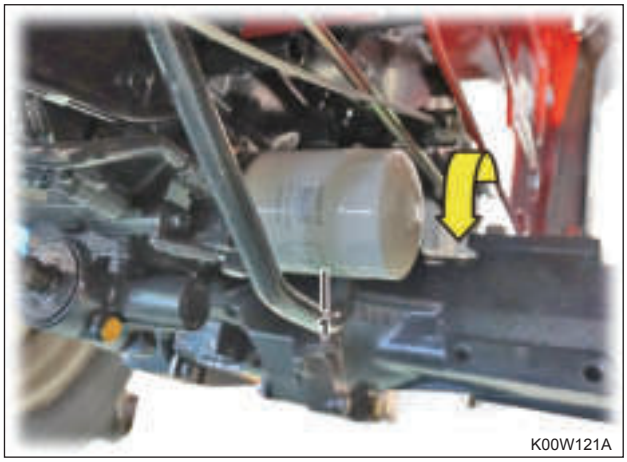
⚠ CAUTION

- **Be sure to use the only BBT genuine oil filter not to damage the engine. Replace the oil filter only after the engine is stopped and cooled down.**



1. Unscrew the filter element (1) and clean its mounting surface.
2. Replace the O-ring on the surface which is to be against a new filter.
3. Apply a thin film of clean oil around the seal ring of a new filter.
4. Fit the new filter and tighten it by hand.
5. Start the engine and check the filter base for oil leakage.
6. Stop the engine and check the oil level. If the level is too low, add more oil.

8.2.10 REPLACING HST FILTER

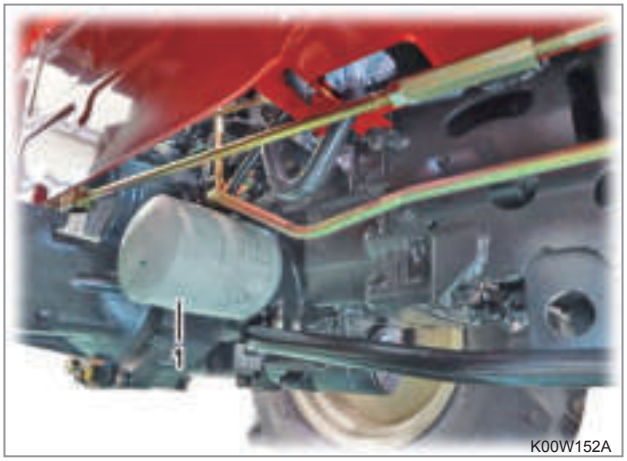


1. Turn the filter element (1) counterclockwise to remove.
2. Apply a clean oil around the seal ring of element of a new filter and tighten it.
3. Start the engine and check oil leakage after operate forward and reverse.

8.2.11 REPLACING TRANSMISSION/ HYDRAULIC FILTER

⚠ CAUTION

- **Replace the transmission fluid filter only after the engine is stopped and cooled down.**
- **Be sure to use the BBT genuine oil filter to keep the transmission intact.**

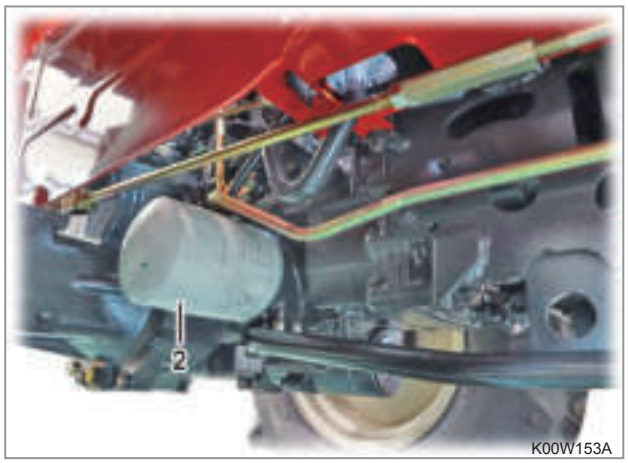


1. Remove the filter element (1) by unscrewing it.
2. Apply clean oil onto the seal ring of a new filter element and tighten this filter element.
3. Start the engine and check the filter base for fuel leakage.
4. Stop the engine and check the oil level. If the level is too low, add more oil.

8.2.12 CHANGING TRANSMISSION FLUID/ HYDRAULIC OIL

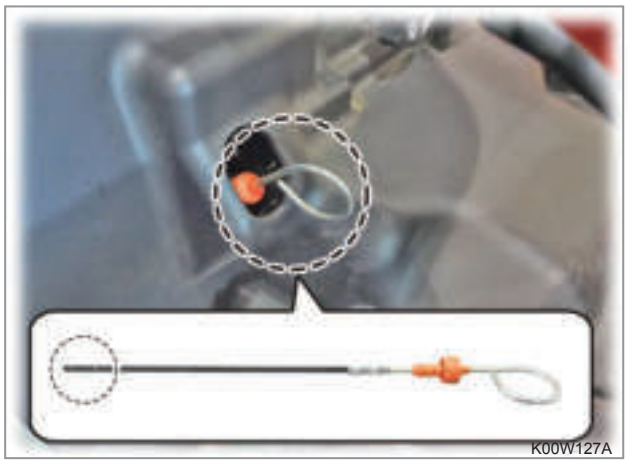
1. Start the engine and activate several hydraulic functions to increase oil temperature.
2. Park the tractor on level ground and lower the implement onto the ground.
3. Stop the engine, remove the ignition key and apply the parking brake. (Set the transmission into the neutral state.)

4. Remove the drain plug (1).



5. Replace the transmission fluid/hydraulic oil filter element (2).
6. Before adding clean oil, replace the seal and tighten the drain plug to 5 kgf.m (36 lbf.ft).

7. Add transmission fluid/hydraulic oil into the transmission case through its filler hole (3).
8. Run the engine for a moment to activate the hydraulic pressure function. Stop the engine.

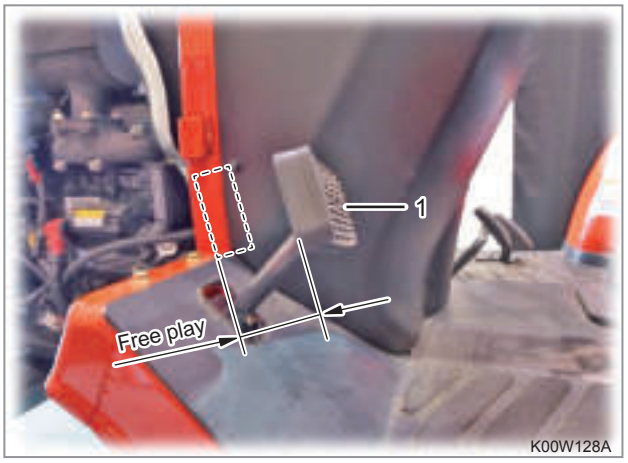


9. Wait for 10 to 15 minutes before checking the oil level. The oil level should be on the mark on the dipstick (4). If not, add oil up to the specified upper limit.

TRANSMISSION FLUID/ HYDRAULIC OIL AMOUNT	10 ℓ (2.64 u.s.gal.)

8.2.13 ADJUSTING CLUTCH PEDAL

Check that the clutch pedal moves by itself when depressing it slightly and releasing it.

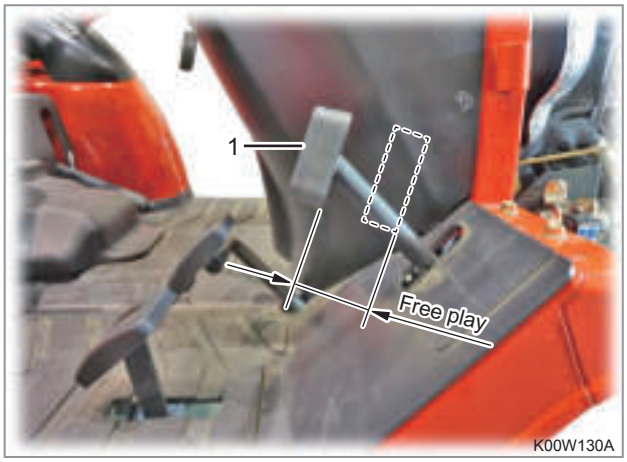


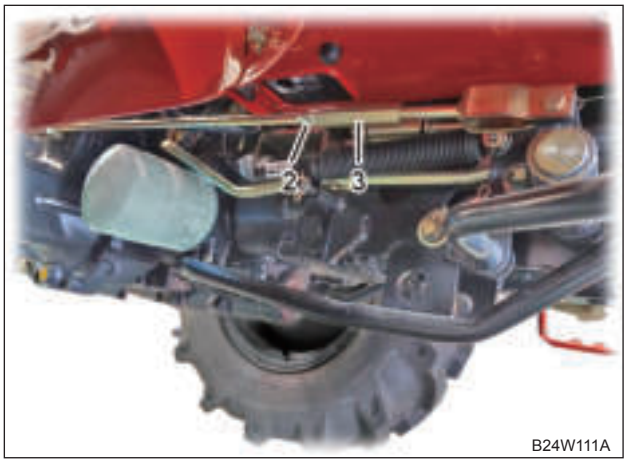
1. Make sure that the machine is parked on level ground.
2. Depress the clutch pedal (1) slightly and then release it.
3. Check if the clutch pedal moves when released.
4. Unscrew the lock nut (2) of the clutch rod and adjust the clutch rod (3) to adjust the free play.
5. Tighten the lock nut.

CLUTCH PEDAL FREE PLAY	25 - 35 mm (0.98 - 1.38 in.)

8.2.14 ADJUSTING BRAKE PEDAL

1. Release the parking brake.





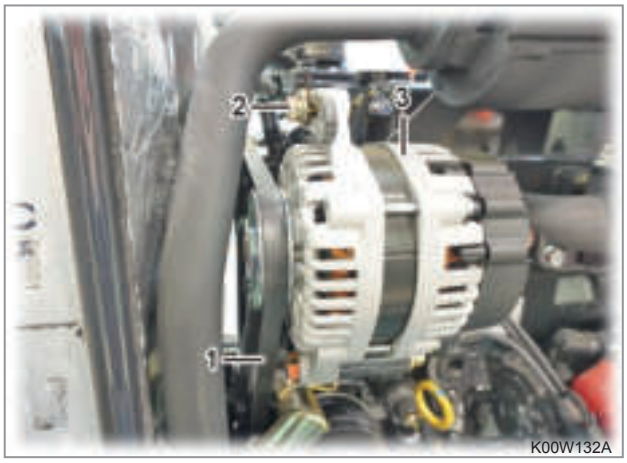
2. Depress the brake pedal (1) slightly and then release it.
3. Check the free play of the pedal when releasing it.
4. Unscrew the lock nut (2) of the brake rod under the floor and turn the turn buckle (3) to adjust the free play.
5. Adjust both pedals to the same amount of free play.
6. Tighten the lock nut.

BRAKE PEDAL FREE PLAY	30 - 40 mm (1.2 - 1.5 in)

8.2.15 ADJUSTING FAN BELT TENSION

⚠ CAUTION

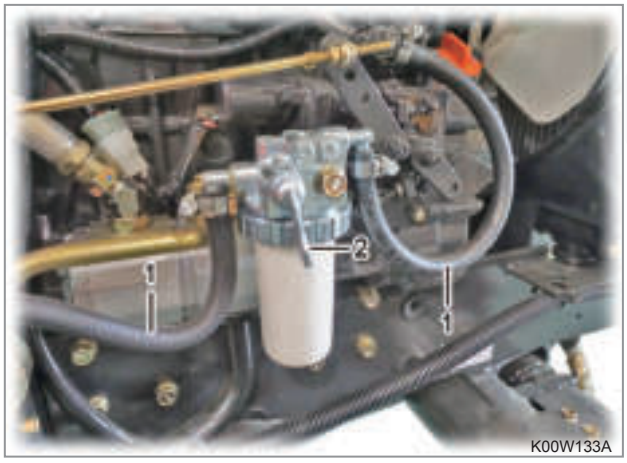
- **Stop the engine before adjusting the tension of the fan belt.**
- **When adjusting the fan belt tension, be careful not to hurt your hands and damage the alternator.**



1. Stop the engine, remove the ignition key and apply the parking brake.
2. Check the tension of the fan belt (1).
3. Loosen the tension adjusting bolt (2).
4. Place a stick or pipe between the alternator (3) and cylinder block.
5. Push the alternator outwards to adjust the fan belt tension.
6. Tighten the adjusting bolt.

BELT DEFLECTION [Pressing with force of 10 kgf (22 lb)]		10 - 15 mm (0.4 - 0.6 in)
TORQUE VALUE	Mounting bolt	26 N.m (19 lbf.ft)
	Adjusting bolt	52 N.m (38 lbf.ft)

8.2.16 CHECKING FUEL LINE



1. Check the fuel line (1) and clamp for leakage.
2. If any abnormal condition is found, replace the corresponding part with a new one.

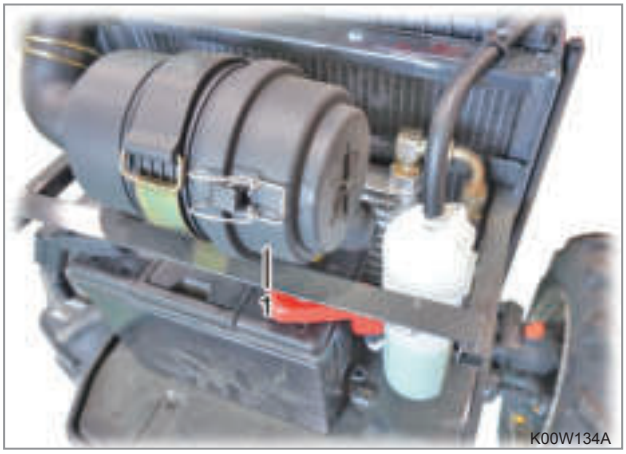
⚠ CAUTION

If replacing the fuel line, make sure to bleed the fuel system.

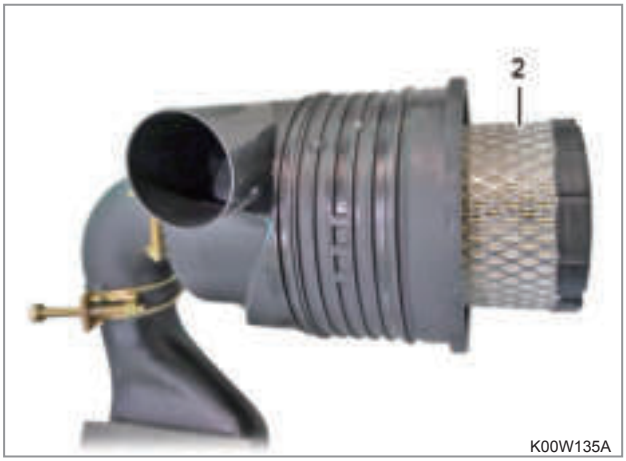
▶ BLEEDING FUEL LINE

- **Turn the cock (2) of the fuel filter to the opening position.**
- **Unscrew the bleeding bolt of the fuel filter slightly.**
- **Turn the ignition switch to crank the engine. Then, check if fuel flows through the bleeding bolt.**
- **If fuel without bubbles flows out, stop cranking the engine and tighten the bleeding bolt completely.**
- **If the engine is still hard to be started, loosen one to two nozzle holders and crank the engine to bleed the system.**

8.2.17 CLEANING AIR CLEANER ELEMENT

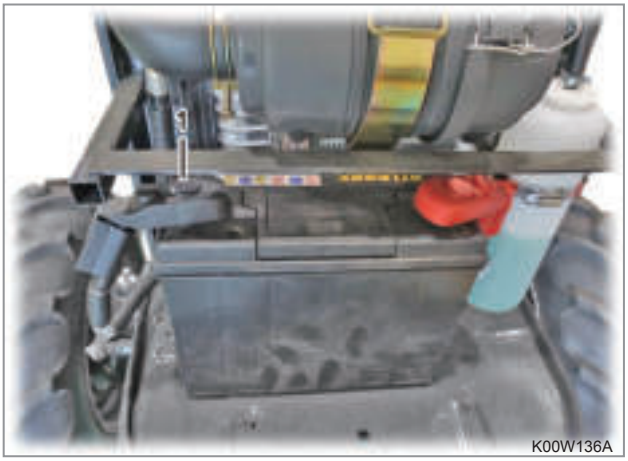


1. Open the air cleaner cover (1) and pull out the air cleaner element.



2. Remove the element (2) and dust it off. If dust is still attached to the element, insert a nozzle into it and blow dust out from inside with compressed air (up to 600 kPa, 6 bar, 90 psi).
3. Replace the part every year or every 6th cleaning schedule whichever comes first.

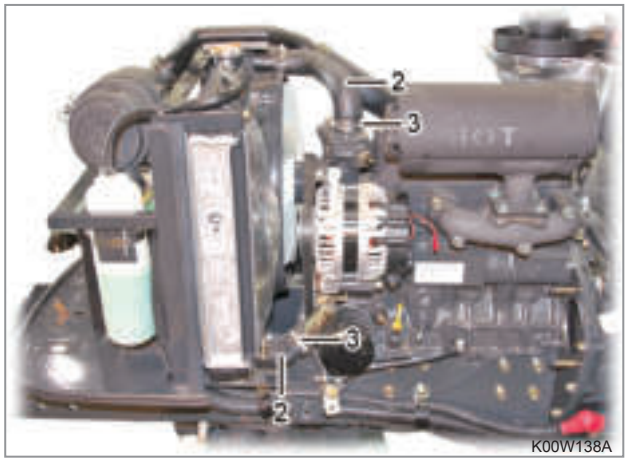
8.2.18 BATTERY



⚠ CAUTION

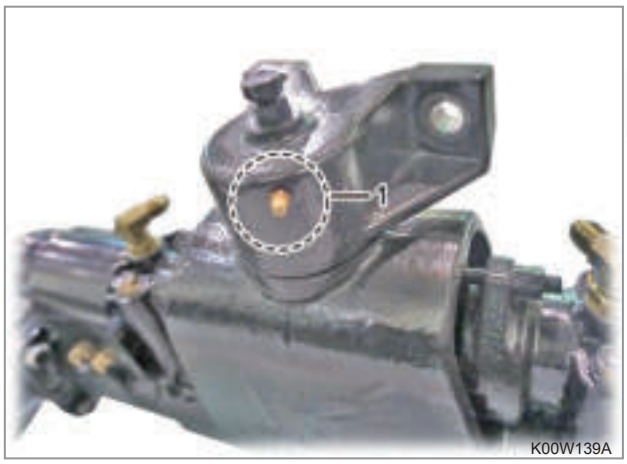
- **Keep any spark or flame away from the battery. It can cause explosion with its gas.**
- **To avoid a spark, disconnect the negative (ground) battery cable (1) first. When connecting the battery, connect the positive cable first.**
- **Never charge the battery with its positive and negative poles touching a metallic object. Use a voltmeter or hydrometer.**
- **If the battery is frozen, it can explode. Heat the battery to 16°C (60°F) before charging it.**
- **The battery cannot be charged when the engine speed is below 1,000 RPM. (It can be charged with the engine running at 1,500 RPM or higher speed.)**

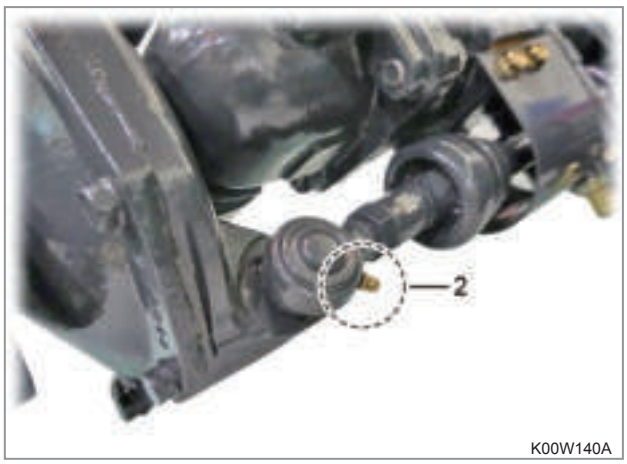
8.2.19 CHECKING RADIATOR AND INTAKE HOSES



1. Check the condition of the air intake hose (1) and radiator hose (2) every six months or 200 hours of use whichever comes first.
2. Check the hose and tighten the clamp (3).
3. A leaking or damaged hose can be a major cause of dust in the engine.
4. If the hose is worn or damaged, replace it with a new one.
5. It is recommended to replace the radiator hose every two years.

8.2.20 APPLYING GREASE





1. Apply grease every 50 hours of use.
2. Check the target positions and apply a proper amount of grease on them before beginning your work. Make sure to apply grease on them especially after working in a wet field.

- Grease applied components
  - Bottom of front axle bracket (1)
  - Left/Right ball joint of front axle (2)
  - Lift link and more

8.2.21 ADDING ANTI-FREEZE

⚠ CAUTION

- **Never remove the cap when the coolant temperature is over the boiling point. To release pressure, unscrew the radiator cap (1) slightly. Then, unscrew it completely.**
- **Never pour cold water or coolant onto the hot engine. Always use warm liquid until the engine is sufficiently cooled down.**

1. If the tractor is equipped with a cabin, turn the heater control dial to the right end.
2. To release pressure, unscrew the radiator cap (1) slightly. Then, unscrew it completely.
3. To collect coolant, place a container under the drain hole.

4. Disconnect the radiator drain hose (2).
5. After coolant is completely removed from the radiator, connect the hose and add clean water to the system.
6. Run the engine until its temperature reaches its operating temperature.

7. Stop the engine and add clean water to the system.
8. Run the engine until its temperature reaches its operating temperature. Then, stop the engine.
9. Then, add the specified anti-freeze to the system.
10. Add the anti-freeze to the “FULL” limit mark.
11. Start the engine and run it for 15 minutes.
12. Stop the engine and add the anti-freeze up to the "FULL" mark.
13. Tighten the radiator cap.

Note: For efficient cooling, the dust grill of the radiator should always be kept clean. Remove any dust or oil from it and spread any bent cooling fan straight.

RESERVOIR CAPACITY	0.45 ℓ (0.12 u.s.gal.)

8.2.22 FUSE AND RELAY

1. A fuse is to protect circuits from electric overload.
2. The relay control current is high load current which flows through a circuit.
3. To prevent damage to the electric system, never use a fuse with higher capacity than the one already installed.

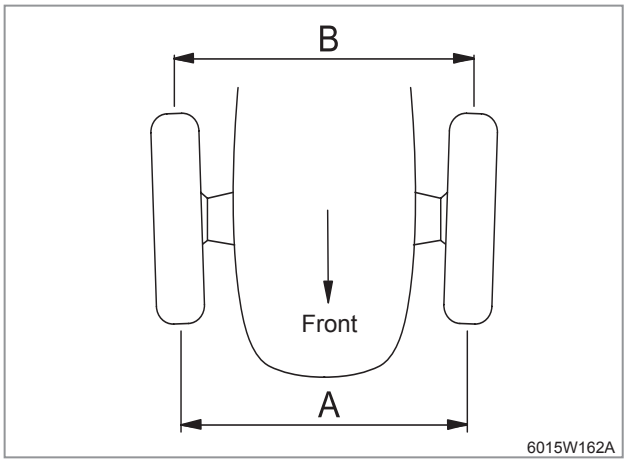
ITEM	SPECIFICATION	DESCRIPTION
Fuse 1	10 A	Panel
Fuse 2	20 A	Turn lamp
Fuse 3	10 A	Fuel stop
Fuse 4	20 A	Glow
Fuse 5	10 A	Hazard
Fuse 6	10 A	Control unit
Fuse 7	10 A	Spare
Fuse 8	20 A	Spare

8.2.23 TIRE INFLATION PRESSURE

1. Performance and expectancy of life of tires depend on maintaining tire's inflation pressure properly.
2. If tire inflation pressure is insufficient, it can cause premature wear. If it is excessive, it can reduce traction and increase wheel slip.
3. The specified tire pressure is different not only by working environment and load, but also by tractor models. Make sure to follow the specified standard inflation pressure set in this manual.

STANDARD	Front wheel	2.0 kgf/cm^2 (28 psi)
	Rear wheel	2.1 kgf/cm^2 (30 psi)

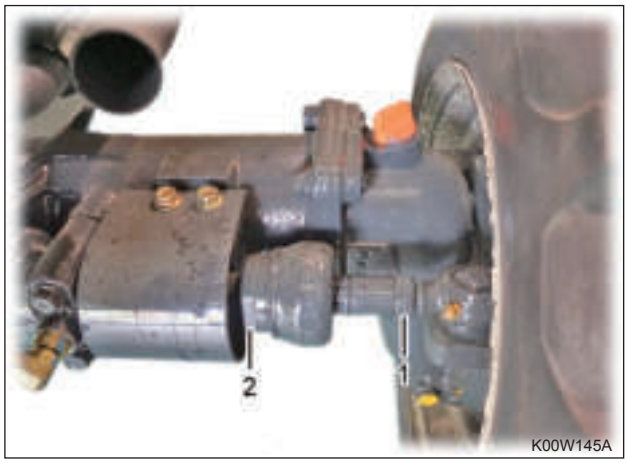
8.2.24 CHECKING TOE-IN



(A) Front distance (B) Rear distance

1. Park the machine on level ground.
2. Measure the front distance (A).
3. Measure the rear distance (B).
4. The difference (B- A) between the front distance (A) and rear distance (B) should be over 4 - 8 mm (0.157 - 0.314 in.).

8.2.25 ADJUSTING FRONT WHEEL TOE-IN



1. Unscrew the mounting nut (1) on the tie rod.
2. Turn the rod (2) inwards or outwards. (Two rods should be same in length.)
3. Adjust the toe-in and tighten the mounting nut (1).

8.2.26 TIGHTENING WHEEL BOLT

Tighten all the bolts on the wheel after initial 4 and 8 hours of operation. Then, check tightness of the bolts every 100 hours of use.

ITEM		TORQUE VALUE
Front wheel	Hub bolt	7.9 - 9.2 kgf.m (56.8 - 66.4 lbf.ft) (77 - 90 N.m)
Rear wheel	Hub bolt (1)	11 - 12.8 kgf.m (79.6 - 92.2 lbf.ft) (108 ~ 125 N.m)

MEMO

CHAPTER 2 ENGINE

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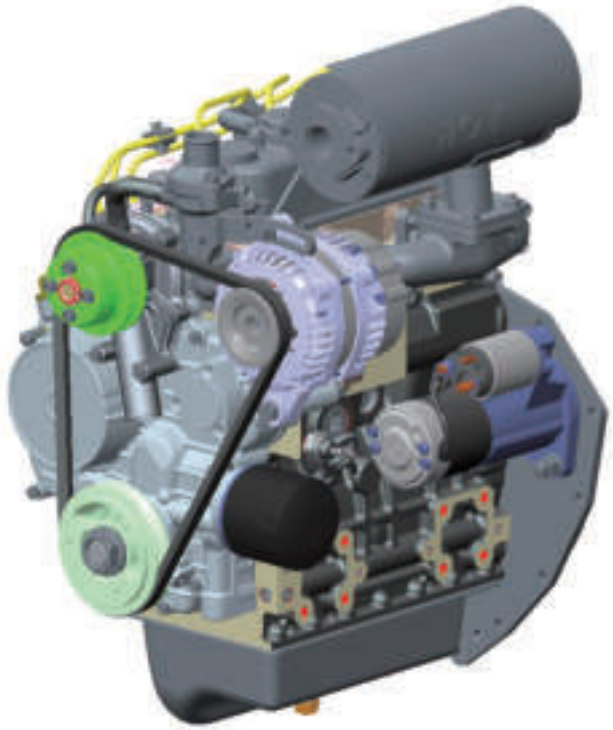
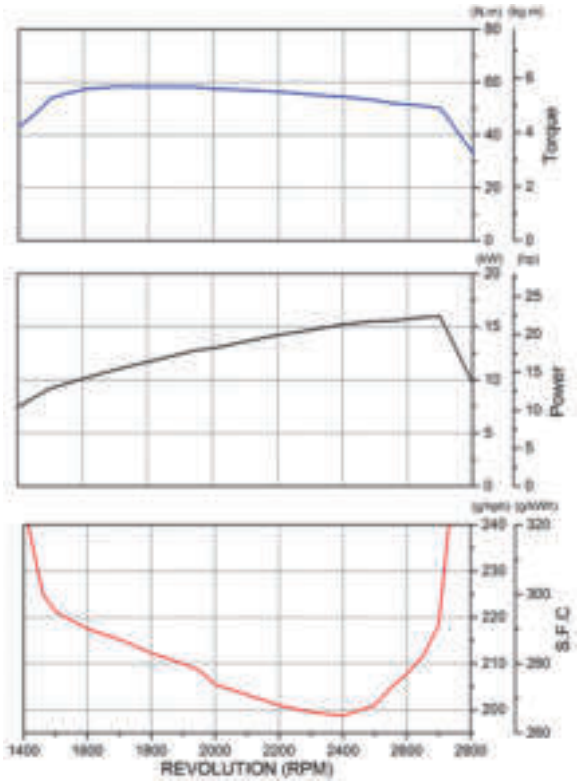
1. EXTERIOR OF ENGINE AND SPECIFICATIONS, NAMES OF PARTS

1.1 SPECIFICATION



Engine performance curve

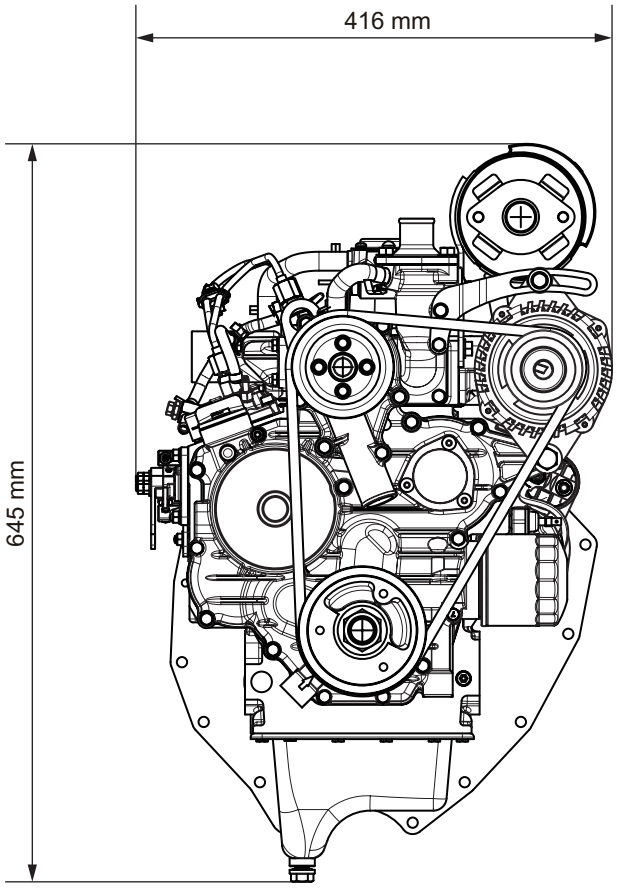


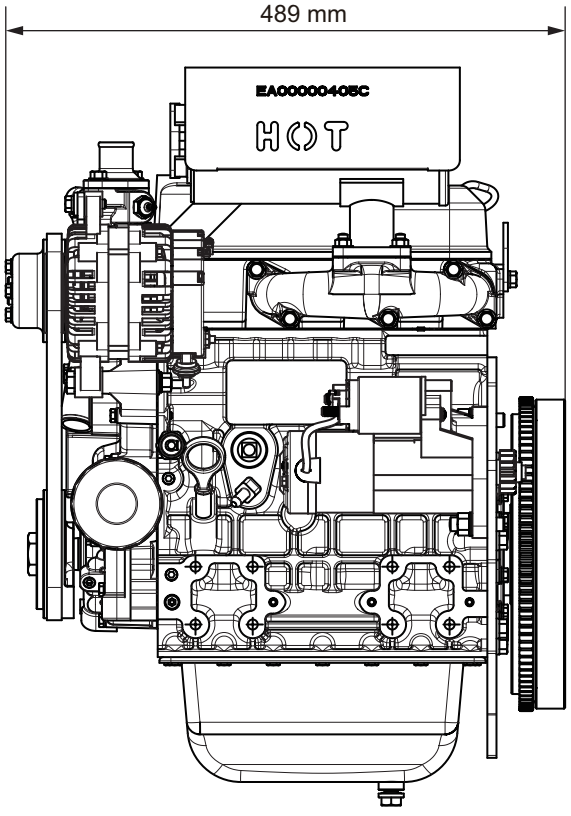
K00W218A

MODEL			UNIT	A1100N2_TIER-4
Type				Vertical Water-Cooled 4-Cycle Diesel Engine
Emission Regulation				Final Tier-4
No. of Cylinders				3
Cylinder Bore x Stroke			mm	78 × 82
Displacement			cc	1,175
Combustion System				IDI (swirl Chamber)
Intake System				Natural Aspirated
Agricultural Use	Gross Intermittent	2,600	kW (HP)	18 (24)
Compression Ratio				21.5 : 1
Direction of Rotation				CCW from Flywheel Side
Cooling System				Pressurized Radiator
Lubricant Capacity			ℓ	3.0
Starter			V-kW	12 - 1.4
Alternator			V-A	12 - 50
Dimension(L x W x H)			mm	489 × 416 × 645
Dry Weight			kg	110

※ Specifications could be changed without notice for performance improvement.

1.2 ENGINE DIMENSIONS





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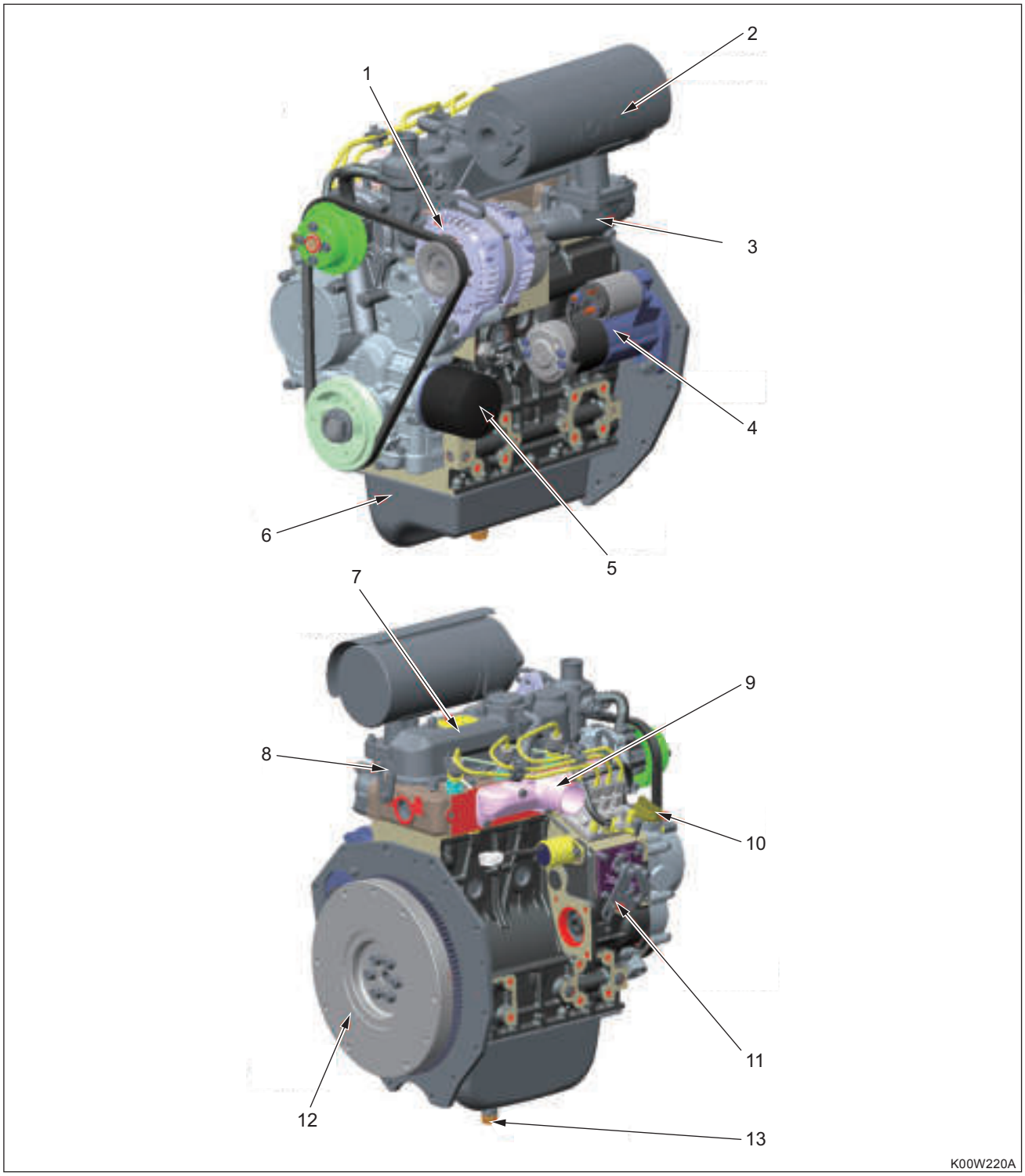
1.3 NAME OF PARTS



(1) Alternator
(2) Muffler
(3) Exhaust manifold
(4) Starter
(5) Oil filter
(6) Oil pan
(7) Head cover
(8) Lift
(9) Intake manifold
(10) Oil cap
(11) Accelerator
(12) Flywheel
(13) Drain plug

* The pictures show the locations of the major external engine components, the filters, and other service and maintenance points. Some external components will be at different locations for different engine models.

NOTE
• **The pictures are only a reference to show a typical engine.**

2. MAIN FUNCTION AND PERIODIC CHECK

2.1 PERIODIC CHECKLIST

Periodic checks and maintenance are very important for keeping the engine in optimum condition. The check contents and timing are indicated in the table below. Be sure to observe.

PART	ITEM		DAILY	EVERY 50HRS	EVERY 250HRS	EVERY 500HRS	1000HRS OR 1YR	2000HRS OR 2YR
Fuel Oil System	Check the fuel level and refill		○					
	Clean the fuel tank			○				
	Check fuel filter and water hose		○					
	Fuel filter			○				
	Replace the fuel fiter element					◎		
	Fuel injection valve	Check the injection condition					●	
	Fuel injection pump	Check the injection timing						●
Lubrication System	Check the lubricating oil level		○					
	Replace the lubricating oil			◎ (first)	◎			
	Replace the lubricating oil filter			◎ (first)	◎			
Coolant System	Check the coolant level		○					
	Check the clean the radiator fin for clogging		○		○			
	Replace the coolant					◎		
	Adjust the fan belt tension			○ (first)	○			
	Check for coolant cleaning and maintenance							●
	Check and replace the fuel-related, cooling water pipe		○					●
Intake air System	Clean the air cleaner, Replace Element				○	◎		
	T/C cleaning of the blower						●	
Engine body	Re-tighten the bolts			○ (Check)				●
	Adjusting the in/exhaust valve clearance						●	
	In/exhaust valve lapping							●
ElectricElectrical equipment	Check the warning lamps		○					
	Check the battery liquid level			○				

※ ○: Customer check / ◎: Replacement of part / ●: Check to garage

2.2 CHECK THE MAIN FUNCTION

- Check the main function is the best way for performance guarantee and long life of engine.

  * Please note the following information to the engine to maintain.

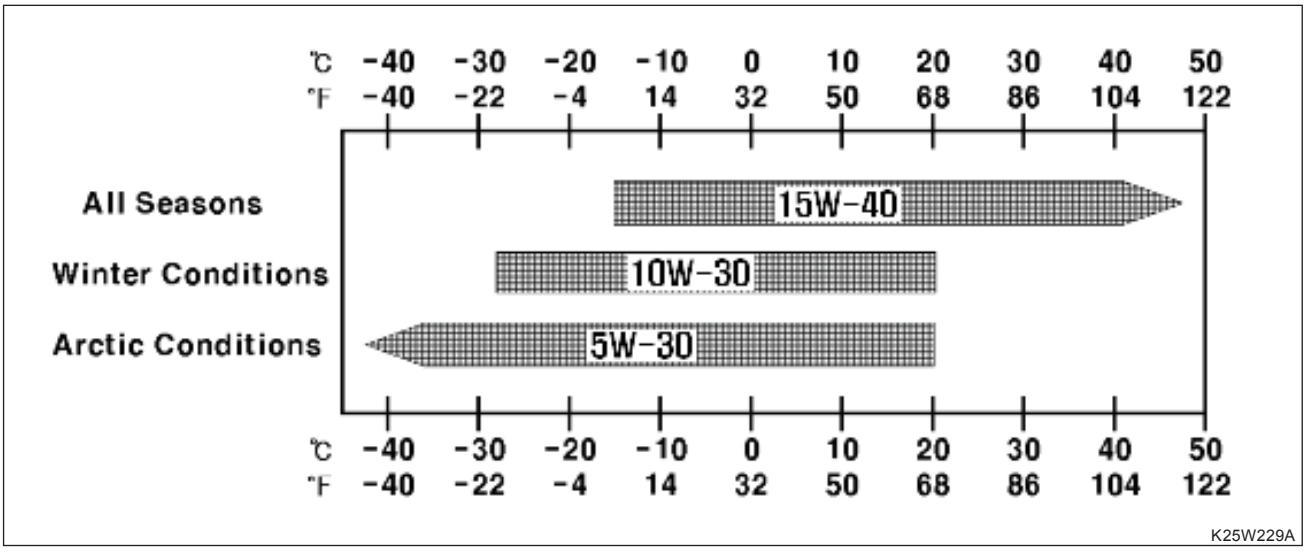
2.2.1 VISUAL INSPECTION

- Visual inspection of the engine around : Check the oil, lubricant and coolant level.
  Worn or damaged belts, clamp.
  Loose or damaged parts.
- If disorder of engine to visual inspection found, Use with repair.

2.2.2 LUBRICATING OIL

- Diesel engines operate under different conditions than gasoline engines, use the correct oil.
- If inferior oil is used or if your engine oil is not changed regularly, accelerated wear of moving components and engine life may be seriously shortened.
- Use the class SAE 15W-40 and API CJ or upper grade oil.

  * Please use the correct oil with next graphic.



- Before engine operating, check the oil level whether it is set at the right level between the L(low) mark the H(high) mark, If necessary, add lubricating oil. If the oil is contaminated or viscosity is low, it should be changed.

  1) While checking the lubricating oil, keep the engine horizontal.

  2) Wait for about 15 minutes after shutting off the engine to check the oil level.

  3) Check the oil level 5~6 minutes later after refilling the lubricating oil.
- Lubricating oil and element replace which at 1st time is after 50hrs operated engine. And then 2nd time and thereafter is every 250hrs.
- Check the lubricating oil often when used in dirty place and replace it.

2.2.3 FUEL

- Use only and approved fuel container. Use only non-metal, portable fuel continers approved by the Underwriter's Laboratory (U.L.) or the American Society for Testing & Meterials (ASTM). If using a funnel, make sure it is plastic and has no screen or filter.

- Replace the fuel filter: every 500hrs.

  If water or dust deposits are in fuel, replace the fuel filter.

- Air bleeding : The fuel system runs from the fuel tank through the fuel filter, fuel injection pump and high pressure piping, to the fuel injection nozzles. Fuel is not injected if there is air in the fuel system.

- Bleed the air according to the following steps.

  1) Loosen the air bleed bolt at top of the fuel filter and push the fuel feed pump until bubbles. Then put clothes near the air bleed bolt for prevent overflow fuel.

  2) If fuel doesn't include bubbles, tighten the air bleed bolts.

  3) Push the pump until tight.

  4) Check the oil leak.

⚠ WARNING

- **Do not smoke or have flammable material around engine.**
- **Extinguish all cigarettes, cigars, pipe and other sources of ignition.**

2.2.4 COOLANT

- Use clean tap water for cooling. Hard water such as from a well causes scale deposits on the coolant system. This reduces the cooling efficiency and raises the coolant temperature too high, causing seizures between the piston and the liner. Use an anticorrosive to prevent rot at summer season and use a coolant to prevent freezing at winter time.
- The anti-freezing liquid to dilute to 40~60% based on the quantity of coolant according to vehicle type.

Coolant (volume %)	30	40	50	60	70
Water	70	60	50	40	30
Freezing point (°C)	-16	-25	-35	-50	-48

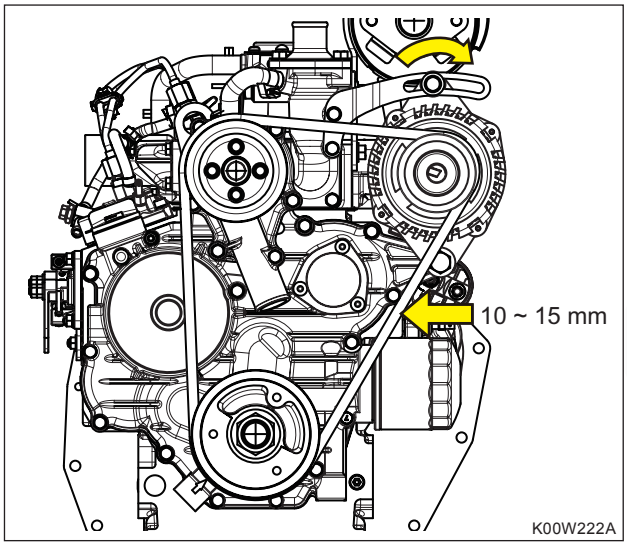
Use antifreeze liquid according to the mixing ratio given by the antifreeze liquid maker to set the temperature 5'c below than the lowest temperature in your area.

- Replace the coolant : Every 500hrs or every 2years.

  Contaminated coolant reduces cooling efficiency so the temperature could be raised too high. This might cause the engine seizure.

- Before operating the engine, always check the amount of coolant in the sub-tank. In addition, check the amount of coolant in the radiator at least once a week. If the coolant is not enough, engine temperature will be raised high. This could be a cause of engine seizure.

2.2.5 V-BELT



- Too much fan belt tension accelerates belt wear, and too little belt tension leaves the pulley idle, overheats the engine, and no power is generated. Adjust the belt tension as follows.

  1) Loosen the adjust bolt, and move the charging generator out wards to increase the tension, or move the charging generator inwards to decrease the tension.

  2) Do not stain the belt with oil. The belt will idle if stained. Wipe off the oil soon.

BELT FLEXION	Within 10~15 mm
CHECK CYCLE	Daily

2.2.6 AIR CLEANER

- Polluted air cleaner is cause which become black in exhaust gas color because it reduce output as well as increase the fuel consumption rate.
- If there is transform, damage, crack in air cleaner, replace it.
- If the engine is operated in dusty conditions for a long time, clean the dust pan and check the element every 50 hours or any time. When cleaning using the compressed air (3~5 kgf/cm^2, 0.294~0.490 MPa, 42.670~71.117 psi), clean from the inside out in air cleaner element.
- Turn the “TOP” side up when installing the dust pan.

2.2.7 RADIATOR

- Check the radiator fan clogging.
- If the fan is clogged, either blow compressed air on the fan or flush the fan with water to remove the dust.
- Check radiator coolant level when the engine is completely cooled.
- If you need long-term storage for the engine, water in the cylinder may cause freezing and crack of the cylinder. Therefore drain the coolant completely before long-term safekeeping of engine.

⚠ WARNING

- **Don’t check the coolant level when coolant in radiator is hot. If you open the radiator cap, you might be scalded because of hot coolant or steam from the radiator.**

2.2.8 BATTERY

Check the electrolyte level and if amount of coolant is insufficiency, fill up with distilled water.

Check the specific gravity of electrolyte, and if less than standard (1.12 ~ 1.28) fill up.

Separate the negative pole terminal first of all when disassembling battery.

Check whether or not the battery terminal loosen and if clean up dirt and corrosion.

⚠ WARNING

1. The electrolyte is the strong sulfuric acid liquid. Therefore please be careful not to stain the body or chassis.

2. Because explosive gases are generated when charging, operate from a place where the aeration goes well and forbid cigarette or flame etc.

3. In the case of contact with skin, flush thoroughly with water and get prompt medical attention.

2.2.9 CHECK EVERY 50HRS.

1. Replace the lubricating oil and oil filter: Replace the lubricating oil and oil filter at the first 50hrs.
2. Remove water in fuel filter.(oil-water separator)
3. Check the batteries.
4. Check the tension of the V belt.

2.2.10 CHECK EVERY 250HRS.

1. Replace the lubricating oil and oil filter : Replace the lubricating oil and oil filter every 250hrs after replacing it at first 50hrs.
2. Check & cleaning the radiator pin.
3. Clean the air cleaner.
4. Check the tension of the V belt.

2.2.11 CHECK EVERY 500HRS.

1. Replace the fuel filter : Replace the fuel filter every 500hrs after replacing it at first 50hrs.
2. Replace the antifreeze coolant.
3. Replace the air cleaner elements.

2.2.12 CHECK EVERY 1,000HRS.

1. Clean the turbocharger blower.

- If engine rotation is worsened or exhaust color is worsened, blower of turbocharger is considered to have been contaminated. In this case, clean the blower with the blower washer.
- Cleaning tips

  1) The blower washer pours amount of standard into the air inlet in sector of 3/4 ~ 4/4 load & number of rotation of the engine. (20cc per 1 time)

  2) After pouring the blower washer 3~5minutes later, clean the blower by pouring the clean water to 20cc.

⚠ WARNING

- **Please note that pouring rapidly large amount of blower washer into the turbocharger can cause an accident.**

  3) If exhaust temperature or boost pressure is not changed after cleaning, repeat the cleaning 10minutes later.

     The case which there is still no change 3~4 times later, there are other causes. Therefore disassemble and maintain.

  4) After cleaning, operate engine in load condition at least 15 minutes in order to dry.

2. Check & correct the injection pressure of injector and the spray condition.(See page 2-72 and call service center)
3. Correct the valve clearance (See page 2-42 and call service center)

2.2.13 CHECK EVERY 2,000HRS.

1. Cleaning & maintenance of the coolant path: Parts related coolant path such as radiator, water pump, cylinder block and head, oil cooler etc. cause cooling efficiency decrease by long-term use. Therefore cleaning & maintenance is required.
2. Check & replace the fuel pipe and coolant pipe: Check the hose class used in the fuel pipe or coolant pipe etc, and the blazing or defected parts replace. Although replacement timing is not reached, hose class replace once every 2 years.
3. Rapping of intake/exhaust valve: Do maintenance to ensure the leak tightness of the cylinder head.
4. Correct the injection timing and check& correct the injection pump.(Call service center)

3. DEFECT DIAGNOSIS AND MANAGEMENT

	TROUBLE	CAUSE	REPAIRING
Engine difficult to start	Operate starter switch but solenoid does not engage	1) Lack of battery capacity.	1) If discharged, change or replace. 2) If lack of the capacity is because of the cold weather, raise slowly the temperature, or charging, replace.
		2) Connection of battery cable is loosen, broken, or corroded. (excessive resistance)	Correction.
		3) Failure of spline which gets in gear pinion of the armature shaft.	Correct the spline.
		4) Failure of the magnetic switch plunger. Or coil disconnection and short.	Correction or replace.
		5) Key-switch circuit is malfunctioning	Correction or replace.
		6) Starter brush failure.	Disassembly and clear, broken components is replaced.
	Pinion engages with ring gear but does not rotate starter.	1) Lack of battery capacity.	1) If discharged, change or replace. 2) If lack of the capacity is because of the cold weather, raise slowly the temperature, or charging, replace.
		2) Disconnection of cable that connect the battery and magnetic switch. Or tightening failure of the connecting wire that connect magnetic switch and terminal of motor.	Correction.
		3) Gearing failure of pinion and ring gear.	Correct or replace the pinion.
		4) Starter failure.	Correction or replace.
		5) Tightening failure of batteries code connection area.	Re-tighten.
	Pinion does not engage with ring gear and does rotate.	1) Starter installation failure.	Re-installation.
		2) Failure of plunger & dimensions adjustment.	Correction
		3) Pinion sleeve spring failure.	Replace.
	The pinion engages with the ring gear and starter is rotated. But engine does not rotate.	1) Overrunning clutch failure.	Replace.
		2) Engine internal failure.	Repair.

TROUBLE		CAUSE	REPAIRING
Engine difficult to start	Engine starts but will not keep running	1) There is not fuel in the fuel tank.	Fill the supply tank.
		2) Air inhalation in the fuel system	Air bleeding.
		3) Fuel element clogging.	Clean or replace.
		4) Air inhalation in injection pump.	Air bleeding.
		5) The electricity does not flow in the fuel cut solenoid valve of injection pump.	Confirm the presence of electricity when key-switch is “ON”. If necessary, check the fuse or wire.
		6) Loose or failure of fuel cut solenoid valve in injection pump.	Re-tighten the solenoid valve, check the operation sound when turn On, Off the key-switch. Replace the failed solenoid.
		7) Injection pump failure	Correction or replace.
		8) Connection area of high pressure pipe is loose.	Re-tighten.
		9) Injection pump sticking.	Correction or replace.
		10) Spray failure of Injection valve.	Correction or replace.
		11) Inappropriate injection pressure.	Correction.
		12) Glow plugs failure.	Correction or replace.
		13) Compress pressure failure. - Closing of valve failure - Cylinder gasket packing failure - The piston, piston ring, cylinder wear	Check the valve and valve seat. Correction Replace Replace
	Start the engine, but it will stop soon	1) Fuel pipe clogged or filter polluted.	Cleaning.
		2) Air inhalation in fuel.	Air bleeding.
		3) Clogging of the air hole in the fuel tank cap.	Correction.
Idle condition failure.		1) Maladjustment of the accelerator lever.	Correct acceleration lever and cable
		2) Air inhalation in injection pump.	Air bleeding
		3) Injector failure	Correction or replace
		4) Injection timing failure	Correction
		5) Injection pump failure.	Correction or replace

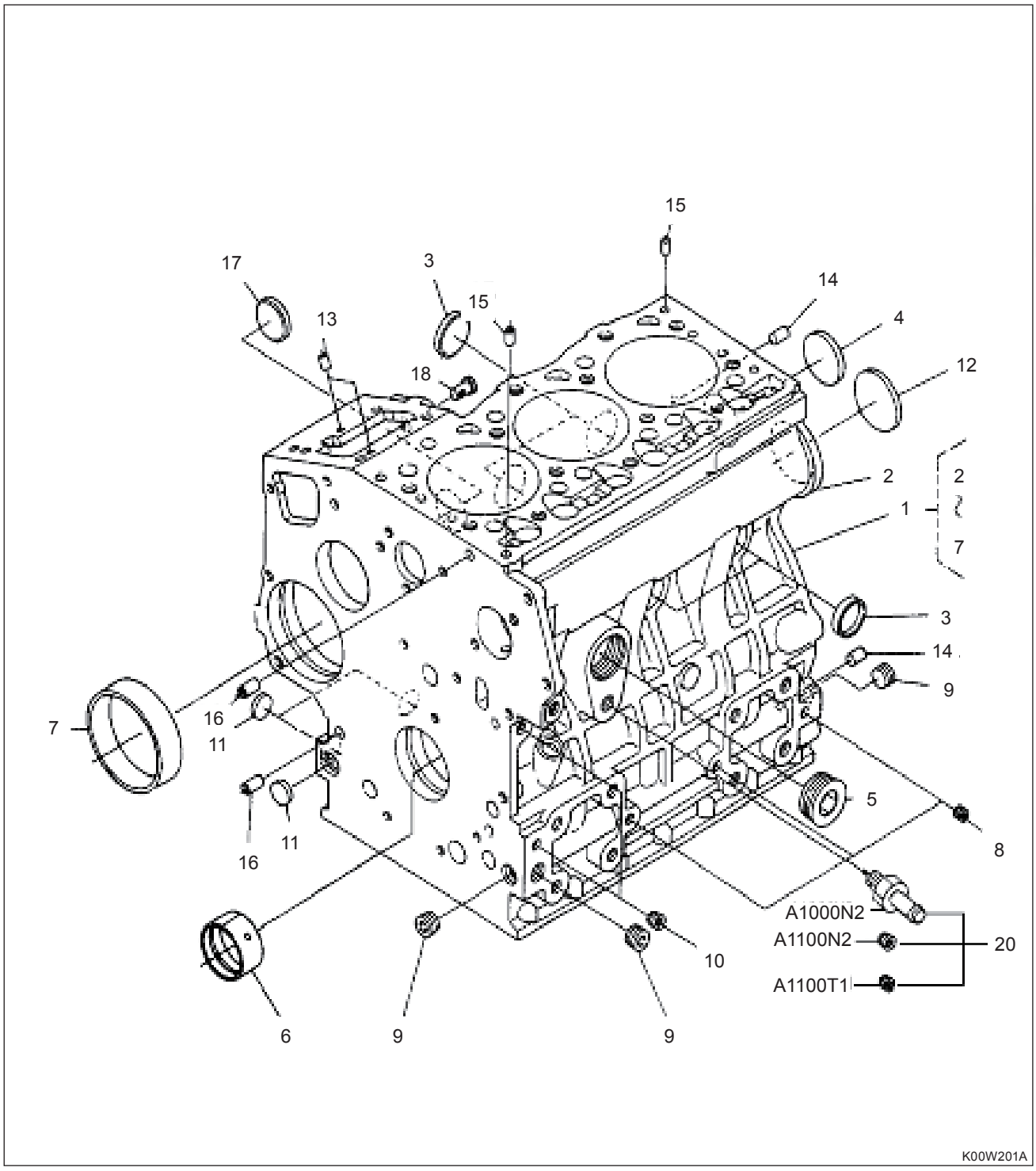
TROUBLE	CAUSE	REPAIRING
Engine power output low.	1) Improper valve clearance	Correction
	2) Adhesion failure of the valve.	Check the valve and valve sheet
	3) Cylinder head gasket gas leak.	Replace the gasket.
	4) Wearing to piston, sticking and breakage.	Replace the piston ring
	5) Air intake quantity shortage.	Clean the element in air cleaner.
	6) Injection timing failure	Correction
	7) Fuel injection quantity shortage.	Correct the pump flow rate.
	8) Injection pressure failure or sticking	Adjusting or replace the injector
	9) Clogging the fuel pipe system.	Correction.
	10) Air inhalation in fuel.	Air bleeding.
	11) Water inhalation in fuel.	Replace the fuel.
	12) Freezing and solidity wax status of fuel line.	After putting in warm garage until freezing or wax disappears, operate the air bleeding.
	13) Injection pump failure.	Replace the injection pump.
	14) Turbocharger failure.	Repair or replace.
Engine overheat	1) Coolant shortage or foam forms.	Refill or clean up.
	2) Fan is loose, damage, or not balanced.	Correction or replace.
	3) Water pump performance degradation.	Correction or replace.
	4) Valve clearance unsuitable.	Correction.
	5) Resistance increase in exhaust system.	Clean up or Replacement.
	6) Clogging the radiator air path.	Clean up.
	7) Inappropriate injection timing.	Correct the injection timing.
	8) Cylinder head gasket breakage.	Replace the head gasket..
	9) Shortage or failure the lubricating oil.	Refill or Replacement..

TROUBLE		CAUSE	REPAIRING
Engine noise excessive	Crankshaft metal	1) Oil clearance increase by wearing the metal or crankshaft.	Replace the metal or polishing the crankshaft.
		2) Eccentricity wearing to crankshaft.	Polishing or replace the crankshaft.
		3) Seizure of metal.	Replace the metal or polishing the crankshaft.
	Connecting rod metal	1) Wearing to crankshaft pin metal.	Replace the metal.
		2) Wearing to crankshaft pin.	Replace the crankshaft.
		3) Bending to connecting rod.	Correction or replace.
		4) Seizure of crankshaft pin metal.	Replace the metal or polishing the crankshaft.
		5) Oil supply shortage by clogging the oil line.	Clean the oil line
	Piston, Piston pin and piston ring	1) Piston clearance increase piston by wearing the piston and piston ring.	Replace piston and piston ring.
		2) Wearing the piston pin dia. and piston pin.	Replace.
		3) Wearing to piston.	Replace.
		4) Piston wear or failure.	Replace.
		5) Piston ring failure.	Replace.
	others	1) Wearing to crankshaft, thrust bearing.	Replace the thrust bearing.
		2) Excessive backlash of timing gear.	Replace the timing gear.
		3) Excessive valve clearance.	Correct the Valve clearance.
		4) Wearing to valve part.	Correction or replace.
		5) Water pump bearing failure.	Replace the pump.
		6) Damage to turbocharger inside.	Correction and replace.
Fuel consumption excessive		1) Fuel leak.	Check and if necessary, replace the all pipe and re-tighten connection area.
		2) Clogging the return pipe or hose.	- If lines were clogged, execute the air bleeding after boring the compressed air. - Check for twisted or crushed return line. Replace if deflection.
		3) Inappropriate injection timing.	Correction.
		4) Check the compression pressure.	Correction or replace.
		5) Injection valve failure.(spray, pressure, etc)	Correction or replace.
		6) Injection pump failure.(excessive injection quantity)	Correction or replace.
		7) Check the head gasket.	Replace.

TROUBLE		CAUSE	REPAIRING
Lubricating oil consumption excessive	Oil up	1) Cylinder and piston excessive clearance.	Replace.
		2) Wearing to piston ring, ring groove.	Replace the piston ring.
		3) Inappropriate piston ring setting inlet location.	Correct the location.
		4) Clogging the air breather	Clean up.
		5) Excessive refill of lubricating oil.	Correction.
	Oil Down	1) Loosing the valve stem and valve guide.	Replace.
		2) Cylinder head gasket failure.	Replace the gasket.
		3) Valve stem seal failure.	Replace.
	Oil leak	1) Connection area loosing in each part.	Tighten.
		2) Packing failure in each part.	Replace the packing.
		3) Oil seal failure.	Replace the oil seal.
Lubricating oil pressure drop		1) Inappropriateness of the fuel quality.	Replace the specified oil.
		2) Pressure-control valve failure.	Replace.
		3) Wearing to oil pump.	Replace.
		4) Oil pipe failure.	Correction or replace.
		5) Wearing to crank metal or crank pin.	Metal replace.
Engine knocking		1) Mismatch the injection timing.	Correction.
		2) Injection pressure failure.	Correction.
		3) Failure of the injection function.	Disassembly& Correction.
		4) Shortage of the intake air.	Clean the air cleaner.
		5) Lubricating oil enter into the combustion chamber. - Oil up. - Oil down. - Oil viscosity is low.	 Correction. Correction. Replace the appropriate oil.
		6) Engine temperature is low.	Warm-up.
Smoke excessive	White exhaust smoke	1) Injection timing is late.	Correction.
		2) Compression pressure is low.	Correction.
		3) Water inhalation in fuel.	Replace.
		4) Air intake quantity shortage.	Correction.
		5) Lubricating oil enter into the combustion chamber.	Correction.
	Black exhaust smoke	1) Injection timing is too late.	Correction.
		2) Becoming overload.	Correct the appropriate load.
		3) Injection quantity is too many.	Injection limit spring failure.
		4) Injection unevenness	Correction.
		5) Spray failure of the injection valve.	Correction or replace.
		6) Intake air shortage	Clean the Air-cleaner.

4. SECTIONAL VIEW FOR MAJOR COMPONENTS

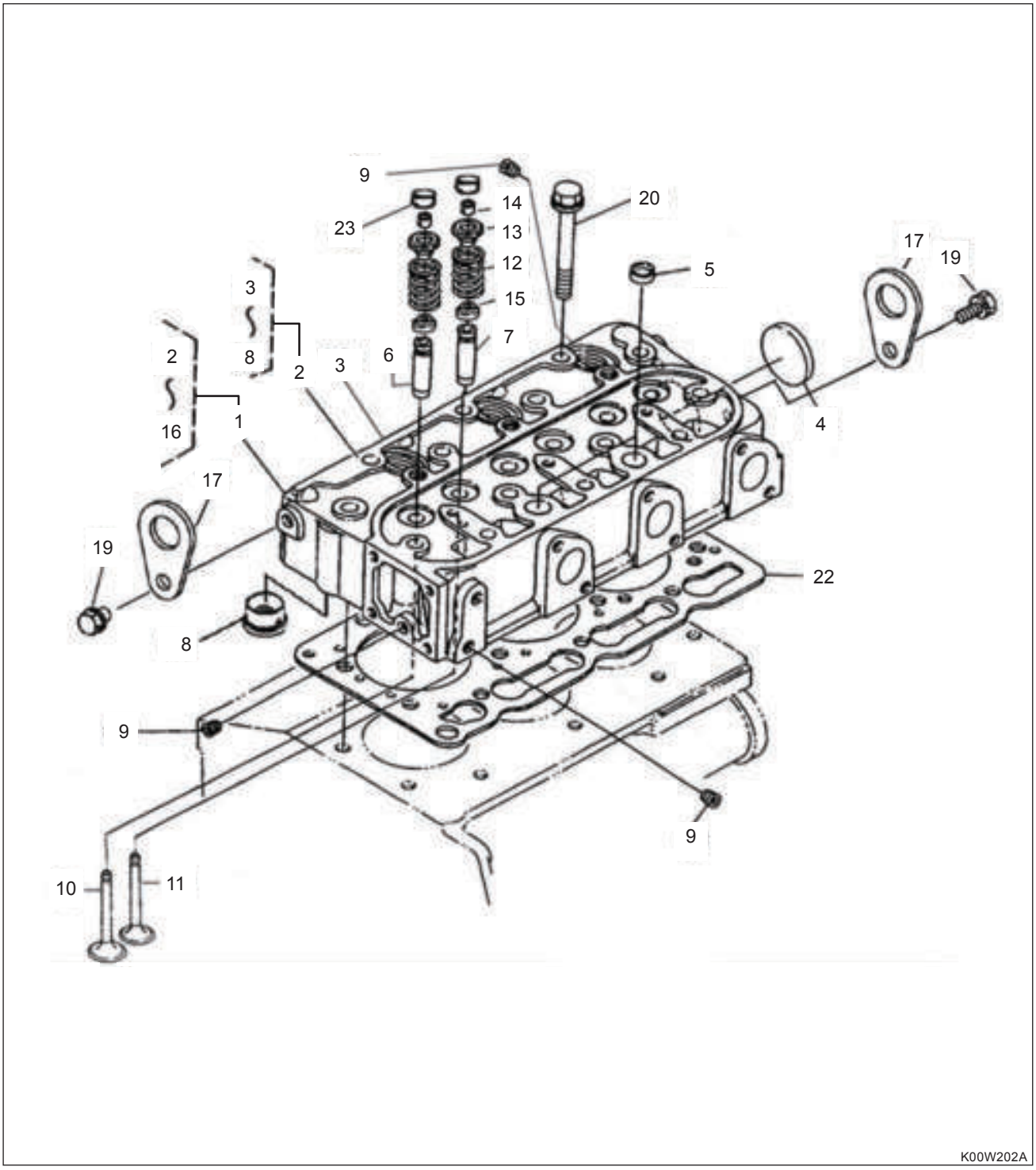
4.1 CYLINDER BLOCK



COMPONENTS

(1) Comp. block, cylinder
(2) Block, cylinder
(3) Plug, expansion
(4) Plug, expansion
(5) Plug, threaded
(6) Bushing, main
(7) Bushing, governor
(8) Plug, pipe
(9) Plug, pipe
(10) Plug, pipe
(11) Plug, expansion
(12) Plug, expansion
(13) Pin, dowel
(14) Pin, dowel
(15) Pin, spring
(16) Pin, pipe
(17) Cap, sealing
(18) Pin, stater spring
(20) Nipple, plain joint

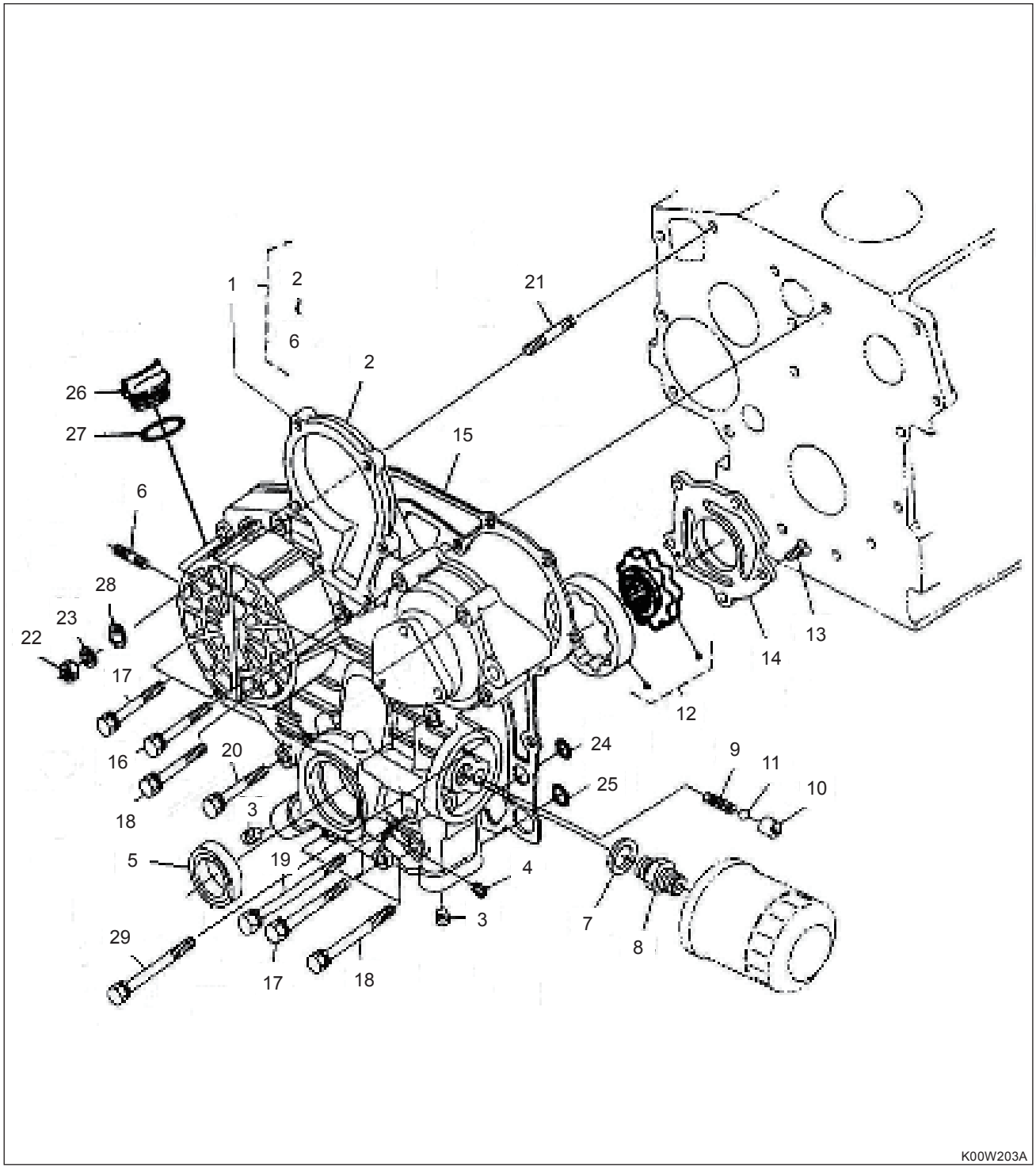
4.2 CYLINDER HEAD



COMPONENTS

(1) Comp. head, cylinder
(2) Comp. head, cylinder
(3) Head, cylinder
(4) Plug, expansion
(5) Plug, expansion
(6) Guide, inlet valve
(7) Guide, exhaust valve
(8) Chamber, injection
(9) Plug, pipe
(10) Valve, inlet
(11) Valve, exhaust
(12) Spring, valve
(13) Retainer, valve spring
(14) Collect, valve spring
(15) Seal, valve stem
(17) Hook, engine
(19) Bolt
(20) Bolt, cylinder head
(22) Gasket, cylinder head
(23) Cap, valve

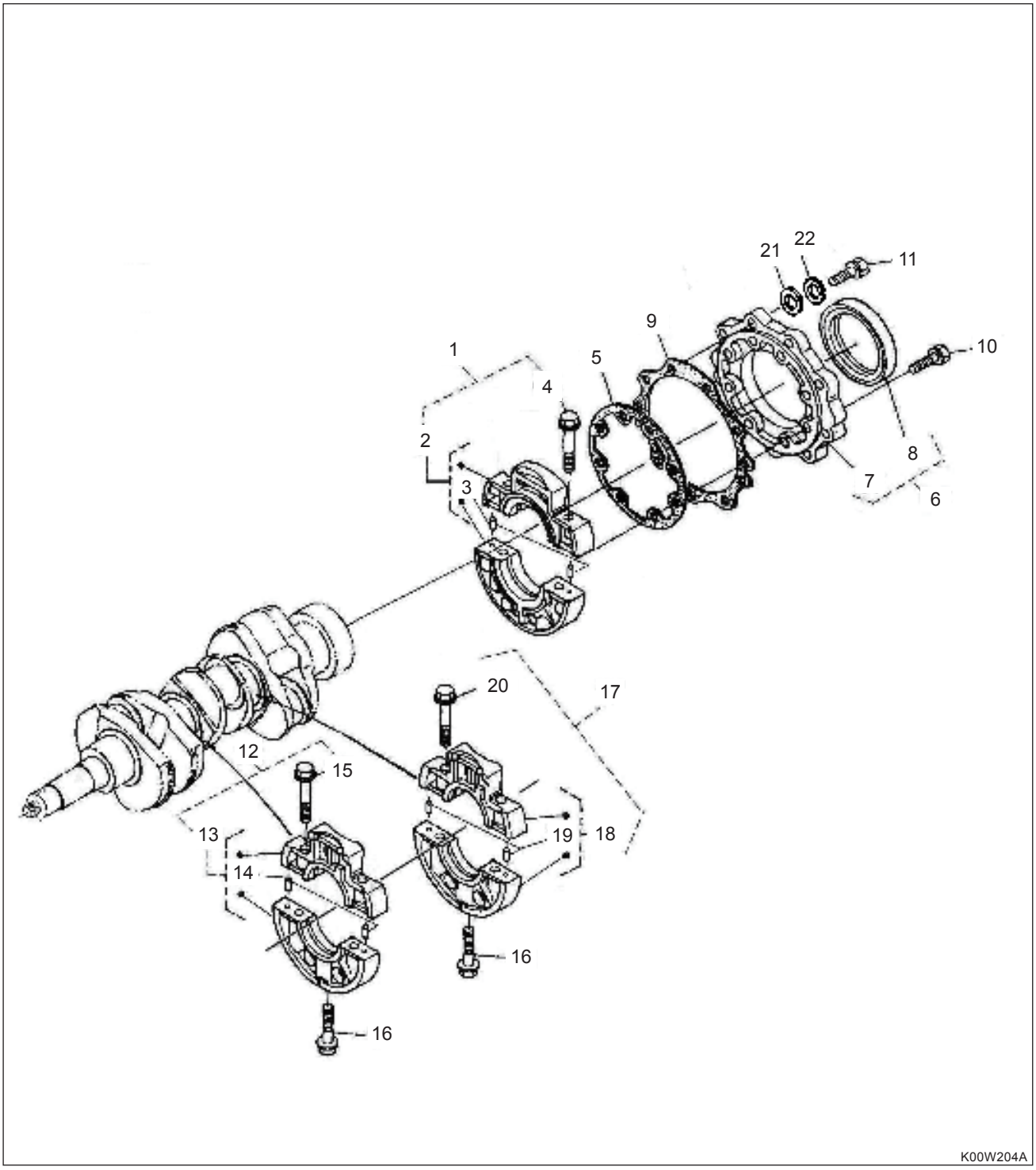
4.3 GEAR CASE



COMPONENTS

(1) Comp.Case gear
(2) Case, gear
(3) Plug, expansion
(4) Plug, expansion
(5) Seal, oil
(6) Stud
(7) Washer, plain
(8) Pipe, joint
(9) Spring
(10) Seat
(11) Ball, steel
(12) Ass'y rotor, oil pump
(13) Screw
(14) Cover, oil pump
(15) Gasket, gear case
(16) Bolt
(17) Bolt
(18) Bolt
(19) Bolt
(20) Bolt
(21) Stud
(22) Nut
(23) Washer, lock
(24) Seal, o-ring
(25) Seal, o-ring
(26) Cap, filler
(27) Seal, o-ring
(28) Washer, plain
(29) Bolt

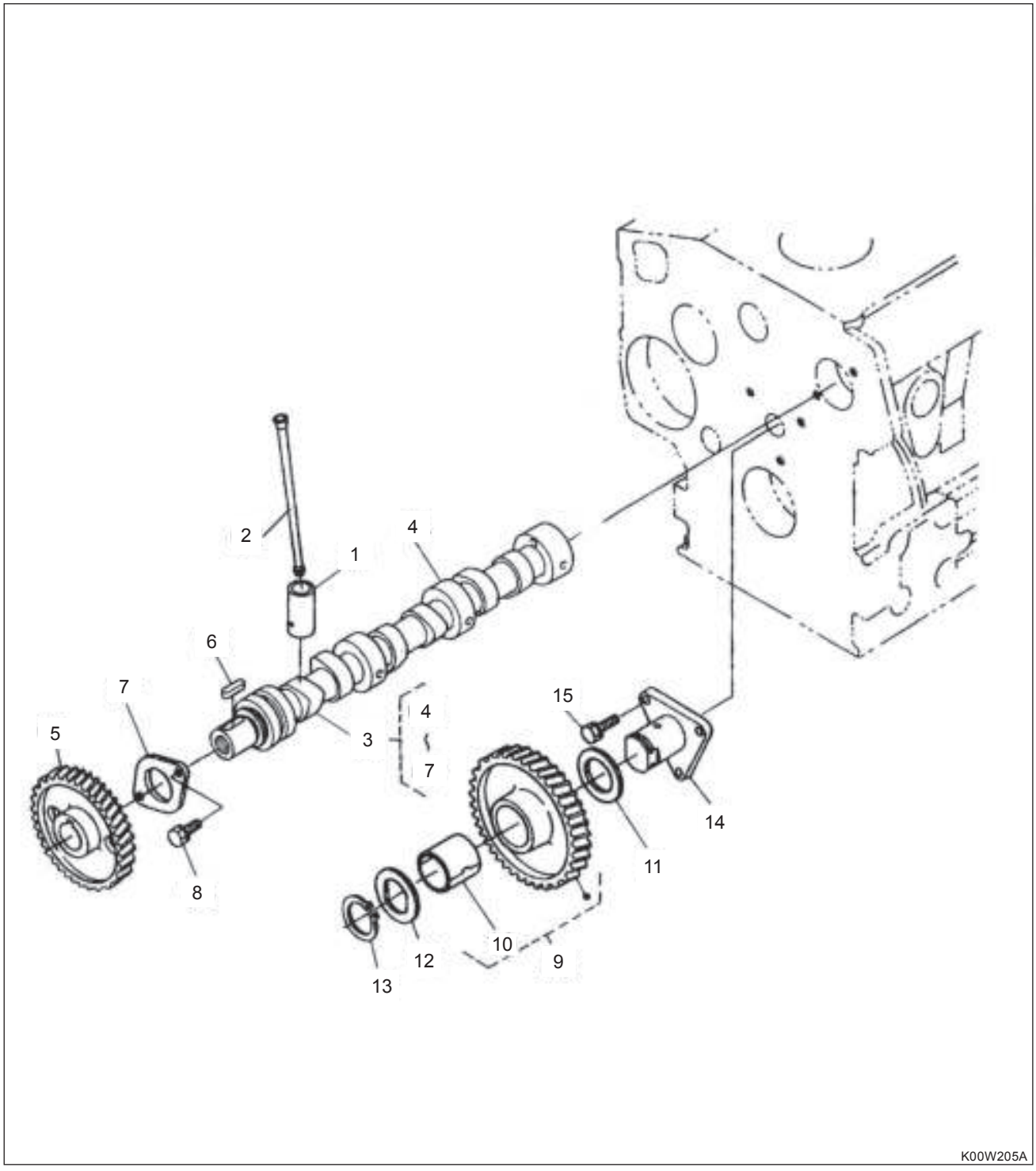
4.4 MAIN BEARING CASE



COMPONENTS

(1) Ass'y case (A), main BRG.
(2) Case (A), main BRG.
(3) Pin, dowel
(4) Bolt_1, BRG. Case
(5) Gasket, BRG. Case
(6) Ass'y cover, BRG. Case
(7) Cover, BRG. Case
(8) Seal, oil
(9) Gasket, BRG. Case cover
(10) Screw, captive washer cap
(11) Screw, captive washer cap
(12) Ass'y case (C), main BRG.
(13) Case (C), main BRG.
(14) Pin, dowel
(15) Bolt_1, BRG. Case
(16) Bolt_2, BRG. Case
(17) Ass'y case (B), main BRG.
(18) Case (B), main BRG.
(19) Pin, dowel
(20) Bolt_1, BRG. Case
(21) Washer, plain
(22) Washer, spring

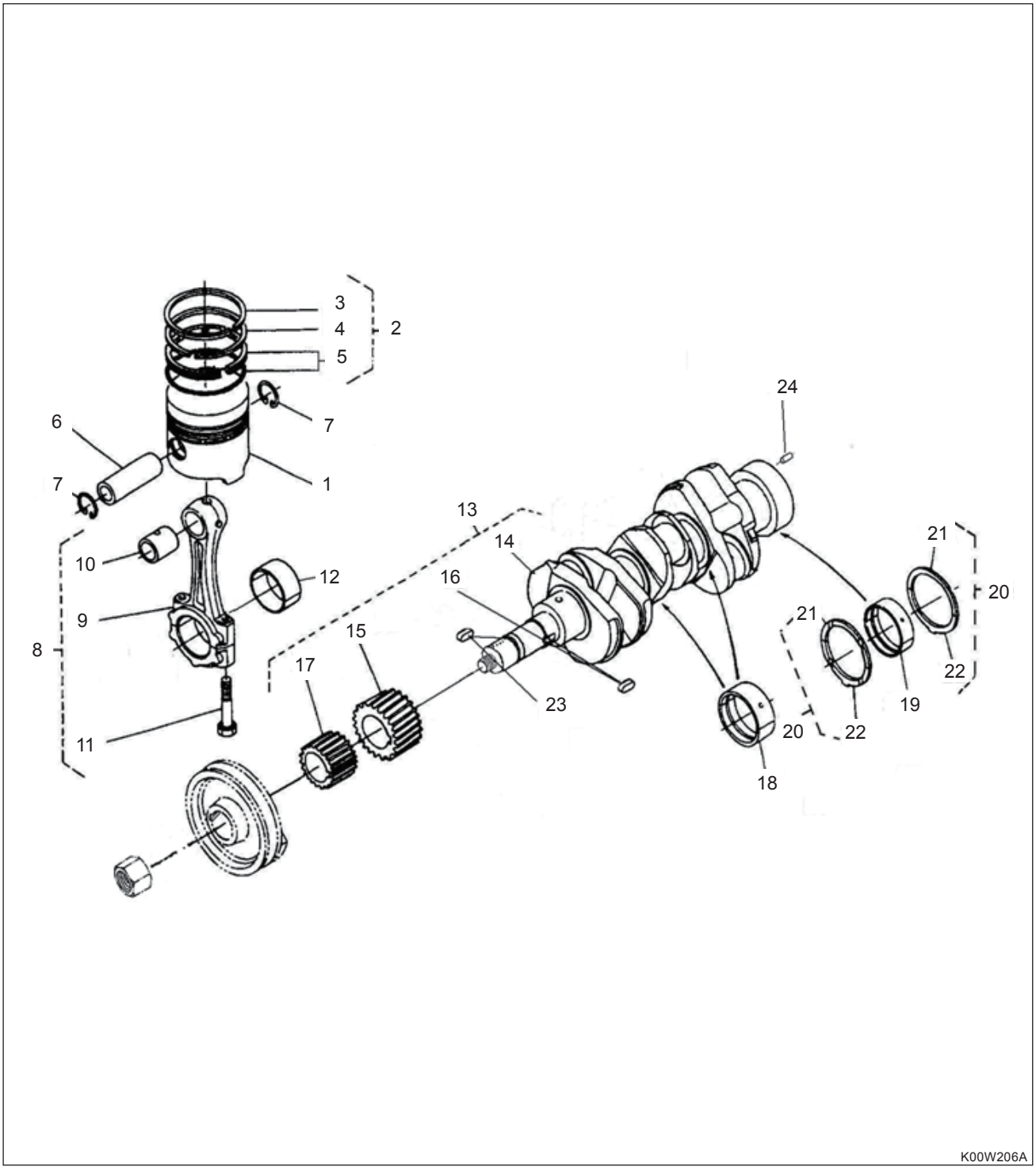
4.5 CAM SHAFT & IDLE SHAFT



COMPONENTS

(1) Tappet
(2) Push rod
(3) Comp. camshaft
(4) Camshaft
(5) Gear, camshaft
(6) Key, square
(7) Stopper, camshaft
(8) Bolt
(9) Comp. gear (A), idle
10 Bush, idle gear
(11) Collar_1, idle gear
(12) Collar_2, idle gear
(13) Cir. clip, idle gear
(14) Shaft (A), idle gear
(15) Bolt

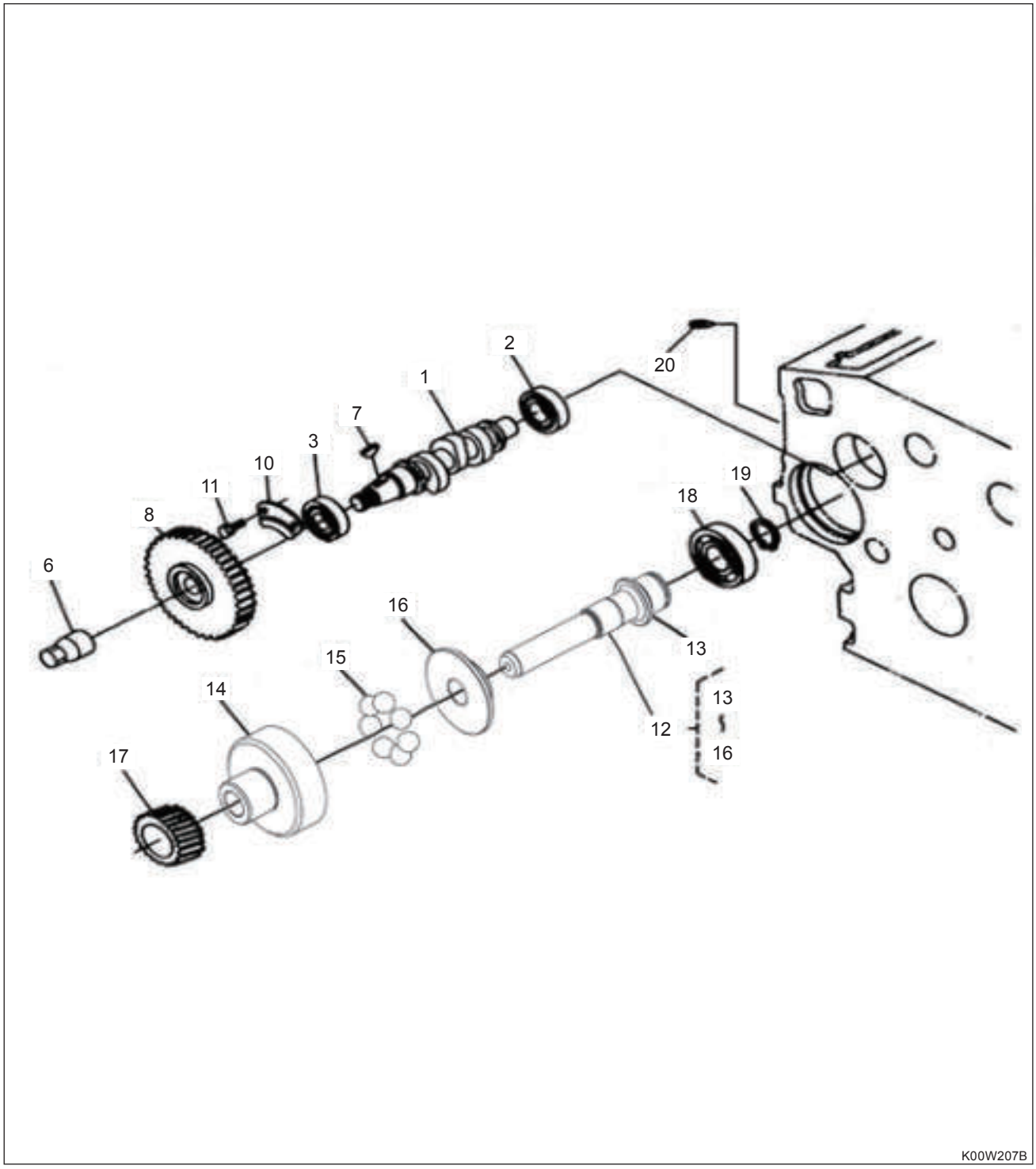
4.6 PISTON & CRANK SHAFT



COMPONENTS

(1) Piston
(2) Comp. ring, piston
(3) Ring (1st), piston
(4) Ring (2nd), piston
(5) Ring, oil
(6) Pin, piston
(7) Cir. clip, piston pin
(8) Ass'y connecting rod
(9) Connecting rod
(10) Bushing, piston pin
(11) Bolt, connecting rod
(12) Comp. metal, crankpin
(13) Comp. crankshaft
(14) Crankshaft
(15) Gear, crank shaft
(16) Key, square
(17) Gear, oil pump drive
(18) Ass'y metal (B) crankshaft
(19) Comp. metal (A) crankshaft
(20) Comp. Metal, side
(21) Upper, side metal
(22) Lower, side metal
(23) Key, square
(24) Pin, dowel

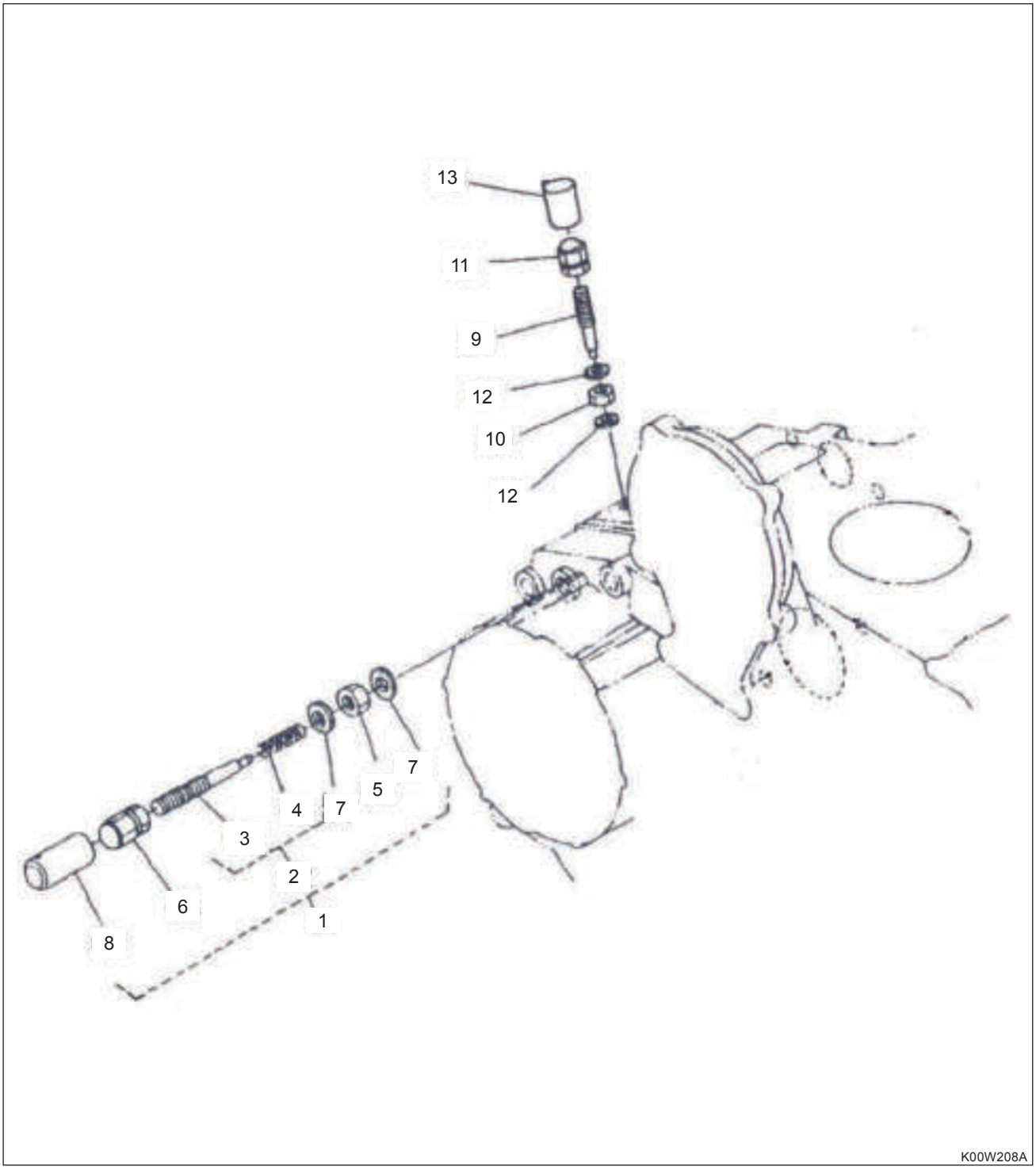
4.7 FUEL CAM SHAFT & GOVERNOR SHAFT



COMPONENTS

(1) Camshaft, fuel
(2) Ball bearing
(3) Ball bearing
(6) Nut, cap
(7) Key, woodruff
(8) Gear, injection pump
(10) Stopper, fuel camshaft
(11) Bolt
(12) Comp. shaft, governor
(13) Shaft, governor
(14) Holder, governor gear
(15) Steel ball
(16) Sleeve, governor
(17) Gear, governor
(18) Ball bearing
(19) Cir. clip, governor shaft
(20) Screw (A), set

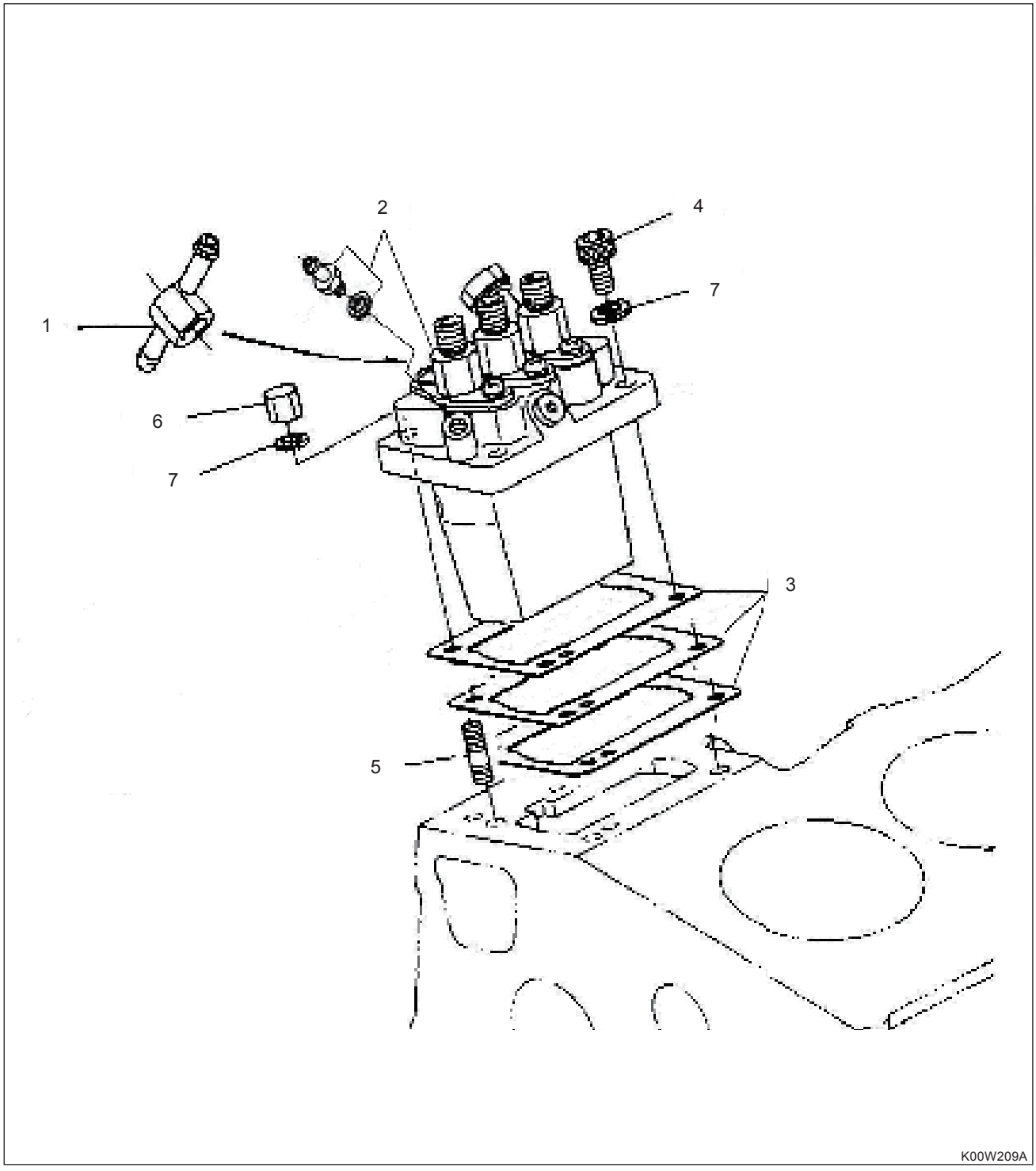
4.8 IDLE APPARATUS



COMPONENTS

(1) Comp. apparatus, idle
(2) Comp. bolt, adjusting
(3) Bolt (A), adjusting
(4) Spring, adjusting
(5) Nut
(6) Nut, cap
(7) Packing
(8) Cap
(9) Bolt (B), adjusting
(10) Nut
(11) Nut, cap
(12) Packing
(13) Cap

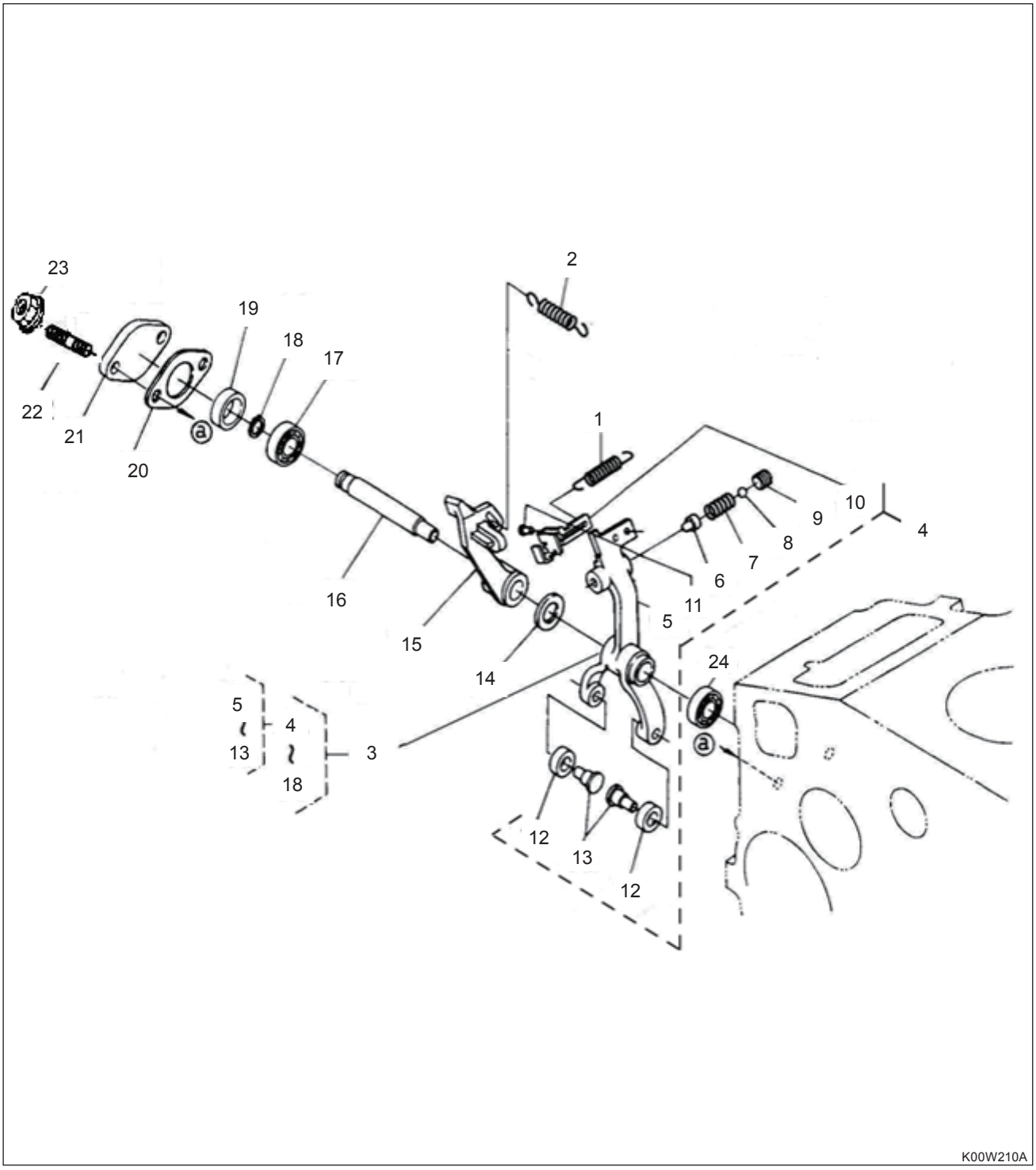
4.9 FUEL INJECTION PUMP



COMPONENTS

(1) Joint, eye
(2) Ass'y pump, injection
(3) Comp. shim, injection pump
(4) Bolt
(5) Stud
(6) Nut, cap
(7) Washer, lock

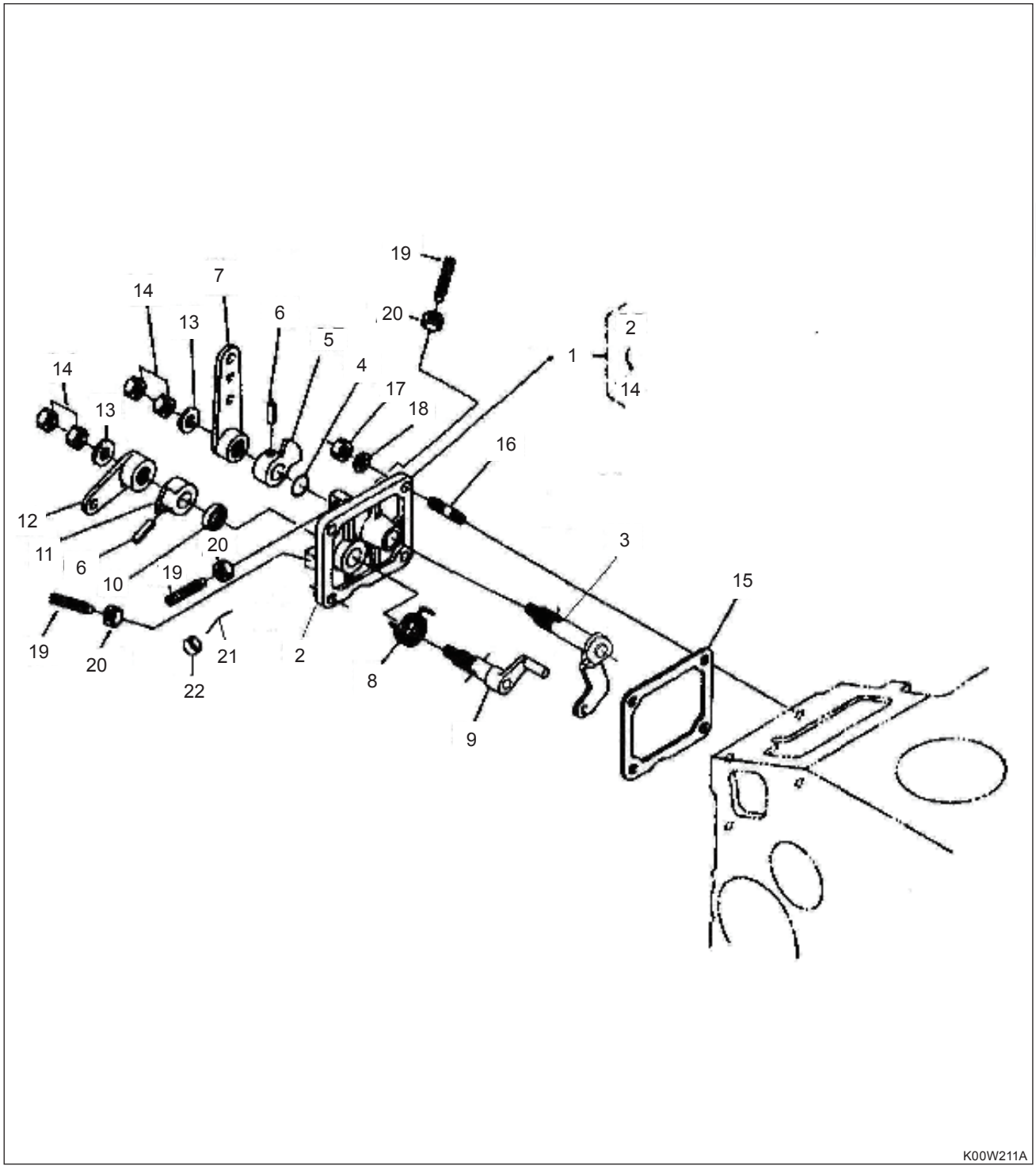
4.10 GOVERNOR



COMPONENTS

(1) Spring, start
(2) Spring (A), governor
(3) Comp. lever, fork
(4) Ass'y lever (A), fork
(5) Lever (A), fork
(6) Pin
(7) Spring
(8) Ball, steel
(9) Screw (B), set
(10) Lever, thrust
(11) Pin (A)
(12) Roller
(13) Pin (B)
(14) Washer, plain
(15) Lever (B), fork
(16) Shaft, fork lever
(17) Bearing 699, miniaturize
(18) Cir. clip, external
(19) Collar
(20) Packing
(21) Cover, fork lever shaft
(22) Stud
(23) Nut, hexagon flange
(24) Bearing 698, miniaturize

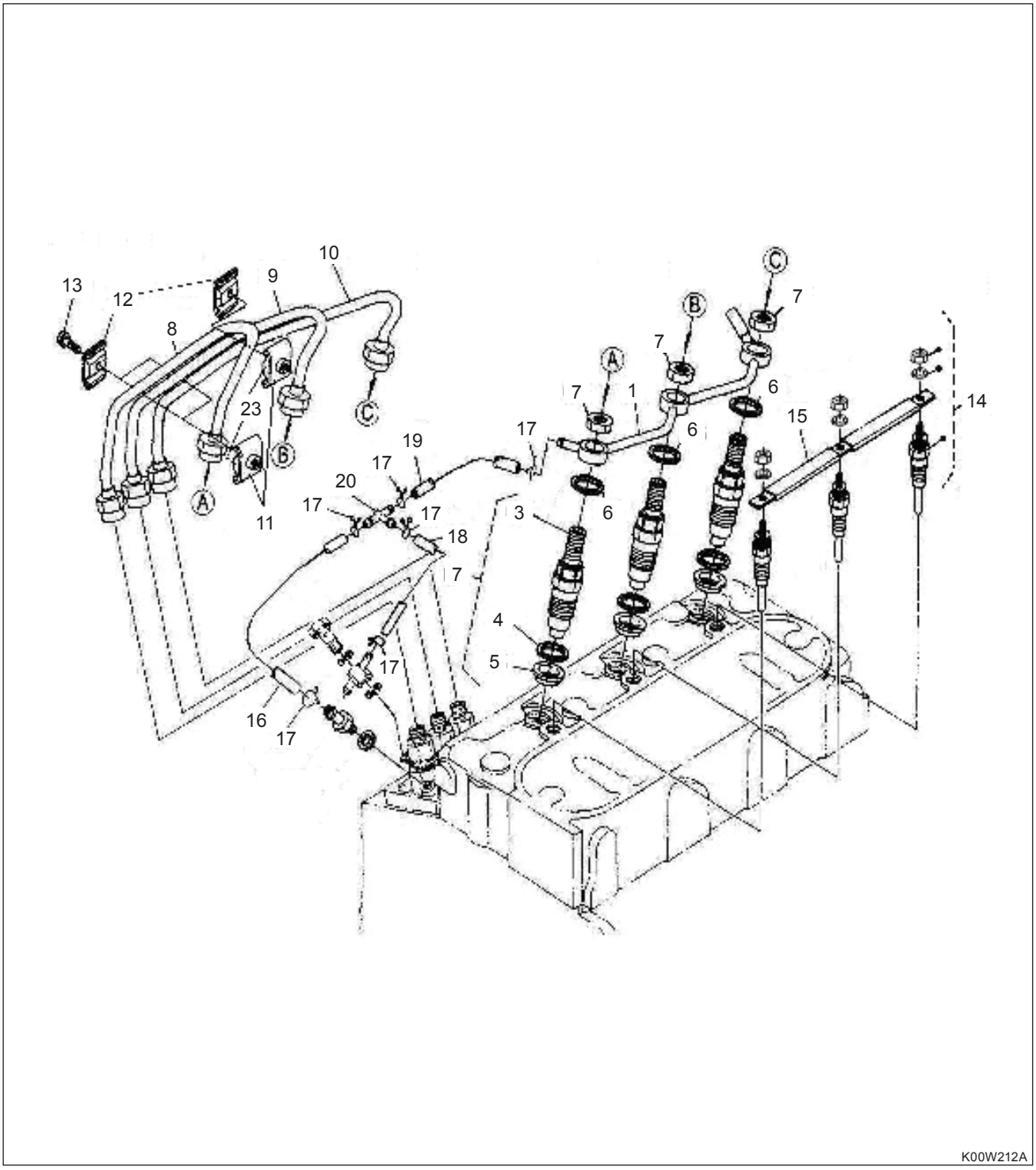
4.11 SPEED CONTROL PLATE



COMPONENTS

(1) Ass'y plate, speed control
(2) Plate, speed control
(3) Ass'y lever, governor
(4) Seal, o-ring
(5) Lever (A), speed control
(6) Pin, spring
(7) Lever (B), speed control
(8) Spring, return
(9) Ass'y shaft, stop lever
(10) Seal, oil
(11) Lever (C), speed control
(12) Lever, engine stop
(13) Washer, plain
(14) Nut
(15) Gasket
(16) Stud
(17) Nut, regular hexagon
(18) Washer, lock
(19) Bolt, adjusting
(20) Nut, regular hexagon
(21) Wire
(22) Lead, sealing

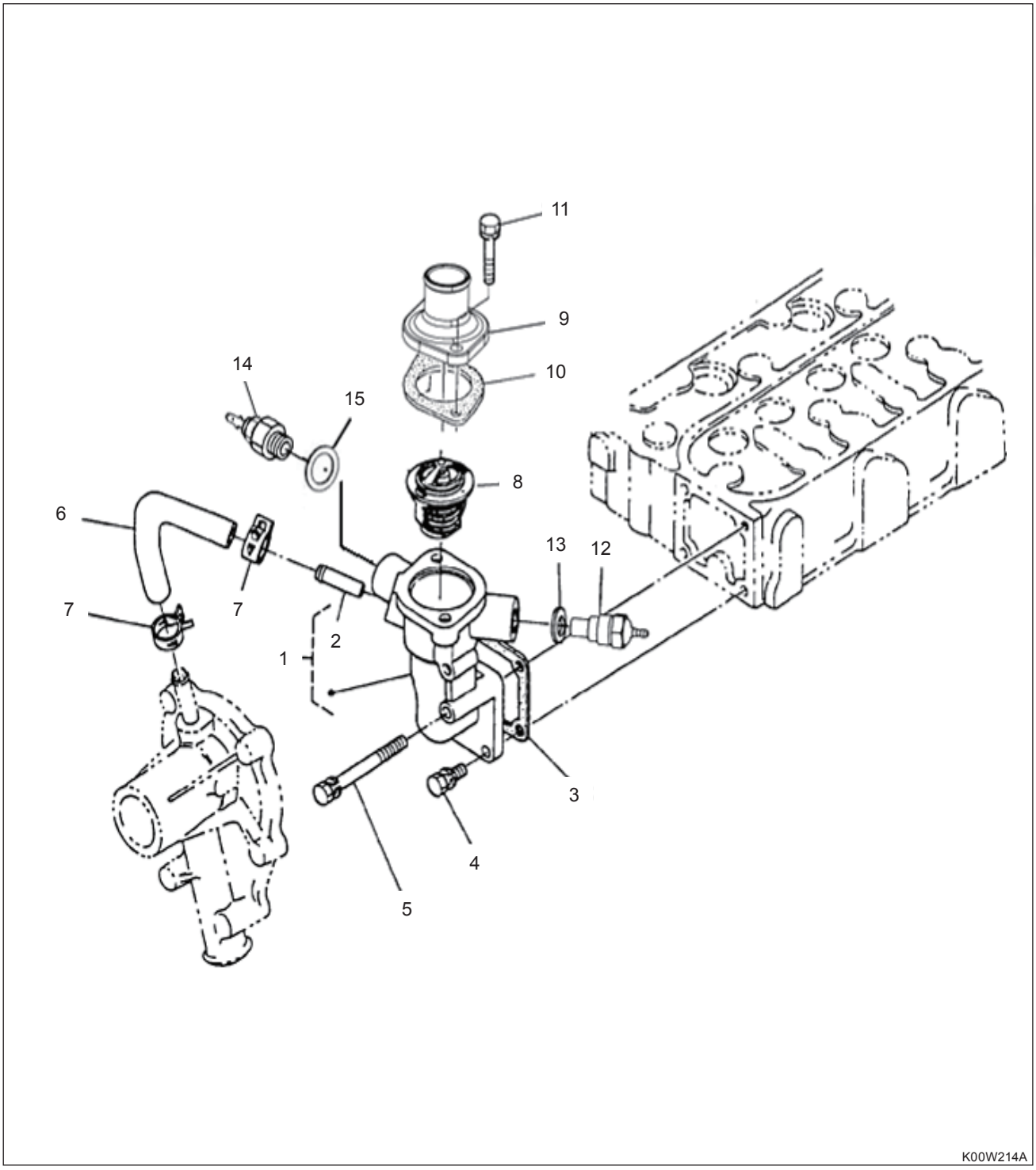
4.12 INJECTOR & GLOW PLUG



COMPONENTS

(1) Ass'y pipe, over flow
(2) Comp, injector
(3) Comp, injector
(4) Seal, gasket
(5) Spacer
(6) Gasket, fuel manifold
(7) Nut, regular hexagon
(8) Pipe (A), injection
(9) Pipe (B), injection
(10) Pipe (C) , injection
(11) Clamp (A), pipe
(12) Clamp (B), pipe
(13) Screw
(14) Plug, glow
(15) Cord, glow plug
(16) Hose (A), over flow
(17) Clip, V band
(18) Hose (B), over flow
(19) Hose (C), over flow
(20) Connector, T

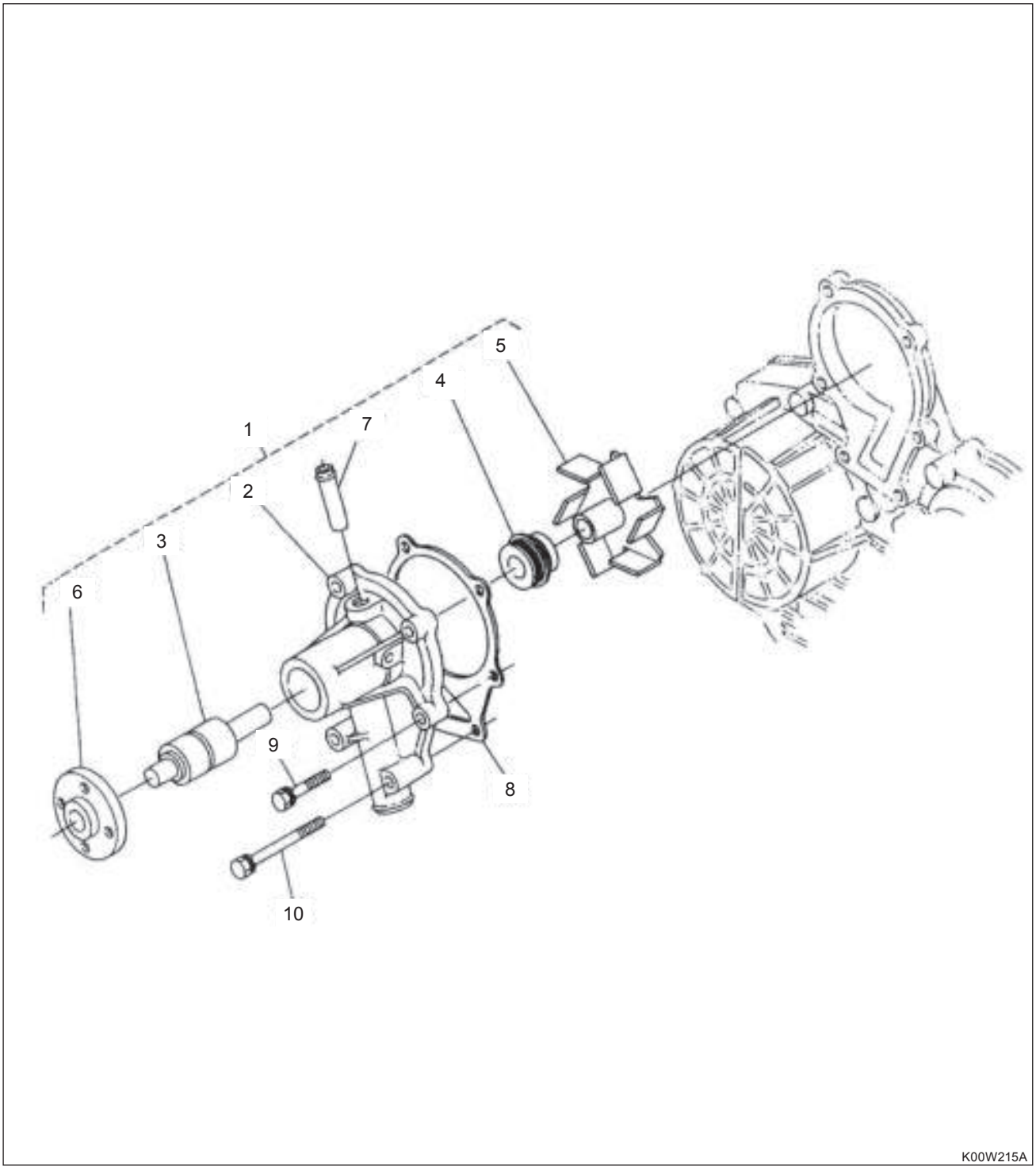
4.13 WATER PUMP FLANGE & THERMOSTAT



COMPONENTS

(1) Ass'y flange, water pump
(2) Pipe
(3) Gasket, W/pump flange
(4) Bolt
(5) Bolt
(6) Hose, water return
(7) Clip, V band
(8) Thermostat
(9) Cover, thermostat
(10) Gasket
(11) Bolt
(12) Sensor, water
(13) Washer, sealing
(14) Sensor, glow plug
(15) Washer, sealing

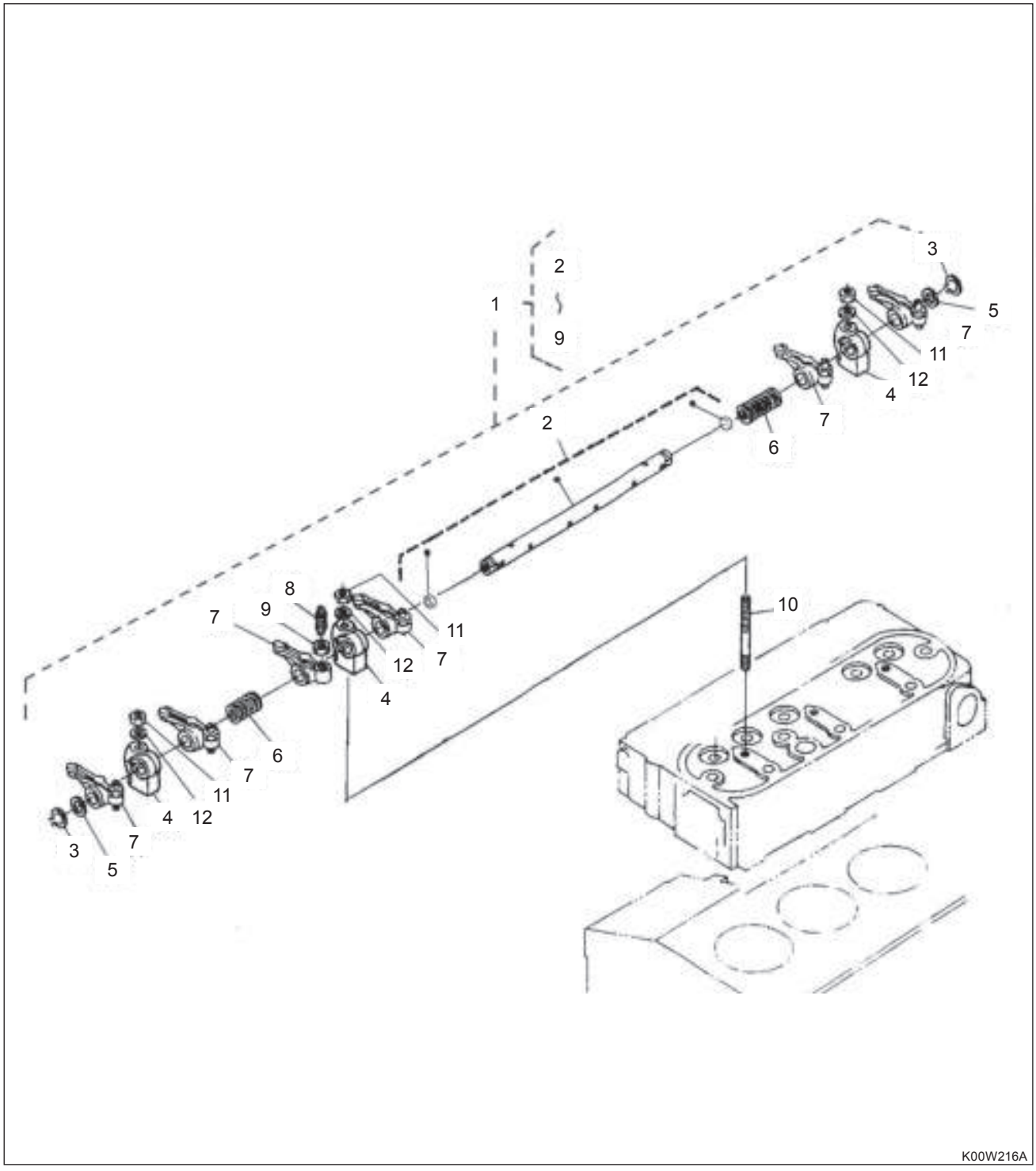
4.14 WATER PUMP



COMPONENTS

(1) Ass'y pump, water
(2) Body, water pump
(3) Bearing, water pump
(4) Seal, mechanical
(5) Impeller, water pump
(6) Flange, water pump
(7) Pipe
(8) Gasket, water pump
(9) Bolt
(10) Bolt

4.15 ROCKER ARM



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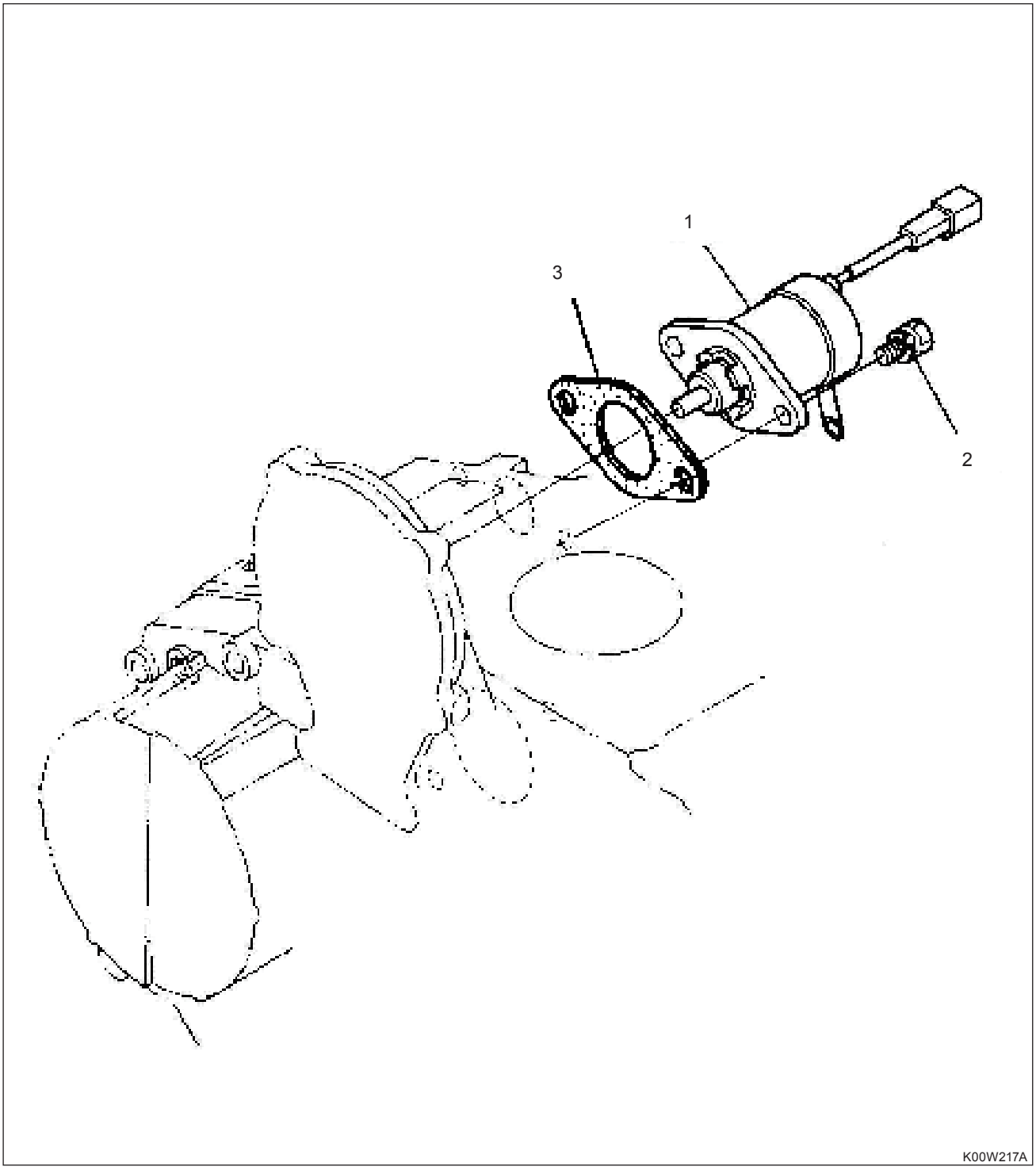
COMPONENTS

(1) Ass'y rocker arm
(2) Ass'y shaft, rocker arm a
(3) Cir. clip
(4) Supporter, rocker arm a
(5) Washer, rocker arm shaft
(6) Spring, rocker arm
(7) Rocker arm
(8) Screw, adjusting
(9) Nut
(10) Stud, rocker arm
(11) Nut, regular hexagon
(12) Washer, plain

4.16 STOP SOLENOID



COMPONENTS

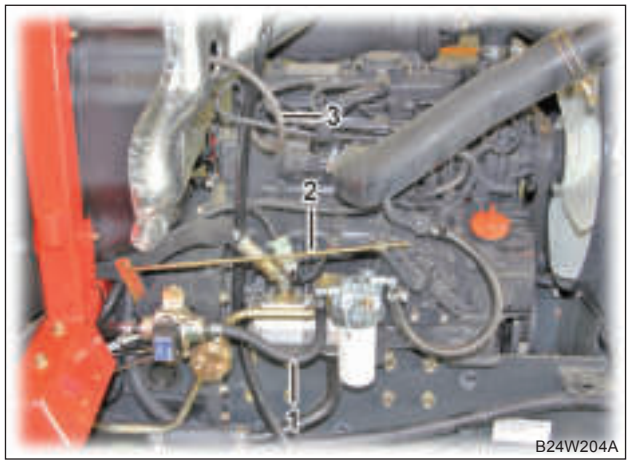
(1) Ass'y solenoid (2) Screw (3) Gasket, ass'y solenoid

5. DISASSEMBLY AND SERVICE

5.1 ENGINE REMOVAL

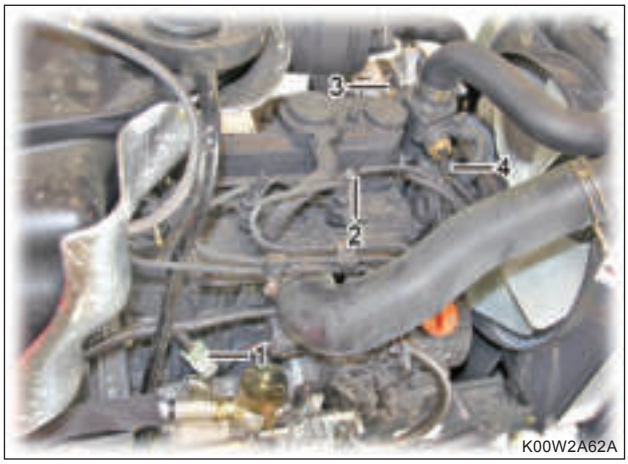
1. Pull the opening lever (1) of the hood to open the hood (2) and disconnect the battery negative (-) cable (3). Then, disconnect the head lamp wiring connector (4) and horn wiring connector (5) from the head lamp section.

2. Unscrew the gas cylinder mounting nuts (1) and hood mounting nuts (2) to remove the hood.

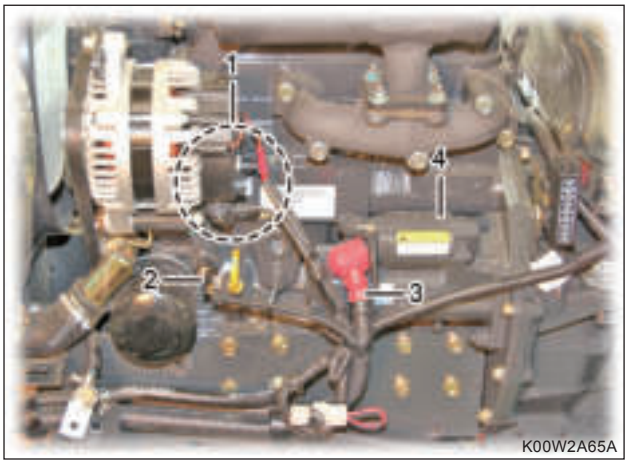


3. Disconnect the fuel hose (1), accelerator rod (2) and fuel drain hose (3) from the right side of the engine.

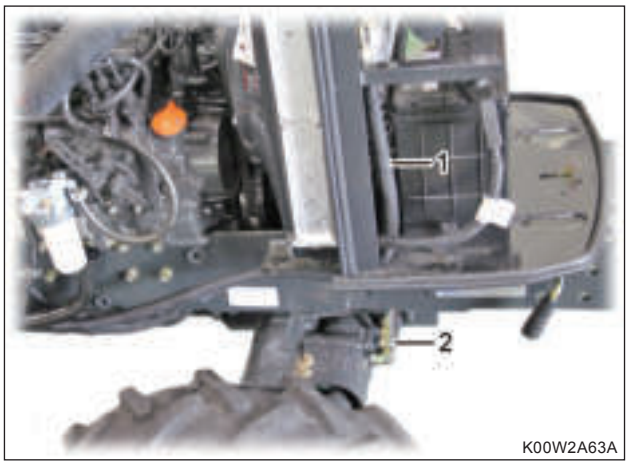
4. Disconnect the suction pipe (1), delivery pipe assembly (2) and PST high-pressure pipe (A) (3) from the hydraulic pump.



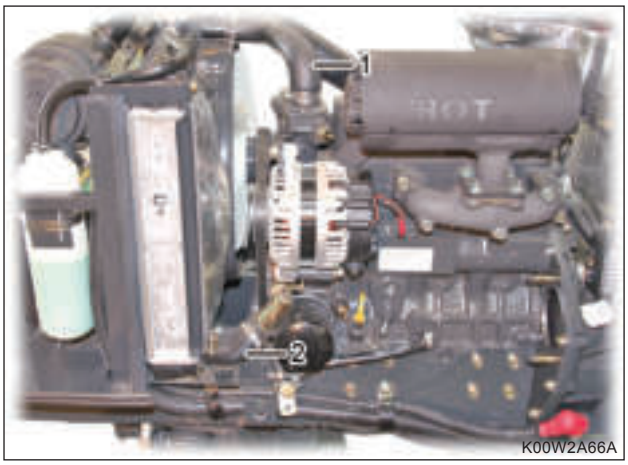
5. Disconnect the fuel cut-off solenoid connector (1), glow plug wiring connector (2), water temp. sensor connector (3) and glow plug sensor connector (4).



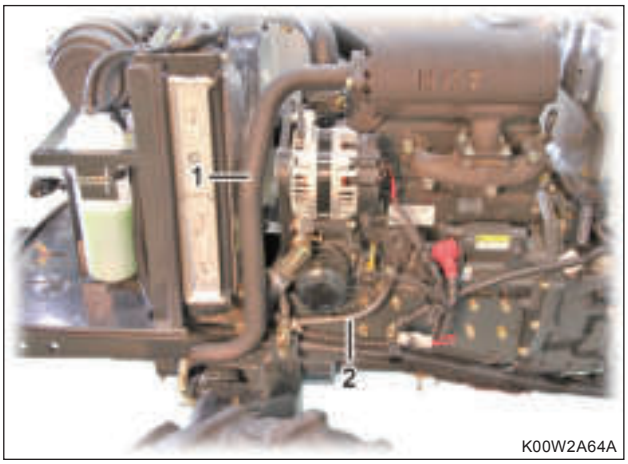
8. Disconnect the alternator wiring harness (1), oil switch connector (2) and starter motor wiring harness (3) to remove the starter motor (4).



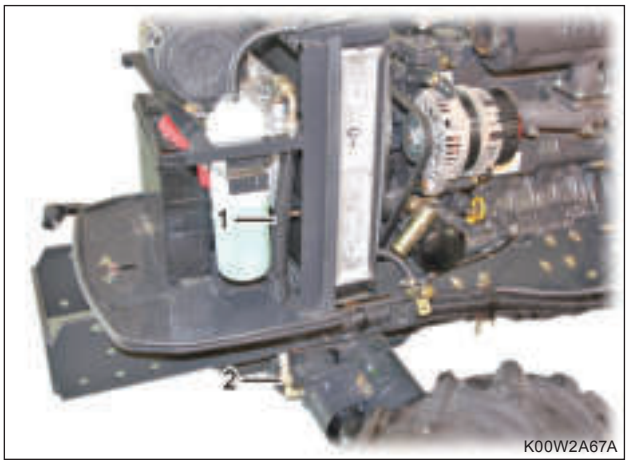
6. Disconnect the steering cooler hose (1) and PST cylinder hydraulic hose (2).



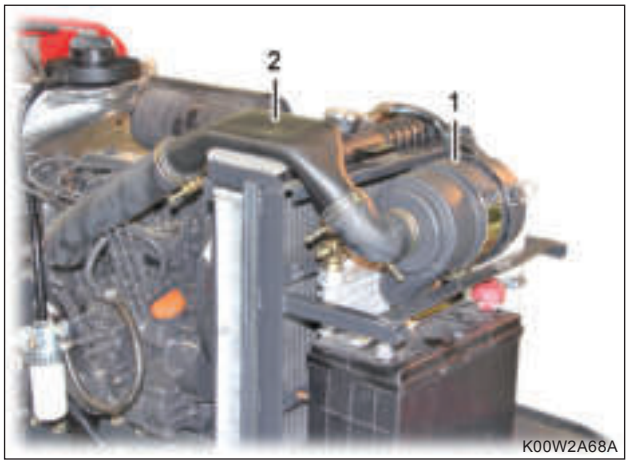
9. Disconnect the coolant hose (1) of the pump and coolant hose (2) of the radiator.



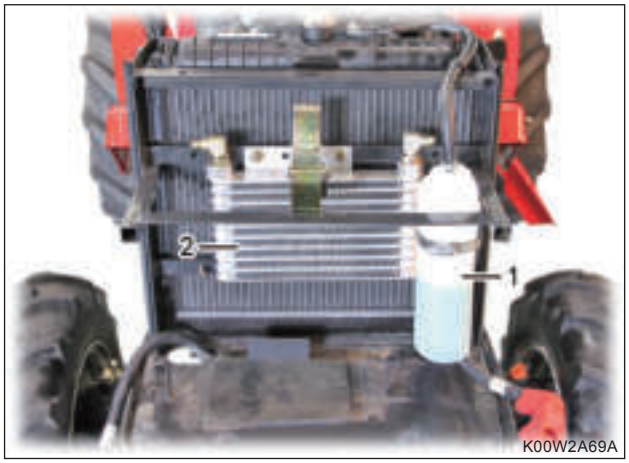
7. Disconnect the muffler pipe (1) and coolant drain hose (2).



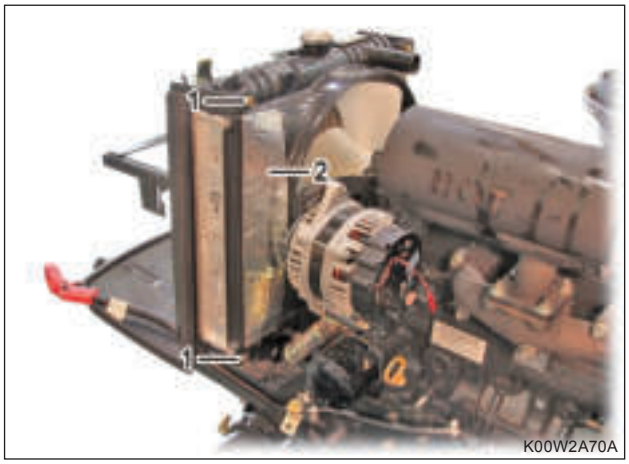
10. Disconnect the oil cooler return hose (1) and PST hydraulic hose (2).



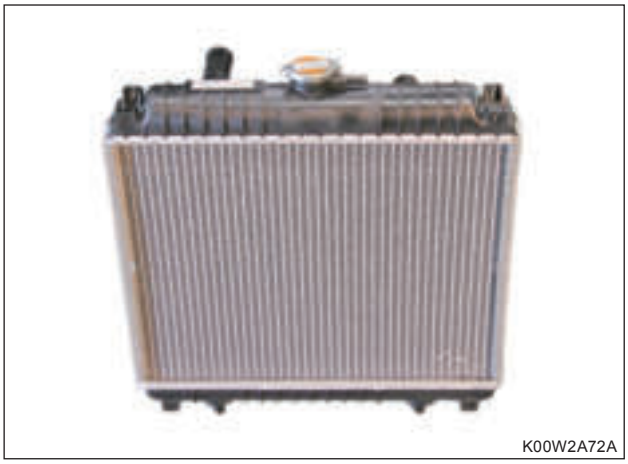
11. Remove the air cleaner assembly (1) and disconnect the connecting hose (2).



12. Remove the reservoir tank assembly (1) and oil cooler (2).

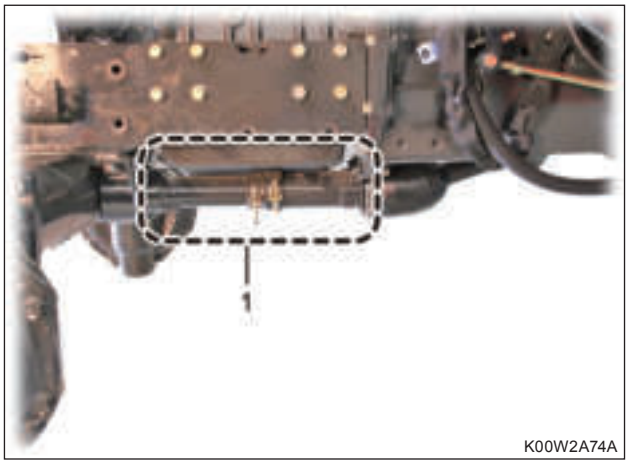


13. Unscrew the fan shroud assembly mounting bolts (1) to remove the fan shroud assembly (2) from the radiator.



14. Remove the radiator net (1) and radiator (2).

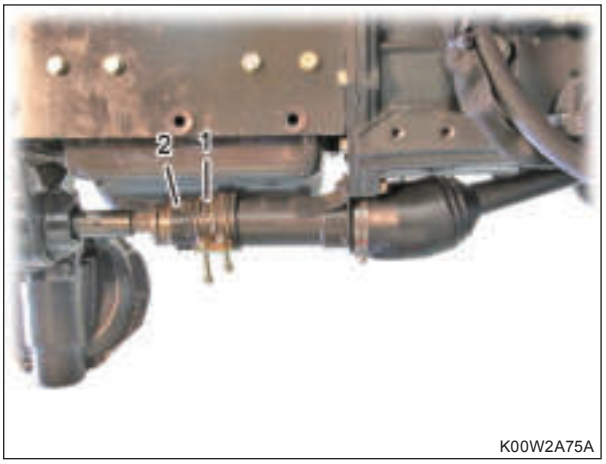
15. Remove the battery bracket (1) from the front axle frame.



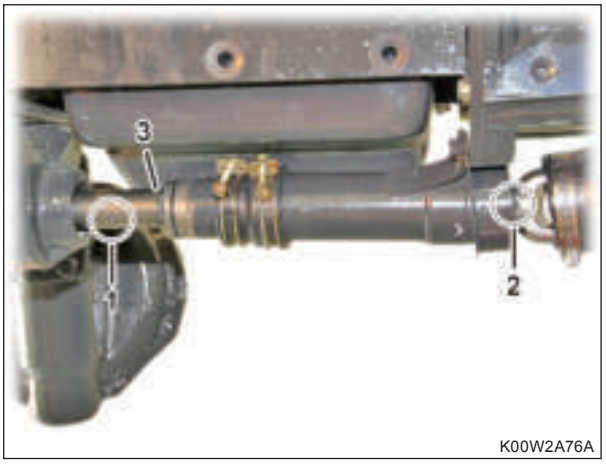
16. Remove the front wheel drive shaft assembly (1).

Notes

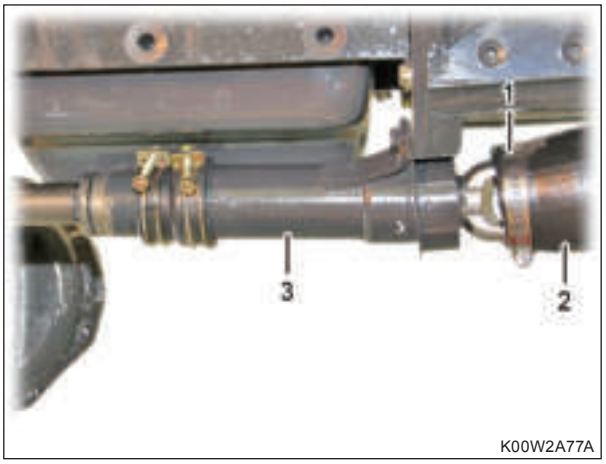
COMPONENTS DISASSEMBLY FOR FRONT WHEEL DRIVE SHAFT ASSEMBLY



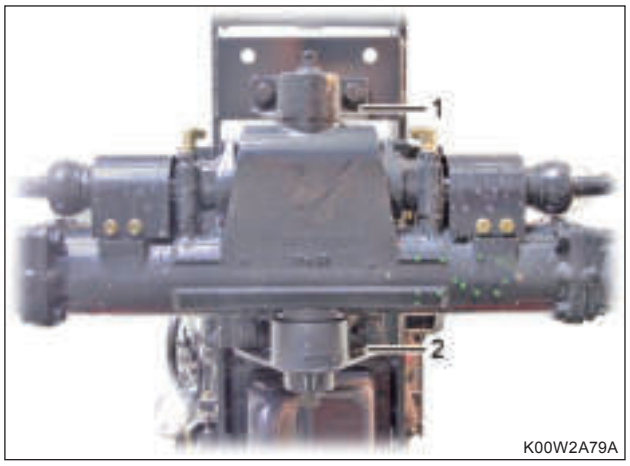
1. Unhook the hose clips (1) to remove the front wheel drive shaft cover B (2).

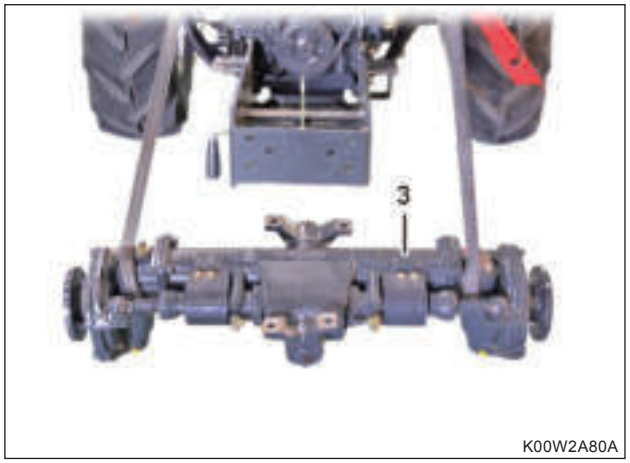


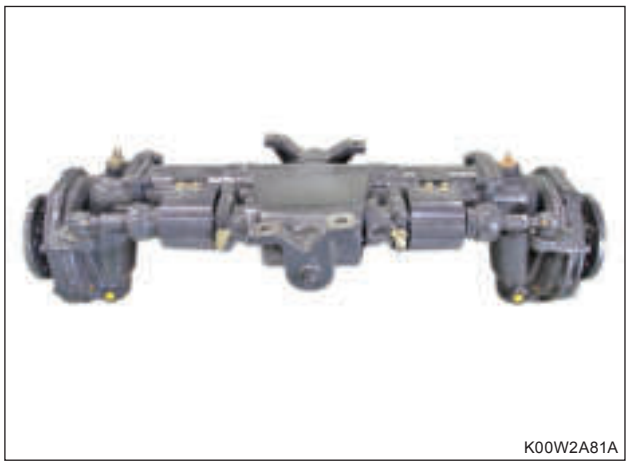
2. Pull out the coupling spring pin (1) and universal joint B spring pin (2) to remove the front wheel drive shaft (3).



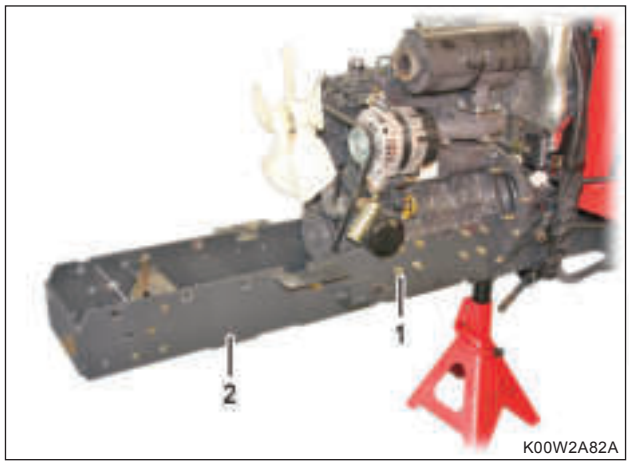
3. Remove the hose band (1) and unscrew the support mounting bolts to remove the front wheel drive cover (2) and front wheel drive cover A (3).



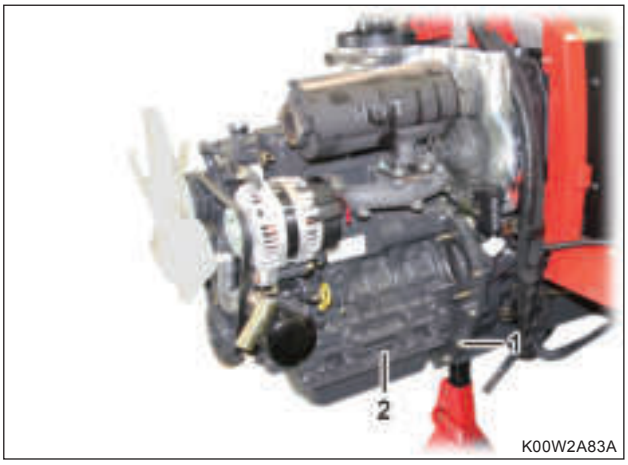




17. Place a support under the oil pan of the engine and unscrew the mounting bolts of the front axle holder (front) (1) and holder (rear) (2). Then, remove the front axle assembly (3) with a hydraulic lift or hoist from the front axle frame.



18. Unscrew the front axle frame mounting bolts (1) (16 EA) to remove the front axle frame (2).



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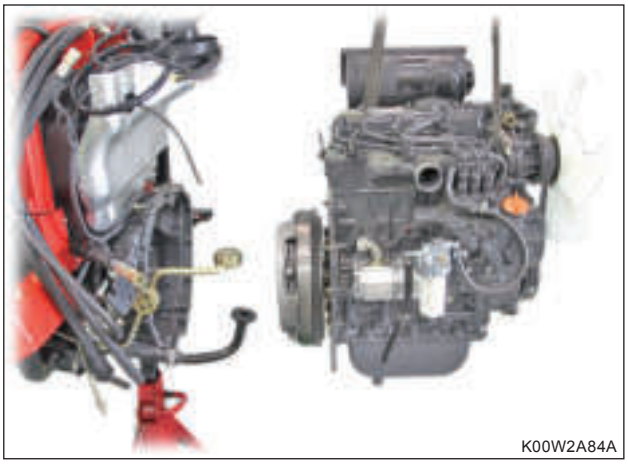
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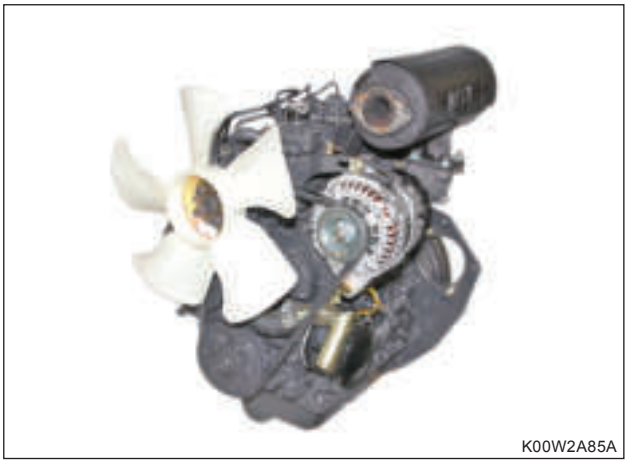
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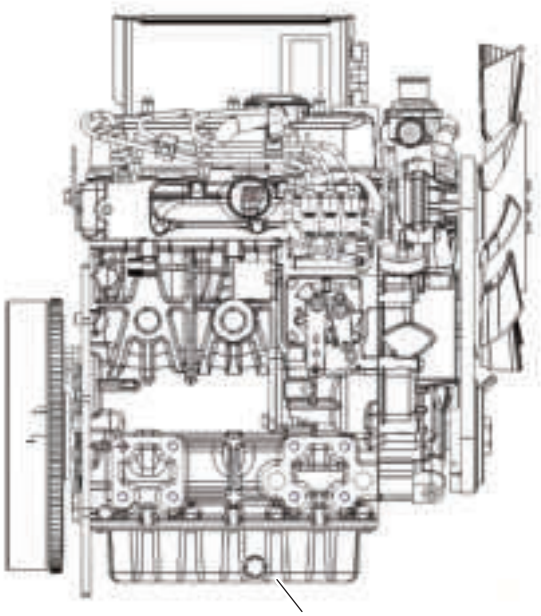
19. Place a support under the clutch housing safely and support the engine assembly with a hoist. Then, unscrew the mounting bolts (1) (13 EA) of the engine rear plate to remove the engine assembly (2) slowly.

5.2 DISASSEMBLY OF ENGINE

5.2.1 GENERAL PRECAUTIONS

1. Select place that must be neatly arranged.
2. Disassemble parts must be carefully handled for prevention of injury or taint. Prepare some vessels for keeping of disassemble parts.
3. Prepare the solvent and compressed air for cleaning of parts.
4. Use the tools that are in good condition and be sure you understand how to use them before performing any job.
5. Disassembly carefully as procedure can be complicated and put display down in order to identify parts to prevent damage of parts when many parts are disassembled. Then work can facilitate when assemble it.

5.2.2 LUBRICATING OIL



K00W223A

Loosen the drain plug from the bottom of the oil pan and drain the oil to the prepared vessel.

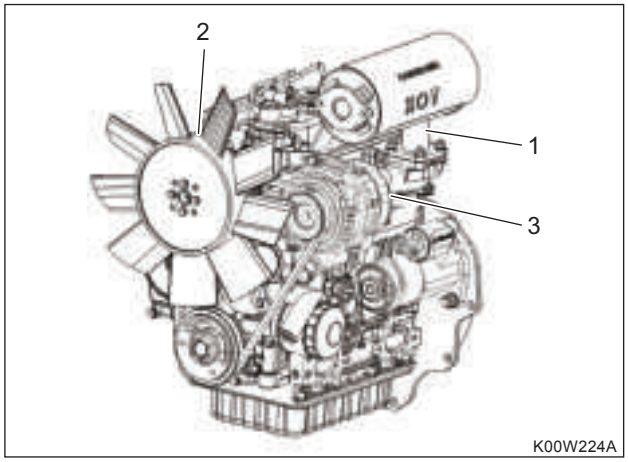
⚠ CAUTION

- **Don't allow hot oil to directly contact skin.**

⚠ WARNING

- **Disposal of waste oil must be treated by related regulations.**

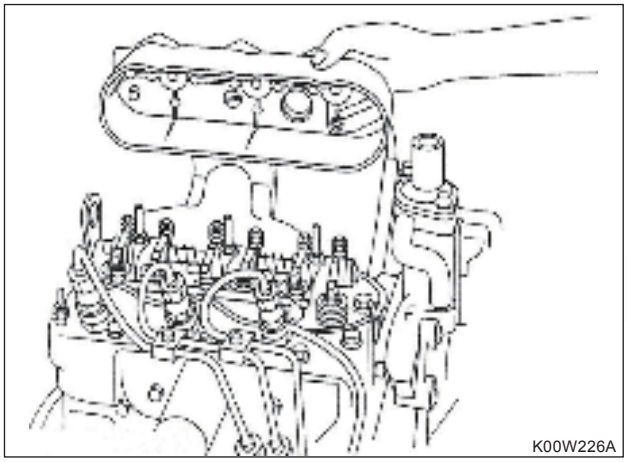
5.2.3 MUFFLER, ALTERNATOR, COOLING PAN



(1) Muffler
(2) Cooling pan
(3) Alternator

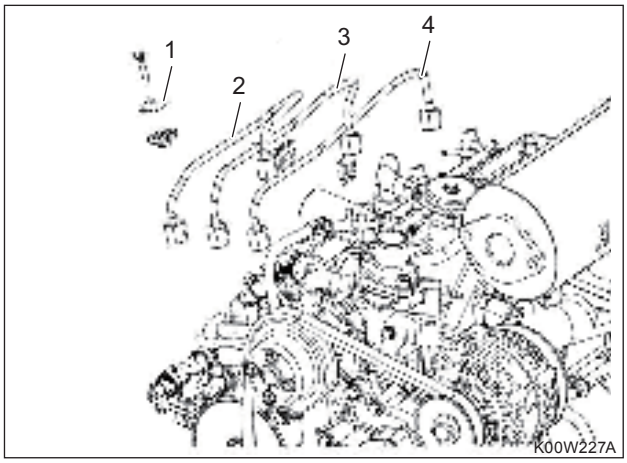
1. Disassemble alternator and cooling pan.
2. Disassemble cooling pan and V-pulley
3. Disassemble muffler.

5.2.4 CYLINDER HEAD COVER



1. Remove the head cover cap nuts.
2. Remove the head cover.

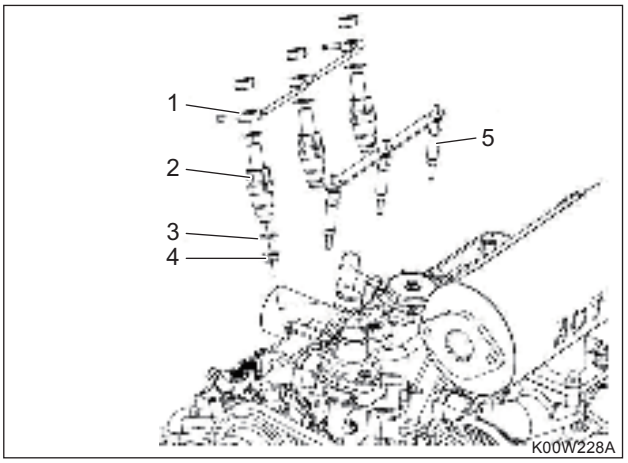
5.2.5 FUEL SUPPLY LINE



(1) Clamps
(2) Fuel supply line1
(3) Fuel supply line 2
(4) Fuel supply line 3

1. Remove the high pressure pipes from the injector. Use two wrenches for prevention to rotate of the injector.
2. Remove the clamps from the high pressure pipes.
3. Remove the high pressure pipe from the fuel injection pump.

5.2.6 FUEL INJECTION VALVE(INJECTOR)



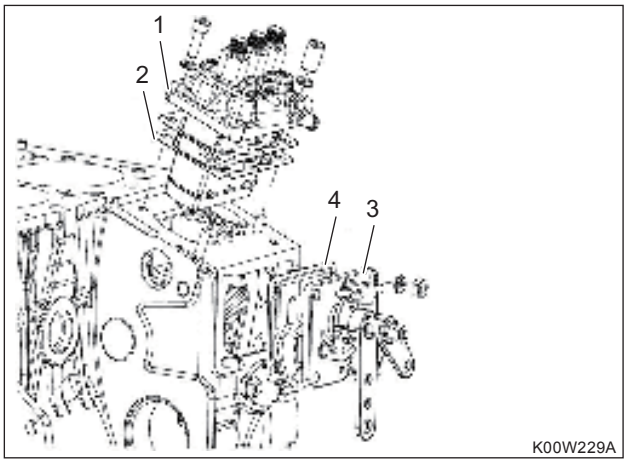
(1) Overflow pipe
(2) Nozzle
(3) Sealing washer
(4) Nozzle space
(5) Glow plug

1. Disassemble overflow pipe.
2. Remove the injectors.
3. Disassemble the sealing washers and nozzle spaces cup from the injectors.
4. Disassemble Glow plug.

⚠ CAUTION

- **Don't re-use the sealing washer and the nozzle space cup**

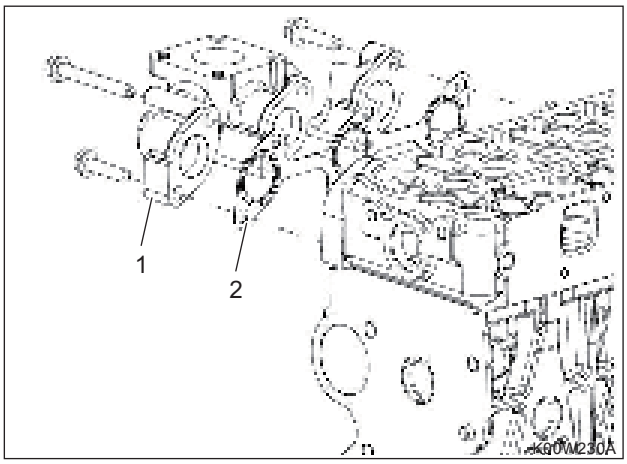
5.2.7 FUEL INJECTION PUMP AND SPEED CONTROLLER



(1) Injection pump
(2) Adjusting shim
(3) Speed controller
(4) Gasket

1. Loosen the fixing bolts and nuts.
2. Remove the injection pump.
3. Remove the controller.

5.2.8 EXHAUST MANIFOLD



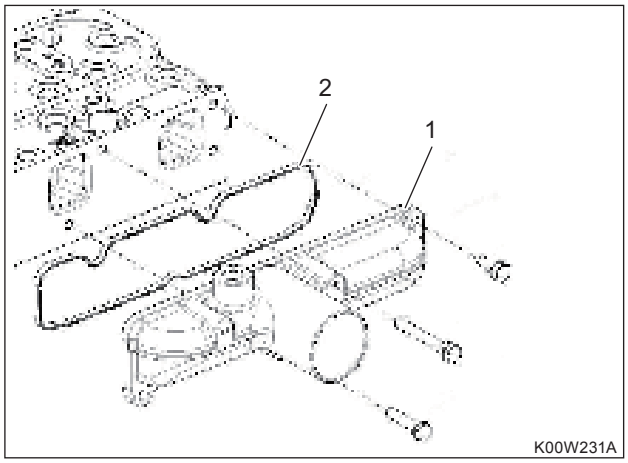
(1) Exhaust manifold
(2) Gasket

1. Loosen the fixing bolts.
2. Remove the exhaust manifold.

⚠ CAUTION

- **Do not re-use the gasket.**

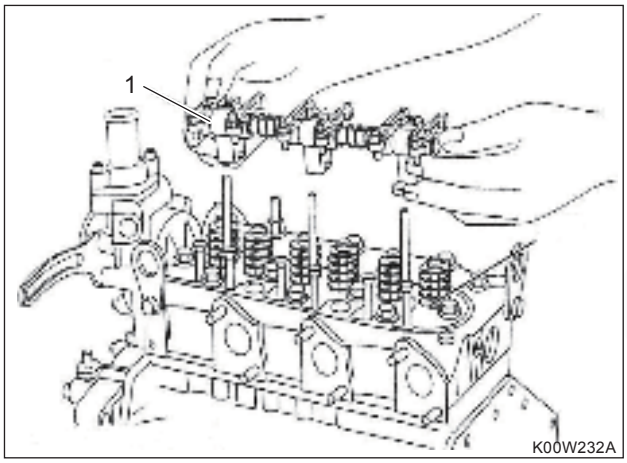
5.2.9 INTAKE MANIFOLD

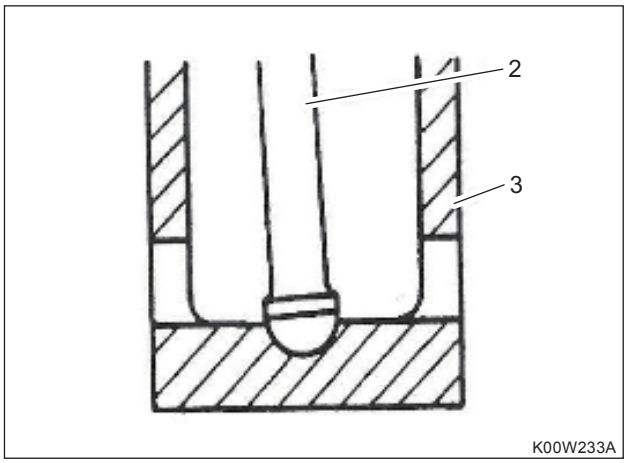


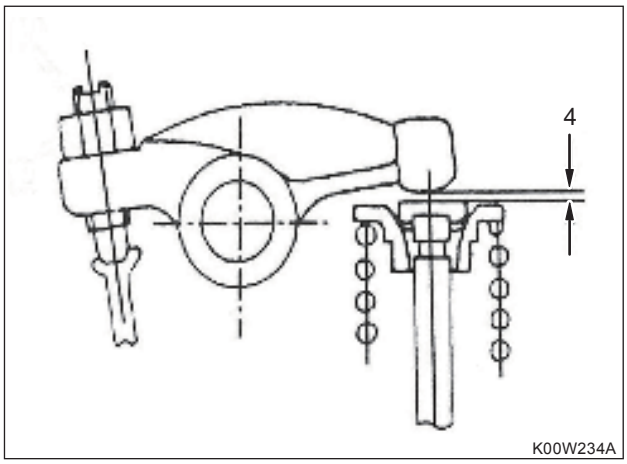
(1) Intake manifold (2) Gasket

1. Loosen the fixing bolts
2. Remove the intake manifold

5.2.10 ROCKER-ARM SHAFT AND PUSH ROD



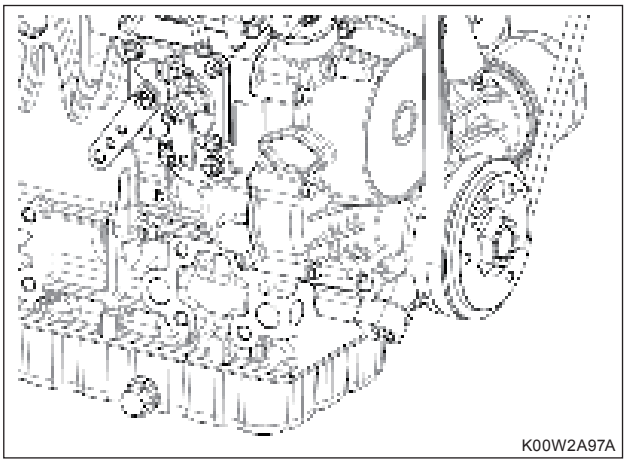




(1) Rocker arm shaft (3) Tappet
(2) Push rod (4) Valve clearance

1. Loosen the fixing Nuts.
2. Remove the rocker arm shaft.
3. Remove the push rods.

ADJUSTMENT PROCEDURE OF VALVE CLEARANCE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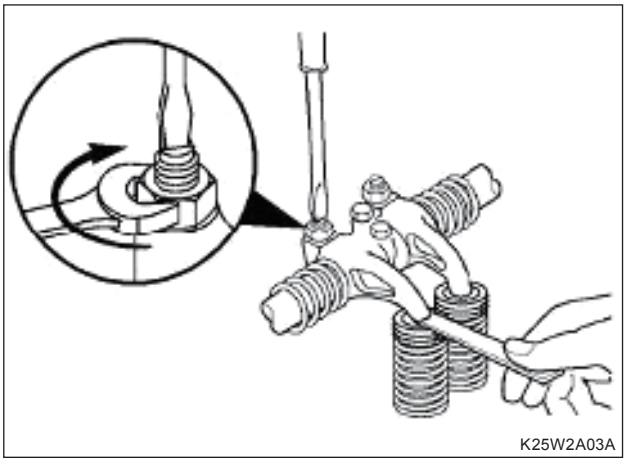
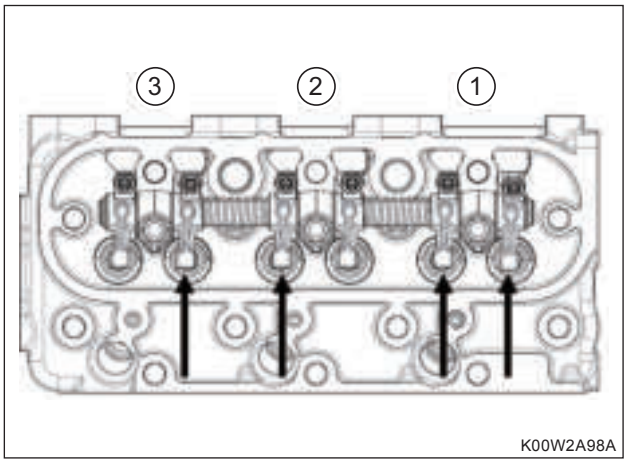

K25W2A03A

1. Rotate the engine until No.1 cylinder stay on TDC. Line up the mark "─1" of crank pulley and the mark "→" of gear case.
2. Install the gauge between rocker arm and valve stem.
3. Adjust the clearance with rotating the adjustment bolt.

VALVE CLEARANCE	
Intake valve	Exhaust valve
0.15 ~ 0.17 mm	0.15 ~ 0.17 mm

4. Tighten the adjustment bolt. (Tightening torque: 2.7 kg•m)

ADJUSTMENT PROCEDURE



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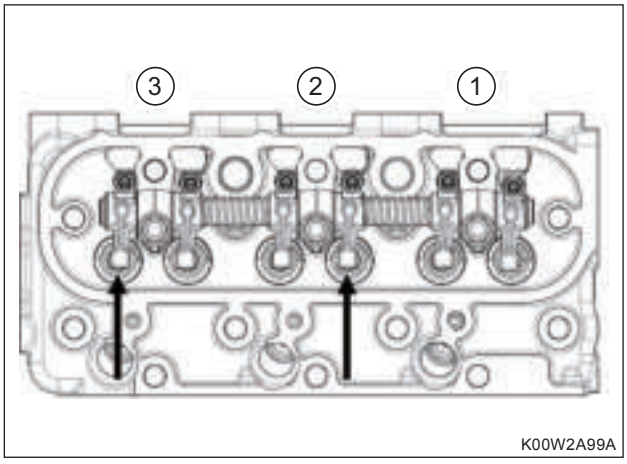
1. Rotate the engine until the No.1 cylinder stay on TDC.
2. Adjust the intake valve of cylinder "1" and "3".
3. Adjust the exhaust valve of cylinder "1" and "2".

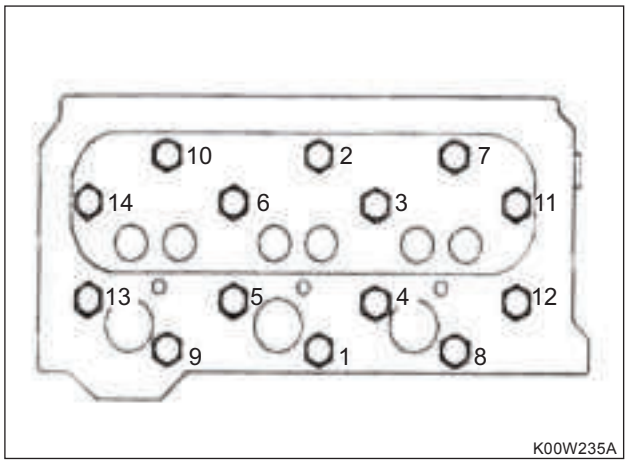


K00W2A99A

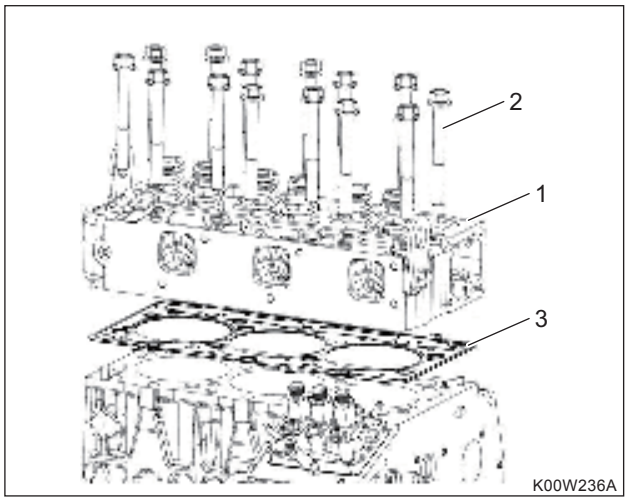
4. Rotate the crankshaft to rotation direction of engine. (360 degree.)
5. Adjust the intake valve of cylinder "2".
6. Adjust the exhaust valve of cylinder "3".

NOTE
• **The clearance must be adjusted with the rocker arm not depressing the intake/exhaust valve**

5.2.11 CYLINDER HEAD



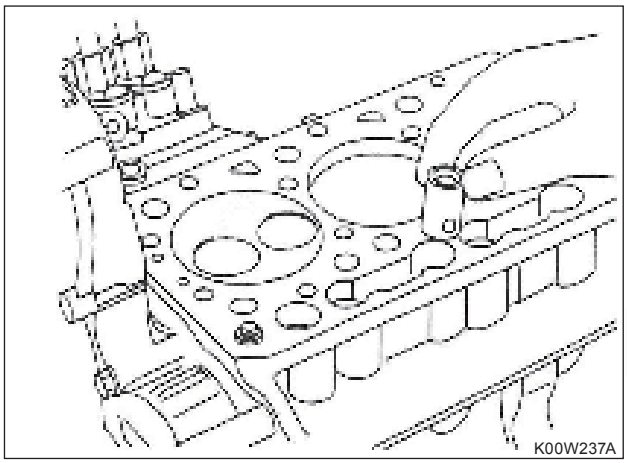
1. Disassemble cylinder head bolt in the order of No.14 ~ No.1.
2. Remove cylinder head.



(1) Cylinder head
(2) Head bolt
(3) Gasket (Cylinder head)

1. When disassembling, pay attention not to damage the bottom of cylinder head and block side.
2. When reassembling, use new head gasket.
3. Assemble the head bolt in the order of No.1 ~ No.14.
4. After assembling, operate it for 30 minutes to recheck the tightening torque of head bolt.

5.2.12 TAPPET

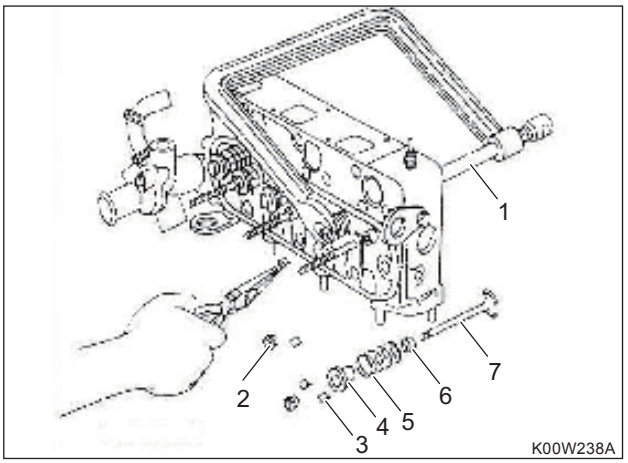


1. Remove the Tappet from crank case.
2. Mark the Tappet according to the piston position and disassembling sequence not to be out of order.

NOTE

- **Check if the lower part of the tappet is worn out evenly round.**
- **Pay attention not to change the sequence of Tappet, and apply the oil to the friction area.**

5.2.13 VALVE



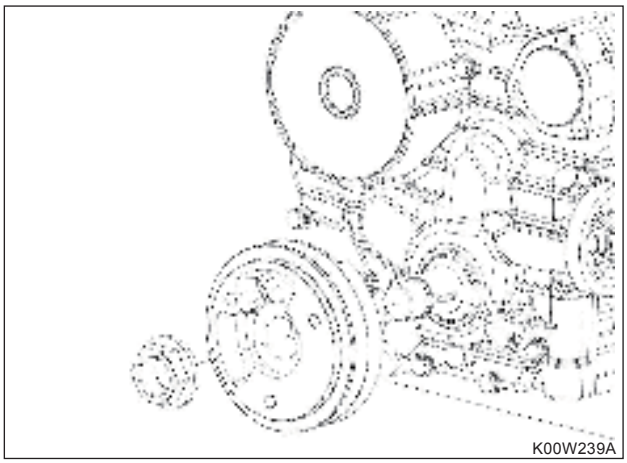
(1) Valve spring puller
(2) Valve cap
(3) Valve spring cotter
(4) Valve spring retainer
(5) Valve spring
(6) Valve stem seal
(7) Valve

1. Remove valve cap.
2. Press valve spring retainer using a jig to remove the valve spring cotter.
3. Remove valve spring retainer, valve spring, valve stem seal in the order.
4. Remove the valve.

NOTE

- **Before removing valve stem seal, check the state of stem seal and the leakage of oil.**
- **After checking the state of valve, replace it.**
- **Pay attention not to change the sequence of valve.**

5.2.14 V-PULLEY

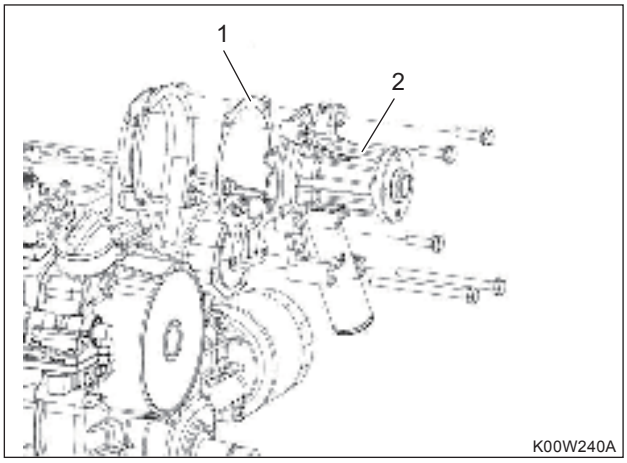


1. Remove the crank shaft V-pulley nut.
2. Remove V-pulley.
3. Remove the parallel pin attached to the crank shaft.

NOTE

- **When removing the V-pulley, use the exclusive jig and do not stand in front as the pulley may be removed.**

5.2.15 COOLANT PUMP



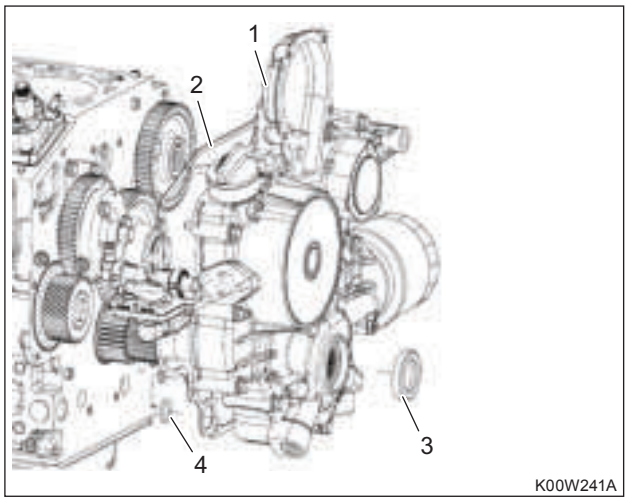
(1) Gasket
(2) Coolant pump combination

1. Disassemble the coolant return hose, and then disassemble the coolant pump fixing bolt.
2. Disassemble the coolant pump.

NOTE

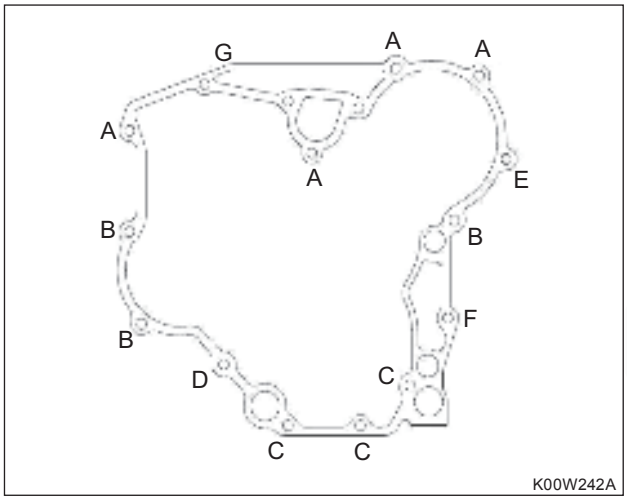
- **Do not reuse the used coolant pump gasket.**

5.2.16 GEAR CASE



(1) Gear case
(2) Gear case gasket
(3) Oil seal
(4) O-ring

1. Disassemble the gear case fixing bolt and then remove the gear case.

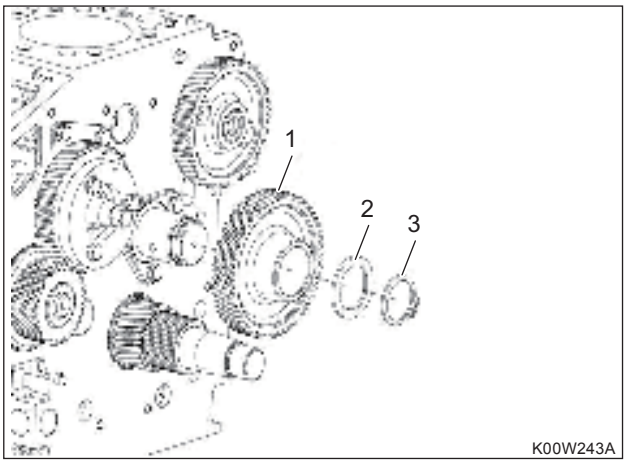


*Length of Bolt			
A	45 mm	E	65 mm
B	50 mm	F	68 mm
C	55 mm	G	Nut
D	60 mm	-	-

NOTE

- **When removing the gear case, pay attention not to damage the oil seal.**
- **When assembling, fix the O-ring (4 places) on the back of gear case suitable for the position.**
- **After removing the remaining gaskets attached to the rear side of gear case and cylinder block clearly, use a new gasket for assembling.**
- **When assembling the feed pump, assemble the gear case prior to prevent the feed pump from damage.**

5.2.17 IDLE GEAR

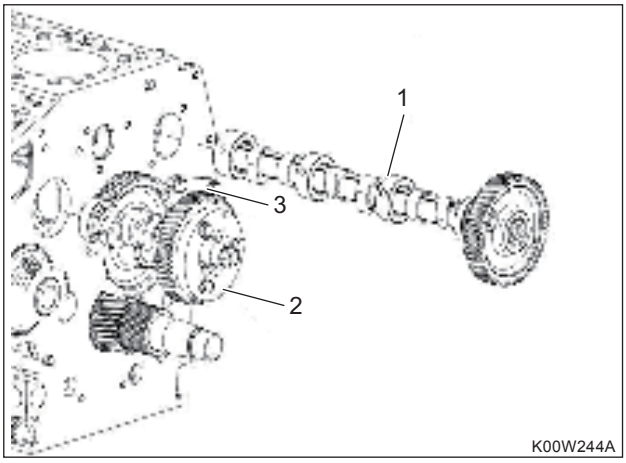


(1) Idle gear
(2) Idle gear bush
(3) Snap ring

1. Use a snap ring puller to disassemble the snap ring.
2. Remove the idle gear collar.
3. Remove the idle gear.

NOTE
• **When assembling the idle gear, check the helm angle of cam shaft gear and crank shaft gear, fuel cam shaft gear before assembling.**

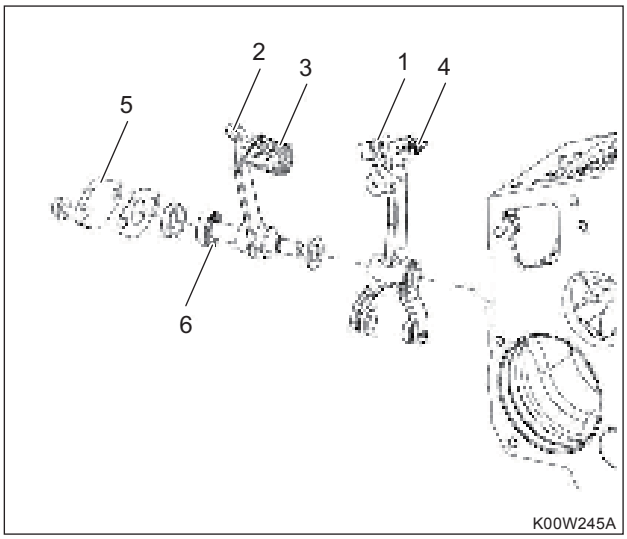
5.2.18 CAM SHAFT AND FUEL CAM SHAFT



(1) Cam shaft
(2) Fuel cam shaft
(3) Fuel cam shaft stopper

1. Turn the cam shaft gear until the fixing bolt inside the gear can be seen, and then disassemble the bolt.
2. Remove the cam shaft.
3. Disassemble the fuel cam shaft stopper.
4. Remove the fuel cam shaft.

5.2.19 FORK LEVER

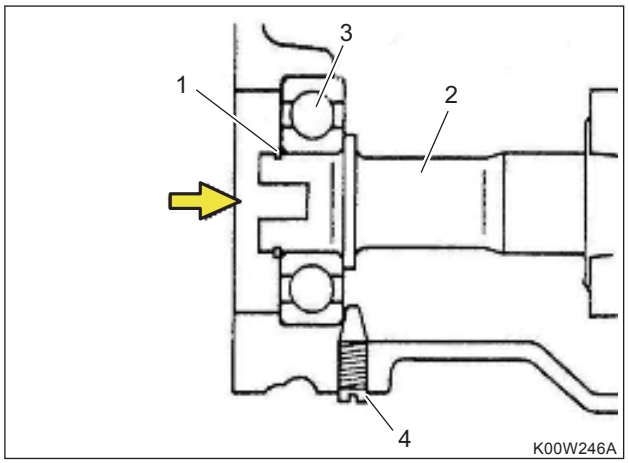


(1) Fork lever A
(2) Fork lever B
(3) Governor spring
(4) Starter spring
(5) Fork lever shaft cover
(6) Fork lever axis

1. Remove the starter spring.
2. Remove the Fork lever shaft cover.
3. As shown in figure, use the tool to remove the fork lever shaft.

NOTE
• **Assemble in sequence.** • **Use only new gasket.** • **Assemble so that the “UP” mark of fork lever shaft cover can be upward.**

5.2.20 GOVERNOR

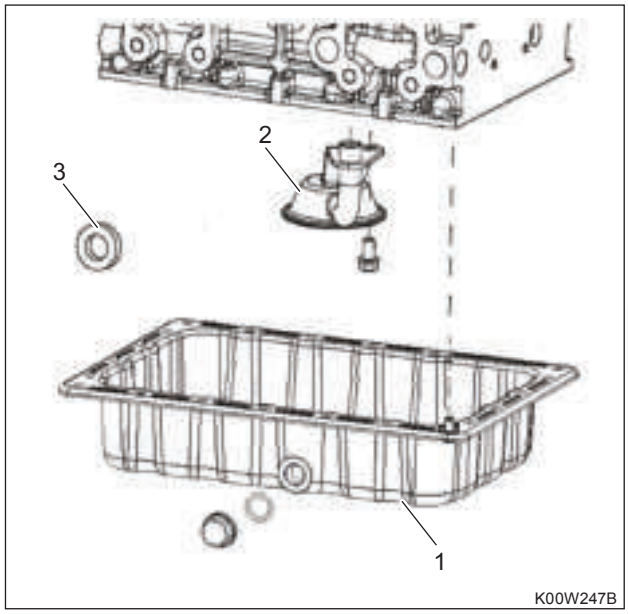


(1) Snap ring
(2) Governor shaft
(3) Ball bearing
(4) Stop bolt

1. Use a snap ring puller to disassemble the snap ring.
2. Remove the governor to the arrow direction.

NOTE
• **While removing the governor, pay attention not to damage the ball bearing.**

5.2.21 OIL PAN AND OIL INTAKE PIPE

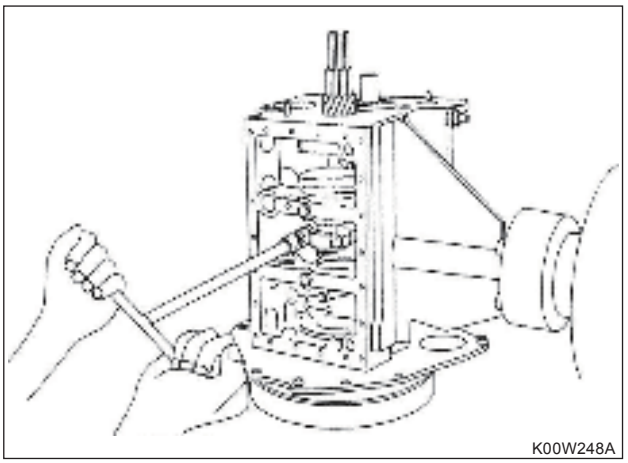


(1) Oil pan
(2) Oil intake pipe
(3) Magnet

1. Remove the oil pan fixing bolt.
2. Tap the oil pan with rubber hammer to remove.
3. Remove the oil intake pipe fixing bolt.
4. Remove the oil intake pipe.

NOTE
• **When assembling, apply sufficient amount of liquid gasket.** • **For the position of magnet in the oil pan, adjust it to be located in the entry of oil intake pipe.**

5.2.22 CONNECTING ROD AND PISTON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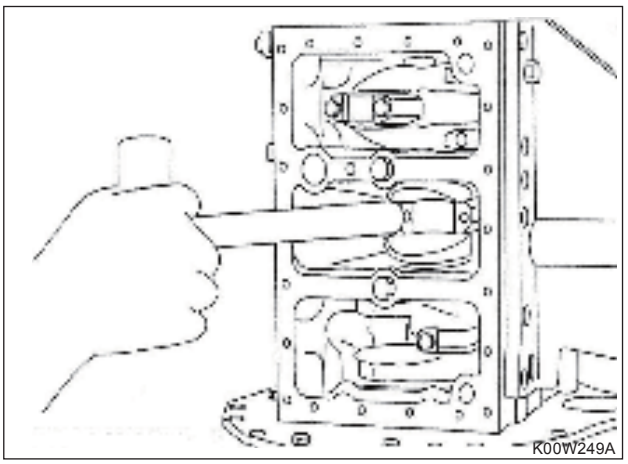
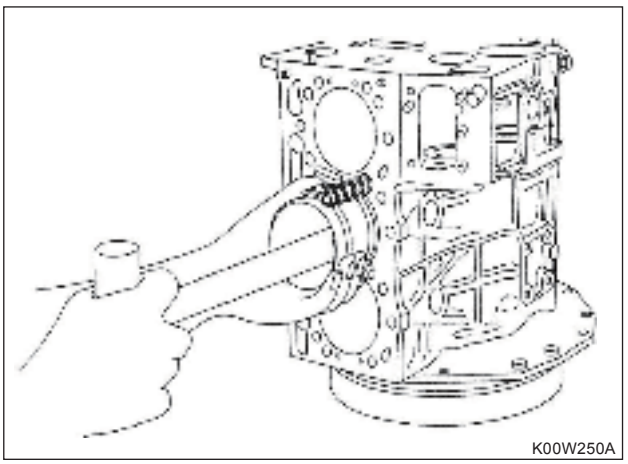
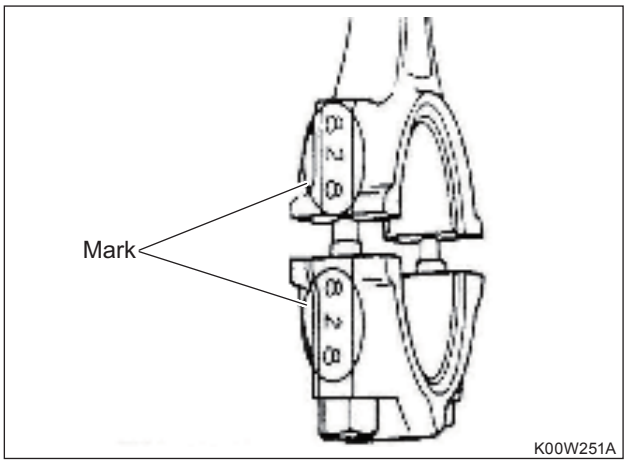

K00W249A


K00W250A

1. Remove the connecting rod cap.
2. Remove the piston and connecting rod by tapping with rubber hammer.

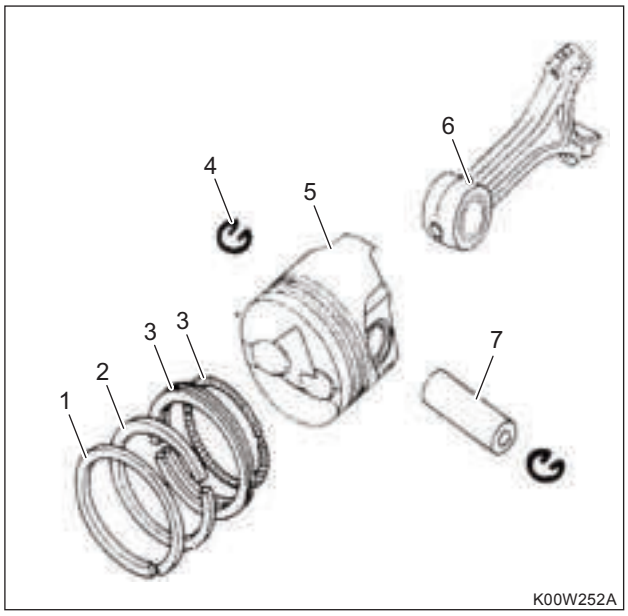


K00W251A

NOTE

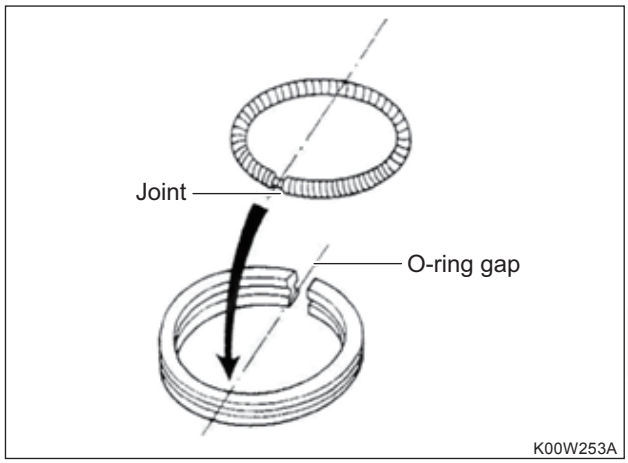
- **When assembling, pay attention not to change the direction and number of marking of connecting rod.**
- **When assembling the piston, use the exclusive jig and check the position of piston ring.**
- **Make the direction of piston clover face to the direction of nozzle.**

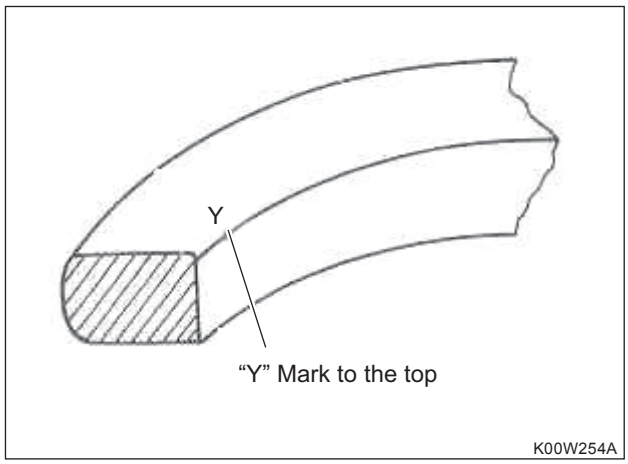
5.2.23 PISTON AND PISTON RING

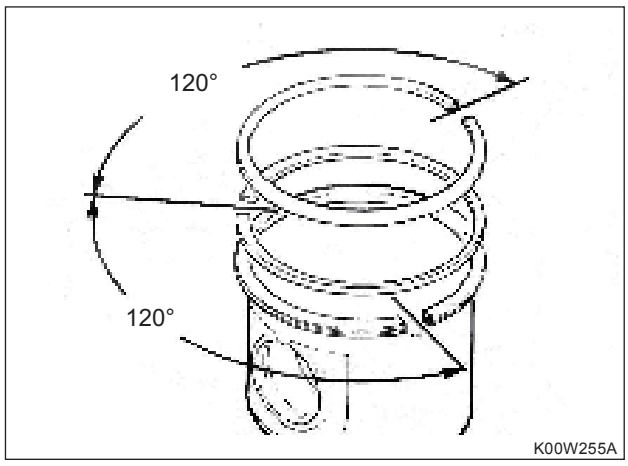


(1) TOP Ring
(2) Second Ring
(3) Oil Ring
(4) Piston snap ring
(5) Piston
(6) Connecting rod
(7) Piston pin

1. Remove the piston pin snap ring and then remove the piston pin.
2. After removing the piston, disassemble the piston ring according to the sequence.

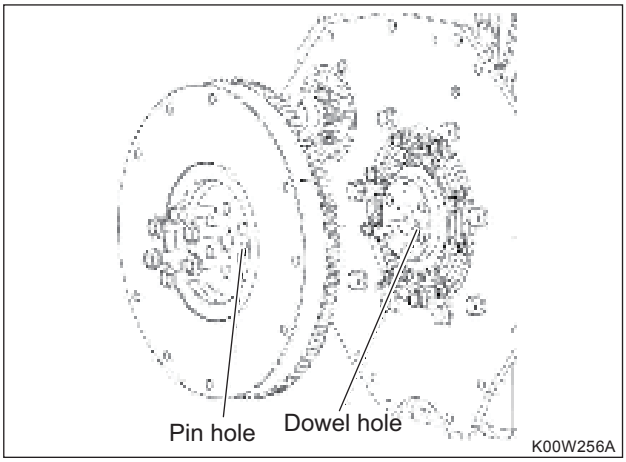






1) For the assembly of piston ring, assemble Oil Ring, Second Ring, Top Ring in the order.
2) For the direction of piston ring, assemble it in a upward direction with the "Y" mark on the upper part of piston ring.
3) When assembling the oil ring, the direction of joint part of spring should be opposite of the oil ring gap.
4) The location of piston ring gap should be kept 120° away in case of assembling.

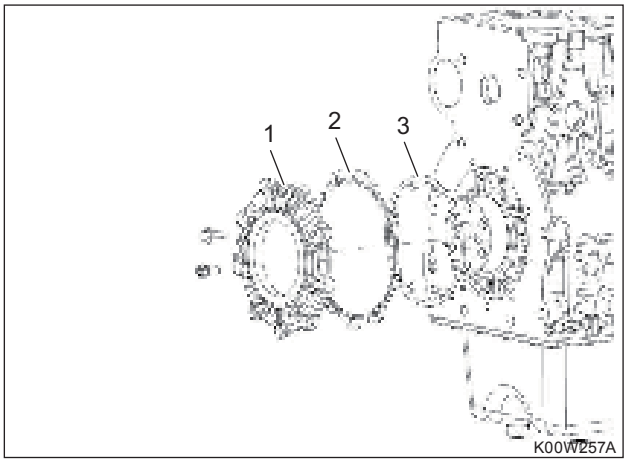
5.2.24 FLYWHEEL

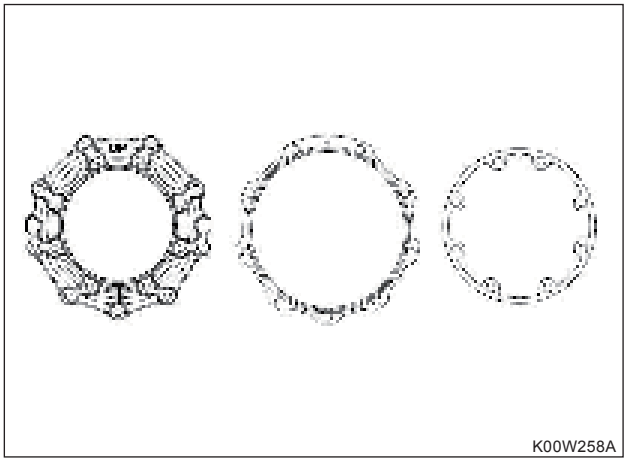


1. Disassemble the flywheel bolt.
2. Remove the flywheel.

NOTE
• **When assembling the flywheel, assemble the flywheel pin hole to the pin of crank shaft properly.**

5.2.25 MAIN BEARING CASE COVER



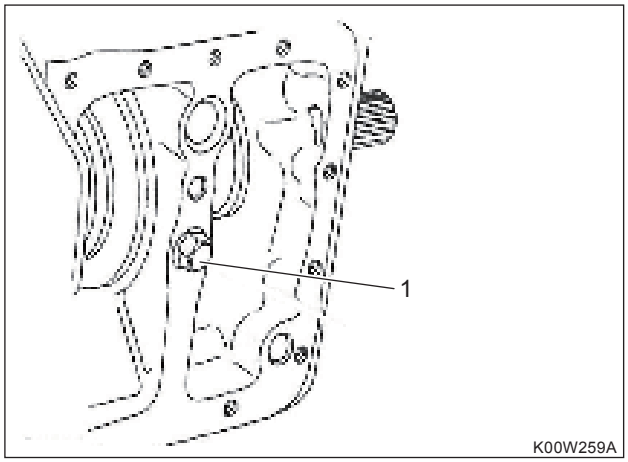


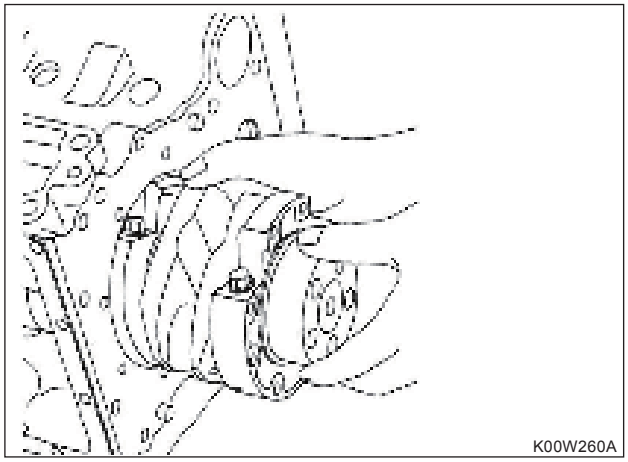
(1) Main bearing case cover
(2) Gasket(bearing case cover)
(3) Gasket(bearing case)

1. Remove the bearing case cover bolt.
2. Remove the bearing case cover.

NOTE
• **When removing the bearing case cover, pay attention not to damage the oil seal.**
• **When assembling, use new gasket and check the location of gasket and the bolt hole correctly to assemble.**
• **Be noted that there are two types of bearing case cover bolt : block fixing bolt and bearing case fixing bolt.**

5.2.26 CRANK SHAFT AND MAIN BEARING CASE





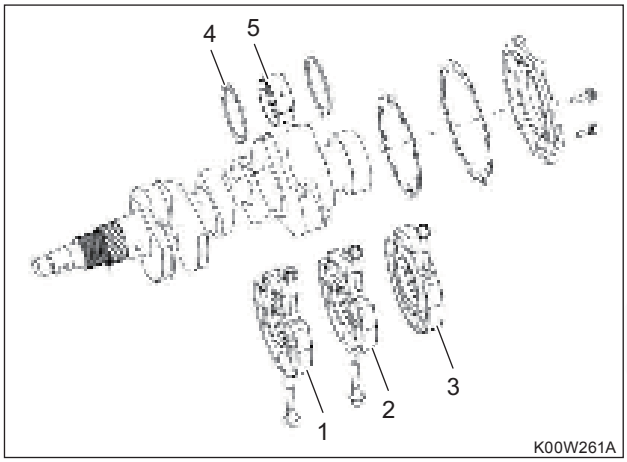
(1) Main bearing case bolt_2

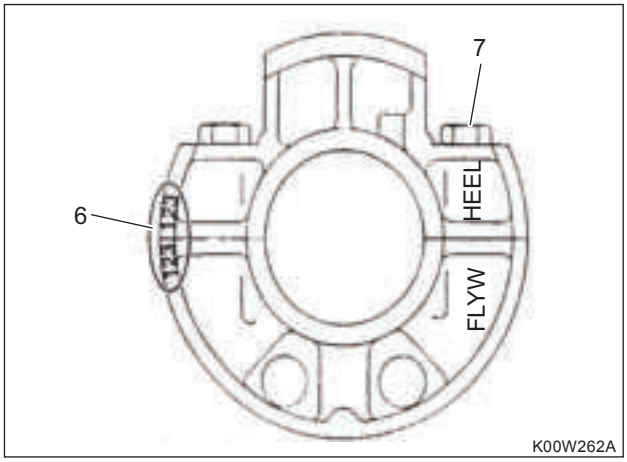
1. Remove the main bearing case bolt 2.
2. Remove the crank shaft.

NOTE

- **When removing the crank shaft, pay attention not to damage the main bearing case.**
- **When assembling, adjust the main bearing case to match the bolt hole of cylinder block and the bolt hole of bearing case.**

5.2.27 MAIN BEARING CASE





(1) Main bearing case A
(2) Main bearing case B
(3) Main bearing case C
(4) Thrust bearing
(5) Crank shaft metal
(6) Mark
(7) Main bearing case bolt 1

1. Remove the bearing case bolt 1.
2. Remove the bearing case by dividing into upper part and lower part.

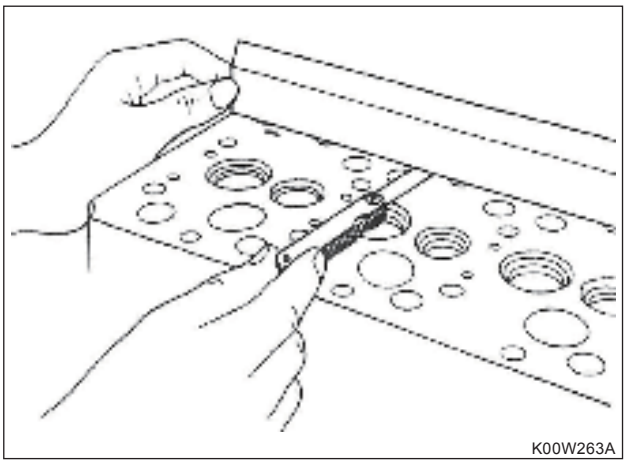
NOTE

- **The bearing case has three types: A, B, C and pay attention not to change the sequence of assembling.**
- **When assembling the bearing case, the number with helm angle and the direction of "FLYWHEEL" marking should be matched.**

5.3 MAIN PARTS INSPECTION & MAINTENANCE

5.3.1 CYLINDER HEAD

CYLINDER HEAD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1. Before cleaning the cylinder head, check that whether or not gas leak, damage, crack of water, gas, etc.

• Check the cracking in head combustion surface by color check.

2. Check the invisible crack or damage by water pressure testing or magnetic particle testing.

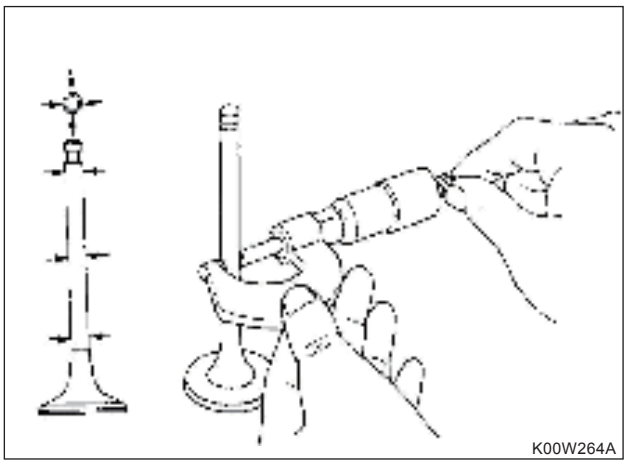
3. Check the plane degree of the cylinder head's bottom if there is any gas leak from gasket.

• Replace the cylinder head if the check result is out oflimit.

LIMIT	More than 0.05 mm

INTAKE & EXHAUST VALVE & VALVE GUIDE

▶ **VALVE**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• Measure the valve stem outer diameter. If the wear is over the limit, replace the valve.

SPECIFICATION	LIMIT
6.95 ~ 6.96 mm	6.9 mm

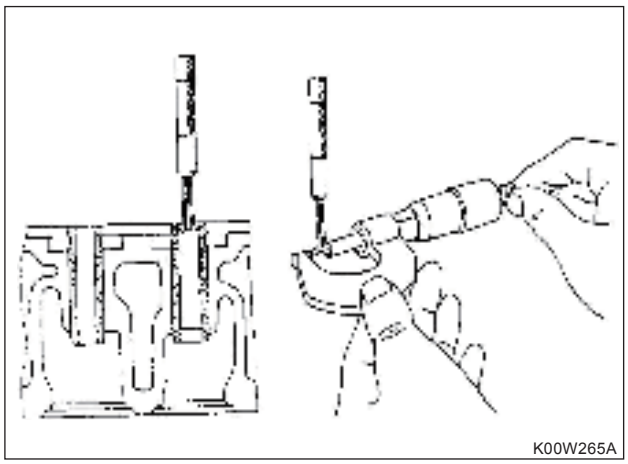
▶ **VALVE SHEET CONTACT SURFACE**

• Check the valve sheet contact surface and if necessary, modify it with grinding paper. And if it got damaged a lot, replace it if it got damaged a lot.

• Check the margin(thickness of valve head) and if less than the limit, replace it.

SPECIFICATION	1.2 mm
LIMIT	0.5 mm

▶ VALVE GUIDE

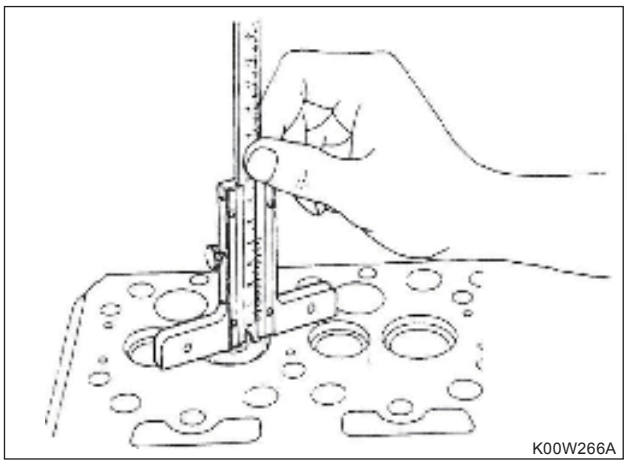


- Measure the distance between the valve guide and valve stem. If the distance is more than limit, replace the valve or valve guide or either parts.

SPECIFICATION	7.015 ~ 7.000 mm
LIMIT	7.1 mm

- Valve guide and the valve sheet should be machined at the same time. (Valve guide must assemble by the press machine.)
- Valve guide's projecting quantity from the head surface : 9 mm

▶ VALVE SHEET



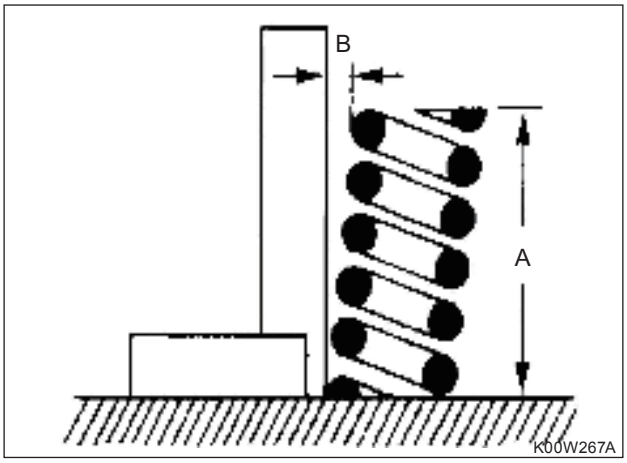
- If the valve's difference is more than limit, replace the valve sheet.

SPECIFICATION	0.05~0.15 mm
LIMIT	0.40 mm

- Modifying the valve sheet
  - When modifying the valve sheet, if necessary, replace the valve guide.
  - Modify the sheet width and sheet angle according to the specification by special tools or valve grinder.

INTAKE VALVE SEAT ANGLE	EXHAUST VALVE SEAT ANGLE
120°	90°

▶ VALVE SPRING



- Squareness, free-length, transformation, etc. of valve spring are direct cause of damage such as valve stem uneven wear, etc. Therefore check certainly it when disassembling.
- If the measurement value is over the limit, replace it.

ITEM	SPECIFICATION	LIMIT
Free length (A)	37.25 mm	-
Inclination (B)	-	1.0 mm
Spring load	12.0 kgf / 31.0 mm (26.4 lbf / 1.22 in.)	-

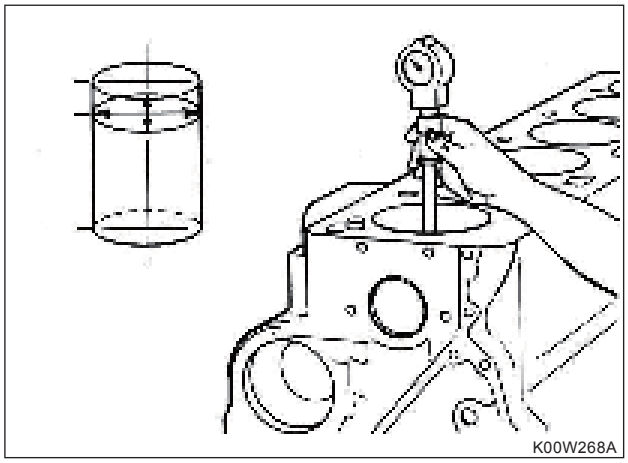
5.3.2 CYLINDER BLOCK

CHECKING THE CYLINDER BLOCK

▶ CHECKING THE CRACK OF EACH PART

- If damaged due to freeze and rupture, turnover etc, check the cylinder block for defects with visual inspection before disassembling.
- Check cylinder head bolt, screws: crack
- If severe crack or damage, change the cylinder block and if minor, revise it.
- To check the crack or leakage, carry out the hydraulic test.
- When changing the plug to prevent the freeze and rupture, apply the bond on the outer of plug. (Three Bond 1194 or equivalent product)

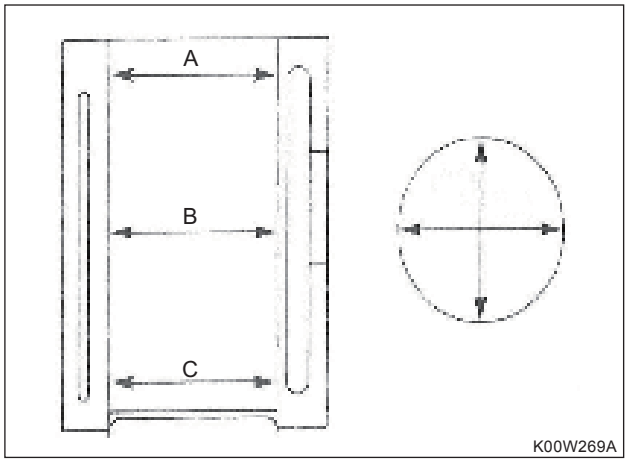
▶ MEASURING THE INNER DIAMETER OF CYLINDER



- Measure the inner diameter of cylinder and if above the allowable limit, replace it.

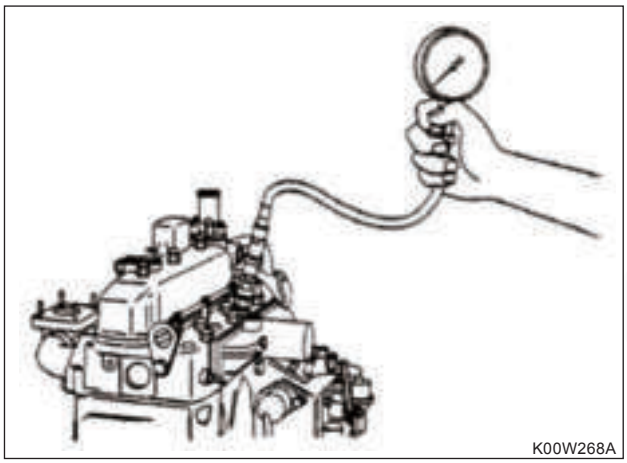
(unit: mm)

ITEM	SPECIFICATION	LIMIT
Cylinder inside diameter	78.015 ~ 78.025	78.20
Cylinder roundness	0.0 ~ 0.01	0.03
Cylinder cylindricity	0.0 ~ 0.015	0.03



- Measuring location: upper part (A) 20 mm section, middle part (B), front of engine and thrust on the lower part (C). (average value)

5.3.3 CYLINDER COMPRESSION PRESSURE INSPECTION



1. Warm up the engine enough then stop the engine.
2. Disassemble the air cleaner, muffler and injection nozzle.
3. Pull the engine stop lever to block the fuel supply.
4. Install the pressure gage in the nozzle.
5. Crank so that each cylinder would turn six or seven times and measure the pressure within the cylinder.

ITEM	SPECIFICATION
Cylinder compression pressure	30.59 kgf/cm^2 (435 psi, 3 MPa)

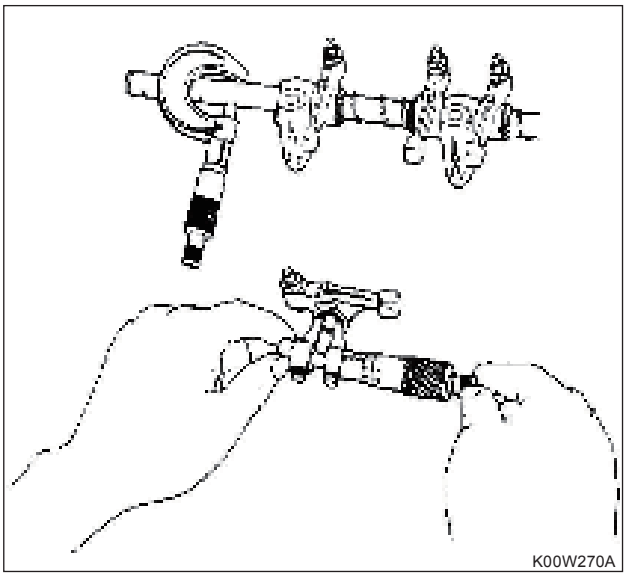
6. If the cylinder pressure is less than allowed, check the assembly of the gage and measure again.
7. If the result is same, check the cylinder head assembly, valve gap and piston top clearance.

5.3.4 VALVE DEVICE

Valve rocker arm has a direct relation with open/close time of valve and the engine performance such as output etc depends on this open/close time. Thus, the correct maintenance is required.

ROCKER ARM

▶ **OUTER DIA. OF ROCKER ARM SHAFT AND INNER DIA. OF ROCKER ARM**

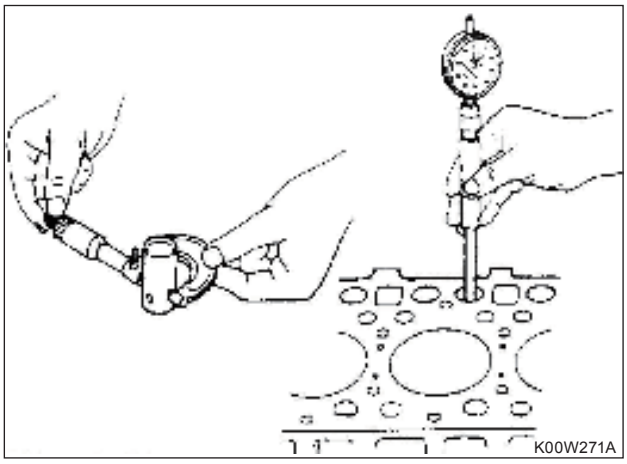


- Measure the outer dia. of shaft and inner dia. of rocker arm and if above the allowable limit, replace it.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
Outer dia. of shaft	12.955 ~ 12.980	12.95
Rocker arm inner dia.	13.000 ~ 13.025	13.09
Clearance	0.020 ~ 0.070	0.14

TAPPET



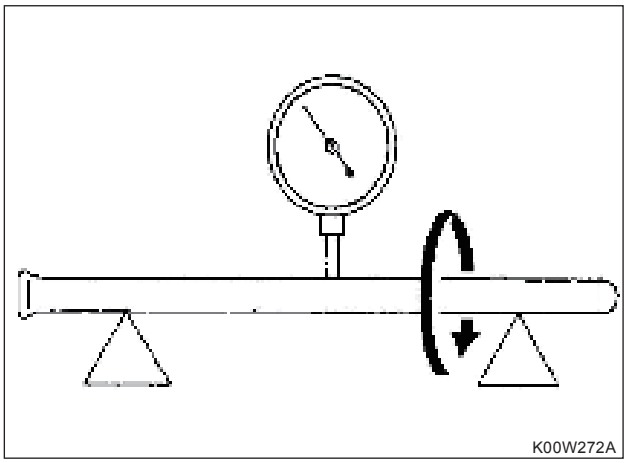
- Measure Tappet outer dia. and tappet hole of cylinder block and if above the Allowable limit, replace it.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
Tappet outer dia.	19.959 ~ 19.980	0.070
Guide inner dia.	20.000 ~ 20.021	-
Clearance	0.020 ~ 0.062	0.12

- Tappet cam shaft contact status: if serious one-sided wear, transformed or damaged, replace the tappet.

PUSH ROD



- Place the push rod on the surface plate and measure the bending degree using a clearance gauge and if exceeded the allowable limit value, replace it.

(unit: mm)

ALLOWABLE LIMIT	0.25

5.3.5 PISTON AND PISTON RING

CHECKING THE PISTON

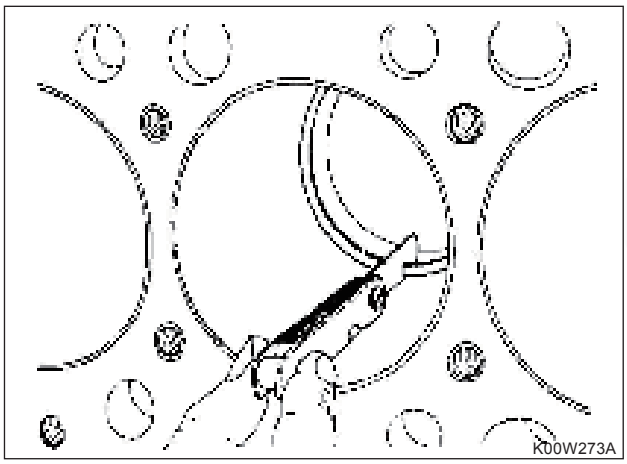
▶ **PISTON OUTER DIA.**

- Measure the main parts and if above the allowable limit, replace it.
- If damaged or cracked on the outer circumference surface, replace it.
- Piston outer dia.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
piston outer dia.	77.953~77.972	77.90
Min. clearance with cylinder	0.041 ~ 0.059	-

▶ **PISTON RING**



- When changing the piston ring, wash the ring groove cleanly and assemble it so that the maker mark engraved in the cutting part of ring can be faced upward of piston (Top) and then check if it works smoothly.
- When assembling the piston ring, assemble 120° dislocated to avoid locating the direction of ring cutting on the lateral pressure part.
- Measure the main parts and if above the allowable limit, replace it.
- Measure the gap of piston ring.

(unit: mm)

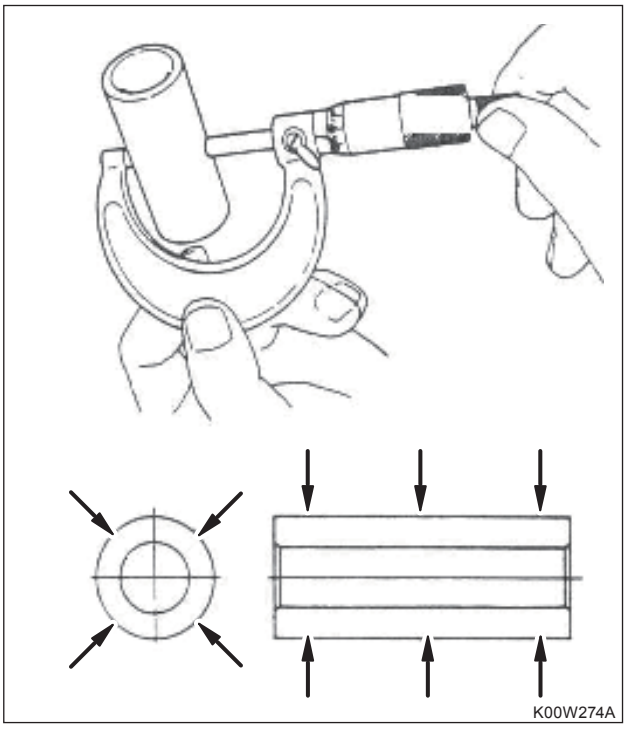
ITEM	SPECIFICATION	LIMIT
Ring 1	0.15 ~ 0.30	1.5
Ring 2	0.30 ~ 0.50	1.5
Oil Ring	0.20 ~ 0.40	1.5

- Measure the clearance of piston ring and ring groove.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
Ring 1	0.15 ~ 0.30	-
Ring 2	0.085 ~ 0.112	0.20
Oil Ring	0.020 ~ 0.055	0.15

▶ PISTON PIN

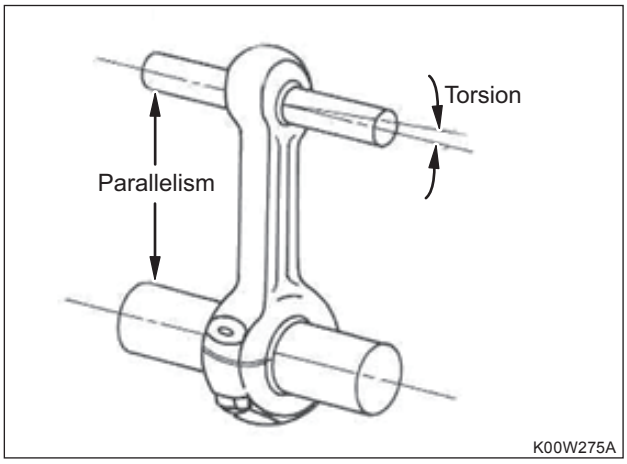


• Measure the main parts and if worn out above the allowable limit or one-sided wear, replace it.

(unit: mm)

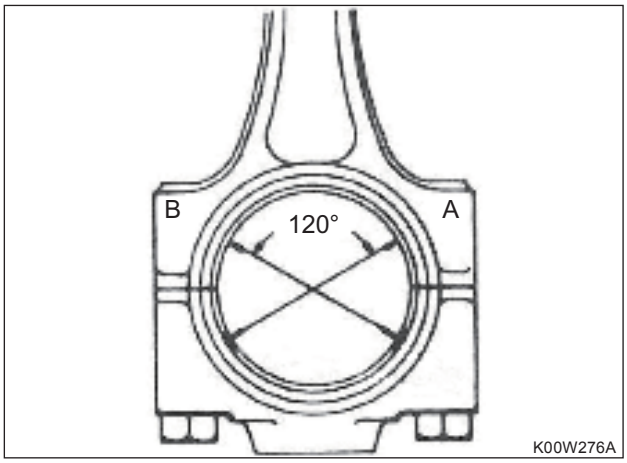
ITEM	SPECIFICATION	LIMIT
Piston pin outer dia.	21.999 ~ 22.005	21.90
Pin bush inner dia.	22.002 ~ 22.007	22.02
Clearance	0.003 ~ 0.008	0.10

▶ CONNECTING ROD



• Measure the distortion and parallelism of connecting rod big end and small end and if above the allowable limit, replace it.

ITEM	SPECIFICATION	LIMIT
Distortion and parallelism	0.03 mm by 100 mm	0.05 mm



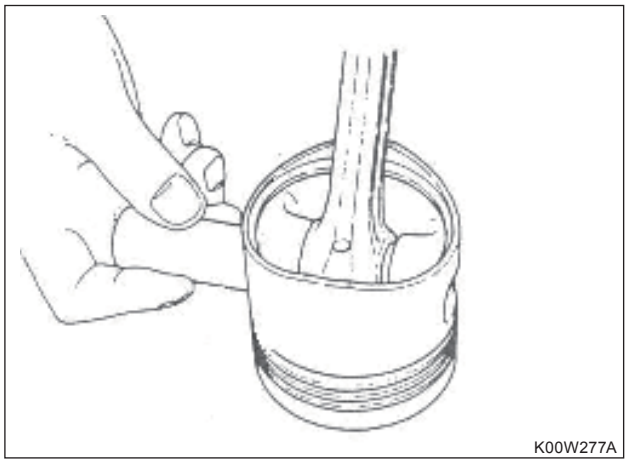
• Check the connecting rod big end.

• When measured, if above the allowable limit, replace the pin bearing. If needed, replace the connecting rod.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
Big end inside diameter	43.0 ~ 43.016	-
Metal thickness	1.487 ~ 1.500	-
Crank pin outer diameter	39.959 ~ 39.975	39.89
Oil clearance	0.025 ~ 0.087	0.15

REPLACE THE PISTON

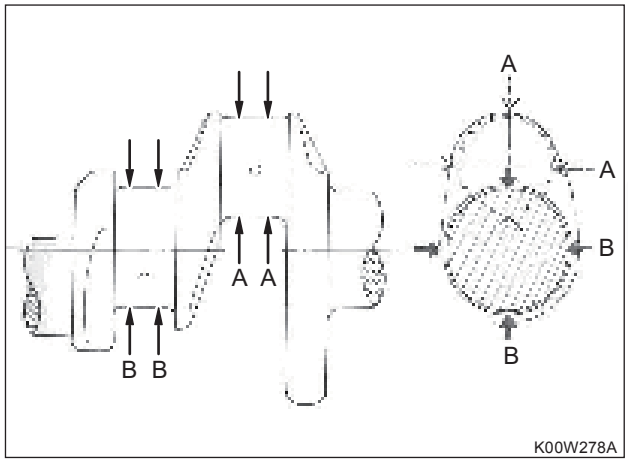


1. When assembling the piston ring and connecting rod, keep it clean.
2. After assembling the piston ring to the piston, check if it works smoothly.
3. Assemble the piston pin stop ring on the one side of piston.
4. Apply the oil to the piston pin and then assemble the connecting rod.
5. Assemble the piston pin stop ring.
6. When changing the piston, change the piston pin together.

5.3.6 CRANK SHAFT

CHECKING THE CRANK SHAFT

▶ **CHECKING THE CRANK SHAFT JOURNAL**

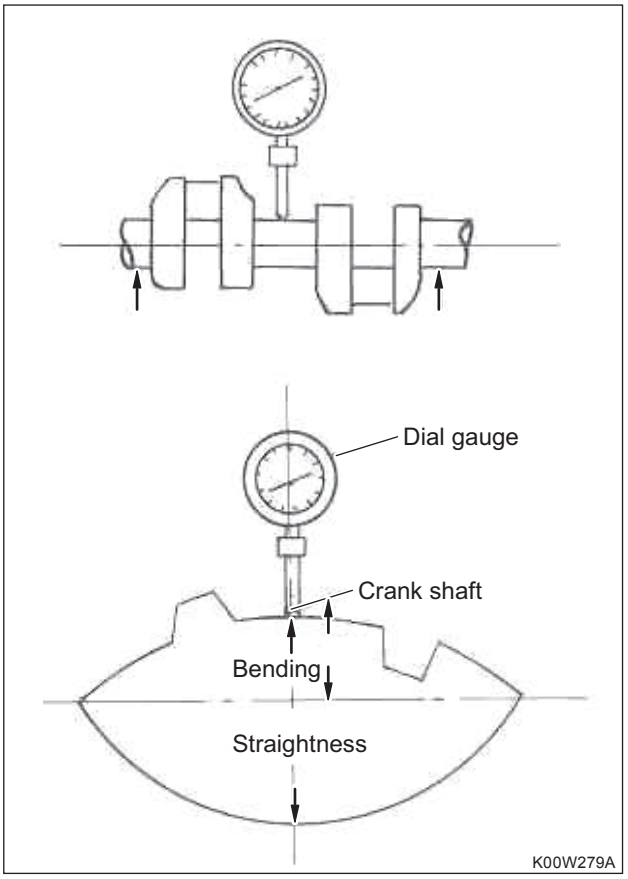


- If cracked or damaged, replace it.
- Measure the main parts and if above the allowable limit, replace the main bearing and if needed, replace the crank shaft.

(unit: mm)

ITEM	SPECIFICATION	LIMIT
Crank journal outer dia.	51.921 ~ 51.940	51.91
Metal thickness	2.002 ~ 2.015	-
Oil clearance	0.020 ~ 0.081	0.10

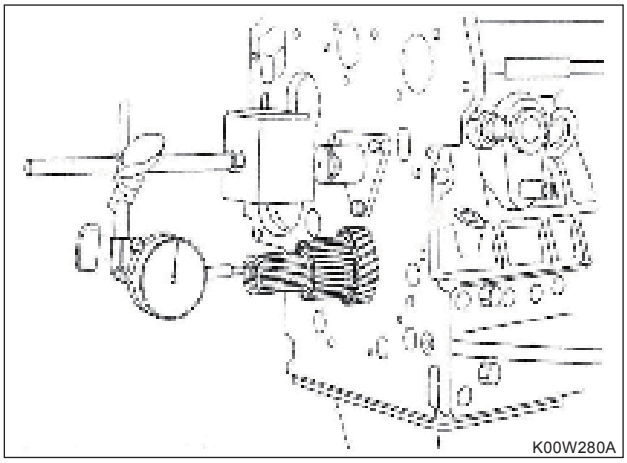
▶ CHECK THE BENDING DEGREE OF CRANK SHAFT



- Measure the bending degree of crank shaft.
- Fix the journal of both side of crank shaft on the V-block on the surface plate and measure the bending degree using a dial gauge by turning the crank shaft and if the straightness of the center of crank shaft is above the allowable limit, replace it.

BENDING STANDARD	Less than 0.02 mm

▶ CHECK THE SIDE CLEARANCE OF CRANK SHAFT



- Measure the side clearance of crank shaft.
- Install the magnetic base on the end of crank shaft and attach the dial gauge over it to measure the side clearance to the shaft direction of crank shaft and if above the allowable limit, replace the thrust bearing or crank shaft.

ITEM	SPECIFICATION
Thrust Clearance	0.15 ~ 0.31 mm

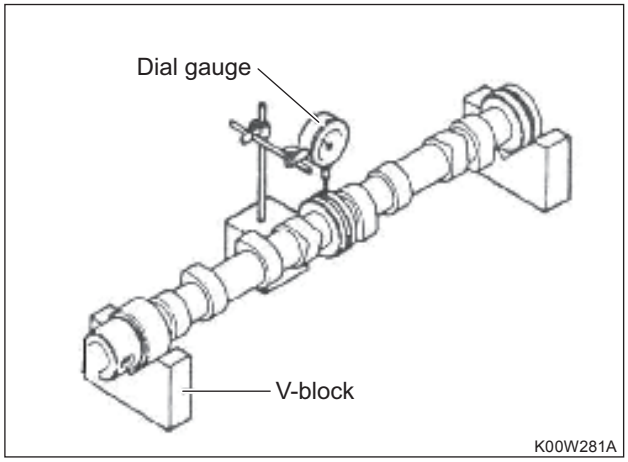
5.3.7 CAM SHAFT

CHECK THE CAMSHAFT

▶ CHECK THE CAMSHAFT'S FIGURE

Check if the contact part of Tappet and cam is worn or the cam gear is damaged.

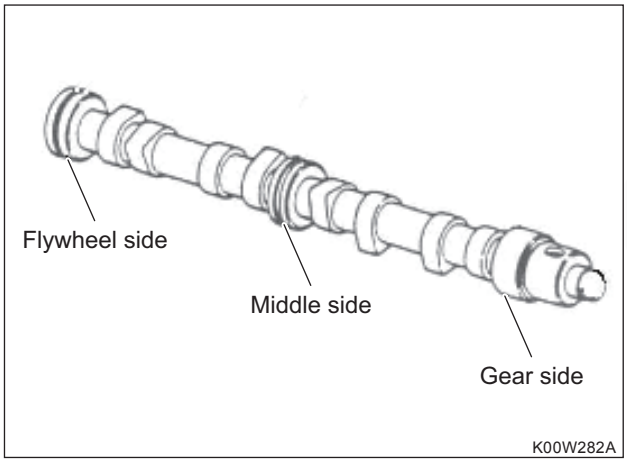
▶ MEASURING THE BENDING DEGREE OF CAM SHAFT



- Measure the bending degree of cam shaft.
- Fix the journal of both side of cam shaft on the V-block on the surface plate and measure the shaking of cam journal on the center of cam shaft using a dial gauge by turning the cam shaft.
- The 1/2 of journal shaking is the bending degree.

ITEM	SPECIFICATION	LIMIT
cam shaft bending degree	Less than 0.02 mm	0.05 mm

▶ CHECKING OF CAM SHAFT JOURNAL

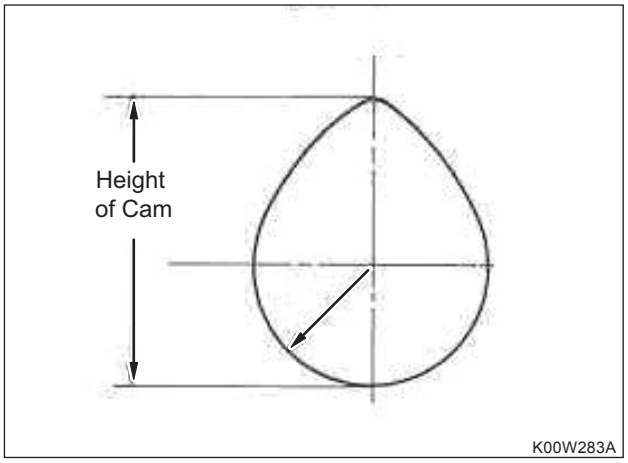


- Measure the cam shaft outer dia. using a micrometer. For oil clearance, measure the cam shaft inner diameter of cylinder block using a cylinder gauge and then calculate the difference from the cam shaft outer diameter.

(unit: mm)

ITEM		STANDARD	LIMIT
Gear side	Cam shaft outer dia.	35.934 ~ 35.950	35.89
	Oil clearance	0.050 ~ 0.091	-
Middle	cam shaft outer dia.	35.934 ~ 35.950	35.89
	Oil clearance	0.050 ~ 0.091	-
Fly wheel side	cam shaft outer dia.	34.934 ~ 35.950	35.89
	Oil clearance	0.050 ~ 0.091	-

▶ CHECKING OF INTAKE/EXHAUST CAM HEIGHT



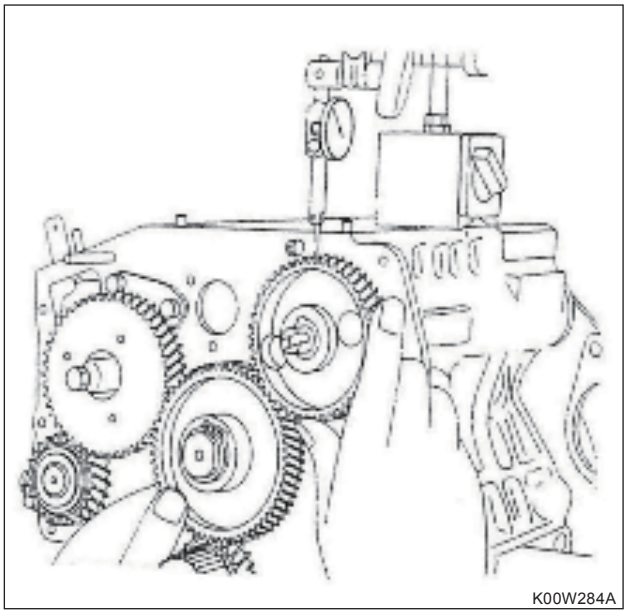
(unit: mm)

ITEM		STANDARD	LIMIT
Cam height	intake	28.80	28.75
	exhaust	29.00	28.95

5.3.8 EACH GEAR

CHECKING OF GEAR

▶ CHECKING OF EACH GEAR



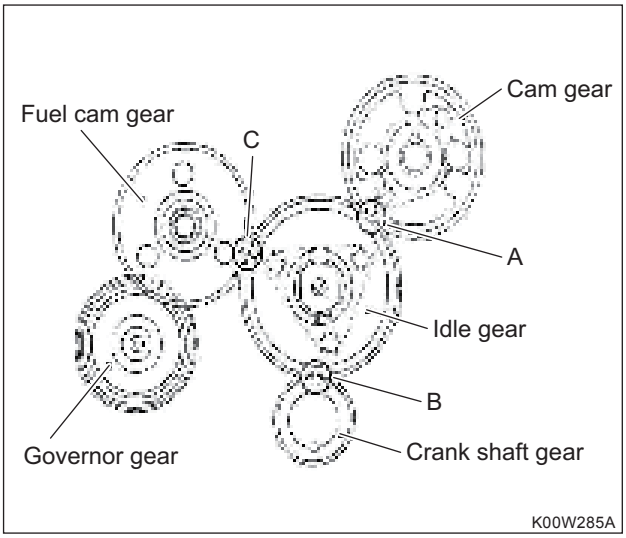
- Check the teeth side of each gear and if damaged or worn, replace it.

▶ GEAR BACKLASH

(unit: mm)

ITEM		STANDARD
Backlash	Crank gear ~ Idle gear	0.032 ~ 0.115
	Idle gear ~ Injection pump gear	0.032 ~ 0.115
	Idle gear ~ Cam gear	0.032 ~ 0.115
	Cam gear ~ Hydraulic pump gear	0.036 ~ 0.114
	Crank gear ~ Oil pump gear	0.032 ~ 0.115

▶ GEAR TRAIN



(A) Point 1ea (B) Point 2ea (C) Point 3ea

- When assembling each gear, check the helm angle mark of Idle gear.
  - Check the helm angle mark by the number of point.

5.4 ENGINE OPERATION

5.4.1 ADVANCE PREPARATION FOR OPERATION

1. Refuel the new engine oil through oil supply inlet.
2. Connect the coolant hose and refuel the coolant.
3. Connect the fuel tank to fuel hose.
4. Exhaust the air of fuel line.

5.4.2 ENGINE OPERATION

For new engine, as the friction part is not yet tame sufficiently, the oil film may shorten the engine life due to overload or over speed and thus it is required to comply with the following.

INITIAL 50 HOURS

1. Operate with the range of 1200 ~ 1500rpm at no load until the temperature of engine becomes the normal operation condition
2. Avoid the overload or continuous operation at high speed.
3. Avoid high speed operation at no load.
4. Avoid the sudden acceleration or sudden stop of engine.
5. Perform the checking and inspection procedure.

5.4.3 CHECKING FOR TAMING

During the initial taming operation, it is required to comply with the following.

1) Check the engine oil level frequently. (Oil level should be between top high limit and low limit)

2) Check the oil pressure information lamp.

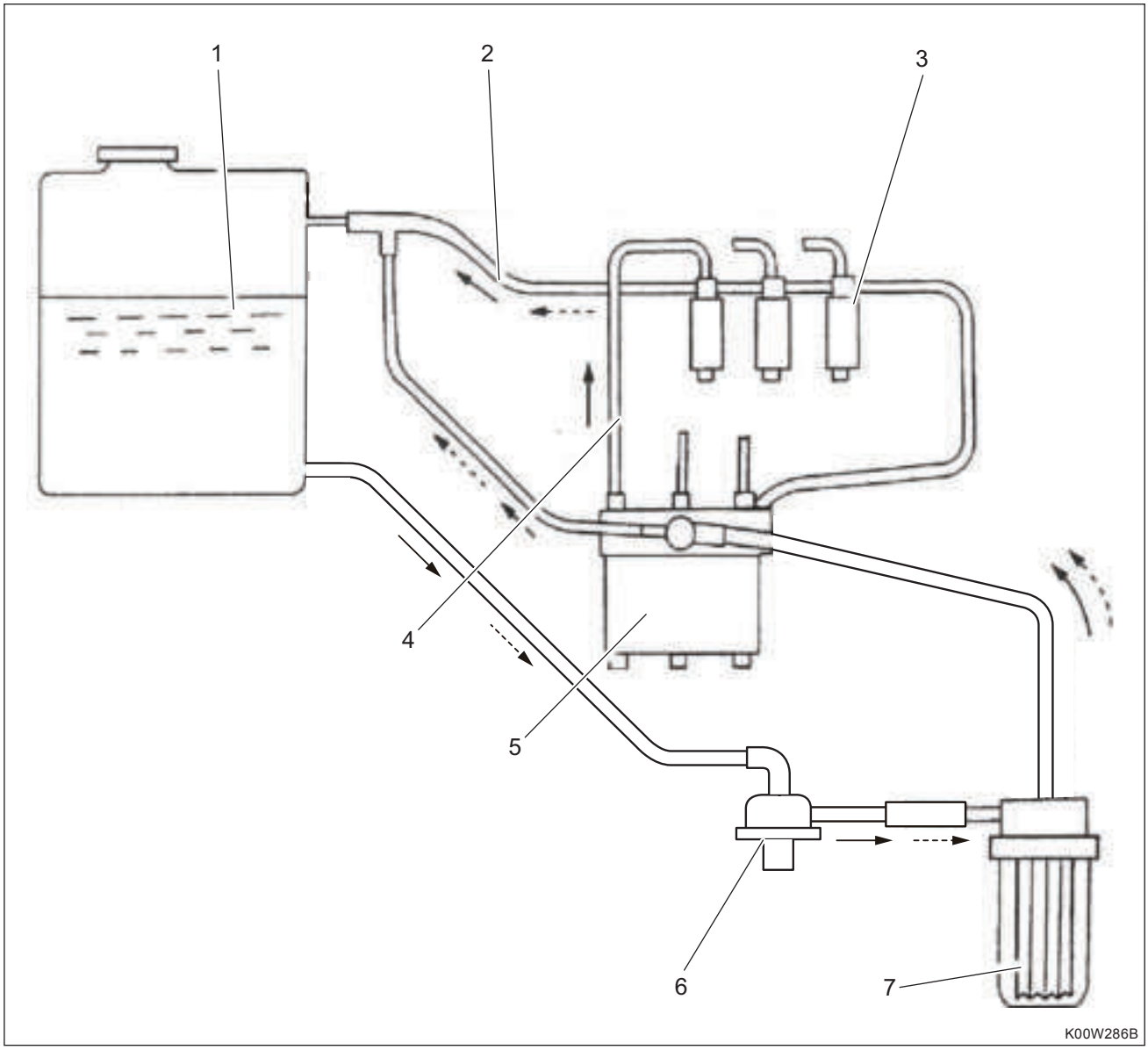
If the lamp is ON, it means that there is a lacking of oil or a problem in lubrication system, and thus check it.

3) Watch the engine coolant gauge and check if the coolant circulates well.

When the taming (50hr) is completed, change the engine oil and oil filter.
(Use the engine oil to meet the local characteristic temperature)

5.5 MAIN PARTS OF ENGINE

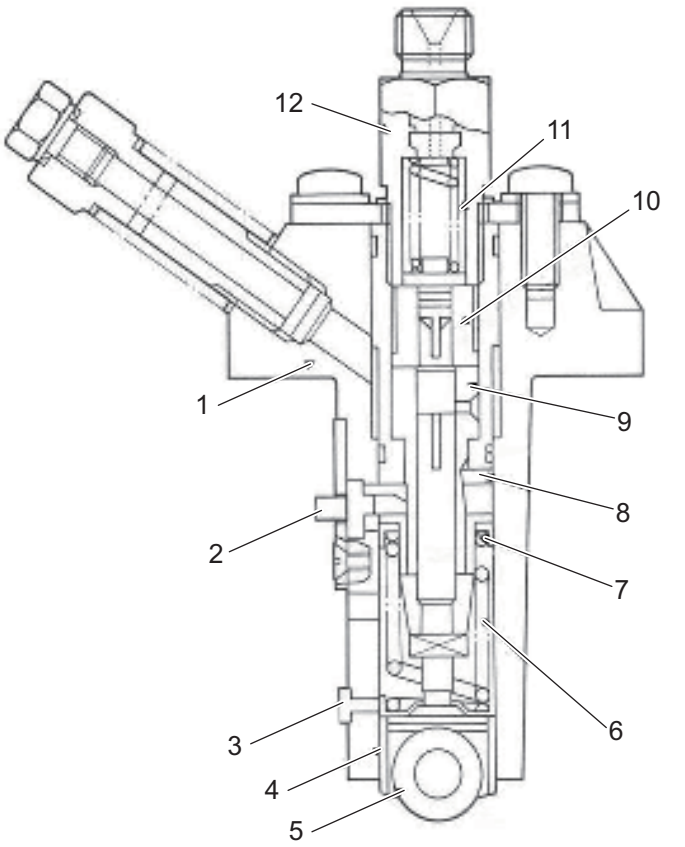
5.5.1 FUEL DEVICE



(1) Fuel tank
(2) Fuel overflow pipe
(3) Injection nozzle
(4) Injection pipe
(5) Injection pump
(6) Fuel feed pump
(7) Fuel filter

Fuel device is composed of fuel tank, fuel feed pump, fuel filter, fuel injection pump, fuel injection valve and the parts connecting.

FUEL INJECTION PUMP



(1) Fuel injection pump housing
(2) Control rod
(3) Pin
(4) Tappet
(5) Roller
(6) Plunger spring
(7) Control sleeve
(8) Pin
(9) Plunger combination
(10) Delivery combination
(11) Delivery valve spring
(12) Delivery valve holder

K00W287A

Fuel injection pump is a distribution type (VE), installed in the gear cover plate and driven by injection pump gear.

Through reciprocating motion of one plunger by rotating, the fuel is distributed and supplied to each cylinder. The fuel is absorbed from fuel tank by external feed pump and internal feed pump and sent to the injection pump via fuel filter. The fuel with low pressure is flowed into the pump chamber and adjusted by the regulating valve. The fuel flows into the high pressure chamber through barrel absorption port via the path of injection pump head from pump chamber. The fuel that becomes to get a high pressure by plunger is injected through fuel injection valve according to the injection sequence. Meanwhile, the excessive fuel in the injection pump returns to the fuel tank through fuel returning hose via overflow valve.

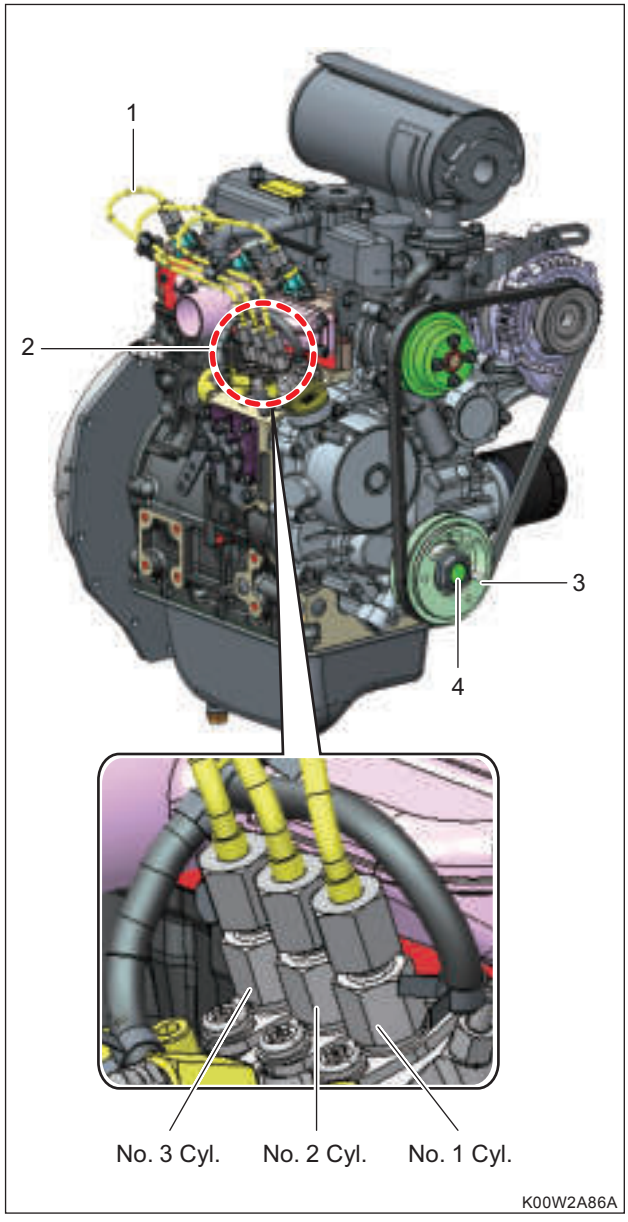
This fuel circulation allows the cooling and lubrication of fuel injection pump. The fuel remained from fuel injection valve is also collected in the injection pump and returned to the fuel tank through the overflow hose. The water in the fuel shortens the pump life extremely and thus the cares should taken not to enter water or dust into the fuel system.

▶ SPECIFICATION

ITEMS		SPECIFICATION	REMARKS
Fuel filter specification		Cartridge filtration knowledge	
Fuel injection pump	Type	PFR	
	Injection sequence	1-2-3	
	Governor type	All Speed	
	Fuel block solenoid	12V / 8Ω	
Fuel injection Valve	Nozzle type	Semi-Throttle Type	
	Holder type	Screw insert type	M20 X 1.5

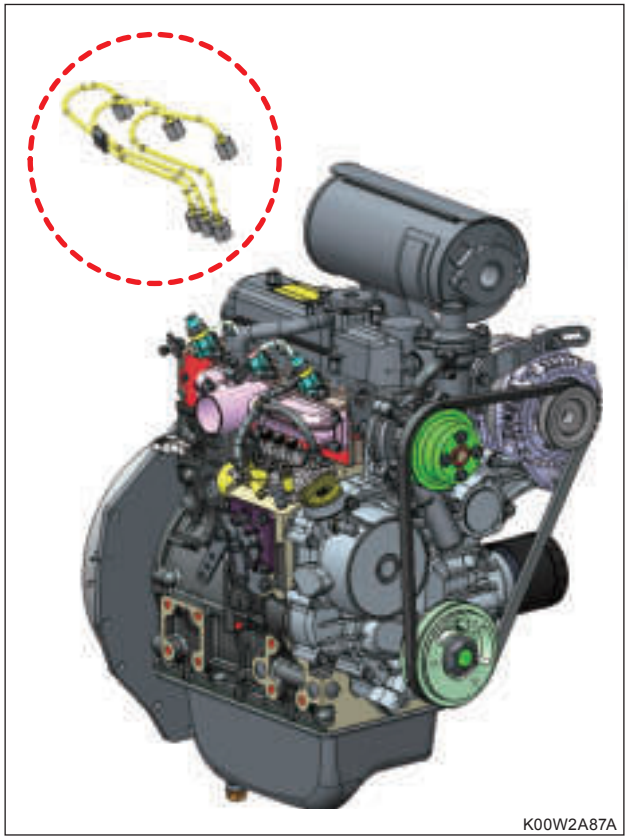
▶ CHECK AND ADJUST THE INJECTION TIMING

(1) INSTALLATION POSITION

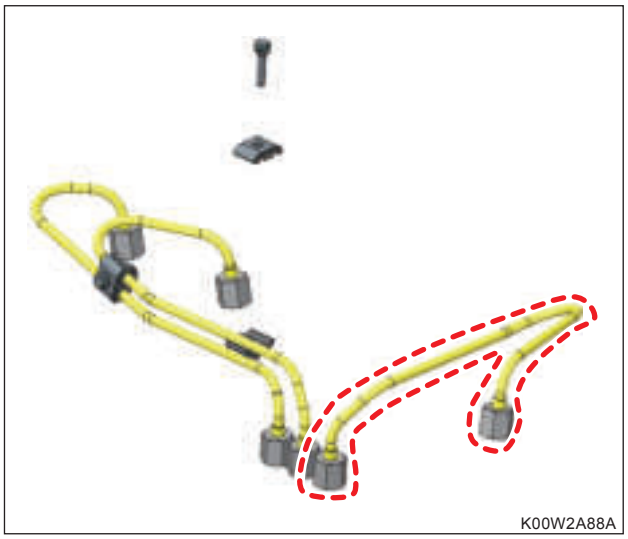


(1) Fuel injection pipe
(2) Fuel injection pump
(3) V-pulley
(4) Nut (V-pulley)

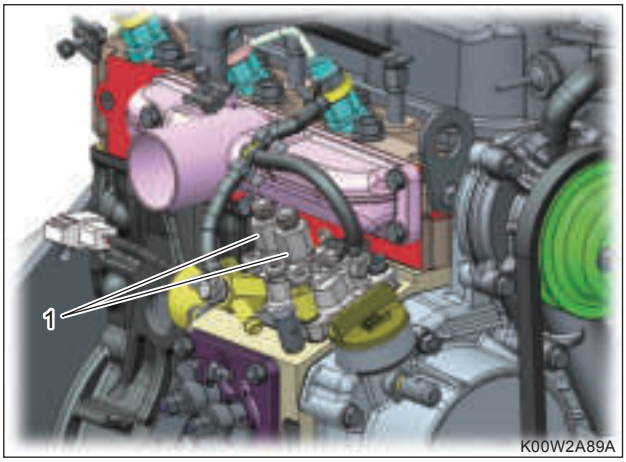
(2) CHECKING AND ADJUSTMENT PROCEDURES



- **Step 1:** Remove the entire fuel injection pipe. (Use 17 mm Spanner)



- **Step 2:** Disconnect only the No. 1 Cylinder fuel injection pipe from the fuel injection pipe combination.



(1) Delivery valve holder

- **Step 3:** Remove the spring/needle inside the delivery valve of the fuel injection pump No. 1 cylinder.

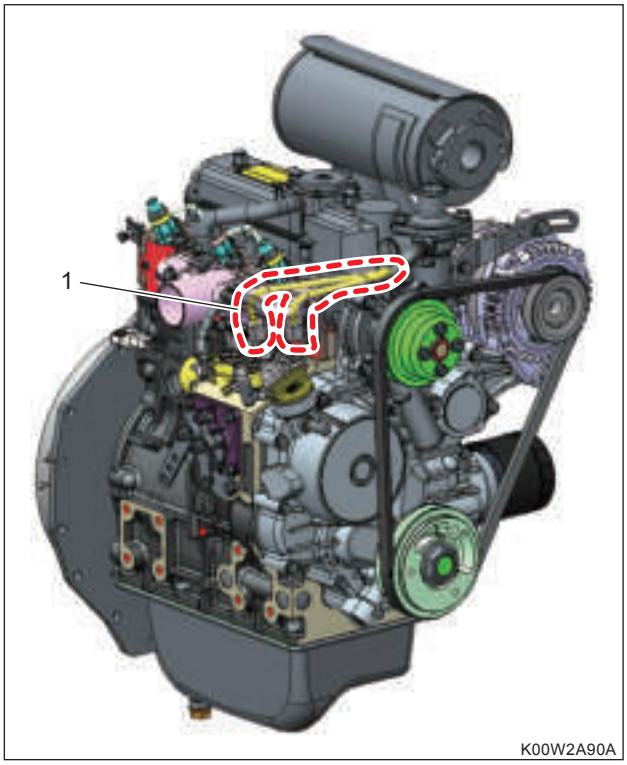
<Details>

① Disassemble the delivery valve holder of the fuel injection pump No. 1 (Use 17 mm spanner)

② Remove springs and needles in the delivery valve. (To enable the fuel injection pump to discharge fuel immediately.)

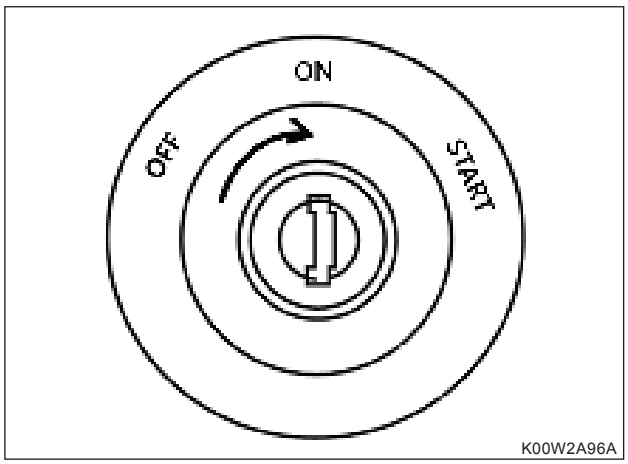
③ Reassemble delivery valve holder

Tightening torque.....4 ~ 4.5 kgf.cm
0.289 ~ 0.325 lbf.ft
0.392 ~ 0.441 N.m



(1) No. 1 Cylinder fuel injection pipe

- **Step 4:** Re-assemble only the No. 1 cylinder fuel injection pipe into the fuel injection pump.



- **Step 5:** Turn key switch to KEY-ON to allow fuel to be supplied to the fuel injection pump.

<Purpose>

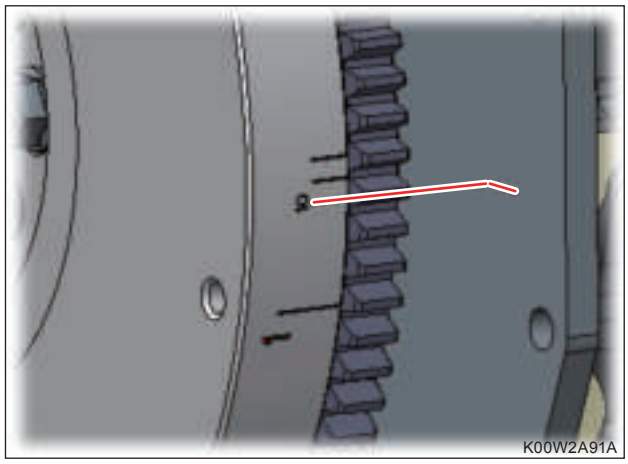
① Serves purpose of sending the fuel of the fuel tank to the fuel injection pump by operating the feed pump.

② Serves purpose of opening flow path so that the fuel sent from the fuel tank can be sent to the delivery valve for injection in the fuel injection pump.

- **Step 6 (Method 1)** : After KEY-ON, rotate the engine until the fuel injection stops at the No.1 pipe.

<Details>

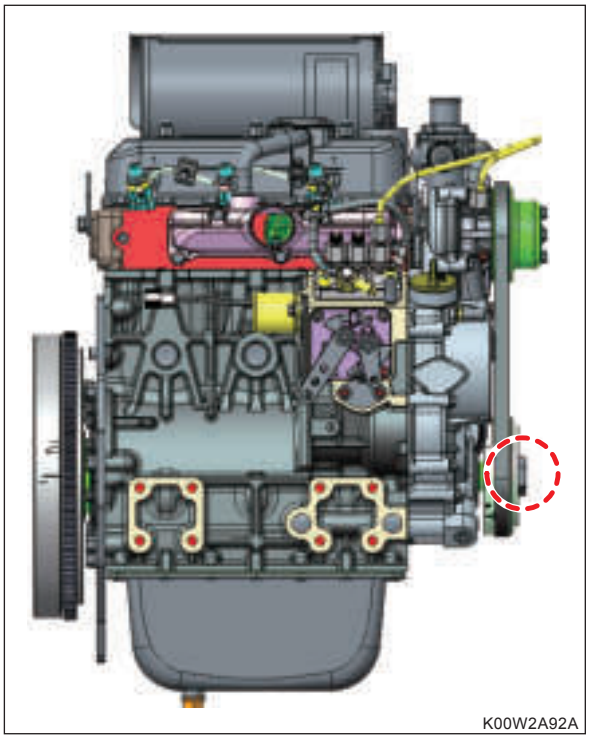
① : Confirm the point when the fuel injecting starts to stop and drops one drop per 10 seconds.



② : After finishing ①, turn nut (V-pulley) clockwise using the engine center.

* Injection timing: BTDC 12.5˚ ~ 13.5˚

NOTE

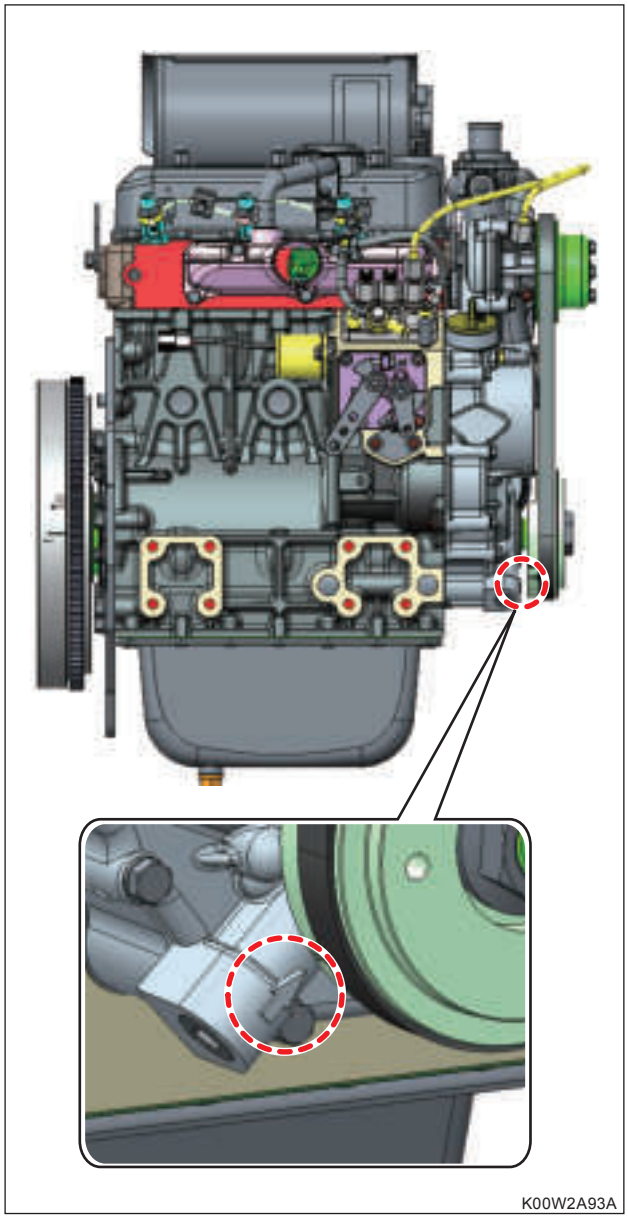


- **Steering angle of the rear plate, the steering angle with “10” on the flywheel, and a 32 mm box socket.**

- **Step 6 (Method 2)** : After KEY-ON, rotate the engine until the fuel injection stops at the No.1 pipe.

<Details>

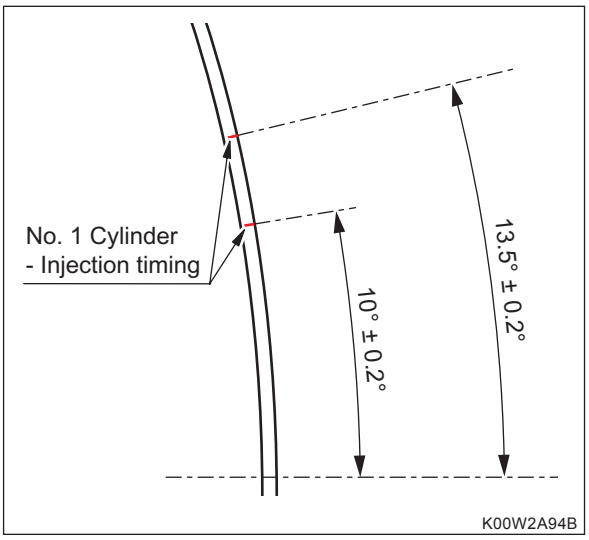
① : Confirm the point when the fuel injecting starts to stop and drops one drop per 10 seconds.

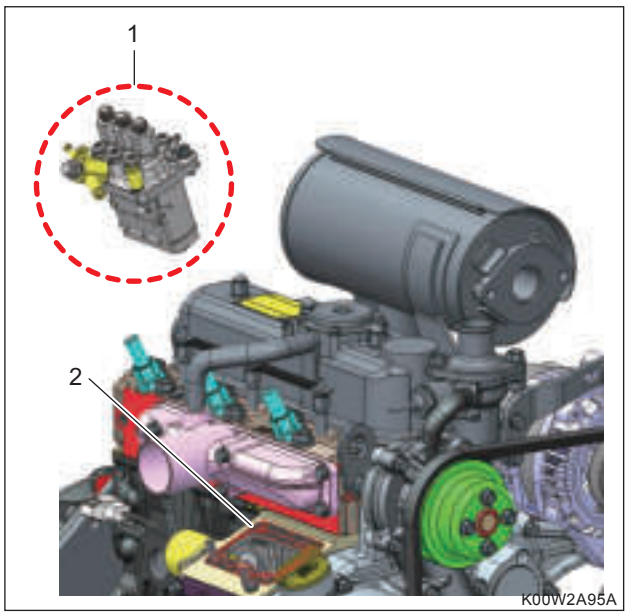


② : After completing ① check gear case arrow mark "→" to an timing mark of the V-pulley to verify it matching.

* Injection timing: BTDC 12.5˚ ~ 13.5˚

NOTE





(1) Fuel injection pump (2) Shim

- **Step 7:** When the set injection timing and the confirmation result are different, adjust as follows.

<Details>

① : Remove fuel injection pump.

② : Shim quantity adjustment.

Shim addition: Injection timing delayed.

Shim removal: Injection timing advanced.

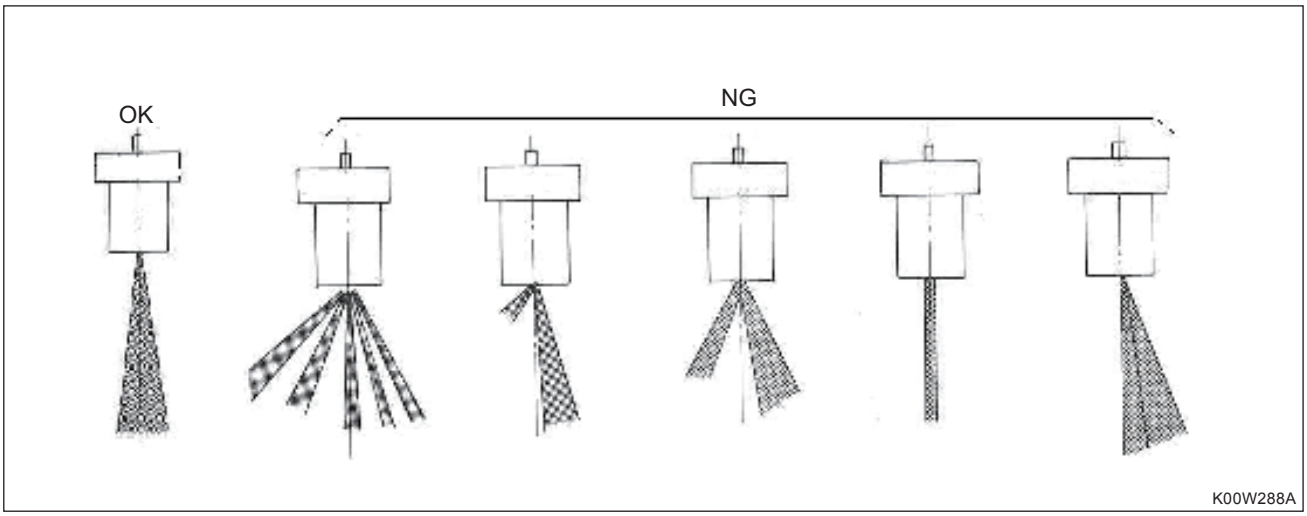
SHIM P/N	THICKNESS
HT14030100A3	0.28 mm
HT14030200A3	0.38 mm

③ : Re-assemble fuel injection pump.

FUEL INJECTION VALVE

The spray shape of fuel injection valve is important factor that affects the performance of diesel engine and thus it is required to adjust and maintain correctly.

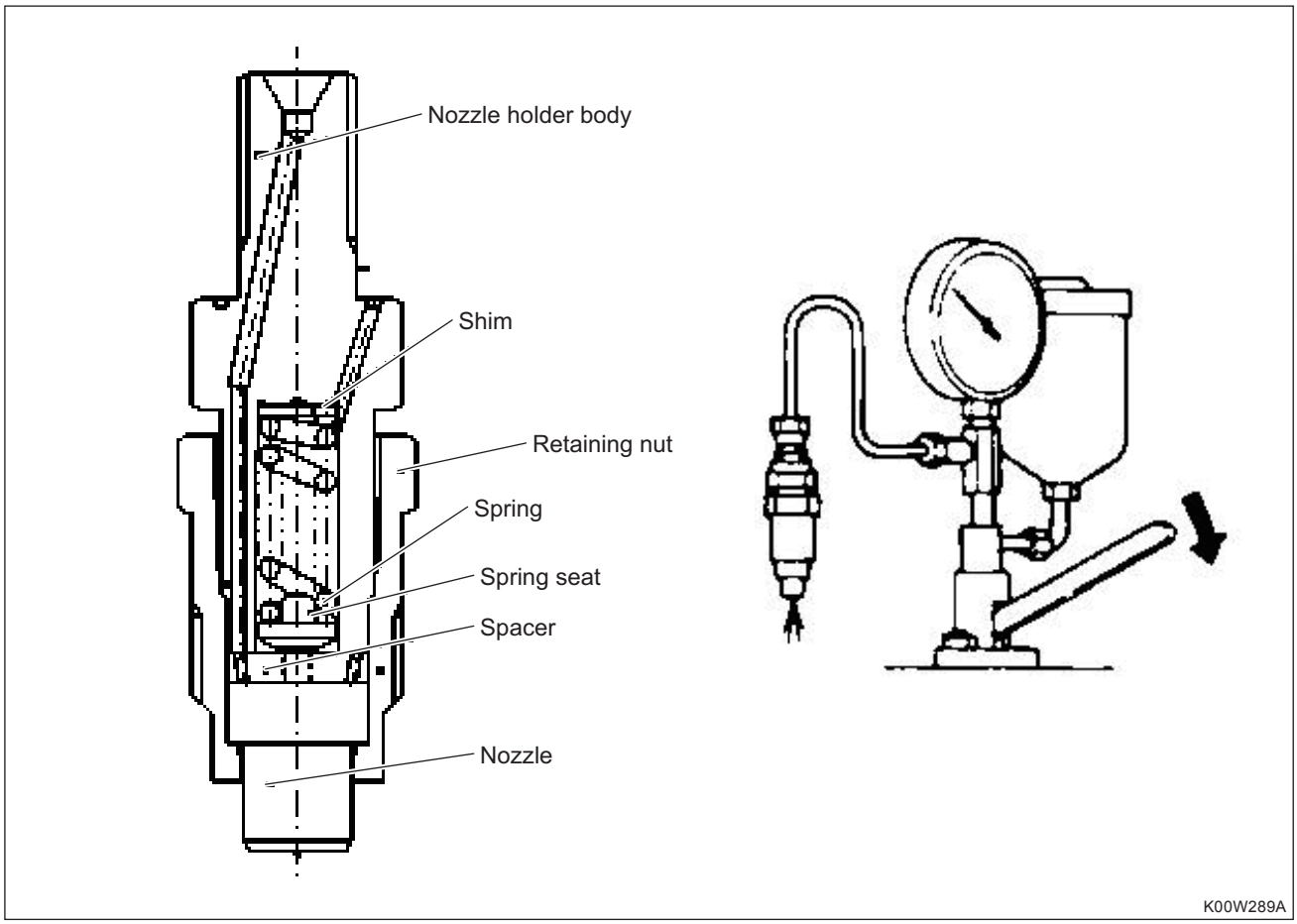
▶ CHECK THE NOZZLE SPRAY SHAPE



Adjust nozzle injection pressure to 140 ± 5 kgf/cm^2 and then attach the nozzle tester to operate the lever 4 ~ 6 times per second. Check the spray state and if a problem found, clean the nozzle or replace it.

1. Check if the spray state is good or not.
2. If not good, disassemble the fuel injection valve and replace the nozzle tube or replace it with assembly.
3. After stopping the spray, check if there is any trace.
4. If not good, disassemble the fuel injection valve and replace the nozzle tube or replace it with assembly.

▶ CHECK AND ADJUST THE NOZZLE: CHECK AND ADJUST THE INJECTION START PRESSURE



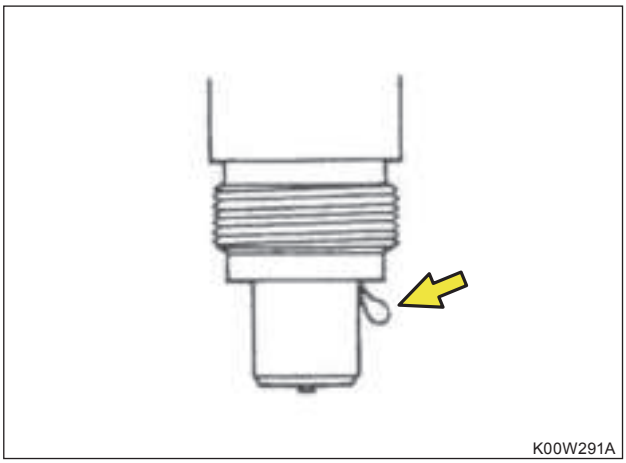
1. Install the nozzle holder to the nozzle tester.
2. Operate the handle of nozzle tester at the speed with one time per second.
3. The pointer of pressure gauge rises slowly and the pointer shakes during injection. Read the position that the pointer starts to shake and check if the start pressure is standard value.

STANDARD PRESSURE	**INDIVIDUAL PRESSURE**	140 kgf/cm^2 (1991.26 psi, 13.73 MPa)
	ADJUSTMENT PRESSURE	145 ~ 155 kgf/cm^2, (2062.381 ~ 2204.614 psi, 15.20 ~ MPa
LIMIT PRESSURE		More than 140 kgf/cm^2(1991.26 psi, 13.73 MPa)

WARNING
• **When disassembling the nozzle holder, pay attention to the dust not to enter in.**

4. Despite of changing the thickness of seam, if it is not possible to adjust the injection start pressure, replace the nozzle with assembly.

▶ CHECK NOZZLE OIL TIGHTPRESSURE



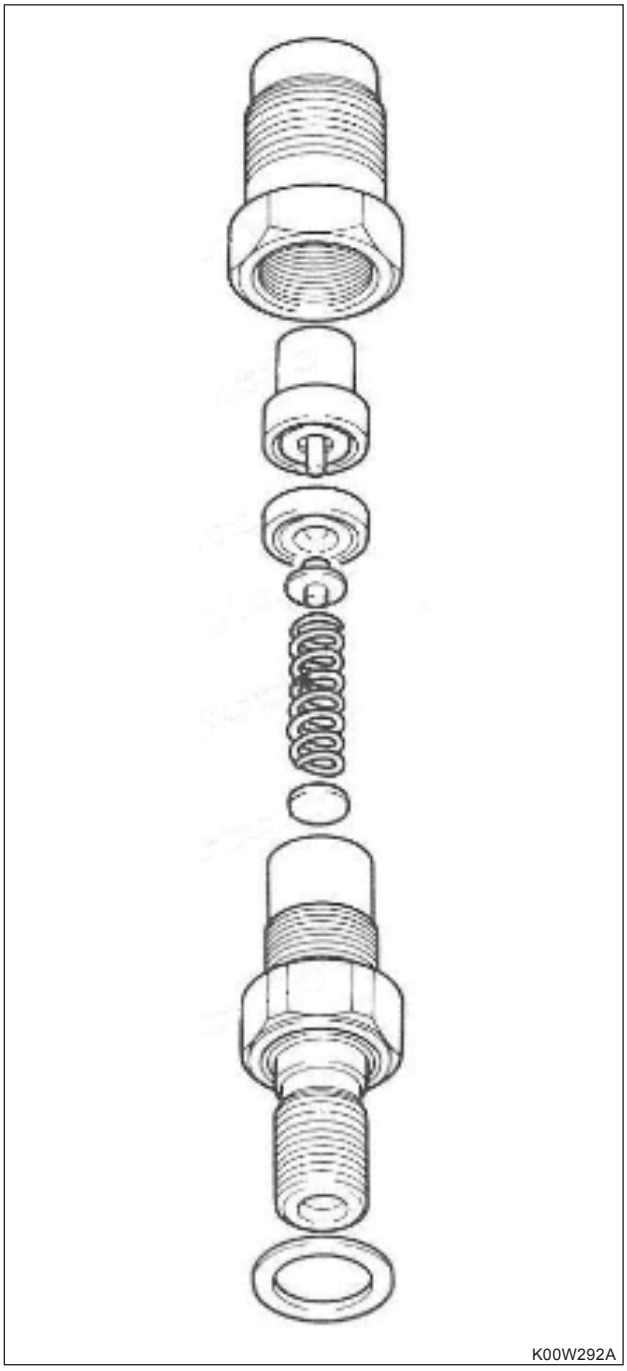
1. Operate the lever of nozzle tester to inject the fuel several times and then wipe the fuel of nozzle and increase the pressure to 130 kgf/cm^2 (1849.03 psi, 12.75 MPa) which is the pressure 20 kgf/cm^2 (284.47 psi, 1.96 MPa) smaller than the regulation injection pressure. If it maintains the pressure, check if there is a leakage of fuel in the nozzle tube.
2. If not good, disassemble the fuel injection valve and replace the nozzle tube or replace it with assembly.

▶ INSULATION PACKING OF COMBUSTION CHAMBER

- Swirl type combustion chamber improved the durability of nozzle by the insulation effect of nozzle valve using an insulation packing and thus it is needed to check the insulation.
- Clean the hole of fuel injection valve of cylinder head and use the new gasket. (Replace the once used and the damaged.)

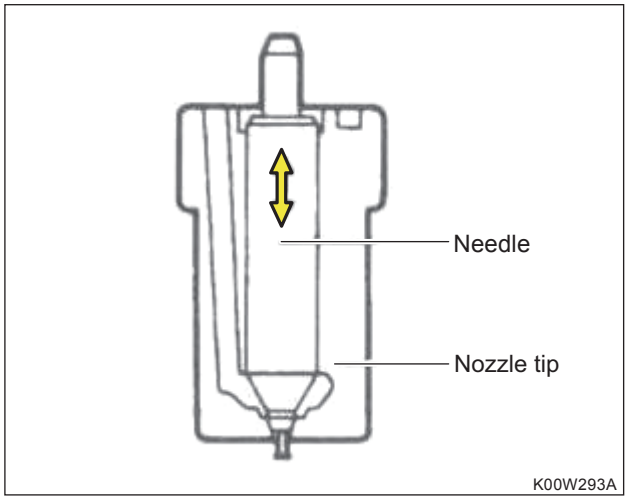
▶ NOZZLE HOLDER

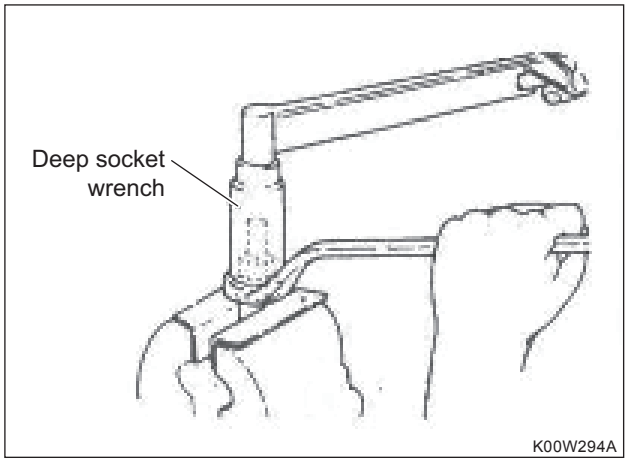
● DISASSEMBLING



1. Fix the retaining nut using a cushion bracket.
2. After fixing the retaining nut with box wrench, disassemble the nozzle holder body using a deep socket wrench.

● CHECK THE NOZZLE TIP



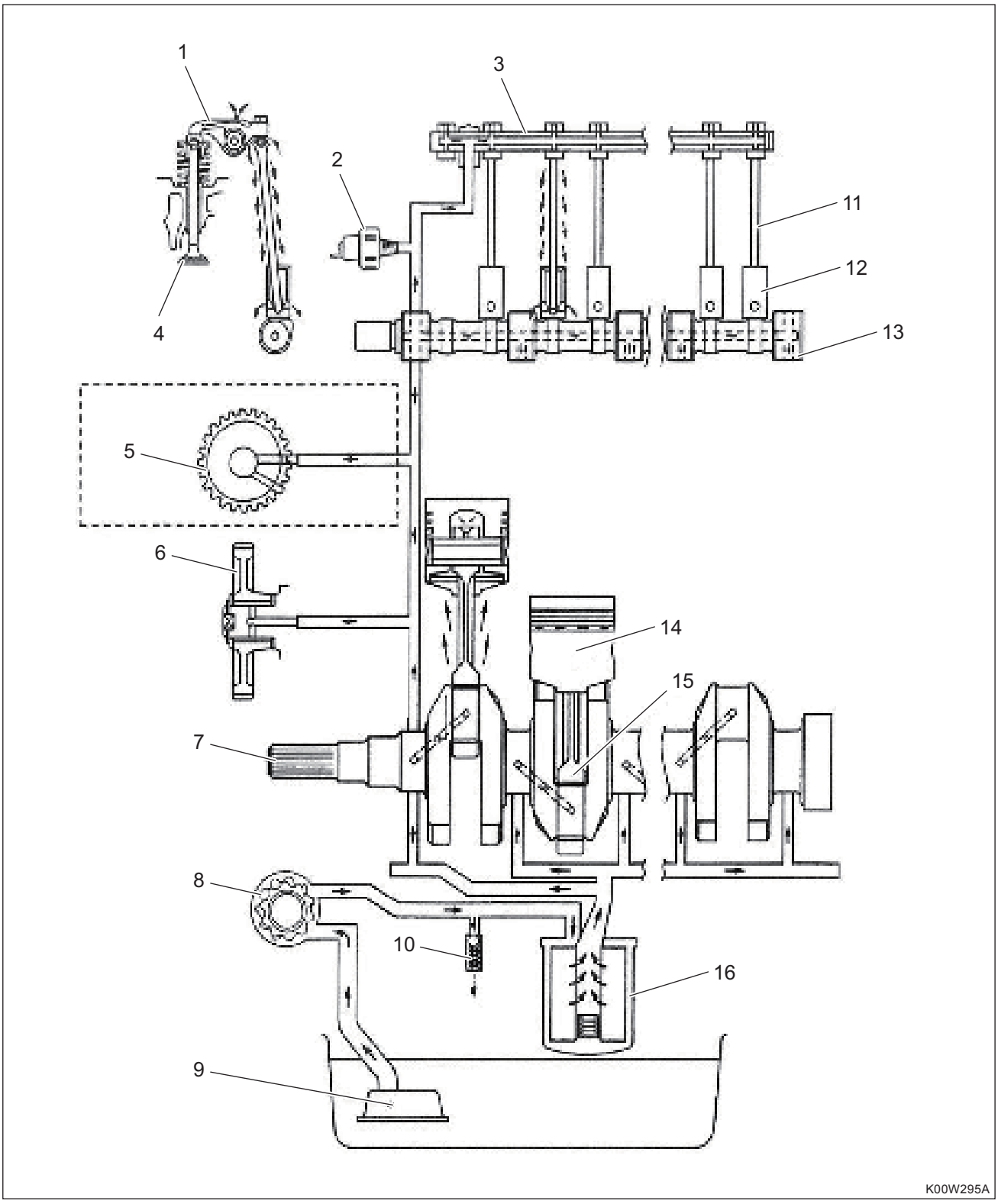


1. Check if the carbon is attached to the nozzle tip. If the carbon is attached, remove the carbon and wash each part with wash liquid and dip it in the light oil. Pay attention to the needle valve of nozzle tip not to be damaged.
2. Dip the nozzle tip in the light oil and check if the needle valve operates smoothly. If not operated smoothly, replace it.
3. Wash the new nozzle tip with clean light oil before using it.

● ASSEMBLE THE RETAINING NUT

1. Tighten the nozzle holder body tightly by hand.
2. Fix the retaining nut lightly by the vice with cushion plate.
3. Fix the retaining nut with box wrench and use the deep socket wrench to assemble the nozzle holder body with the setting torque.

5.5.2 LUBRICATING DEVICE



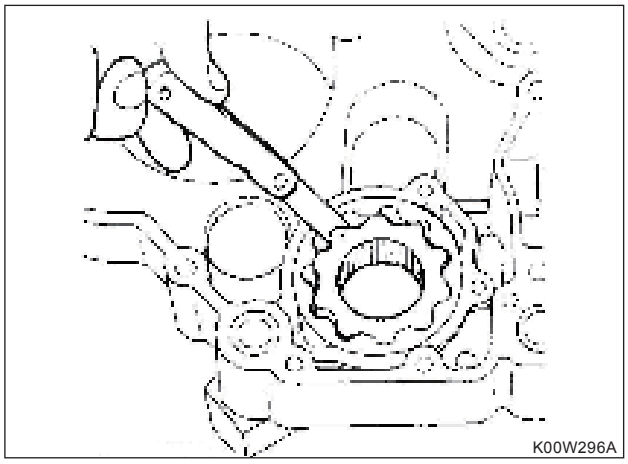
(1) Rocker arm
(2) Oil pressure switch
(3) Rocker arm shaft
(4) Valve
(5) Governor shaft
(6) Idle gear
(7) Crank shaft
(8) Oil pump
(9) Oil intake pipe
(10) Relief Valve
(11) Push rod
(12) Tappet
(13) Cam shaft
(14) Piston
(15) Connecting rod
(16) Oil filter

The engine oil is absorbed and conveyed through oil intake pipe by the operation of oil pump and after passing the oil filter, it is supplied to each lubricating part for lubrication.

OIL PUMP

- Oil pump is a trochoid pump that is driven by crank shaft gear, which is compact and less change of pressure and during operation, is supplied to each part at 3.5 kgf/cm^2 (49.78 psi, 0.34 MPa) pressure.
- When the discharge pressure of lubricating oil pump is low, check the flow rate and if no problem, check the lubricating oil pump with the following method.

▶ CLEARANCE BETWEEN OUTER ROTOR AND INNER ROTOR

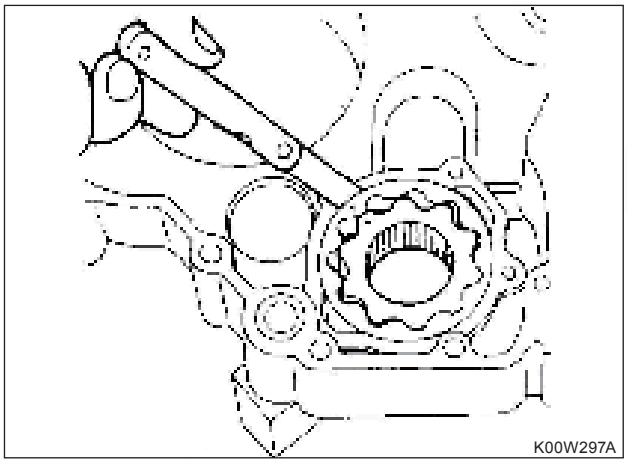


- Use the clearance gauge to check the clearance between outer rotor and inner rotor.

(unit: mm)

TYPE	STANDARD	ALLOWABLE LIMIT
Clearance	0.07	0.15

▶ CLEARANCE OF PUMP BODY AND OUTER ROTOR AND INNER ROTOR

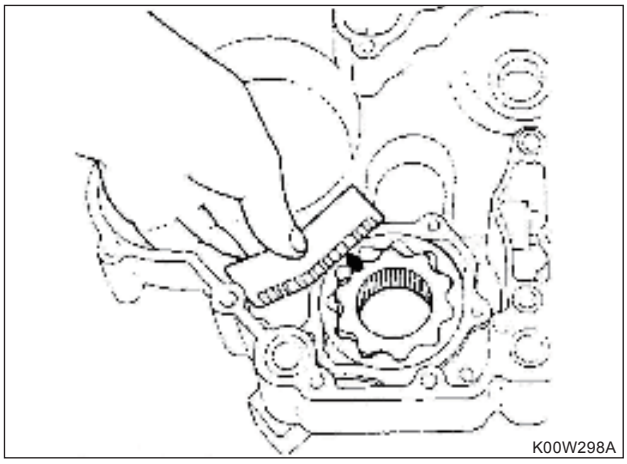


- Use the clearance gauge to check the clearance of outer rotor and pump body.

(unit: mm)

TYPE	STANDARD	ALLOWABLE LIMIT
Clearance	0.100	0.180

▶ CLEARANCE OF INNER ROTOR SHAFT AND OIL PUMP COVER

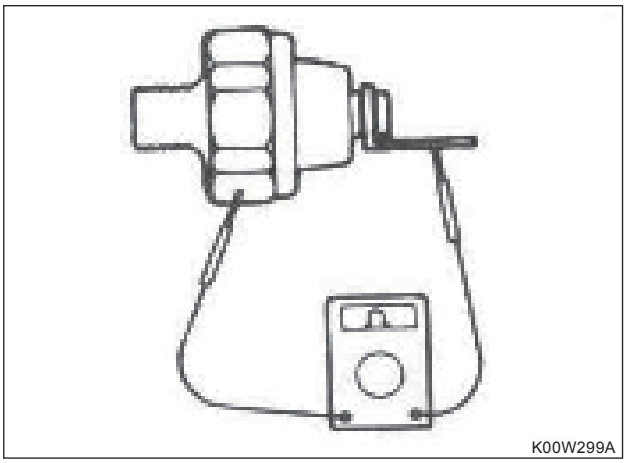


- Measure the clearance of rotor and oil pump cover and check it.

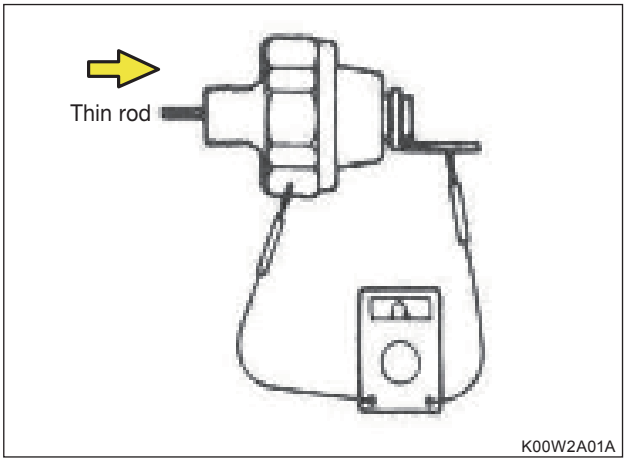
(unit: mm)

TYPE	STANDARD	ALLOWABLE LIMIT
Clearance	0.030	0.085

OIL PRESSURES SWITCH

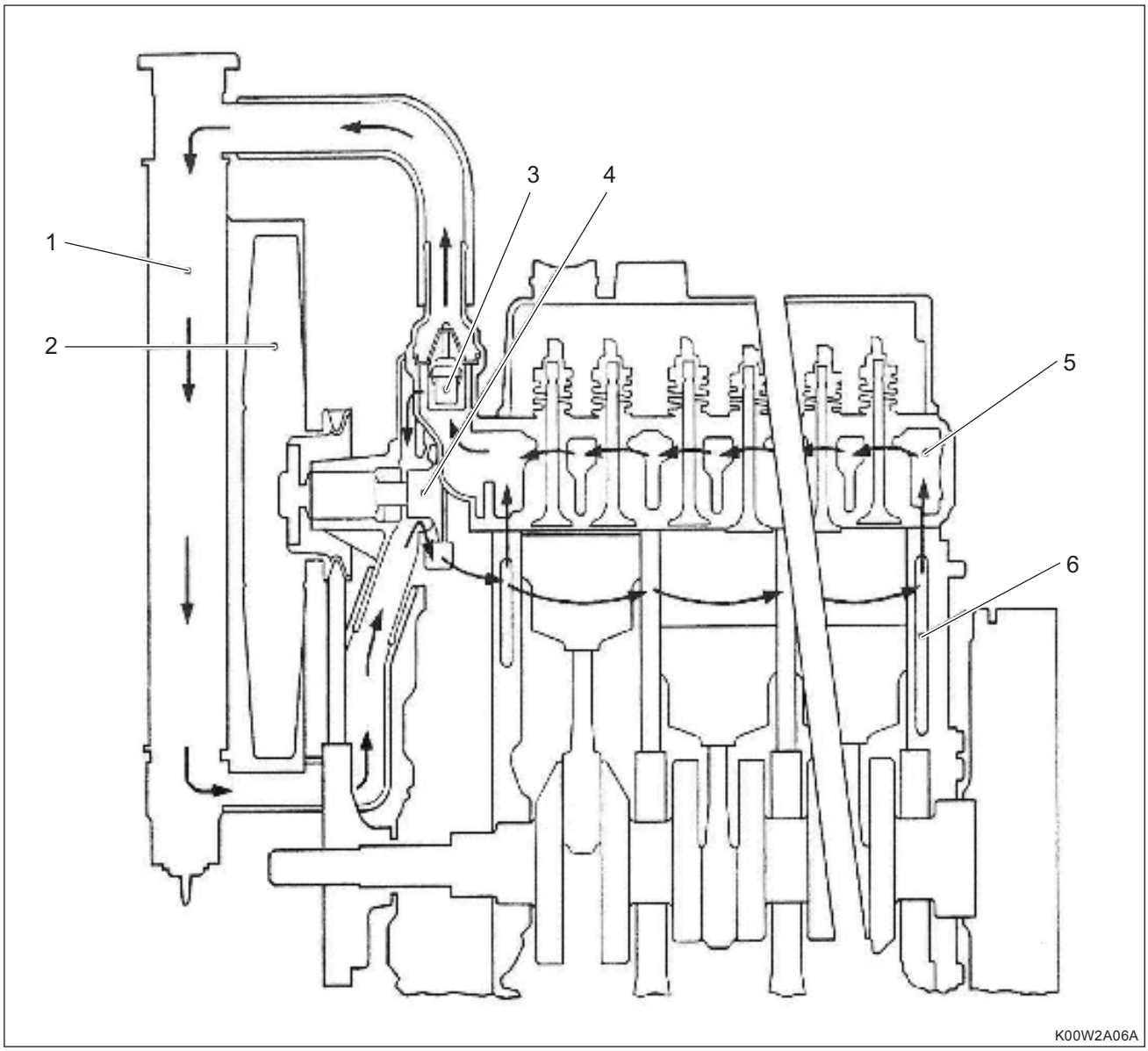


- Connect the tester (Ω) between the terminal and the body to check if the electric current was applied. If applied, it is normal but if not applied, replace the switch.



- Insert the thin rod in the oil hole and press it slightly.
- At this time, if the electric current was not applied, normal but if applied, replace the switch.
- When applying the air pressure of 0.5 kgf/cm^2 (7.11 psi, 0.05 MPa) to the oil hole, if the electric current is not applied, normal. At this time, check if the air is leak, and if there is an air leakage, it means that the diaphragm is damaged. Replace the switch.

5.5.3 COOLING DEVICE



(1) Radiator
(2) Cooling fan
(3) Thermostat
(4) Coolant pump
(5) Cylinder head water jacket
(6) cylinder block water jacket

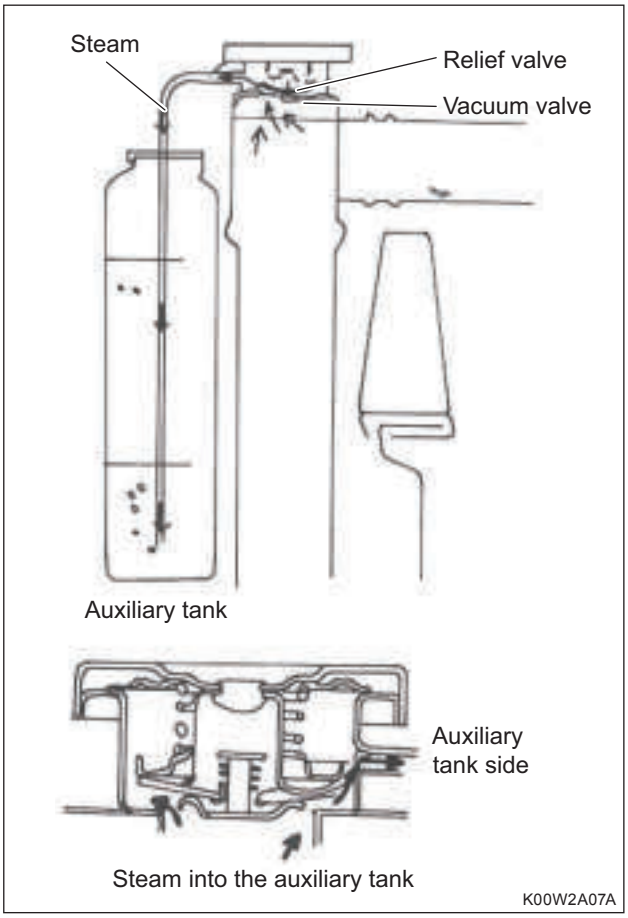
This engine is a water-cooled type which absorbs the combustion heat and engine oil heat by coolant and discharges it outside for the normal operation of engine.

Cooling device system is that the coolant supplied by coolant pump circulates to the oil cooler through the coolant hose and absorbs the oil heat and absorbs the combustion heat through the cooling jacket of cylinder block and the cooling path of cylinder head.

The coolant that absorbs the oil heat and combustion heat goes into the thermostat of coolant pump. If the temperature of coolant is lower than the valve open temperature of thermostat, it is re-circulated into the cylinder and if it is higher than valve open temperature, it flows to the radiator. This radiator discharges the absorbed heat in the coolant and makes it cooled and then circulates to the coolant pump again.

THE EFFECT OF AUXILIARY TANK (EXTENSION OF COOLANT MAKEUP TIME)

▶ WHEN THE STEAM PRESSURE INCREASES

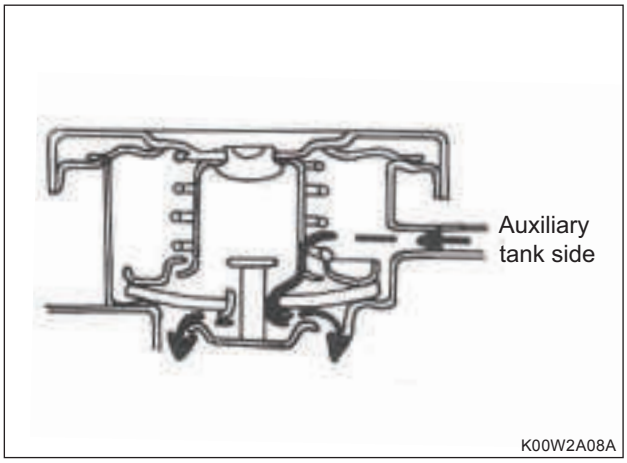


If the engine operates to increase the coolant temperature, it becomes cooling in the radiator by the intake wind of cooling fan which inhibits the increase of water temperature.

However, in case of overload or continuous operation for a long time, the water temperature increases and the steam pressure in the radiator increases and if the steam pressure is more than 0.9kgf/cm^2 (12.80 psi, 0.09 MPa), the pressure valve will open to discharge the steam and at this time the coolant will be consumed.

The thing that prevents this consumption is the auxiliary tank, and the steam is discharged into the coolant in the auxiliary tank and liquified.

▶ WHEN NEGATIVE PRESSURE OF RADIATOR OCCURS



On the contrary, if the engine stops or the load is not applied, the pressure in the radiator becomes the negative pressure and the coolant in the auxiliary tank will be absorbed into the radiator. This allows the operation of engine without filling the coolant for a long time.

In addition, when checking the coolant amount, it is available to check it only by checking the quantity of auxiliary tank without removing the radiator cap. Thus there is no hazard of burns by the discharge of steam.

CHECKING THE COOLANT PUMP

- Check the coolant pump and if any defect found, replace the coolant pump with assembly.

1. Coolant leakage (check the leakage on the drain hole on the bottom of pump body during operation)
2. Damage and crack of coolant pump body
3. Damage and crack of impeller
4. Damage of bearing (When rotating the pump shaft slightly, it rotates smoothly without flow.)

CHECK THE COOLING TEMPERATURE SENSOR

- Put the sensor in water and apply the heat slowly to measure the resistance value. (the resistance of terminal and the body)

Temperature (°C)	80	115
Resistance value (Ω)	118	42

CHECK THE GLOW PLUG CONTROLLER SENSOR

- Measure the resistance value of sensor. (the resistance of terminal and the body)

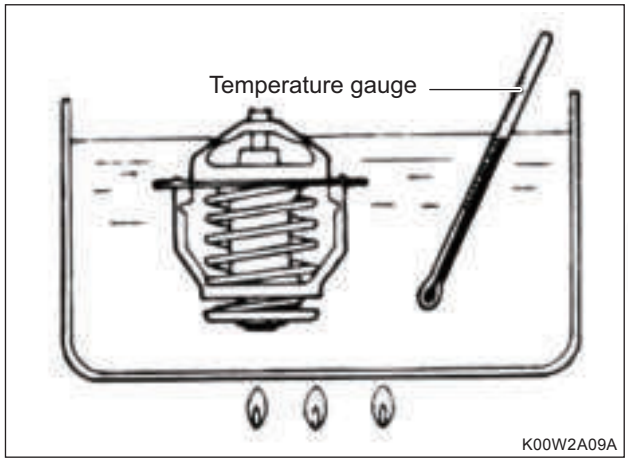
Temperature (°C)	-15	20
Resistance value (Ω)	9.6	2.4

CHECK THE OVERHEAT WARNING SENSOR

- Apply the heat to the engine oil and when oil temperature reaches the standard value, check if the sensor is ON.

ON	OFF
110 ± 2°C	More than 100°C

THERMOSTAT



- Thermostat maintains the coolant temperature consistently and prevents the heat loss and is used to increase the heat efficiency of engine.
- When heating the thermostat in the water, check the valve open temperature.

VALVE OPEN TEMPERATURE	72 ± 2°C (start to open)
	85 ± 2°C (completely open)

- Valve displacement head: more than 8 mm

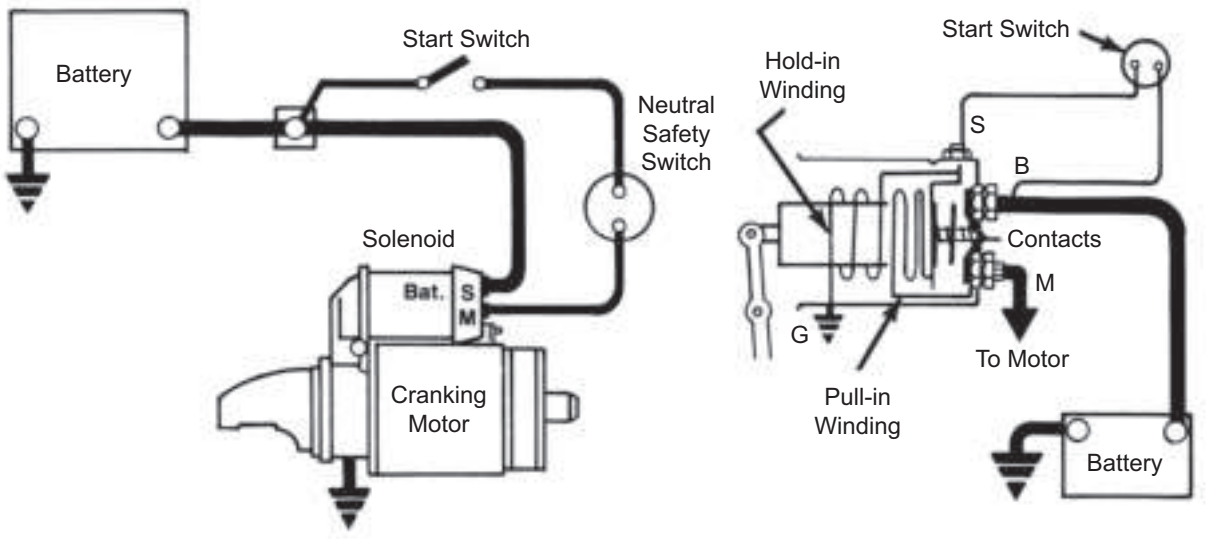
OVER HEAT

- When the engine is overheated, if you stop the engine suddenly, the circulation of coolant will stop and the overheat may become severe locally and in addition, if the engine is cooled rapidly, there may be a crack in cylinder head, block etc.
- In this case, but run the engine at low speed to make the temperature fall down naturally and then supply the coolant slowly to remove the cause of overheat.

5.6 ELECTRIC SYSTEM

5.6.1 STARTER

BASIC CIRCUIT DIAGRAM



Basic Wiring Circuit **Basic Solenoid Circuit**

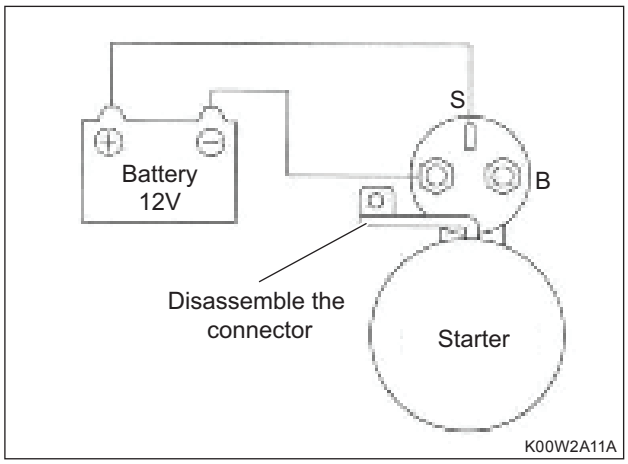
K00W2A10A

SPECIFICATIONS

ITEM	SPECIFICATION	REMARKS
Output	12V / 1.4kW	
Number of pinion teeth	15	
No load voltage	11.5V	

CHECKING

▶ PULL-IN COIL TEST OF MAGNETIC SWITCH (SOLENOID)

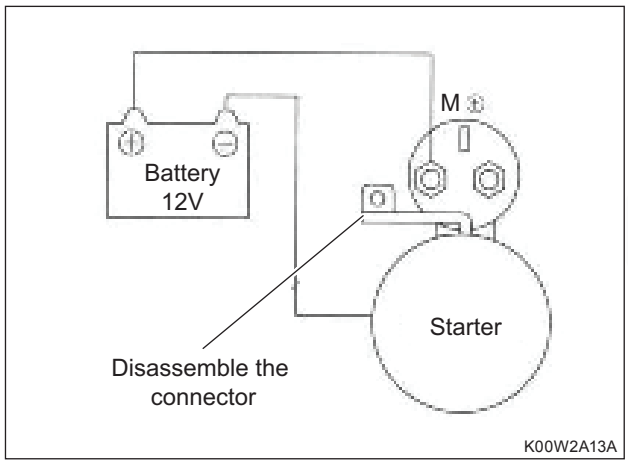


When the battery is connected between S-M terminals of magnetic switch, if the plunger is absorbed and the pinion is projected, the pulling coil (pull-in winding) is normal. If not projected, replace the magnetic switch.

⚠ CAUTION

- **- When checking this, remove the connector from M terminal.**
- **- Do not connect continuously more than 10sec.**

▶ MAGNETIC SWITCH RETURN TEST

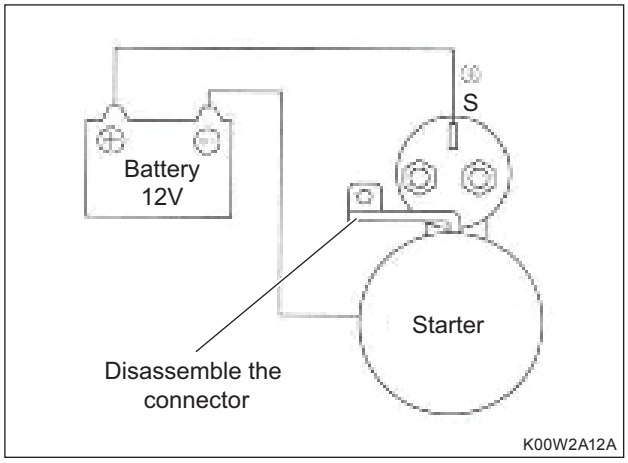


When the battery is connected between M terminal of magnetic switch and the body, draw out the pinion to the position of stopper by hand. When you let go your hand, if the pinion returns immediately, both coils are normal.

⚠ CAUTION

- **Do not connect more than 10sec.**

▶ HOLDING COIL SUPPORT TEST OF MAGNETIC SWITCH

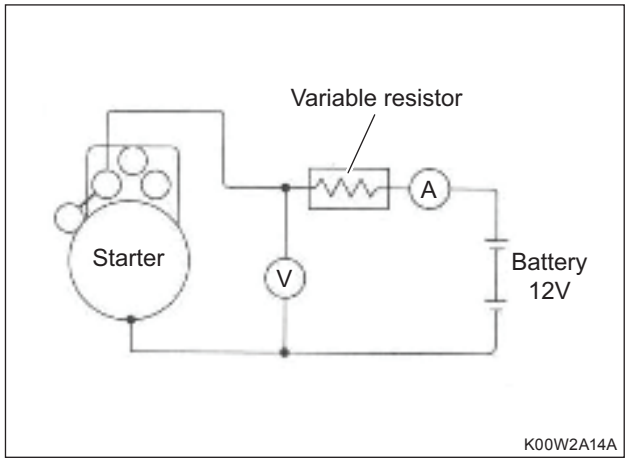


When the battery is connected between S terminal of magnetic switch and the body, draw out the pinion to the position of stopper by hand. If the pinion returns when you let go your hold, the holding coil (Hold- in winding) is normal.

⚠ CAUTION

- **Do not connect more than 10 sec.**

▶ NO LOAD TEST



1. As shown in the figure, connect starter motor, battery and manometer, amperemeter and variable resistance.
2. When the switch is ON at max. variable resistance, if it rotates smoothly, the starter motor is normal.

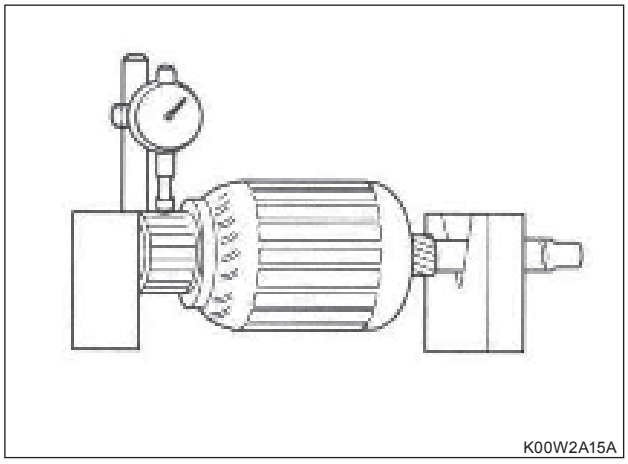
   Adjust the starter to make the manometer show a 11.5V and if the current and the rpm is out of the standard value, estimate the failure cause based on the following table for repair.

FAILURE	FAILURE CAUSE
The current is strong and the rpm is low. (The torque is not strong)	- Metal damage, oil contamination - Pole piece of armature code is worn out - Shortage of armature coil
The current is strong and no rotation.	- Ground of electronic switch
	- Ground of armature coil and field coil
	- Metal adhesion
The current flows but no rotation.	- Disconnection of armature coil and field coil
	- Disconnection of brush and pigtail
	- Poor connect of brush and commutator due to the contamination of commutator, Highmica etc.
The current is weak and the rpm is low. (The torque is not strong)	- poor contact of field coil connection area (but, only the shunt coil is disconnected or poor contact, the rpm is high.)
The current is strong and the rpm is high. (The torque is not strong)	- Shortage of field coil

CLEANING OF STARTER PART

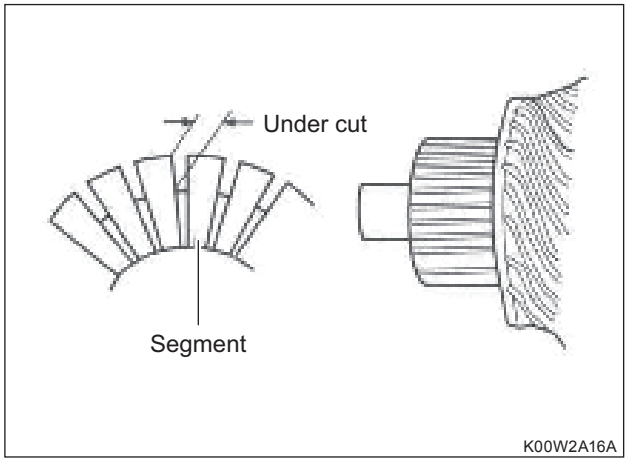
1. Do not dip the parts in the solvent. If you immerse the york, wheeled coil assembly and commutator in the solvent, the insulation will be damaged. If these parts are contaminated, wipe them with a cloth.
2. Do not dip the driver unit in the washing agent. As the over running clutch is refueled at the factor in advance, if washed, the solvent will wash the refuel of clutch.
3. For the driver unit, clean with a wet brush with a washing agent and then dry with a cloth.

CHECKING OF COMMUTATOR



- Place the commutator on one set of V-block and check the out of roundness using a dial gauge.

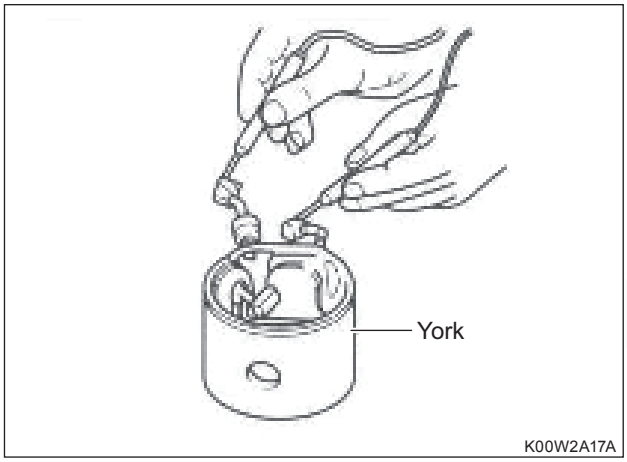
STANDARD VALUE	0 ~ 0.03 mm
LIMIT VALUE	0.1 mm



- Check the undercut depth between segments.

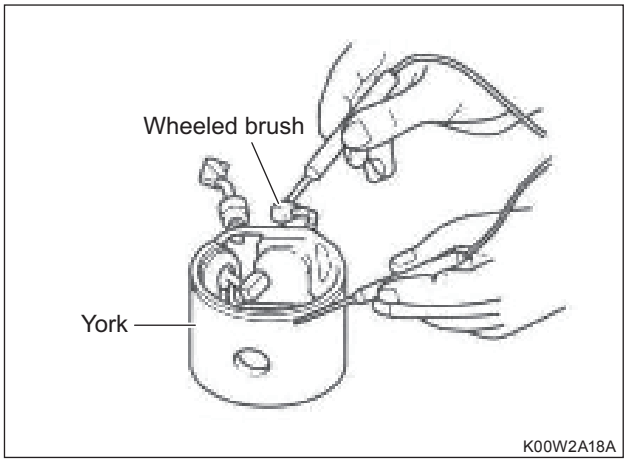
STANDARD VALUE	0.5 mm
LIMIT VALUE	0.2 mm

CONDUCTIVITY TEST OF FIELD COIL



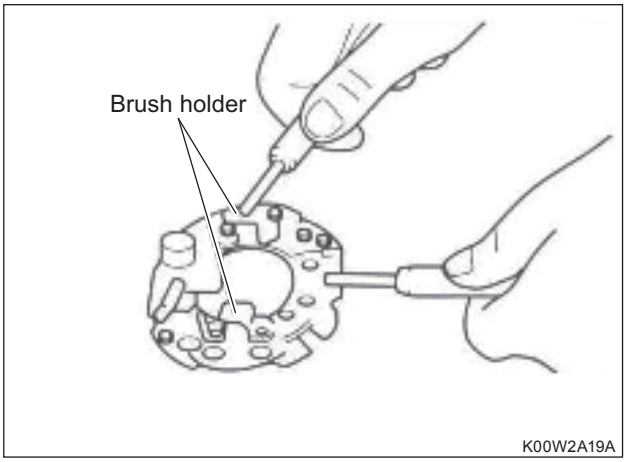
- Check the conductivity between field brushes.
- If no conductivity, normal.

GROUND TEST OF FIELD COIL



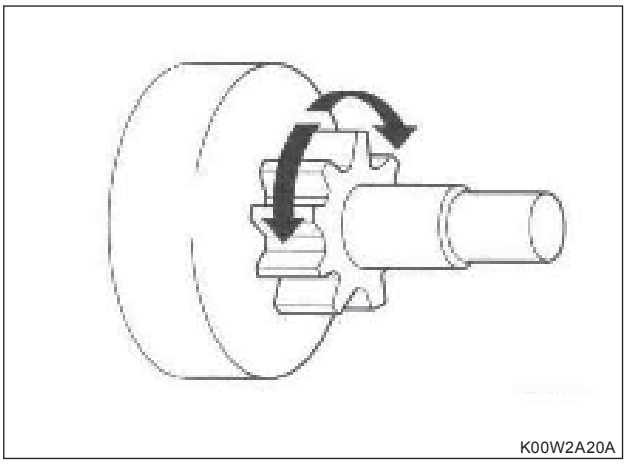
- Check the conductivity between field coil brush and york.
- If no conductivity, normal.

BRUSH HOLDER



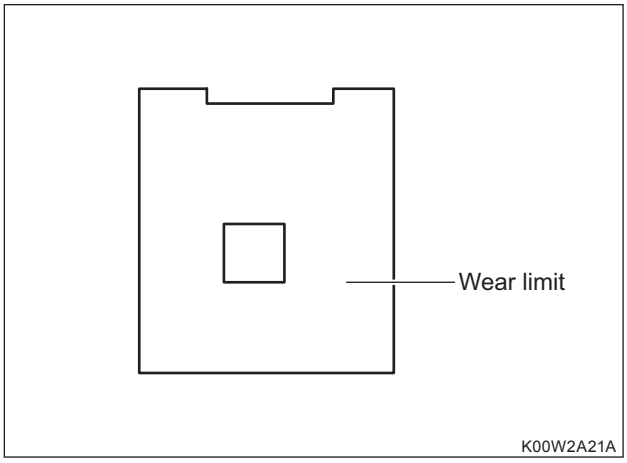
- Check the conductivity between brush holder and plate holder.
- If no conductivity, normal.

OVER RUNNING CLUTCH



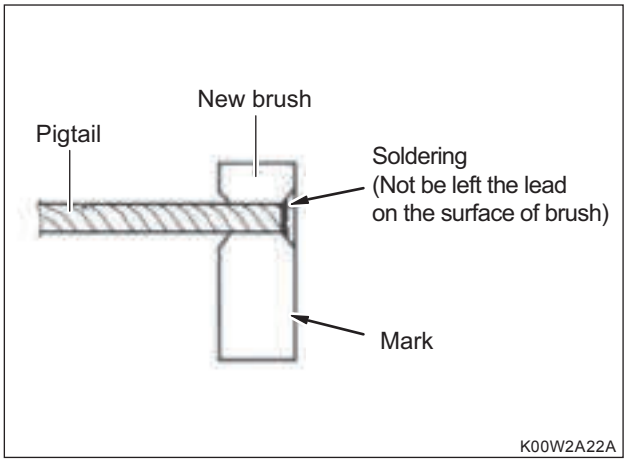
- Check whether the pinion is locked when turning to the left and when turning to the opposite direction (right), it rotates smoothly.
- Check the wear and damage of pinion.

BRUSH CHECKING



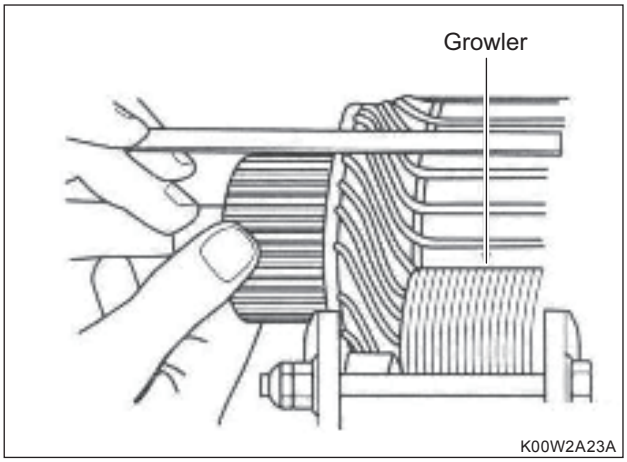
1. Check the roughness with commutator and the brush length.

STANDARD VALUE	Wear limit line



2. If the contact surface is revised or the brush is replaced, revise the contact surface of commutator with sand paper.
3. When removing the remaining worn brush with a flyer, pay attention not to damage the pig tail.
4. To adhere the soldering, polish the end of pig tail with a sand paper.
5. Insert the pig tail into the hole of new brush for soldering. Check if there is the remaining solder in the brush.

▶ SHORT CIRCUIT TEST OF COMMUTATOR COIL

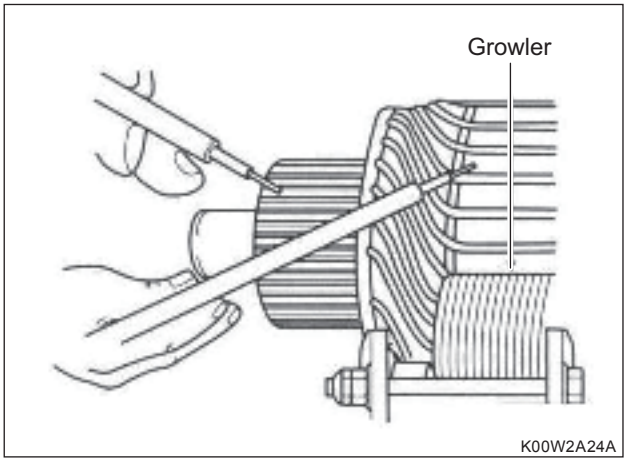


1. Install the commutator on the growler.
2. Place the thin steel plate to the commutator in parallel and rotate the commutator slowly. If the steel plate is not absorbed or not vibrated, normal.

⚠ CAUTION

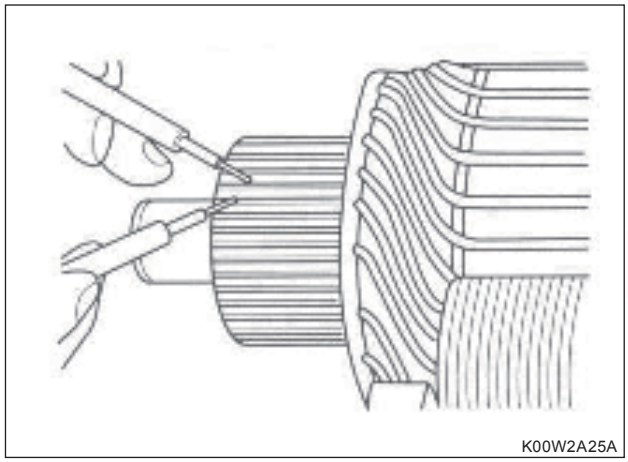
- **Remove all attachments on the surface of commutator before checking.**

▶ GROUND TEST OF COMMUTATOR COIL



Check the insulation between segment of cummutator and armature coil core and if not conducted, normal.

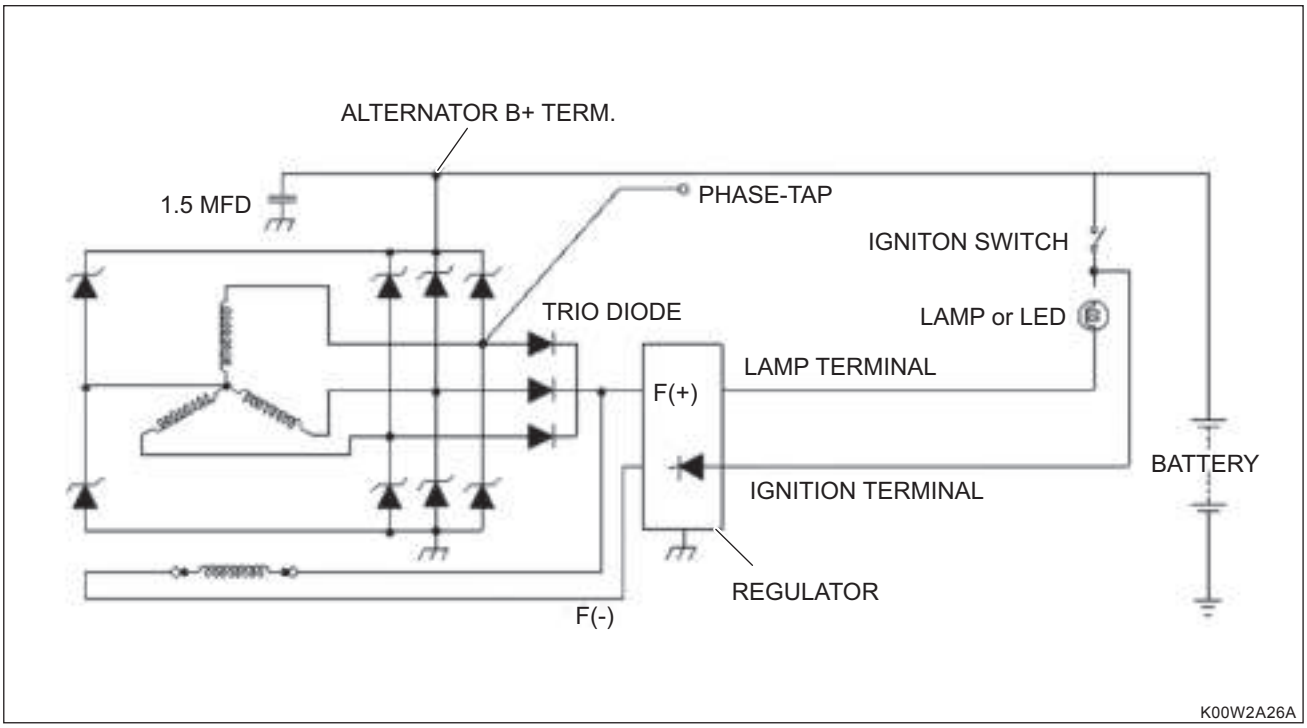
▶ DISCONNECTION OF ARMATURE COIL



Check the conductivity between each segment and if conducted, normal.

5.6.2 GENERATOR (ALTERNATOR)

BASIC CIRCUIT DIAGRAM

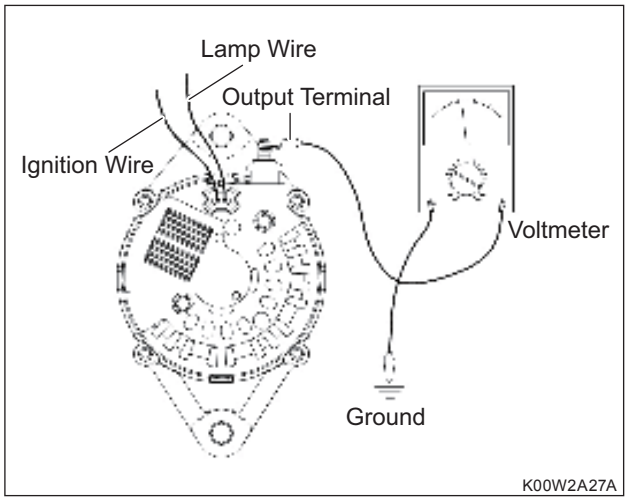


SPECIFICATIONS

ITEM	DESCRIPTION	REMARKS
Type	Alternating generation rectifier type	
Output	12V / 50A	
Motor speed	1,000~18,000 rpm	
Regulator setting voltage	14.7 ± 0.3V	
Temperature compensation	-7 ± 3 mV/℃	

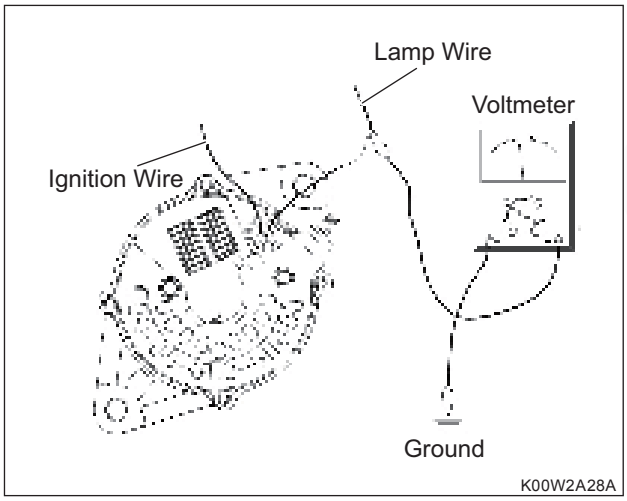
CHECKING

▶ MEASURE THE GENERATOR OUTPUT VOLTAGE WHILE THE ENGINE ROTATES



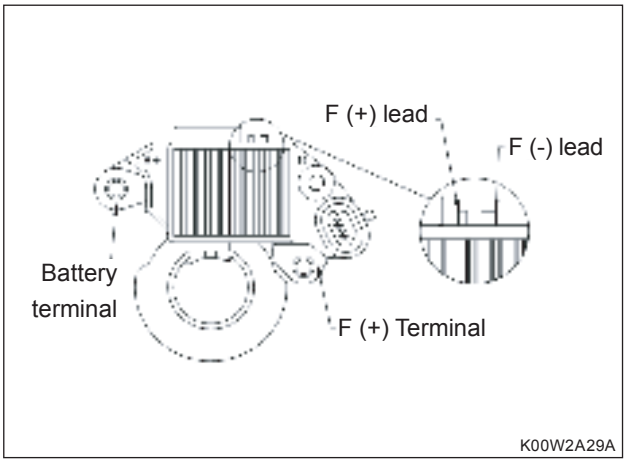
1. Connect the positive pole(+) of voltmeter to the output terminal (B+) of generator and connect the negative pole (-) of voltmeter to the ground.
2. If the engine rotates at 1500ERPM and all equipment are ON, the output voltage should be 13.4 ~ 15.7 V.
3. If, the output voltage is not measured, or the voltage is not constable, check if the output circuit is damaged, loosened or contaminated with dust.
4. Nevertheless, if the output voltage is not measured, check the wear of brush or slip ring, foreign materials or damaged.
5. If the condition of brush and slip ring is good, the inside of generator is damaged.

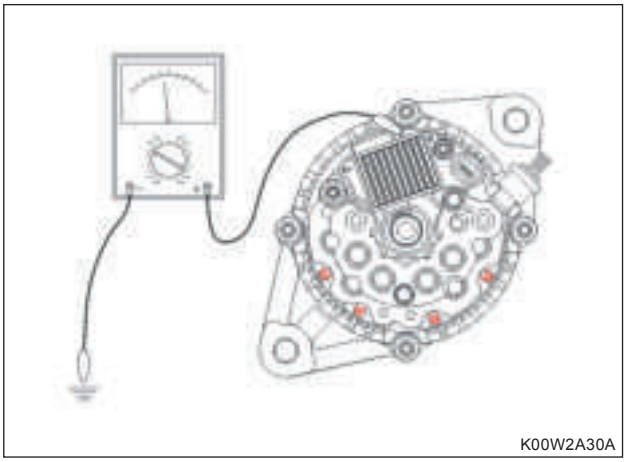
▶ LAMP CIRCUIT INSPECTION WHEN THE ENGINE STARTED



1. Connect the positive pole (+) of voltmeter to the lamp line and connect the negative pole (-) of voltmeter to the ground of generator.
2. If the charging lamp is not ON or the output voltage is not measured in the state that the engine started, the lamp line or lamp is short-circuited or disconnected.
3. Or if the output voltage is measured a little, the governor circuit or rotation magnetic coil is short-circuited or disconnected.

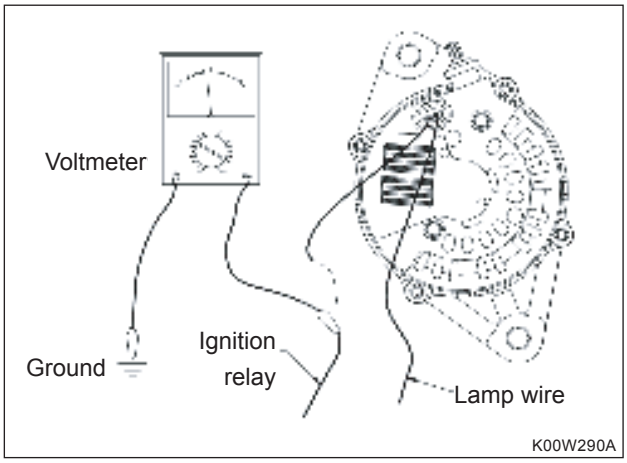
▶ LAMP CIRCUIT INSPECTION WHEN THE ENGINE ROTATES





1. Connect the positive pole (+) of voltmeter to the lamp line and connect the negative pole (-) of voltmeter to the ground part of generator.
2. If the charging lamp is not ON and the voltage is not measured, it means that the governor circuit or rotation magnetic coil or rectifier diode is short-circuited or disconnected.
3. After removing the cover, connect the positive pole (+) of voltmeter to the F(+) of brush and governor combination and connect the negative pole (-) of voltmeter to the ground part of generator. If the voltage is not measured in the battery, there is a problem in the voltage regulator or rectifier and thus it should be replaced.

▶ STARTER CIRCUIT TEST WHEN THE ENGINE STARTS

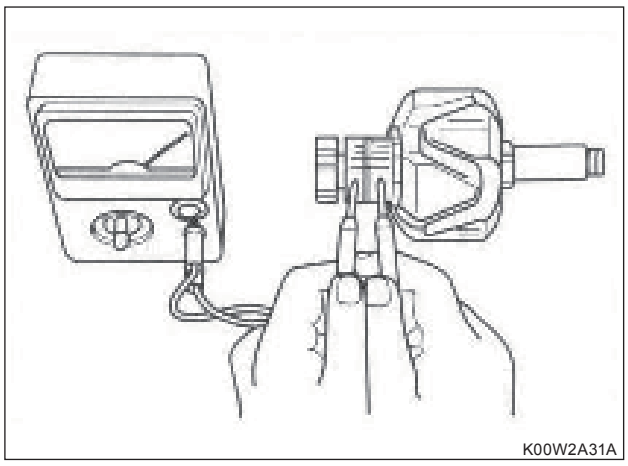


(1) Disconnect the ignition terminal plug from the voltage regulator.

(2) Connect the ignition line of wiring device to the positive pole (+) of voltmeter and connect the negative pole (-) of voltmeter to the ground part.

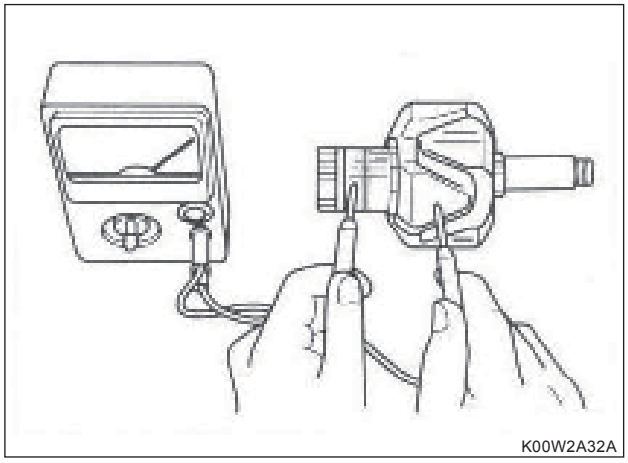
(3) The battery voltage should be measured in the voltmeter and if the voltage is not measured, check if the ignition circuit is loosened, contaminated or damaged.

▶ ROTOR



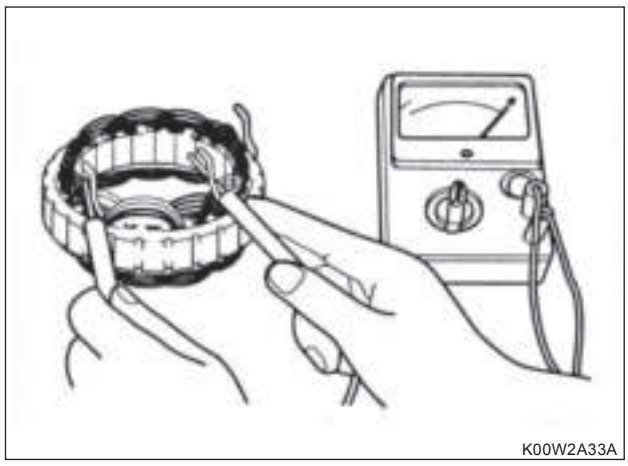
1. Check the conductivity of rotor coil. Check if there is conductivity between slip rings. Measure the resistance of rotor and if the resistance is very small, it means that it is short-circuited. If no conductivity, or short-circuited, the rotor assembly should be replaced.

STANDARD VALUE	Approx. 27.5Ω / 20°C

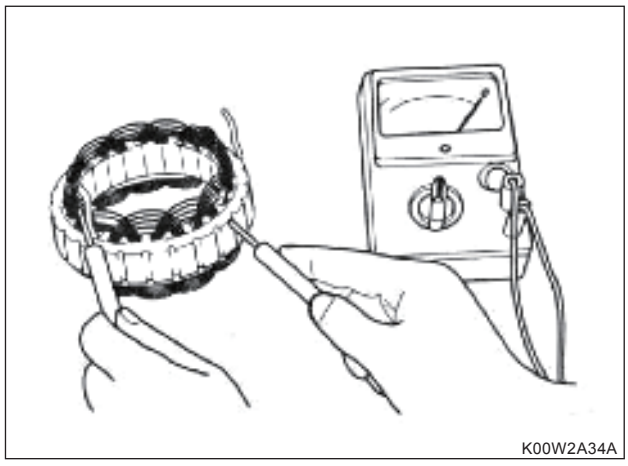


2. Check the earth of rotor coil. Check if there is conductivity between slip ring and earth. If conducted, replace the rotor assembly.

▶ STATOR

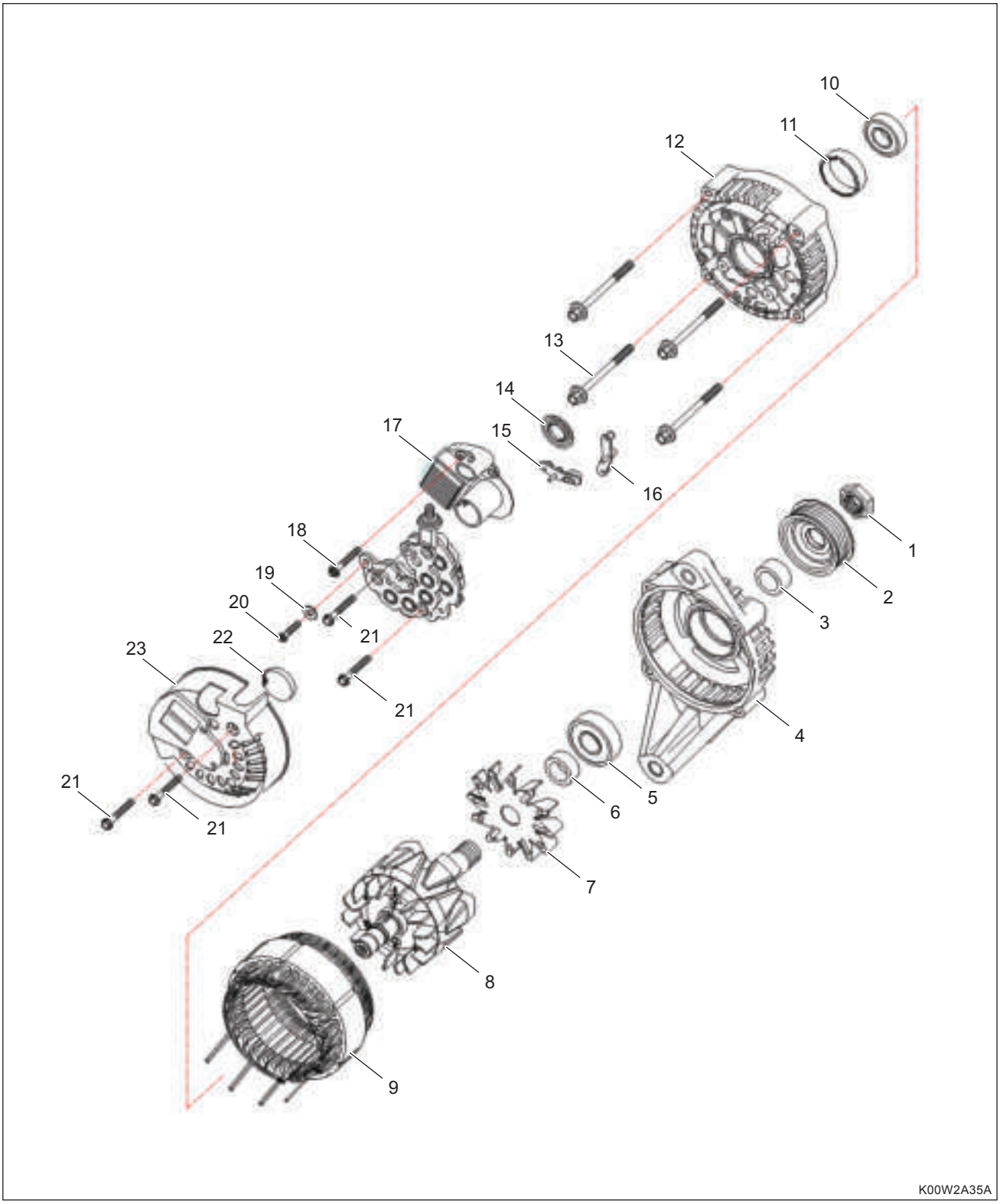


1. Check the conductivity of stator. Check if there is conductivity between coil and lead. If no conductivity, replace the stator assembly.



2. Check the earth of coil. Check if there is conductivity between coil and core. If there is conductivity, replace the stator assembly.

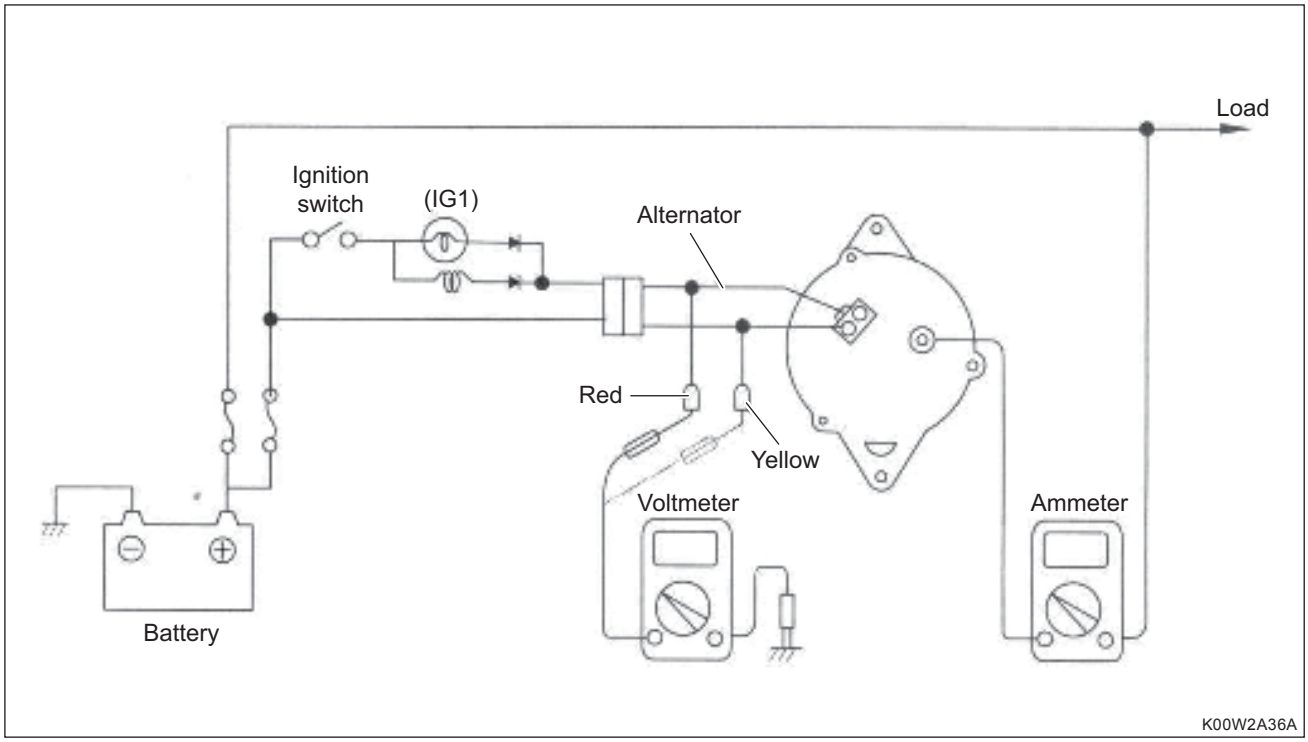
DISASSEMBLY DIAGRAM AND COMPONENTS



(1) Nut
(2) pulley
(3) Spacer
(4) Motion frame
(5) Bearing(front)
(6) Spacer
(7) Fan (front)
(8) Rotor combination
(9) Stator combination
(10) Bearing (back)
(11) Gap ring
(12) Rotation frame
(13) Bolt (4EA)
(14) Separator
(15) Insulation
(16) Insulation
(17) Brush, regulator combination
(18) Screws
(19) Insulation
(20) Screws
(21) Screws
(22) Brush fixing rubber
(23) Cover

CHECK THE ADJUSTING VOLTAGE OF IC REGULATOR (NO LOAD CHECKING)

- Set the special tool wiring connector and voltmeter and ammeter as below.



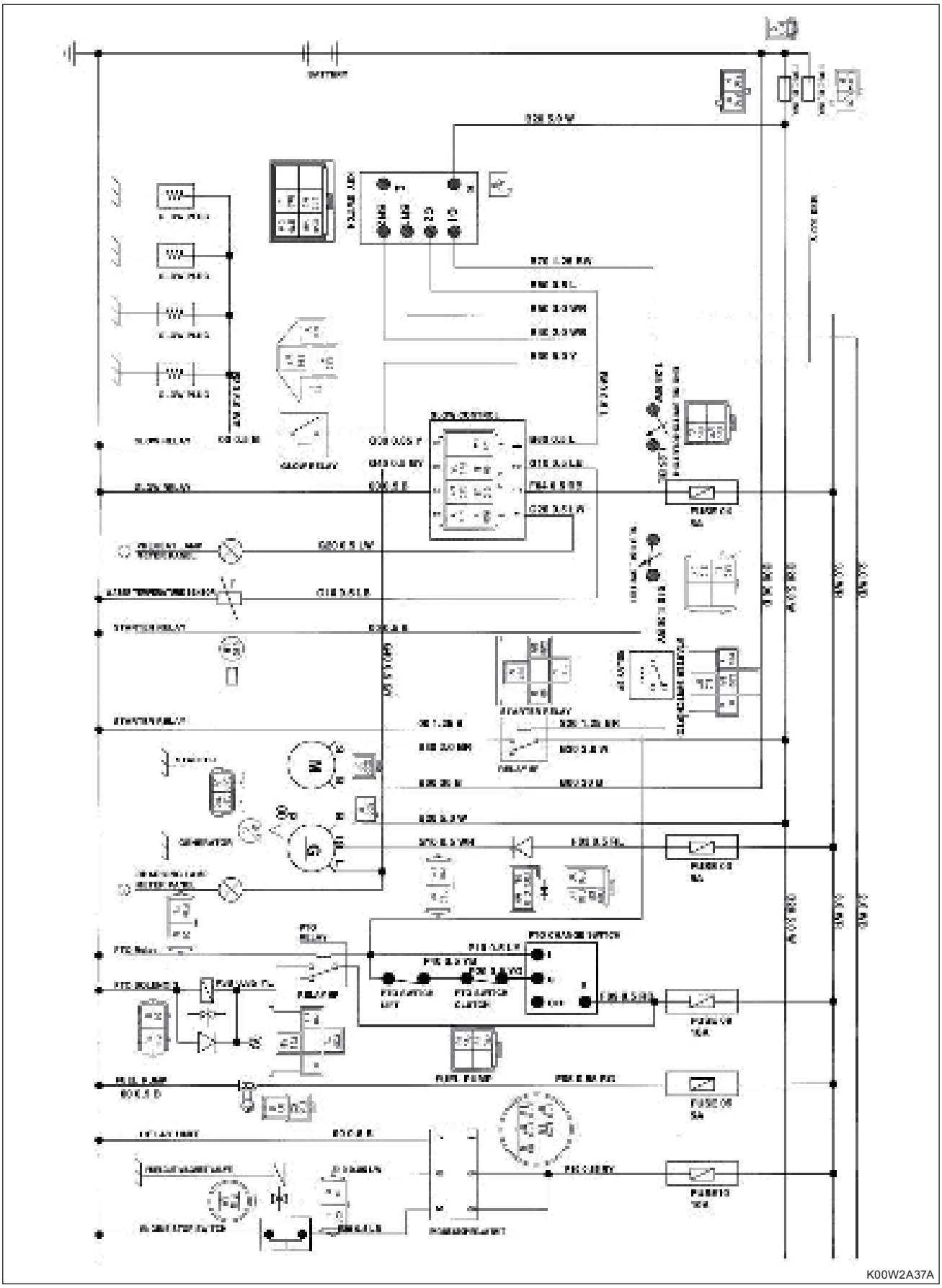
- Check it according to the sequence of the following table.

SEQ.	CHECKLIST	OPERATION	JUDGMENT		CAUSE	ACTION
			NORMAL	FAILURE		
1	Voltage between L terminal and earth	Ignition switch : OFF	0V	Voltage occur	Poor wiring or poor alternator	Revise wiring or repair alternator
		Ignition switch : ON	2~5V	0V		
				Battery volt.	ALTR poor	Repair ALTR
2	Voltage between S terminal and earth	ignition switch : OFF	Battery voltage	0V	Wiring or fusible link disconnection	Revise wiring or replace the link
		ignition switch : ON				
3	Voltage between S terminal and earth	Start the engine and maintain the rpm at 2000 ~ 3000rpm.	14.4 ± 0.5 V (at 20°C)	Largely exceeded the standard	IC regulator poor	Repair alternator
				Less than standard value	If output current is more than 5A	Charge fully or battery in full discharge
					If output current is less than 5A, alternator is poor.	Repair alternator

5.6.3 ELECTRIC WIRING

ELECTRIC WIRING DIAGRAM

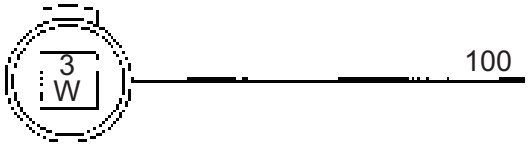
- The following electric wiring diagram is the representative example.



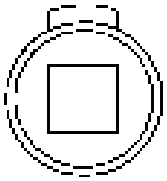
ELECTRIC WIRING CONNECTOR

FUEL STOP WIRING

Fuel cut solenoid
PB625-01027



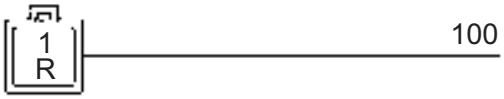
Union Machine
PB625-01027



1. HOUSING

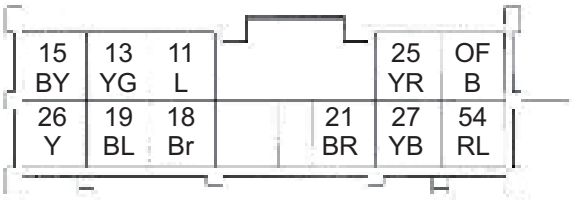
STARTER WIRING

Start
250 1FW(MG610041)



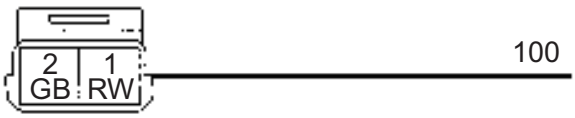
CONTROLLER WIRING

Engine control unit
MG651965



GENERATOR WIRING

Generator
packard-12162195



Packard
12162195

5. CONNECTOR ASSEMBLY

NOTICES FOR ELECTRIC WIRING

▶ GENERATOR (ALTERNATOR)

- Do not connect battery reversely.

  If you connect the positive (+) and negative (-) of battery cable reversely, the diode of generator will be broken which results in the failure of charging. In addition, the stator coil will be burnt. To avoid the reverse connection, adjust the battery cable or manufacture the reverse connection prevention structure.

- Do not use the output voltage for charging as for control.

  As the number of engine rotation and the output voltage of generator is not proportional, it is not allowed to use the output voltage for control.

- Lamp control

  When the charging starts, the charging lamp is OFF and even if the number of engine rotation falls down which leads to the failure of discharge, the lamp will not be ON.

  If the charging circuit is normal, the lamp will not be re-lit and if the lamp is ON, it means that the generator is out of order or V-belt is broken.

- Use the V-belt with designated specification.

- Do not use the high voltage washer for high voltage washing.

  If a high pressure washing, water may enter into the brush which may result in the poor charging.

▶ STARTER (START MOTOR)

- Use the battery suitable for the specification.

  The engine start depends on the capacity of battery. The battery capacity should be changed according to the temperature condition and the use condition of working period.

  Thus, select the battery capacity suitable for the use condition and use it.

- Total wiring resistance of battery cable (+,-) should be less than 2/1000Ω .

  When total wiring resistance exceeds the indication value, it may cause the loss of function of starter motor or failure.

- If the wiring resistance of start motor is more than the indication value,

  Total resistance of reciprocating wiring between start motor and Key switch (or power relay, safety rely : when using) should be less than 5/100Ω.

- When there is no safety relay,

  The main cause of failure of start motor is the over running (the time of applying the current is too long). The overrun causes the damage of armature coil and the failure of clutch. Be careful when using.

- Do not apply the high voltage washing using a high pressure washer.

  The water proof of start motor is the same level as that when the rain falls or spraying the water. Thus, do not dip it in water or do not apply the high pressure washing.

▶ CURRENT LIMIT

- Do not use the over discharging (less than 8V) battery. When using, the abnormal high voltage may occur which may damage other electric equipment. Charge the over discharged battery before using.

- Do not remove the battery during operation. If you remove the battery during operation, the current limit may operate wrong according to the type of the connected electric equipment, which results in the failure to control the output voltage. In this case, high voltage will occur continuously which may damage the electric equipment.

6. MAINTENANCE STANDARD TABLE

6.1 MAJOR PARTS TORQUE CHART

ITEMS	STANDARD	HEXAGON WIDTH	FASTENING TORQUE	REMARKS
Cylinder head bolt	M10×1.25	14 mm	6.75 ± 1.25 kgf.m 66.15 ± 12.25 N.m 48.74 ± 9.03 lbf.ft	
Connecting rod bolt	M8×1.0	13 mm	4.5 ± 0.2 kgf.m 44.10 ± 1.96 N.m 32.49 ± 1.44 lbf.ft	
Flywheel attachment bolt	M10×1.25	14 mm	6.75 ± 0.25 kgf.m 66.15 ± 2.45 N.m 48.74 ± 1.81 lbf.ft	
Metal cap attachment bolt	M8×1.25	12 mm	3.25 ± 0.25 kgf.m 31.85 ± 2.45 N.m 23.47 ± 1.81 lbf.ft	
Crank shaft V-pulley attachment bolt	M22×1.5	32 mm	17.5 ± 0.5 kgf.m 171.50 ± 4.90 N.m 126.35 ± 3.61 lbf.ft	
Glow plug	M10×1.25	12 mm	1.75 ± 0.25 kgf.m 17.15 ± 2.45 N.m 12.64 ± 1.81 lbf.ft	
Fuel injection valve	M20×1.5	22 mm	7.5 ± 0.5 kgf.m 73.50 ± 4.90 N.m 54.15 ± 3.61 lbf.ft	

6.2 GENERAL BOLT TIGHTENING TORQUE TABLE

SIZE	4T		7T		9T	
	NORMAL THREAD	FINE THREAD	NORMAL THREAD	FINE THREAD	NORMAL THREAD	FINE THREAD
M 5	40 ± 5 kgf·cm 3.92 ± 0.49 N.m 2.89 ± 0.36 lbf.ft	-	60 ± 10 kgf·cm 5.88 ± 0.98 N.m 4.33 ± 0.72 lbf.ft	-	90 ± 10 kgf·cm 8.82 ± 0.98 N.m 6.50 ± 0.72 lbf.ft	-
M 6	60 ± 10 kgf·cm 5.88 ± 0.98 N.m 4.33 ± 0.72 lbf.ft		130 ± 10 kgf·cm 12.74 ± 0.98 N.m 9.39 ± 0.72 lbf.ft		135 ± 10 kgf·cm 13.23 ± 0.98 N.m 9.75 ± 0.72 lbf.ft	
M 8	150 ± 20 kgf·cm 14.70 ± 1.96 N.m 10.83 ± 1.44 lbf.ft		270 ± 30 kgf·cm 26.46 ± 2.94 N.m 19.49 ± 2.16 lbf.ft		330 ± 20 kgf·cm 32.34 ± 1.96 N.m 23.83 ± 1.44 lbf.ft	
M 10	300 ± 50 kgf·cm 29.40 ± 4.90 N.m 21.66 ± 3.61 lbf.ft	240 ± 40 kgf·cm 23.52 ± 3.92 N.m 17.33 ± 2.89 lbf.ft	530 ± 70 kgf·cm 51.94 ± 6.86 N.m 38.27 ± 5.05 lbf.ft	420 ± 60 kgf·cm 41.16 ± 5.88 N.m 30.32 ± 4.33 lbf.ft	690 ± 30 kgf·cm 67.62 ± 2.94 N.m 49.82 ± 2.17 lbf.ft	550 ± 30 kgf·cm 53.90 ± 2.94 N.m 39.71 ± 2.16 lbf.ft
M 12	530 ± 70 kgf·cm 51.94 ± 6.86 N.m 38.27 ± 5.05 lbf.ft	420 ± 60 kgf·cm 41.16 ± 5.88 N.m 30.32 ± 4.33 lbf.ft	900 ± 100 kgf·cm 88.20 ± 9.80 N.m 64.98 ± 7.22 lbf.ft	720 ± 80 kgf·cm 70.56 ± 7.84 N.m 51.98 ± 5.77 lbf.ft	1130 ± 70 kgf·cm 110.74 ± 6.86 N.m 81.59 ± 5.05 lbf.ft	900 ± 60 kgf·cm 88.20 ± 5.88 N.m 64.98 ± 4.33 lbf.ft
M 14	780 ± 70 kgf·cm 76.44 ± 6.86 N.m 56.32 ± 5.05 lbf.ft	620 ± 60 kgf·cm 60.76 ± 5.88 N.m 44.76 ± 4.33 lbf.ft	1350 ± 150 kgf·cm 132.30 ± 14.70 N.m 97.47 ± 10.83 lbf.ft	1080 ± 120 kgf·cm 105.84 ± 11.76 N.m 77.98 ± 8.66 lbf.ft	1850 ± 150 kgf·cm 181.30 ± 14.70 N.m 133.57 ± 10.83 lbf.ft	1480 ± 120 kgf·cm 145.04 ± 11.76 N.m 106.86 ± 8.66 lbf.ft
M 16	1250 ± 150 kgf·cm 122.50 ± 14.70 N.m 90.25 ± 10.83 lbf.ft	1000 ± 120 kgf·cm 98.00 ± 11.76 N.m 72.20 ± 8.66 lbf.ft	1900 ± 200 kgf·cm 186.20 ± 19.60 N.m 137.18 ± 14.44 lbf.ft	1520 ± 160 kgf·cm 148.96 ± 15.68 N.m 109.74 ± 11.55 lbf.ft	2580 ± 220 kgf·cm 252.84 ± 21.56 N.m 186.28 ± 15.88 lbf.ft	2060 ± 220 kgf·cm 201.88 ± 21.56 N.m 148.73 ± 15.88 lbf.ft
M 18	1750 ± 150 kgf·cm 171.50 ± 14.70 N.m 126.35 ± 10.83 lbf.ft	1400 ± 120 kgf·cm 137.20 ± 11.76 N.m 101.08 ± 8.66 lbf.ft	2650 ± 250 kgf·cm 259.70 ± 24.50 N.m 191.33 ± 18.05 lbf.ft	2120 ± 200 kgf·cm 207.76 ± 19.60 N.m 153.06 ± 14.44 lbf.ft	3800 ± 300 kgf·cm 372.40 ± 29.40 N.m 274.36 ± 21.66 lbf.ft	3040 ± 240 kgf·cm 297.92 ± 23.52 N.m 219.49 ± 17.33 lbf.ft
M 20	2450 ± 250 kgf·cm 240.10 ± 24.50 N.m 176.89 ± 18.05 lbf.ft	1960 ± 200 kgf·cm 192.08 ± 19.60 N.m 141.51 ± 14.44 lbf.ft	3700 ± 400 kgf·cm 362.60 ± 39.20 N.m 267.14 ± 28.88 lbf.ft	2960 ± 320 kgf·cm 290.08 ± 31.36 N.m 213.71 ± 23.10 lbf.ft	5400 ± 400 kgf·cm 529.20 ± 39.20 N.m 389.88 ± 28.88 lbf.ft	4320 ± 320 kgf·cm 423.36 ± 31.36 N.m 311.90 ± 23.10 lbf.ft

	SIZE	1/8	1/4	3/8	1/2	3/4
PT PLUG	ALUMINUM	150 ± 20 kgf·cm 14.70 ± 1.96 N.m 10.83 ± 1.44 lbf.ft	200 ± 30 kgf·cm 19.60 ± 2.94 N.m 14.44 ± 2.17 lbf.ft	250 ± 30 kgf·cm 24.50 ± 2.94 N.m 18.05 ± 2.17 lbf.ft	350 ± 50 kgf·cm 34.30 ± 4.90 N.m 25.27 ± 3.61 lbf.ft	460 ± 50 kgf·cm 45.08 ± 4.90 N.m 33.21 ± 3.61 lbf.ft
	CASTING	200 ± 20 kgf·cm 19.60 ± 1.96 N.m 14.44 ± 1.44 lbf.ft	250 ± 30 kgf·cm 24.50 ± 2.94 N.m 18.05 ± 2.17 lbf.ft	360 ± 30 kgf·cm 35.28 ± 2.94 N.m 25.99 ± 2.17 lbf.ft	560 ± 50 kgf·cm 54.88 ± 4.90 N.m 40.43 ± 3.61 lbf.ft	770 ± 50 kgf·cm 75.46 ± 4.90 N.m 55.59 ± 3.61 lbf.ft

	M 8	M 12	M 14	M 16
HOLLOW BOLT	150 ± 20 kgf·cm 14.70 ± 1.96 N.m 10.83 ± 1.44 lbf.ft	300 ± 50 kgf·cm 29.40 ± 4.90 N.m 21.66 ± 3.61 lbf.ft	450 ± 50 kgf·cm 44.10 ± 4.90 N.m 32.49 ± 3.61 lbf.ft	550 ± 50 kgf·cm 53.90 ± 4.90 N.m 39.71 ± 3.61 lbf.ft

6.3 ENGINE ASSEMBLY TOLERANCE

6.3.1 CYLINDER HEAD

(Unit: mm)

MODEL			A1100N	
ITEMS			STANDARD	ALLOWABLE LIMIT
Cylinder head combustion wheel			Less than 0.03	0.15
Valve seat angle	Intake		120°	-
	Exhaust		90°	-
Valve seat width	Intake		1.6 ± 0.1	2.23
	Exhaust		1.6 ± 0.1	2.62
intake Valve	Valve stem outer dia.		Ø7 $^{-0.040}_{-0.050}$	Ø6.9
	Valve Guide inner dia.		Ø7 $^{+0.015}_{0}$	Ø7.1
	Oil Clearance		0.055 ~ 0.065	0.15
exhaust Valve	Valve stem outer dia.		Ø7 $^{-0.040}_{-0.040}$	Ø6.9
	Valve Guide inner dia.		Ø7 $^{+0.015}_{0}$	Ø7.1
	Oil Clearance		0.040 ~ 0.055	0.15
Valve Guide projection (head side)			13	-
Valve settlement depth	Intake Valve		0.4 ± 0.1	0.7
	Exhaust Valve		0.4 ± 0.1	
Valve head thickness	Intake Valve		1.9 ± 0.15	0.5
	Exhaust Valve		1.9 ± 0.15	
Intake valve timing	Open	b. TDC	14°	-
	Close	a. BDC	34°	
Exhaust valve timing	Open	b. BDC	58°	
	Close	a. TDC	14°	
Valve spring	Free field		37.25	-
	Incline		-	1.0
	Load (in case of 1 mm Compression)		1.902	-
Intake &·exhaust valve clearance			0.15 ~ 0.17	-

6.3.2 CYLINDER BLOCK

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
cylinder block inner dia.	L	Ø78 $^{+0.025}_{+0.015}$	-	20 mm downward from head assembly side in cylinder
	S	Ø78 $^{+0.015}_{0}$		
cylinder block inner dia. cylindricity		0 ~ 0.015	-	

6.3.3 VALVE ROCKER ARM

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Intake·exhaust rocker arm	Rocker arm outer dia. of shaft	Ø13 $^{-0.020}_{-0.045}$	Ø12.95	
	Rocker arm inner dia.	Ø13 $^{+0.025}_{0}$	Ø13.09	
	Oil Clearance	0.020 ~ 0.070	0.14	
Push rod Bending degree		Less than 0.25	-	-
Tappet	Tappet stem outer dia.	Ø20f7 $^{-0.020}_{-0.041}$	Ø14.18	
	Tappet Guide hole inner dia.	Ø20f7 $^{+0.020}_{0}$	Ø14.30	
	Oil Clearance	0.020 ~ 0.062	0.12	

6.3.4 PISTON

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Piston outer dia.	A	Ø77.966 ± 0.009	Ø77.90	
Min. clearance between piston and cylinder block		0.041 ~ 0.059	-	
Saw Clearance		0.66 ± 0.15	-	
Piston & Piston pin	piston pin outer dia.	Ø22 $^{+0.005}_{-0.001}$	Ø21.90	
	piston pin hole inner dia.	Ø22 $^{+0.007}_{+0.002}$	Ø22.02	
	Oil Clearance	0.003 ~ 0.008	0.10	

6.3.5 PISTON RING

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Top ring	Ring groove width	1.896 ± 0.01	-	
	Ring width	$1.803\ ^{0}_{-0.024}$	-	
	Ring and ring groove clearance	0.15 ~ 0.30	-	
	End clearance	0.15 ~ 0.30	1.5	
2nd ring	Ring groove width	$1.5\ ^{+0.09}_{+0.07}$	-	
	Ring width	$1.5\ ^{-0.09}_{-0.03}$	-	
	Ring and ring groove clearance	0.080 ~ 0.120	-	
	End clearance	0.30 ~ 0.50	1.5	
Oil ring	Ring groove width	$3.0\ ^{+0.03}_{+0.01}$	-	
	Ring width	$3.0\ ^{-0.03}_{-0.01}$	-	
	Ring and ring groove clearance	0.020 ~ 0.060	-	
	end clearance	0.20 ~ 0.40	1.5	

6.3.6 CONNECTING ROD

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Crank Pin	Crank Pin inner dia.	$Ø43\ ^{0}_{+0.016}$	-	
	Crank Pin metal thickness	1.487 ~ 1.500	-	
	Crank pin outer dia.	$Ø39.9\ ^{+0.059}_{+0.075}$	Ø39.89	
	Oil Clearance	0.025 ~ 0.087	0.15	
piston pin	piston pin bush inner dia.	$Ø22\ ^{+0.005}_{+0.001}$	Ø22.10	
	piston pin outer dia.	$Ø22\ ^{+0.040}_{+0.025}$	Ø21.90	
	Oil Clearance	0.014 ~ 0.038	0.2	
Big/small end parallelism (distortion)		Less than Ø0.03/100mm	Ø0.05	

6.3.7 CAM SHAFT

(Unit: mm)

MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Gear side	cam shaft journal outer dia.	Ø36 $^{-0.050}_{-0.066}$	Ø35.89	
	Oil Clearance	0.050 ~ 0.091	-	
Middle side	cam shaft journal outer dia.	Ø36 $^{-0.050}_{-0.066}$	Ø35.89	
	Oil Clearance	0.050 ~ 0.091	-	
Flywheel side	cam shaft journal outer dia.	Ø36 $^{-0.050}_{-0.066}$	Ø35.89	
	Oil Clearance	0.050 ~ 0.091	-	

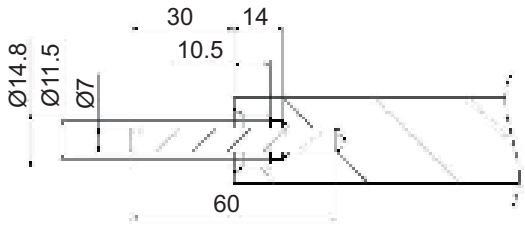
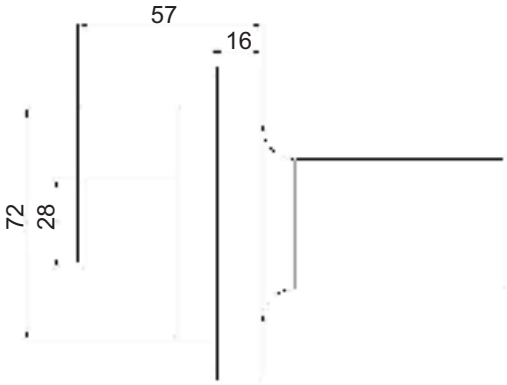
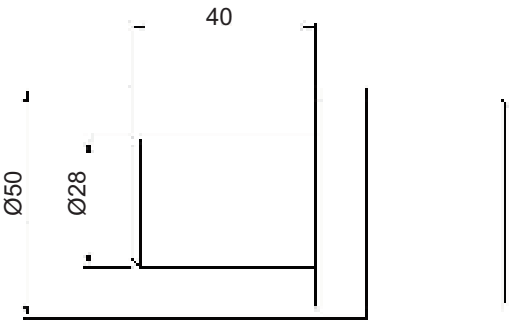
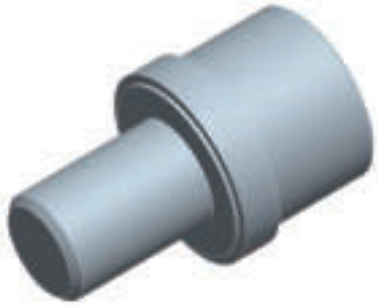
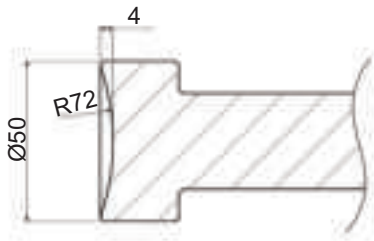
6.3.8 CRANK SHAFT

(Unit: mm)

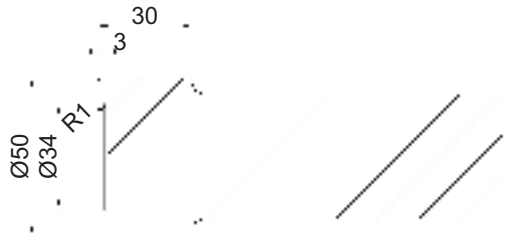
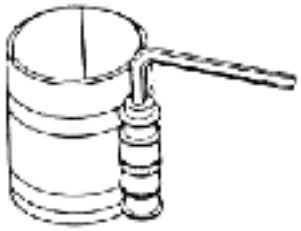
MODEL		A1100N		REMARKS
ITEMS		STANDARD	ALLOWABLE LIMIT	
Crank journal	Crank journal outer dia.	Ø52 $^{-0.060}_{-0.079}$	Ø51.91	
	bearing metal thickness	2.0 $^{+0.015}_{+0.002}$	-	
	Oil Clearance	0.020 ~ 0.081	0.10	
Bending degree		Less than 0.02	-	-

6.4 MAJOR PARTS TORQUE CHART

(Unit: mm)

TOOL NAME	TOOL STANDARD (unit : mm)	REFERENCE
Stem seal press jig		
Flywheel oil seal press jig		
Gear case oil seal press jig		
Plate type plug press fit jig		

(Unit: mm)

TOOL NAME	TOOL STANDARD (unit : mm)	REFERENCE
Governor shaft gear press fit jig		
Piston assembly jig	Sales for market (Ø60 ~ Ø125 applied)	
Piston ring assembly jig	Sales for market	-
Oil filter wrench	Sales for market	

CHAPTER 3 CLUTCH

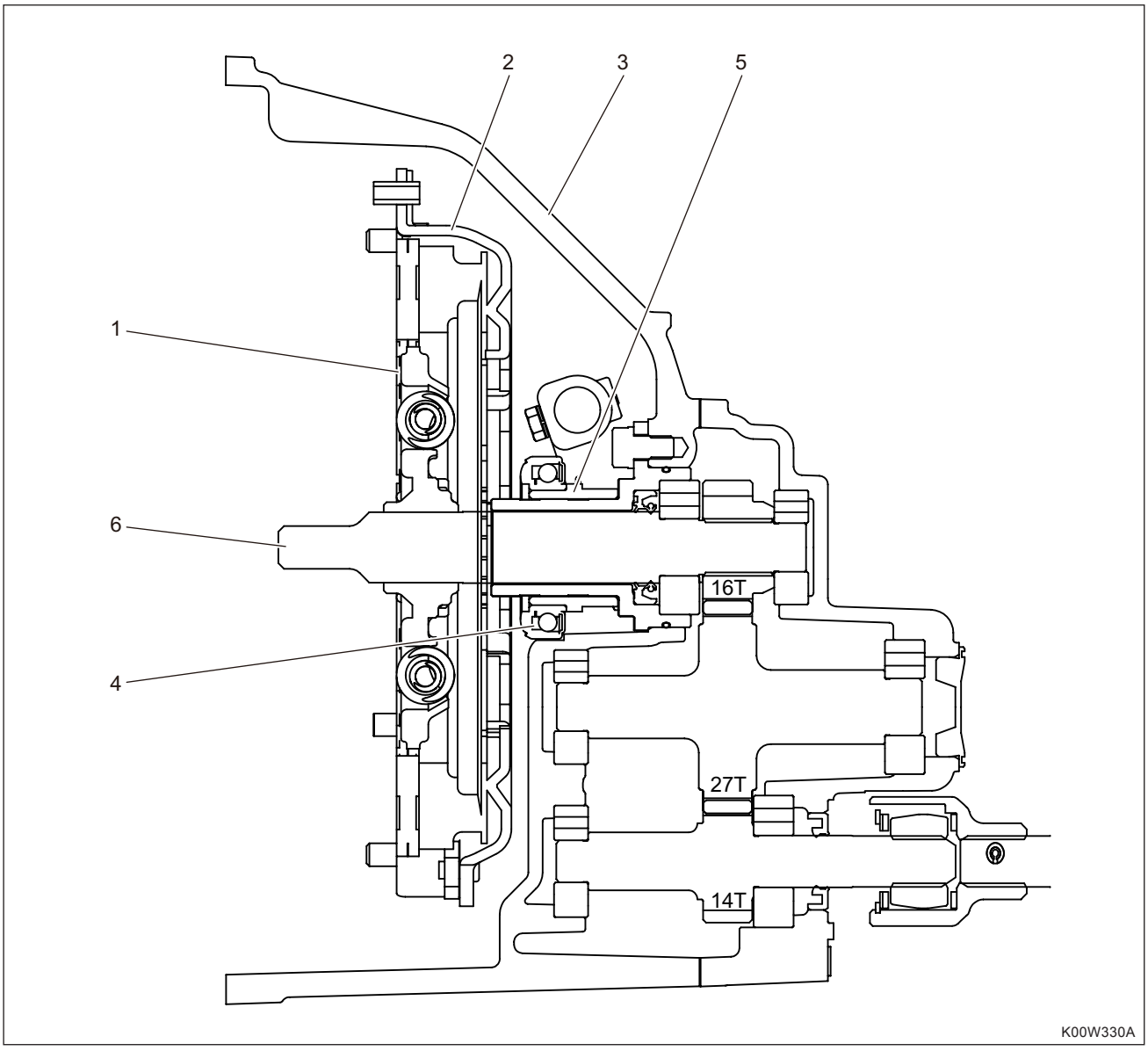
TABLE OF CONTENTS

1. OVERVIEW

The clutch is to deliver or cut off power from the engine to the transmission. When the clutch disc is pressed against the flywheel, the rotating force from the engine is delivered into the transmission through the shaft which is connected to the spline boss of the clutch.

However, when the clutch pedal is depressed, its clutch rod pulls the release shaft which then pushes the release bearing in the clutch housing to press the clutch cover spring. As a result, the clutch disc is separated from the flywheel, so rotating force from the engine is no longer transmitted to the transmission.

1.1 SECTIONAL VIEW OF CLUTCH ASSEMBLY

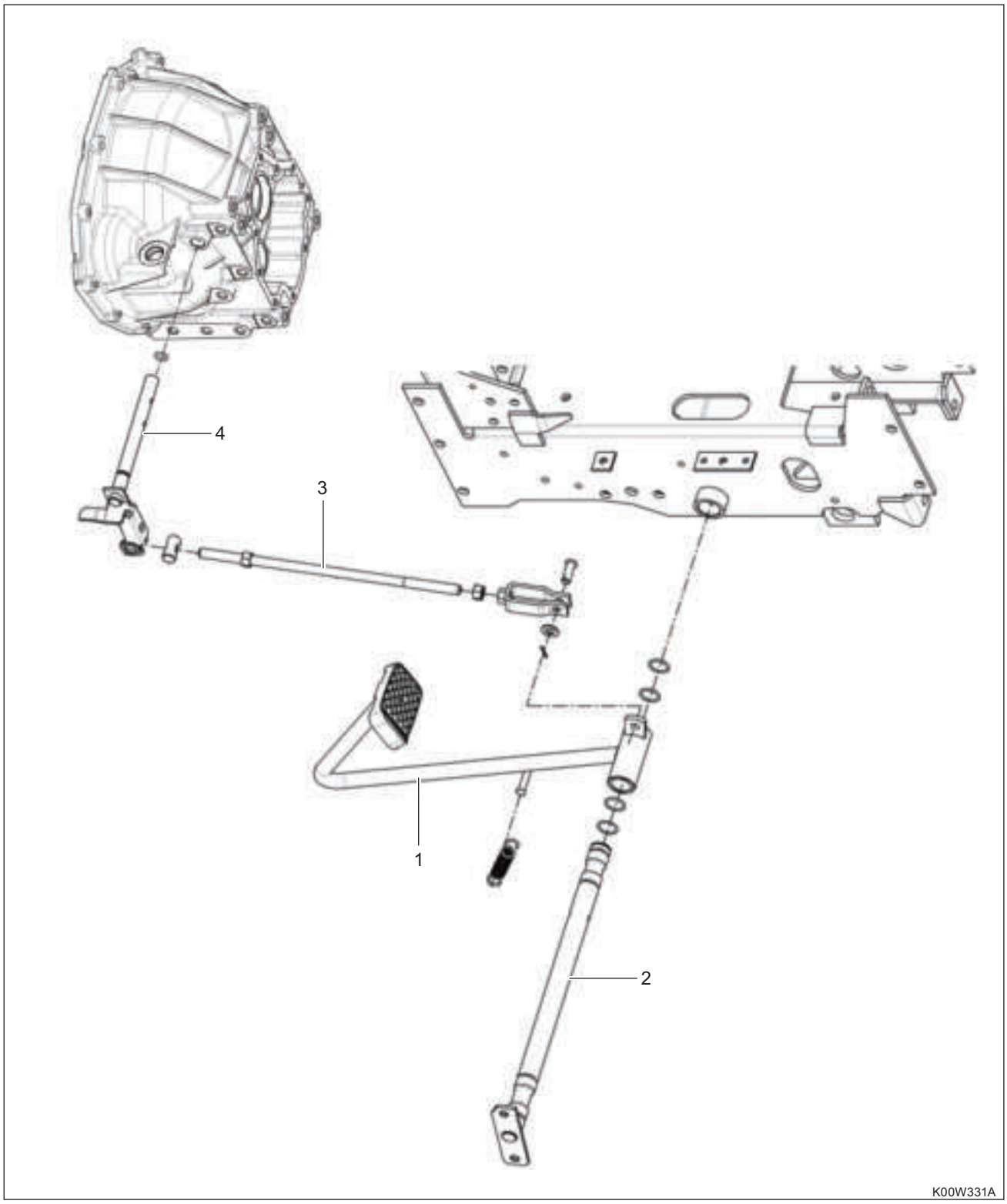


(1) Clutch disc assembly
(2) Clutch disc cover (Comp. plate, pressure)
(3) Clutch housing
(4) Release bearing
(5) Bearing sleeve
(6) Clutch shaft

The clutch shaft (6), which its splines are engaged with the splines on the boss of the clutch assembly connected to the flywheel, serves to transfer rotating power from the engine directly to the transmission.

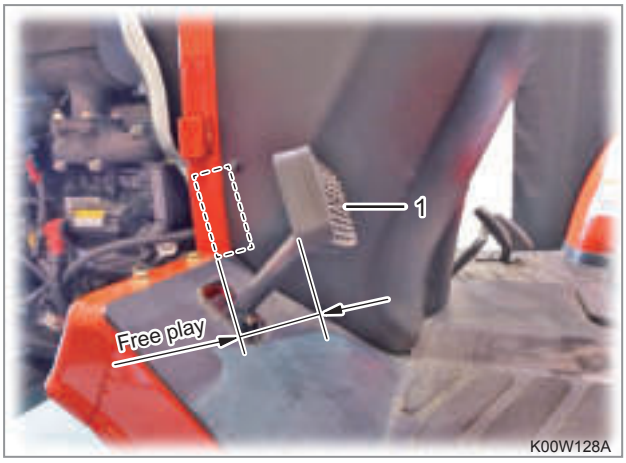
Accordingly, in the disengaged state when the clutch pedal is not pressed, the engine's rotating power is transferred to the clutch shaft by means of frictional force between the clutch disc and flywheel.

1.2 CLUTCH PEDAL COMPONENTS



(1) Clutch pedal
(2) Pedal shaft
(3) Clutch rod
(4) Release shaft

1.3 CLUTCH PEDAL PLAY ADJUSTMENT



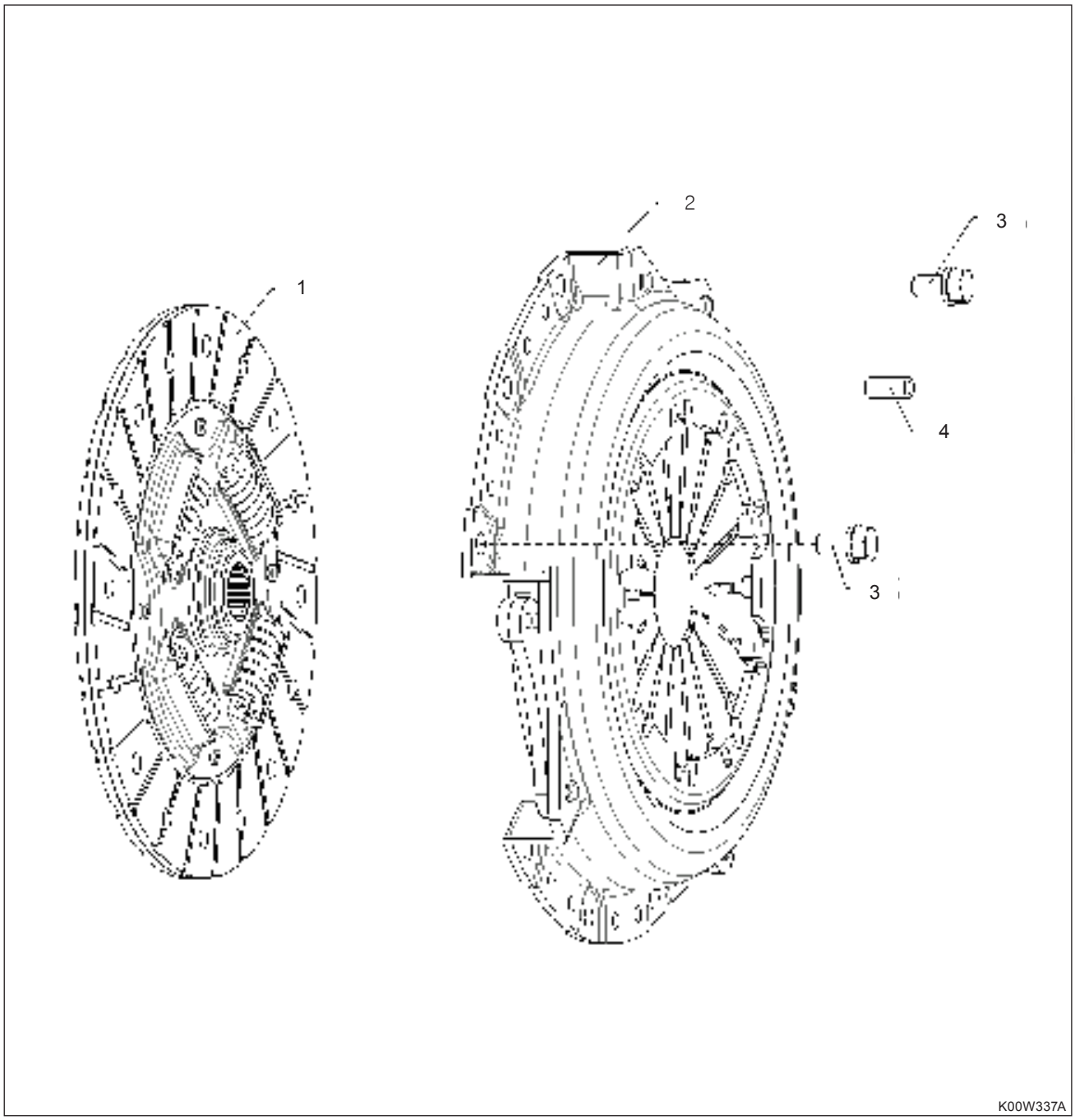
1. Depress the clutch pedal (1) slightly. Then, release it.
2. Measure its free play.

ITEM	STANDARD
Clutch pedal free play	25 - 35 mm (0.98 - 1.38 in)

3. If the free play is out of the specification, unscrew the lock nut (2) of the clutch rod and adjust the clutch rod (3) to adjust the free play. Then, tighten the mounting nut.

2. SECTIONAL VIEW FOR MAJOR COMPONENTS

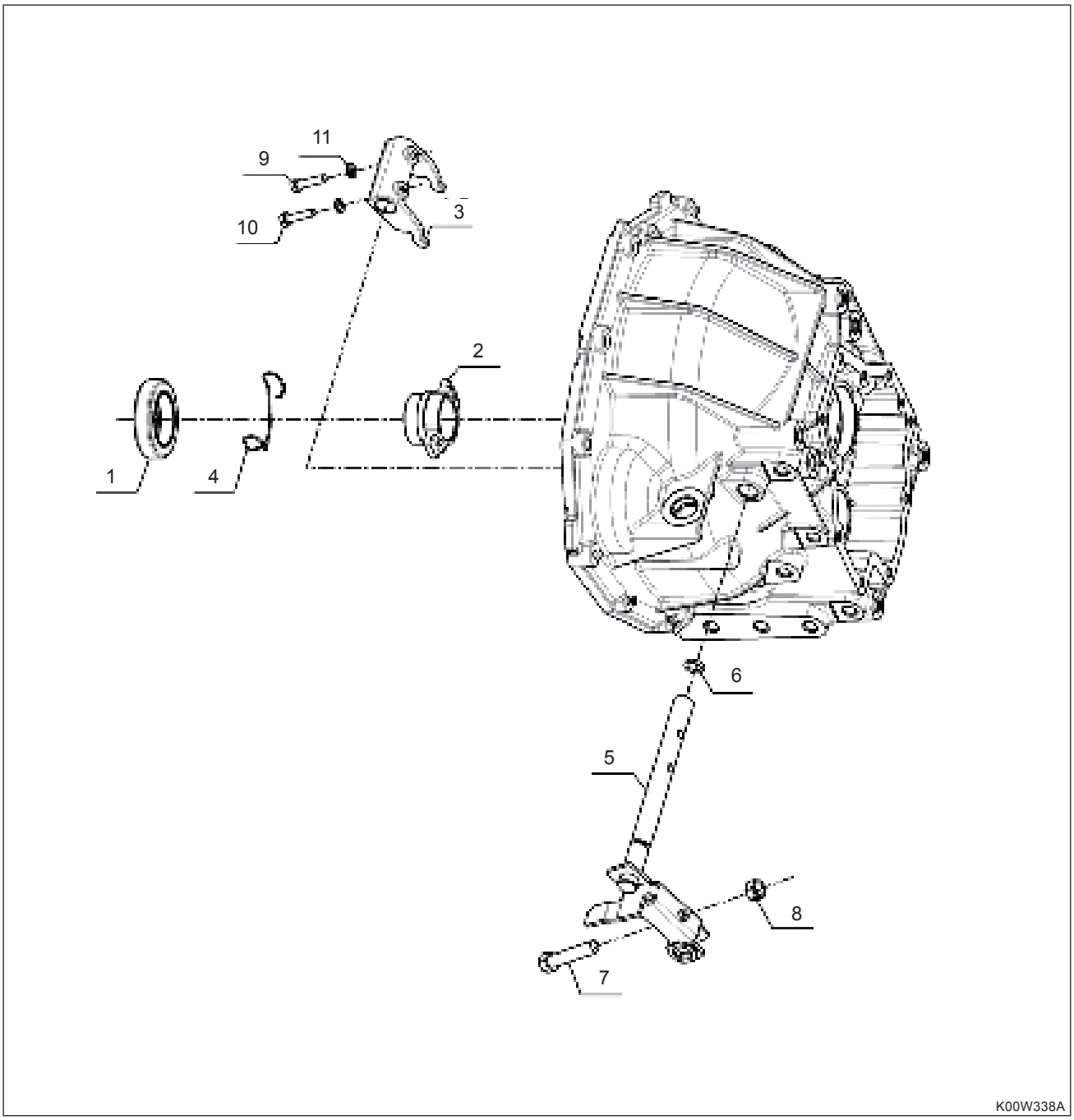
2.1 CLUTCH



COMPONENTS

(1) Clutch disc ass'y
(2) Comp. plate, pressure
(3) Bolt
(4) Pin, straight

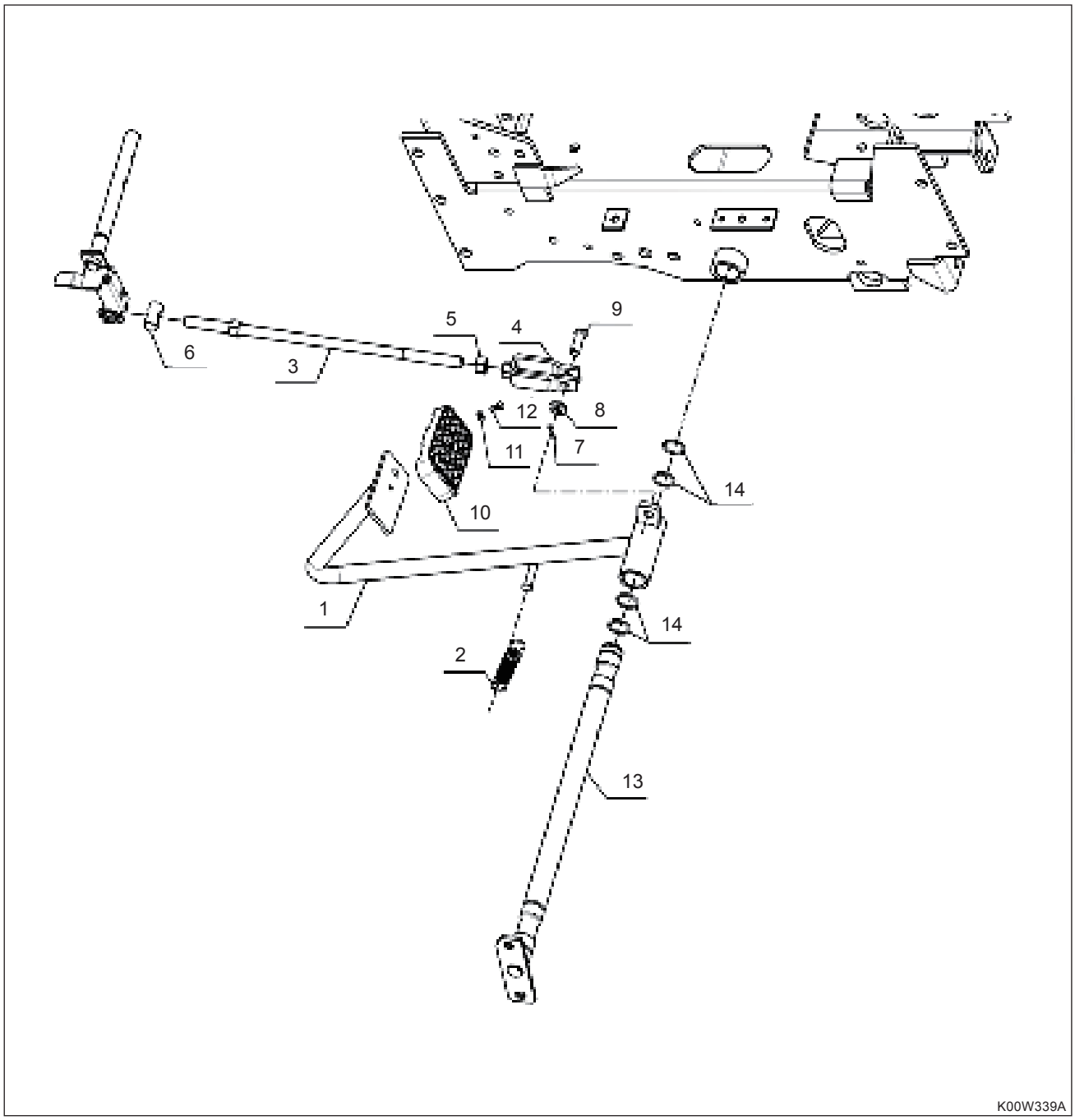
2.2 CLUTCH ROD



COMPONENTS

(1) Bearing, release
(2) Holder, bearing
(3) Fork, clutch release
(4) Spring
(5) Shaft, clutch rod
(6) O-ring
(7) Bolt
(8) Nut
(9) Bolt
(10) Bolt
(11) Washer, spring

2.3 CLUTCH PEDAL



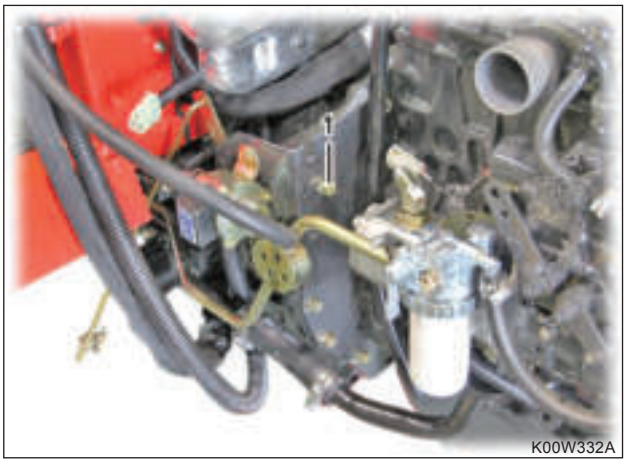
COMPONENTS

(1) Pedal, clutch
(2) Spring, clutch
(3) Rod, clutch
(4) U_joint
(5) Nut_L
(6) Pin_clutch
(7) Cotter pin
(8) Washer
(9) Pin, fastener
(10) Cover, pedal
(11) Washer
(12) Rivet
(13) Shaft, pedal
(14) O-ring

3. DISASSEMBLY

3.1 CLUTCH HOUSING REMOVAL

1. Park the tractor on level ground and apply the hand brake.
2. Disconnect the negative battery cable.
3. Drain the transmission fluid.
4. Remove the hood and propeller shaft.
5. Disconnect the hydraulic hose, wiring connector and various cables between the vehicle body and engine.
6. Place a stand under the clutch housing and a portable jack under the engine oil pan.
7. Remove all the related parts, including the fuel hose and main wiring connector, between the engine and vehicle body.

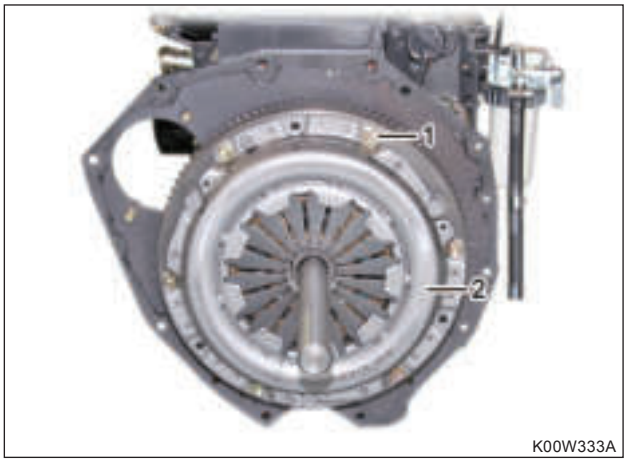


8. Unscrew the mounting bolt (1) from the clutch housing and engine mounting flange. Then, push the front axle section to separate it from the clutch housing.

ITEM	TORQUE VALUE
M8 bolt	2.4 ~ 2.8 kgf.m (17.4 ~ 20.2 lbf.ft)
M10 bolt	4.9 ~ 5.7 kgf.m (35.5 ~ 41.2 lbf.ft)

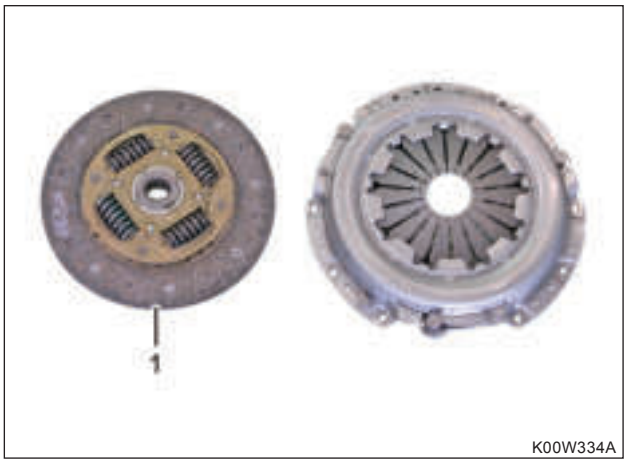
9. For more detailed disassembly procedures, refer to the instructions for engine removal in Chapter 2.

3.2 CLUTCH DISASSEMBLY

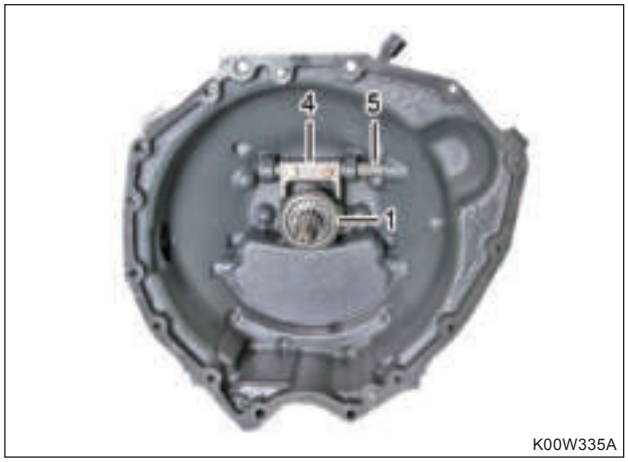


1. Unscrew the clutch assembly mounting bolts (1) from the engine flywheel to remove the clutch disc cover (2).

ITEM	TORQUE VALUE
Clutch assembly mounting bolt	2.4 ~ 2.8 kgf.m (17.4 ~ 20.2 lbf.ft)



2. Remove the clutch disc (1).



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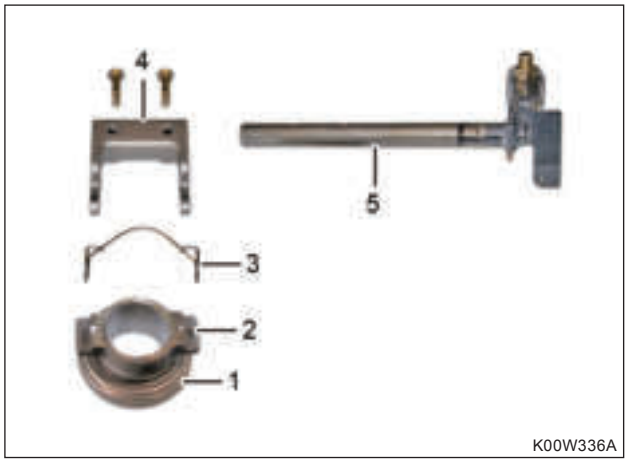


K00W336A

3. As necessary, remove the release bearing (1), bearing holder (2), release spring (3), clutch release fork (4) and clutch rod shaft (5) from the clutch housing.

MEMO

CHAPTER 4 TRANSMISSION

TABLE OF CONTENTS

1. OVERVIEW

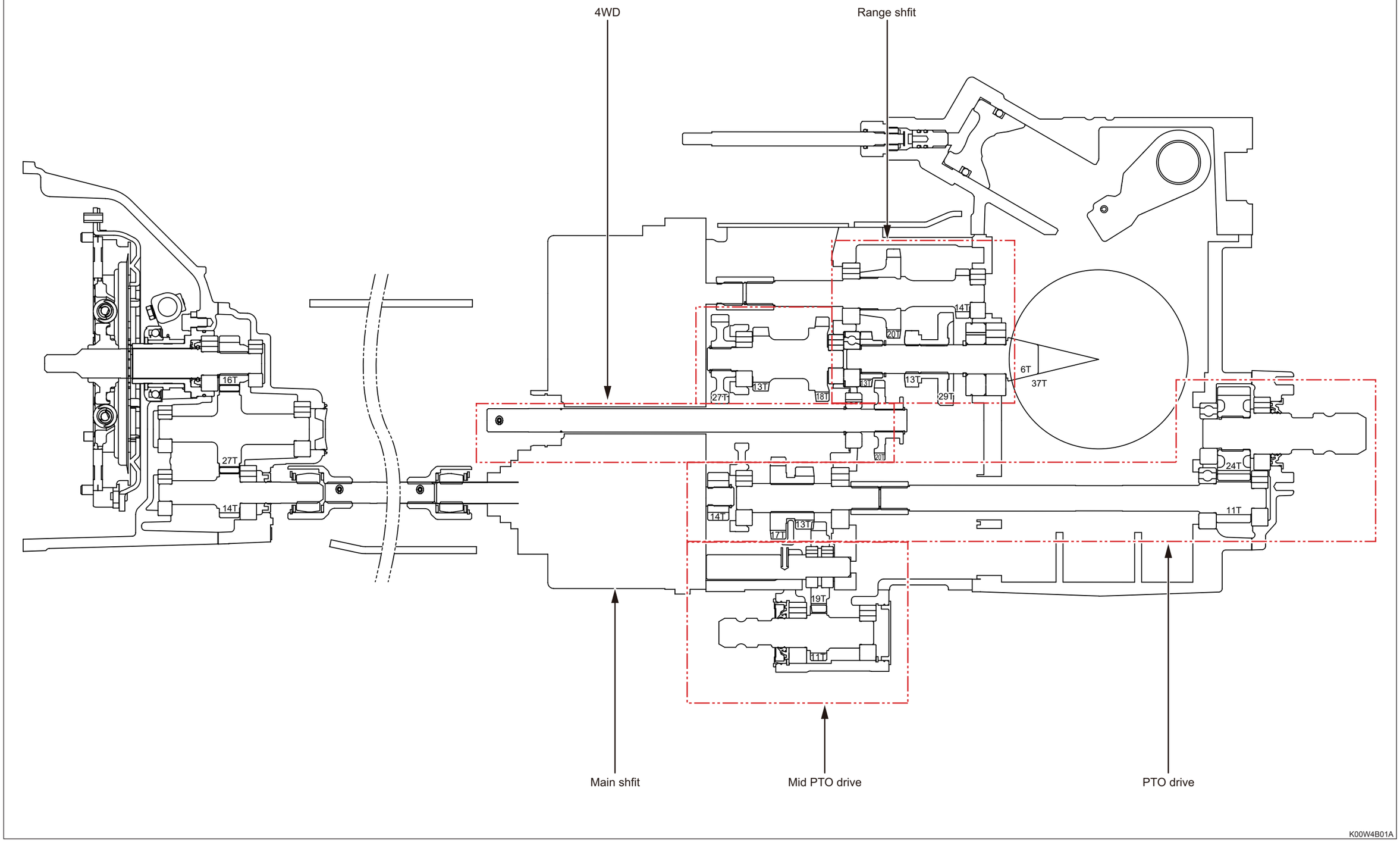
1.1 SPECIFICATION

<table>
<tr><th colspan="3">ITEM</th><th colspan="5">SPECIFICATION</th></tr>
<tr><td rowspan="10">Transmission system</td><td colspan="2">Shuttle type</td><td colspan="5">Hydrostatic</td></tr>
<tr><td colspan="2">Main shift</td><td colspan="5">HST</td></tr>
<tr><td colspan="2" rowspan="2">Range shift</td><td>2024H</td><td colspan="4">2 speeds, Sliding-mesh</td></tr>
<tr><td>3026H</td><td colspan="4">3 speeds, Sliding-mesh</td></tr>
<tr><td colspan="2" rowspan="2">Shifting gear and driving speed</td><td>2024H</td><td>CVT</td><td>6 - 12
9.5 - 16</td><td colspan="2">Forward driving: 0 ~ 19.5 km/h (0 ~ 12.1 MPH)
Reverse driving: 0 ~ 19.5 km/h (0 ~ 12.1 MPH)</td></tr>
<tr><td>3026H</td><td>CVT</td><td>6 - 12
9.5 - 16</td><td colspan="2">Forward driving: 0 ~ 23.9 km/h (0 ~ 14.9 MPH)
Reverse driving: 0 ~ 23.9 km/h (0 ~ 14.9 MPH)</td></tr>
<tr><td rowspan="4">PTO shift</td><td>Type</td><td colspan="5">Dependent</td></tr>
<tr><td>Stage</td><td colspan="5">2</td></tr>
<tr><td>Revolution</td><td colspan="5">1st: 540 rpm, 2nd: 960 rpm, Mid: 2,500 rpm</td></tr>
<tr><td>PTO shaft</td><td colspan="5">Ø 35 mm, 6 splines</td></tr>
<tr><td colspan="2">Rear axle</td><td colspan="5">Reduction ratio: $\frac{6}{37}$ x $\frac{10}{57}$ = 0.02845</td></tr>
<tr><td rowspan="2">Brake</td><td colspan="2">Main brake</td><td colspan="5">Wet disc</td></tr>
<tr><td colspan="2">Parking brake</td><td colspan="5">Hand brake lever type</td></tr>
<tr><td colspan="2" rowspan="2">Transmission fluid</td><td>Capacity</td><td colspan="5">10ℓ (2.64 u.s. gal)</td></tr>
<tr><td>Specification</td><td colspan="5">TF500</td></tr>
</table>

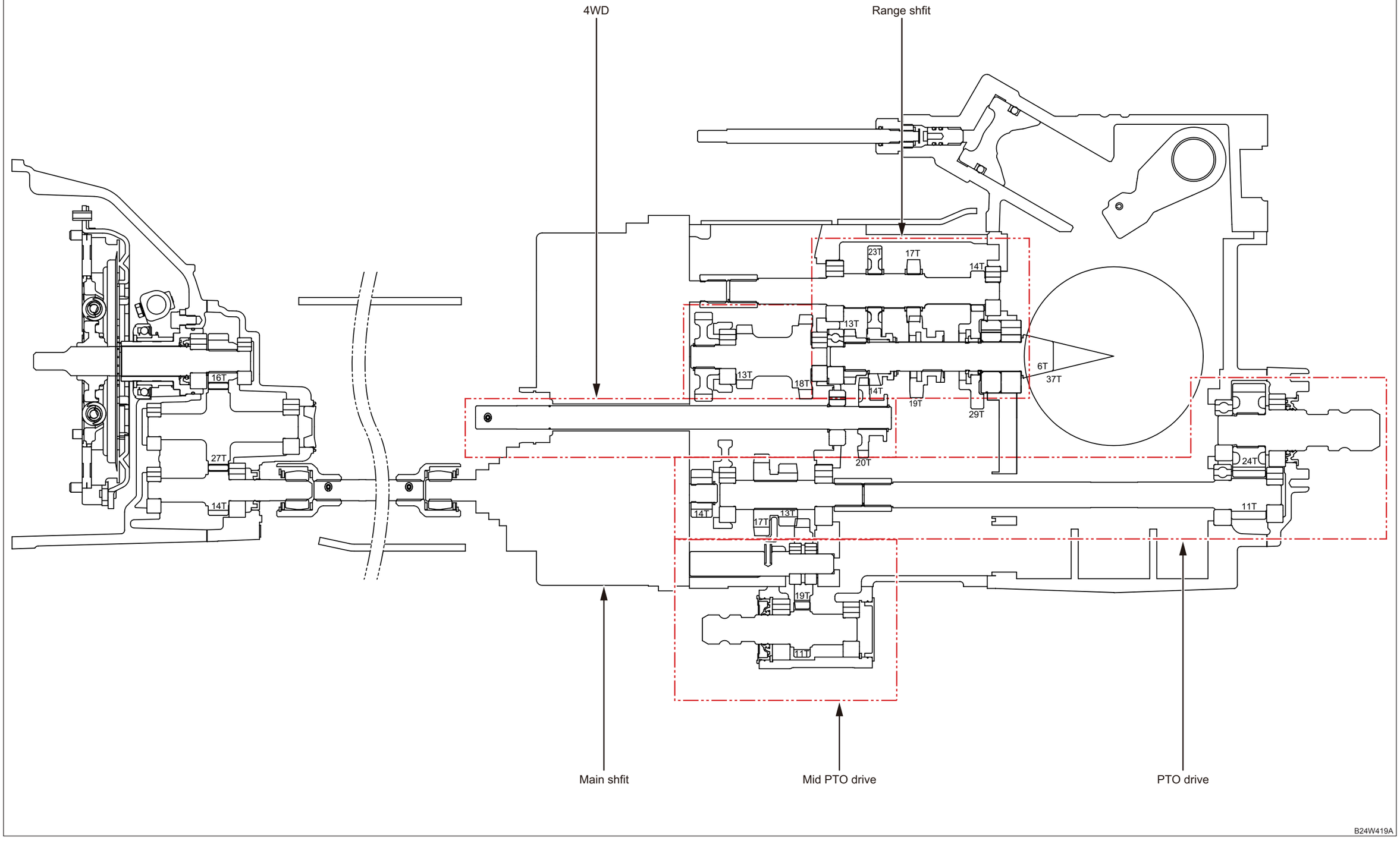
1.2 POWER TRANSFER

1.2.1 TRANSMISSION ASSEMBLY DIAGRAM

2024H



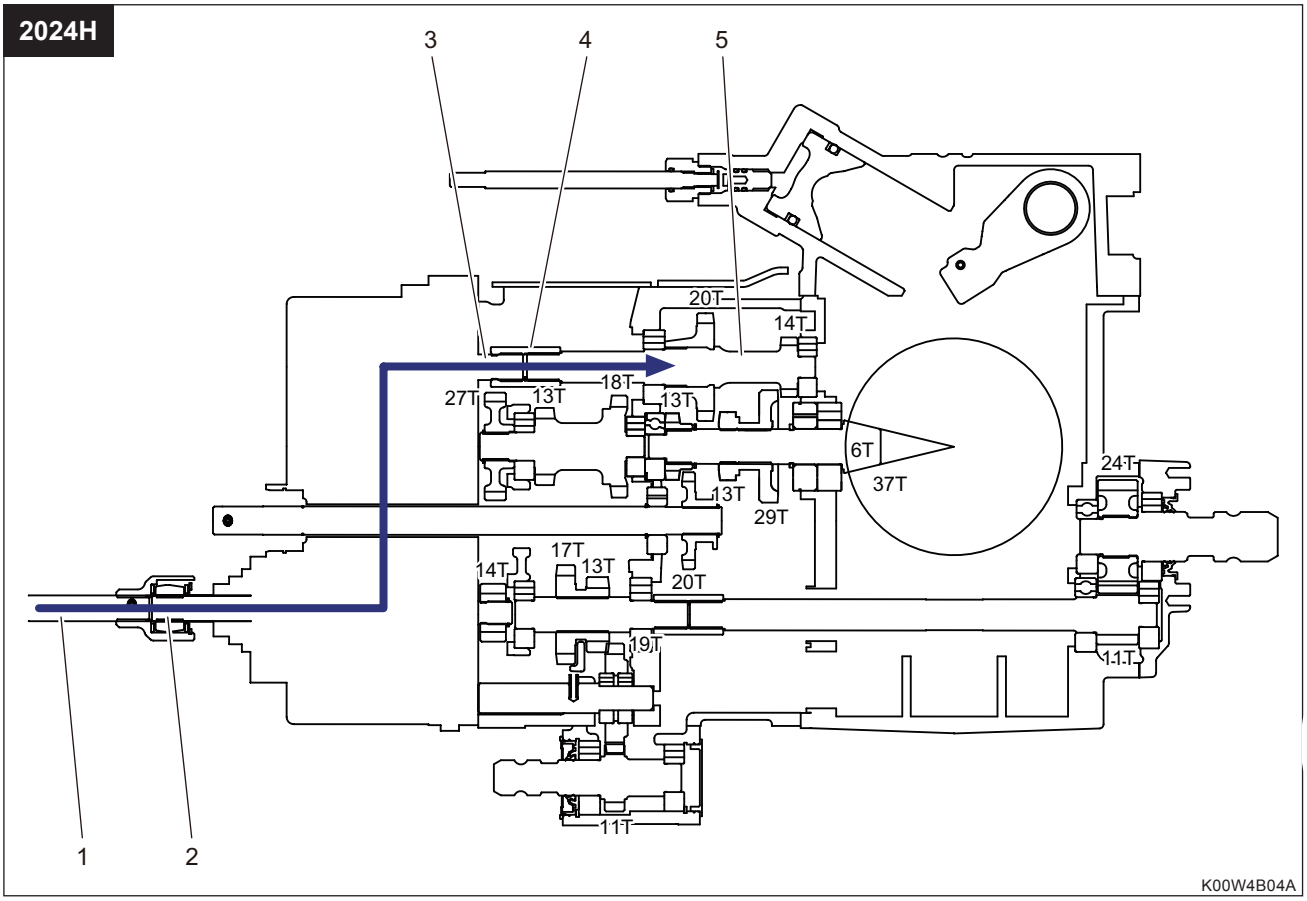
3026H


4WD
Range shfit
16T
27T
14T
23T
17T
14T
13T
13T
18T
14T
19T
29T
6T
37T
20T
24T
14T
17T
13T
11T
19T
11T
Main shfit
Mid PTO drive
PTO drive
B24W419A

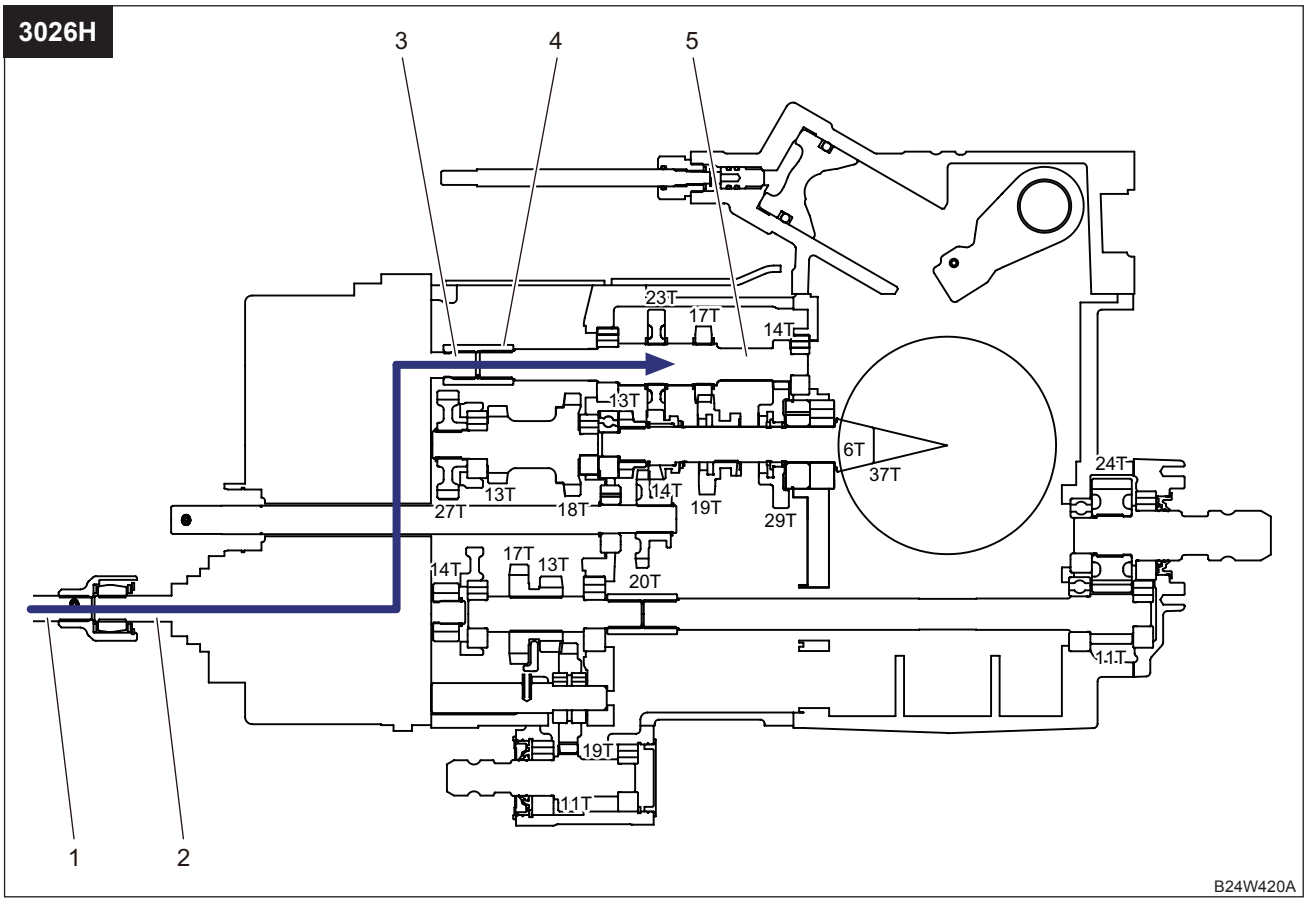
2. STRUCTURE AND OPERATING PRINCIPLE

2.1 MAIN SHIFT

2024H



3026H

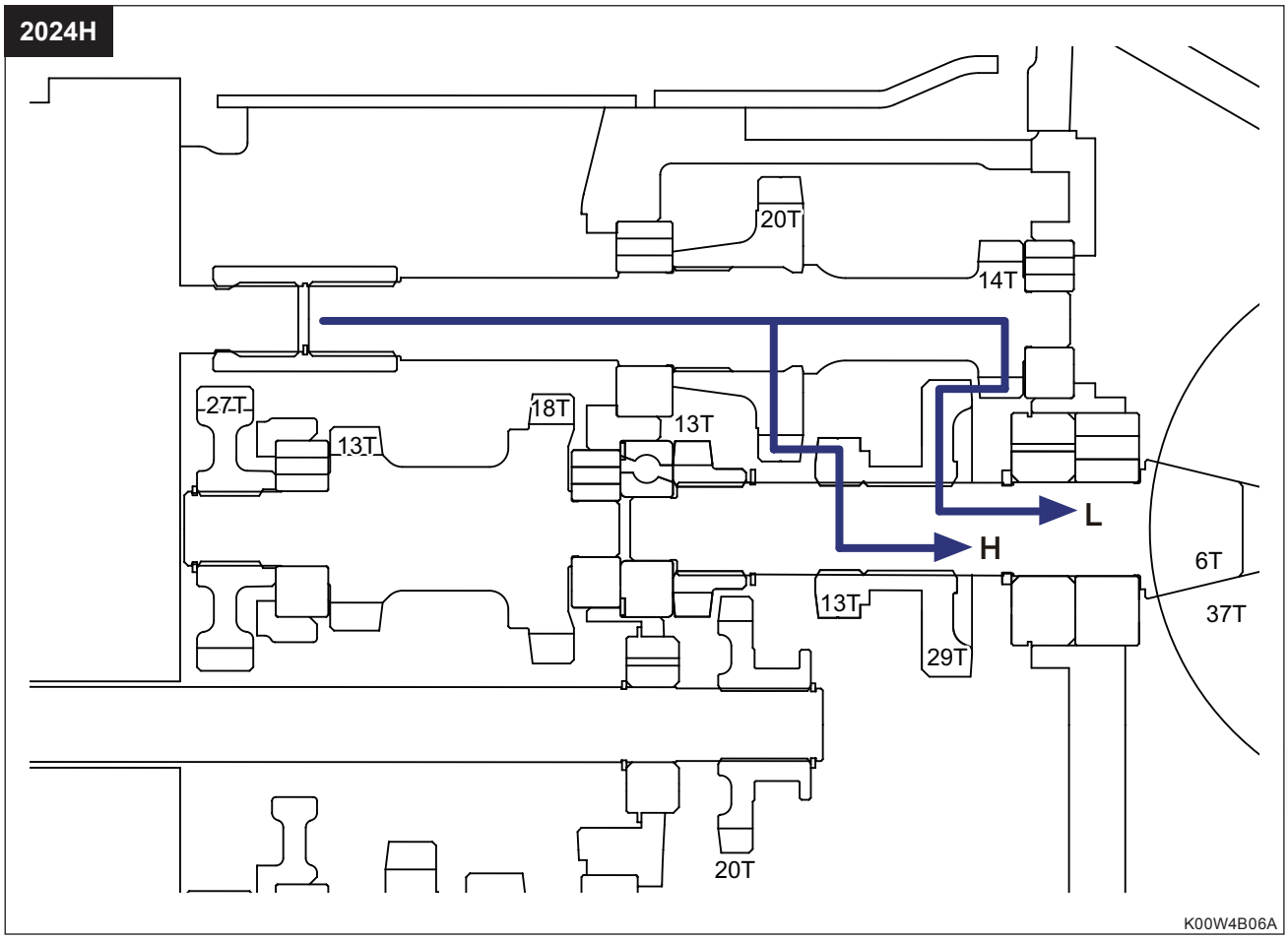


The rotating power from the engine passes through the propeller shaft (1) and is subsequently transferred to the pump shaft (2), which functions as the HST input shaft.

Accordingly, the upper motor shaft (3) is rotated by hydraulic pressure produced by the rotation of the HST pump shaft, transferring rotating power to the range shift gear shaft (5) connected to a joint (4) by means of the motor shaft, which functions as the output shaft.

All main shift operation is performed in the HST as the rotating speed is varied continuously based on the operating mode of the swash plate in the HST and its rotating direction is switched for forward and reverse drive.

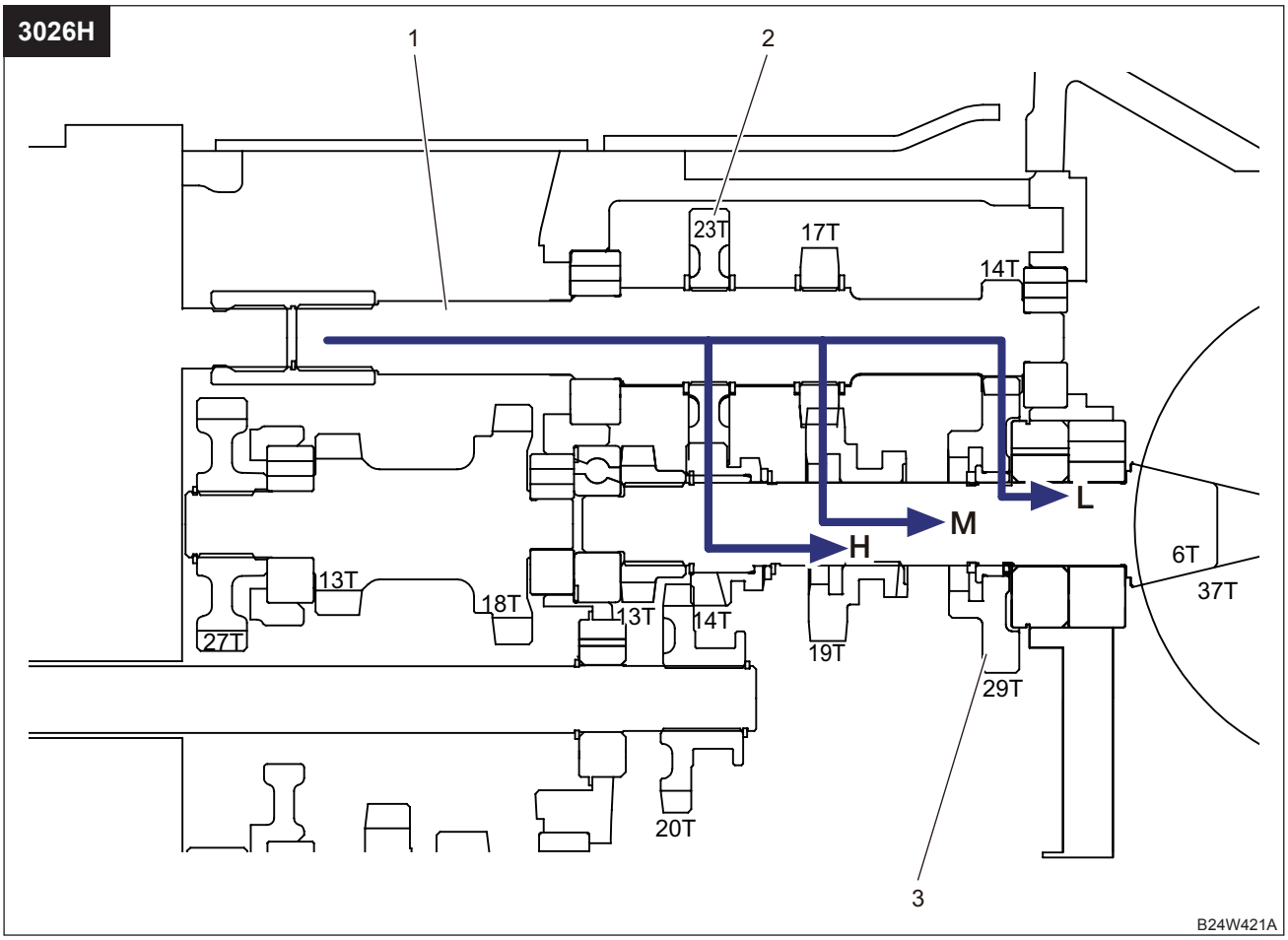
2.2 RANGE SHIFT



The range shift consists of two speeds: high (H) and low (L).

Rotational force transmitted by the main shift causes gear shaft 14T (1) to rotate, and gear 20T (2), connected with splines, begins rotating as well.

Moving gear 13-29 (4) on the bevel pinion shaft (3) to the left and engaging gear 13 on gear 13-29 with gear 20T on gear shaft 14T shifts to high speed (H), while moving gear 13-29 to the right and engaging gear 29 on gear 13-29 with gear 14T on gear shaft 14T shifts to low speed (L) on the range shift.



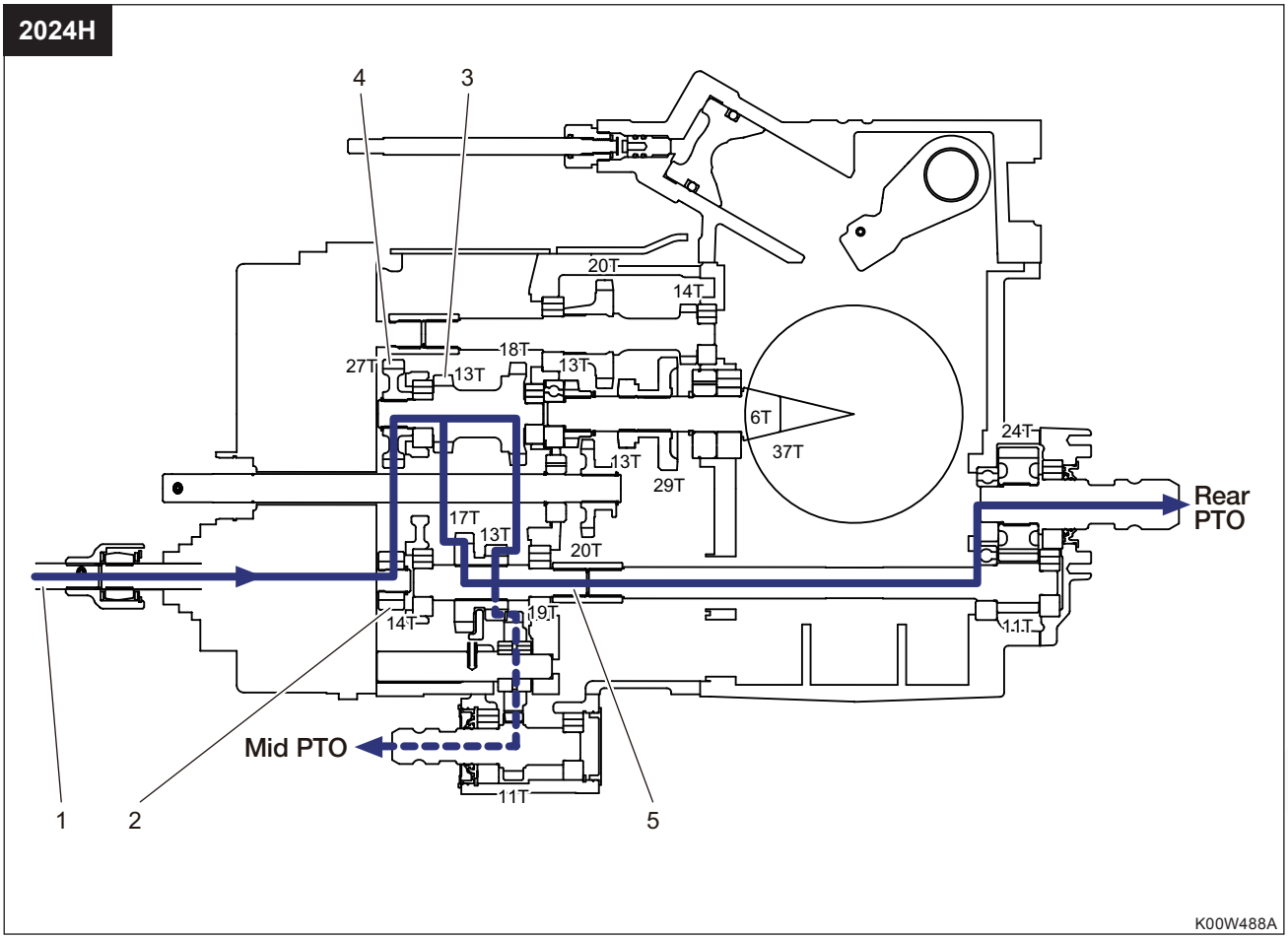
The rotating power transferred through the main shift gear shaft (1) causes the gear shaft to rotate together with range shift gear 23 (2), which is engaged with splines.

To switch to high speed (H) on the range shift, move range shift gear 14 (3) on the bevel pinion shaft to the left, and engage range shift gear 14T and range shift gear 23T on the gear shaft with one another.

To switch to mid speed (M), engage range shift gear 19T on the bevel pinion shaft with range shift gear 17T on the gear shaft. Likewise, to switch to low speed (L), move range shift gear 29 all the way to the right to engage range shift gear 29T on the bevel pinion shaft with gear 14T on the gear shaft.

2.3 PTO SHIFT

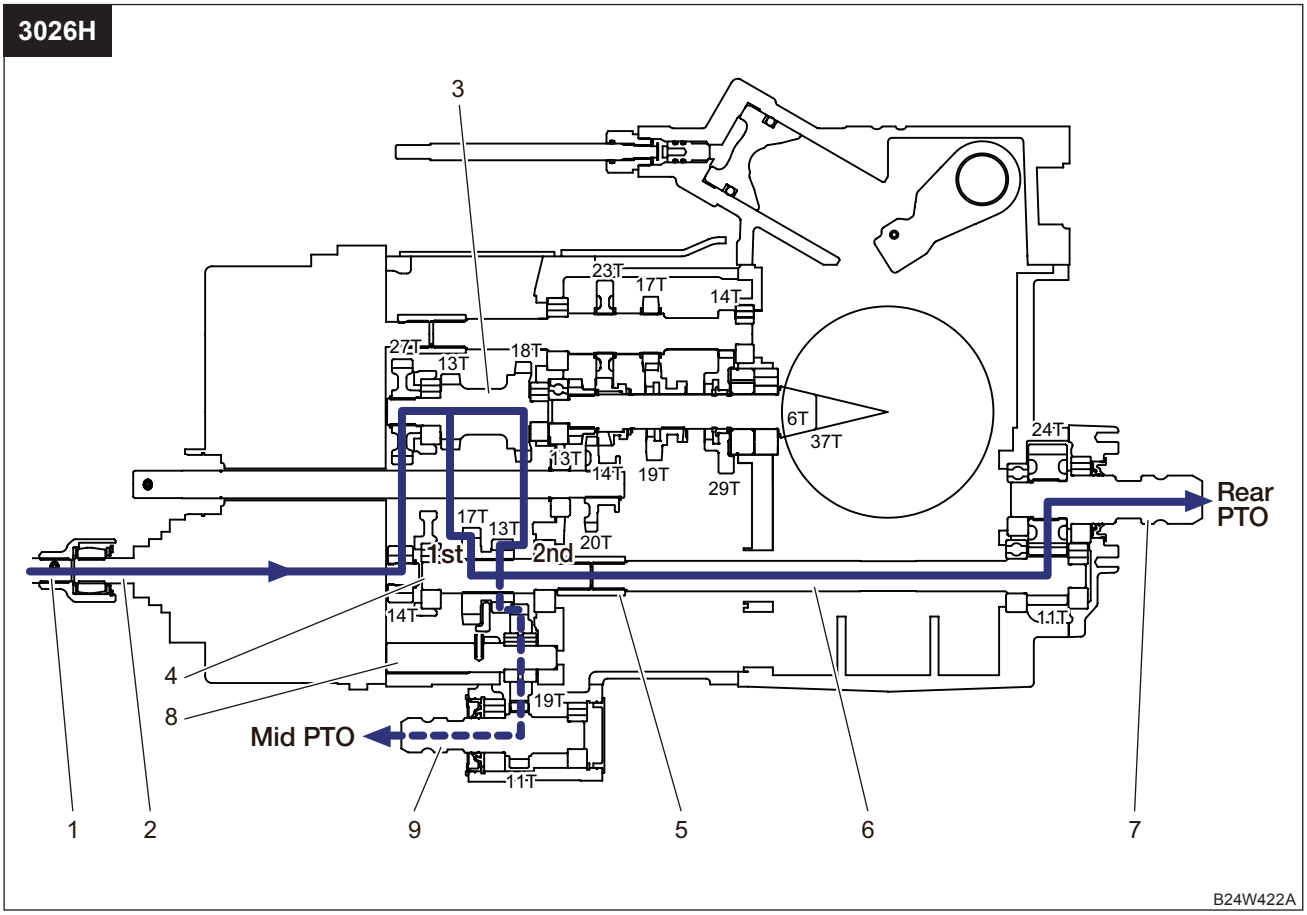
2024H



The rotational force transmitted to the propeller shaft (1) causes gear shaft 13-18 to rotate by means of gear 27T (4) on gear shaft 13-18 (3) engaged with gear 14T (2) on the end of the HST pump shaft.

Thus, PTO first gear, second gear and mid PTO are shifted and driven by shifting gear 17-13 on shaft 3 (5).

3026H

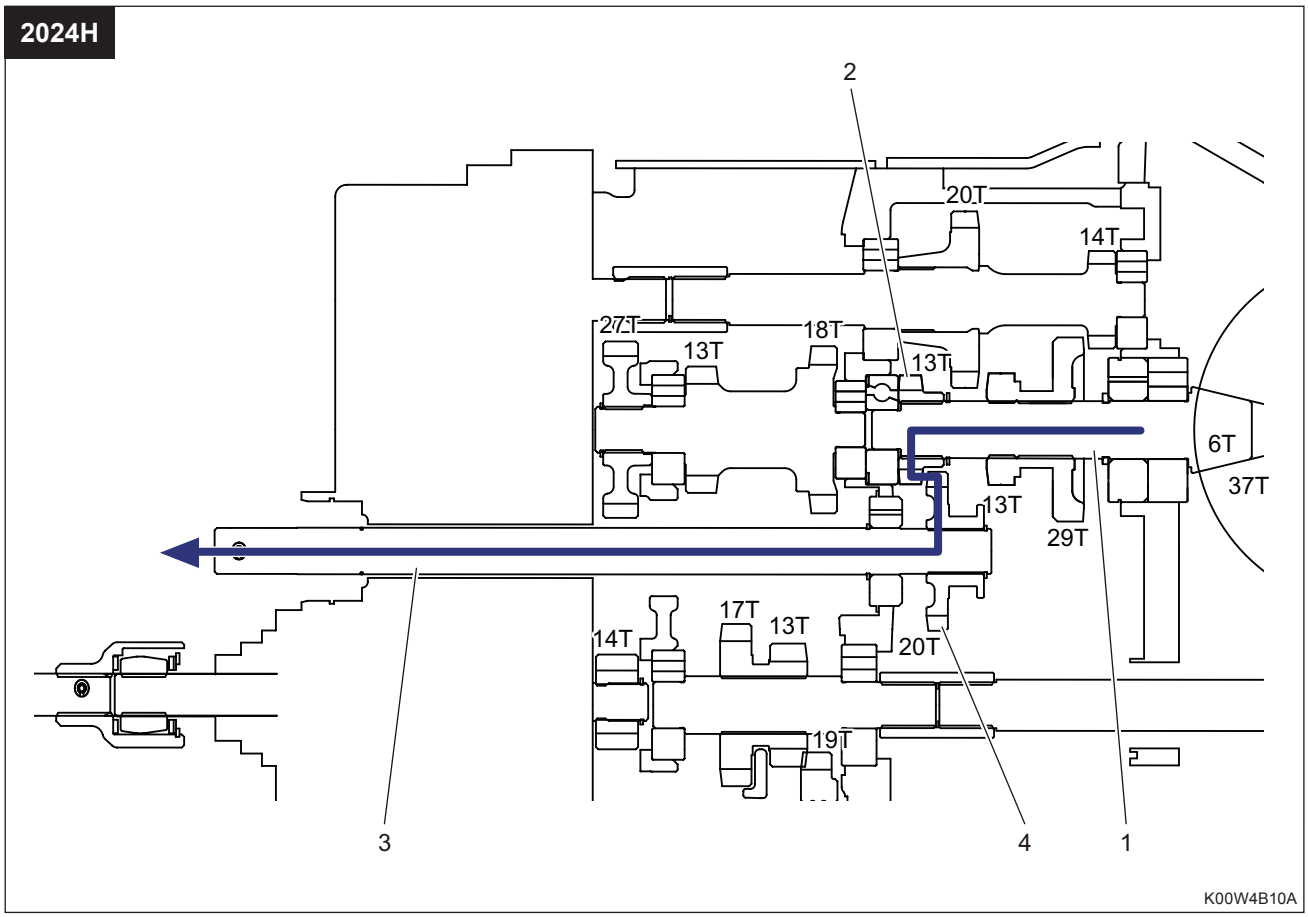


Engine rotating power from the propeller shaft (1) is transferred by means of the HST input pump shaft (2), while gear 14T at the end of the shaft rotates and causes the engaged gear 27T on gear shaft 13-18 (3) to rotate. Accordingly, gear shaft 13-18, connected to gear 27T with splines, rotates, shifting gear 17-13 on the shaft (4) connected to the PTO to the left. Engaging gear 17T with gear 13T on gear shaft 13-18 at this time switches the PTO to first gear. In addition, shifting gear 17-13 to the right and engaging gear 13T on gear 17-13 with gear 18T on gear shaft 13-18 simultaneously switches the PTO to second gear and shifts to mid PTO.

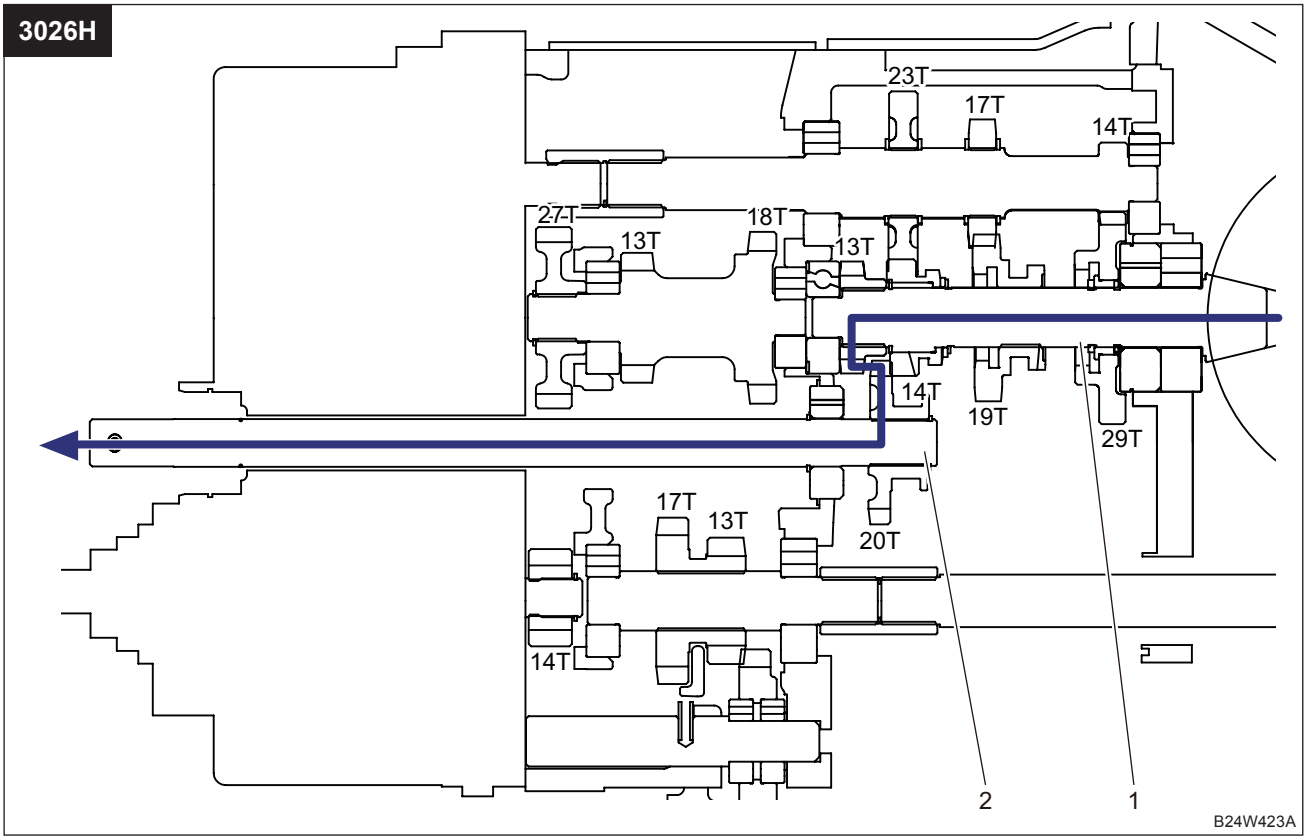
Accordingly, shifting to rear PTO mode causes the rear PTO shaft (7) to rotate by means of the joint (5) connected to gear shaft 11 (6) and gear 24T. Also, shifting to mid PTO mode causes power transferred by engaging gear 13T on gear 17-13, gear 19T on the idler shaft (8), and gear 11T on the mid PTO shaft (9) operates the mid PTO shaft.

2.4 4WD

2024H



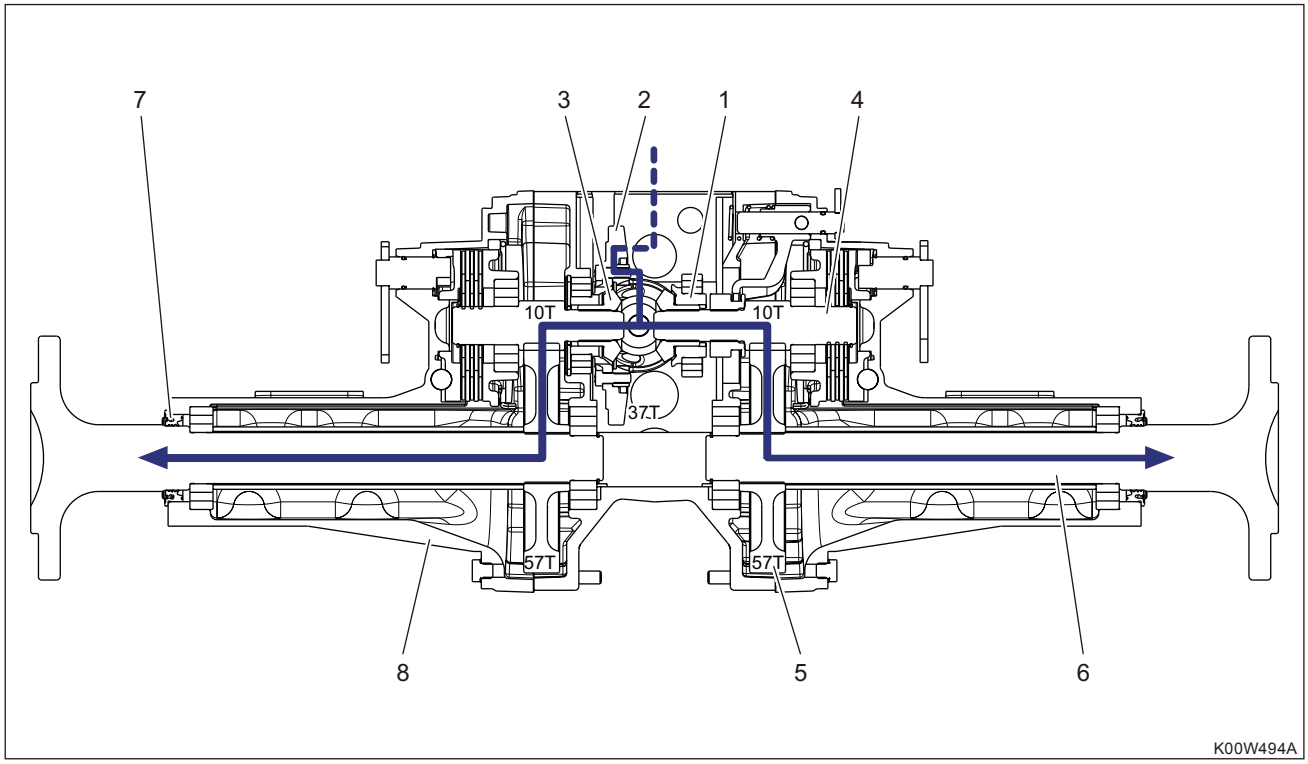
When the bevel pinion shaft (1) rotates, gear 13T (2), connected with splines, rotates as well. Moving the 4WD gear (4) on the 4WD shaft (3) to the left and engaging it with gear 13T transmits the rotational power of gear 13T to the 4WD shaft by means of gear 20T, thereby shifting to 4WD and driving the front wheels with the connecting shaft.



The bevel pinion shaft (1) is rotated by engaging certain teeth in the range shift gear. The 13T 4WD gear connected to this shaft with splines also rotates together with it.

In order to activate 4WD, shifting the 20T 4WD gear on the 4WD shaft (2) to the left and engaging it with the 13T 4WD gear connects the rotating power for front-wheel drive and transfers rotating power to the front axle through the 4WD shaft.

2.5 REAR AXLE



(1) Differential case
(2) Ring gear
(3) Differential side gear
(4) Differential gear shaft
(5) Rear axle gear
(6) Rear axle
(7) Oil seal
(8) Rear axle housing

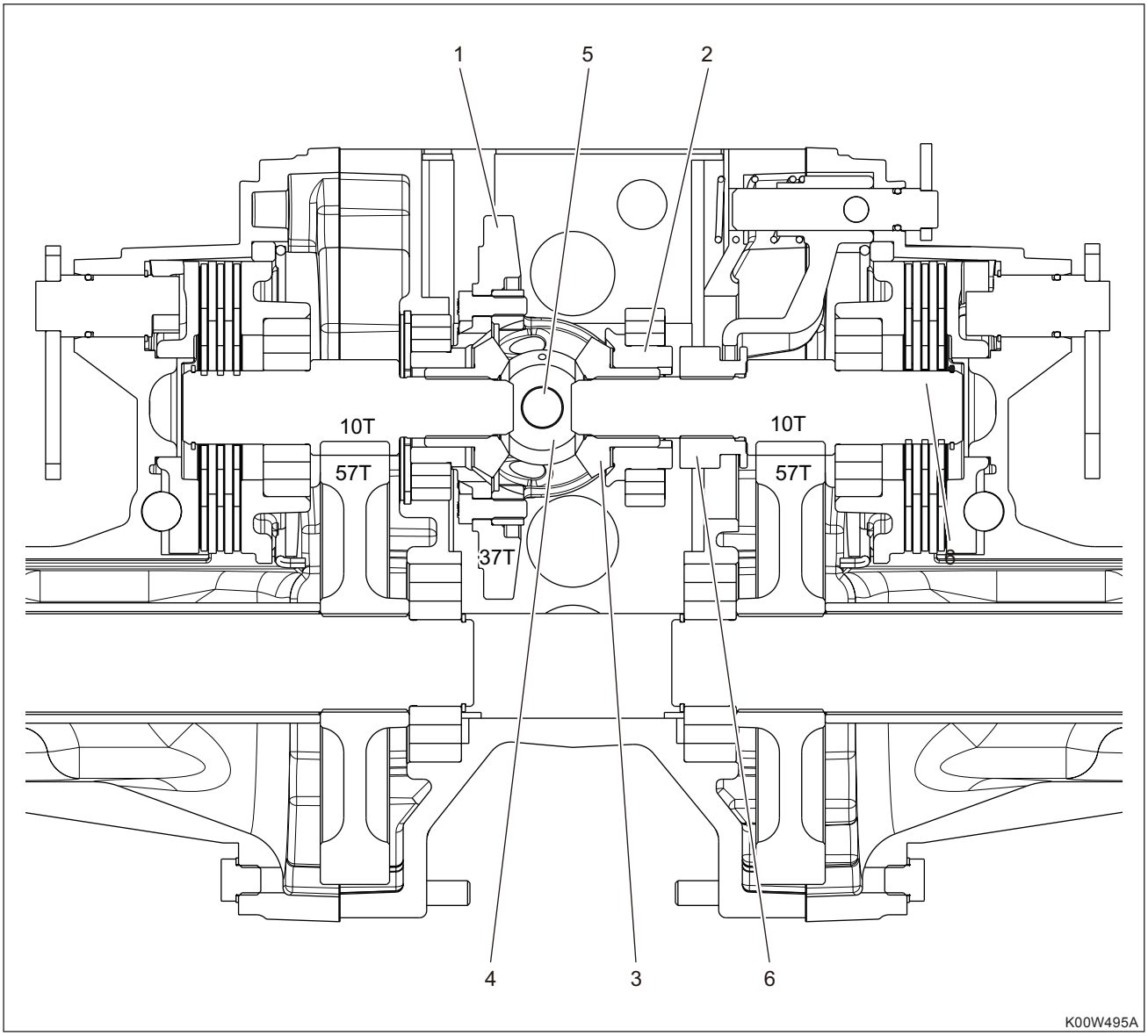
2.5.1 POWER TRANSFER

When rotating force arrives at the bevel pinion shaft, it rotates the differential case (1) through the ring gear (2). As the differential rotates, the differential pinion and differential side gear (3) inside the differential case to deliver the rotating force to the differential gear shaft (4).

Then, the speed of the rotating force at the differential gear shaft is reduced through engagement of the 10 gear of the differential gear shaft with the 57 rear axle gear (5), and it is finally transmitted to the rear axle (6), which is connected with splines, in order to rotate the rear wheels.

3. OPERATION AND ADJUSTMENT

3.1 DIFFERENTIAL SYSTEM



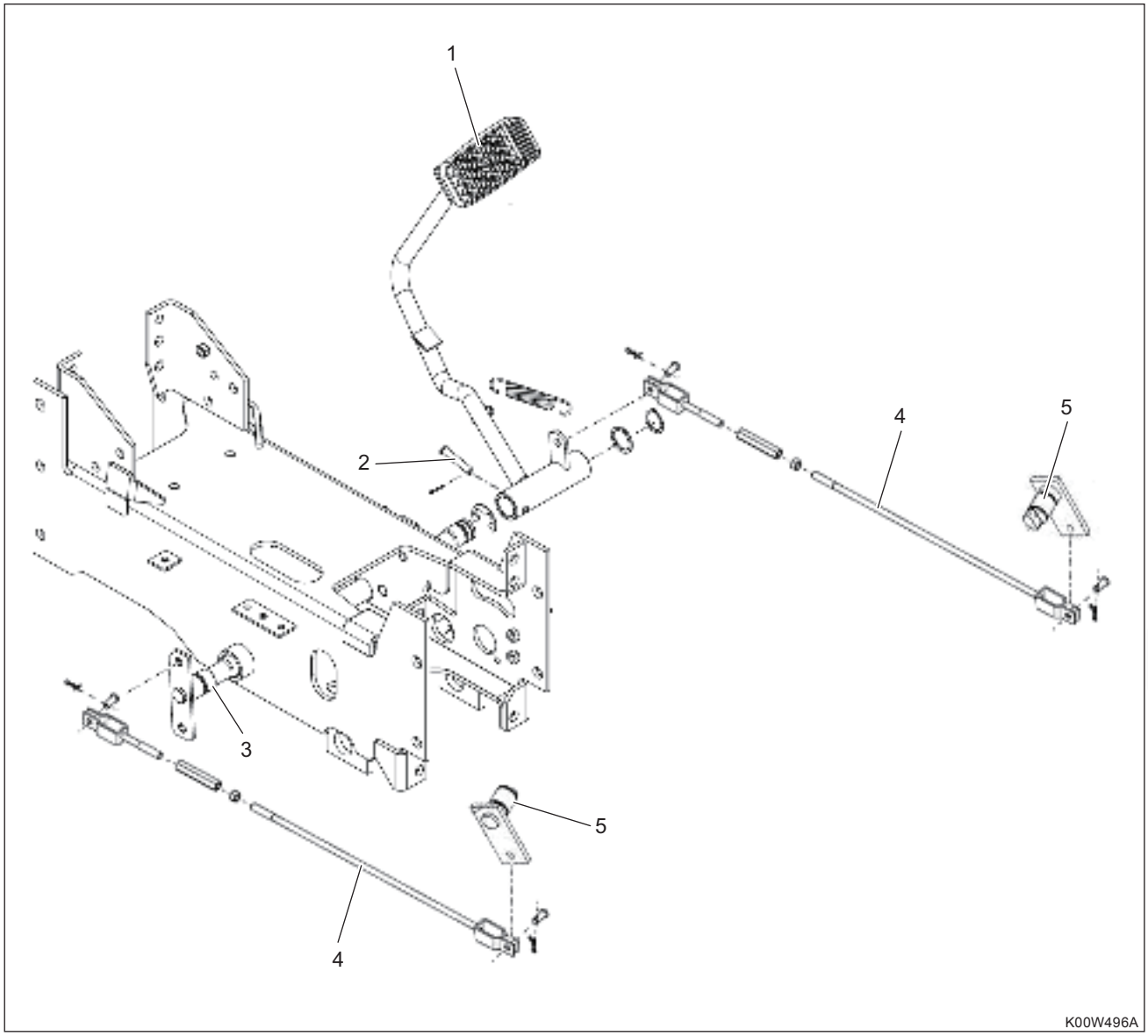
The differential system is to rotate the left wheel and right wheel at different speeds for smooth turning. When turning, this system rotates the inner wheel in the turning direction slower and the outer wheel faster to turn the vehicle in the desired direction.

Also, when a wheel got stuck in mud, it is hard to escape the pit since the wheel in mud with no friction rotates at faster speed and the wheel on road with friction does not rotate due to the differential system. To prevent this situation, the vehicle is equipped with the differential lock. The differential lock moves the differential lock slide to fix the differential case and differential side gear together with the pin, resulting in rotation of the side gear on the other side as well. Therefore, the wheels on both sides are rotated at the same speed to escape the pit.

The differential system consists of the ring gear (1), differential case (2), differential side gear (3), differential pinion (4), differential pinion shaft (5) and differential lock slide (6).

3.2 BRAKE

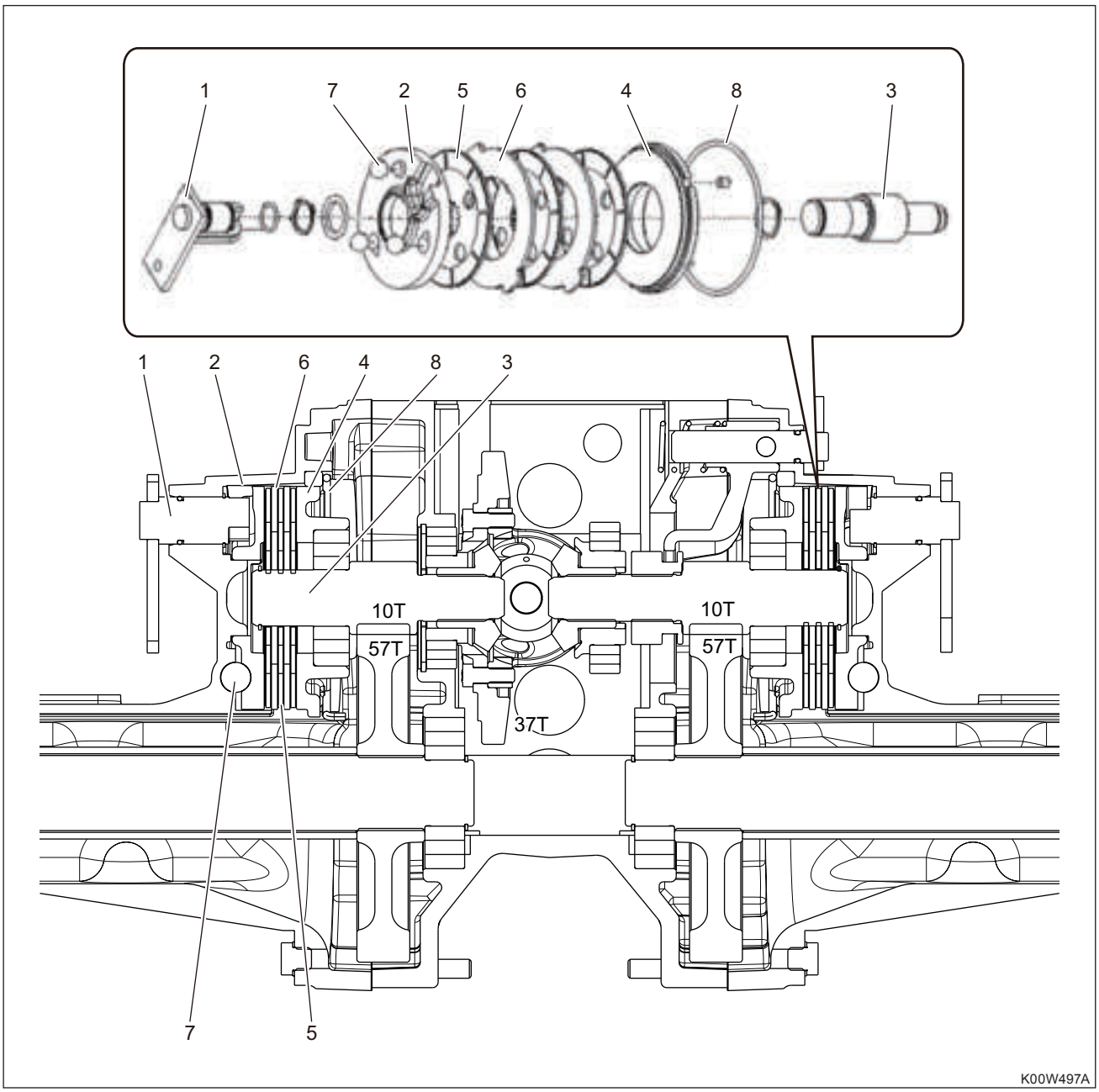
3.2.1 OVERVIEW



When the brake pedal (1) is depressed, the pedal shaft (3), which is fixed with the brake pedal boss and joint pin (2), starts to rotate. Then, as the pedal shaft is connected to the brake rod (4) with the snap pin, the shaft pulls the rod which then turns the brake activating brake cam lever (5) to operate the internal brake.

As this brake is a wet multi-plate type, it is soaked in oil for superior lubrication, cooling and durability.

3.2.2 OPERATING PRINCIPLE OF BRAKE



(1) Brake cam lever
(2) Actuator
(3) Differential gear shaft
(4) Bearing holder
(5) Brake disc
(6) Friction plate
(7) Steel ball
(8) Clip

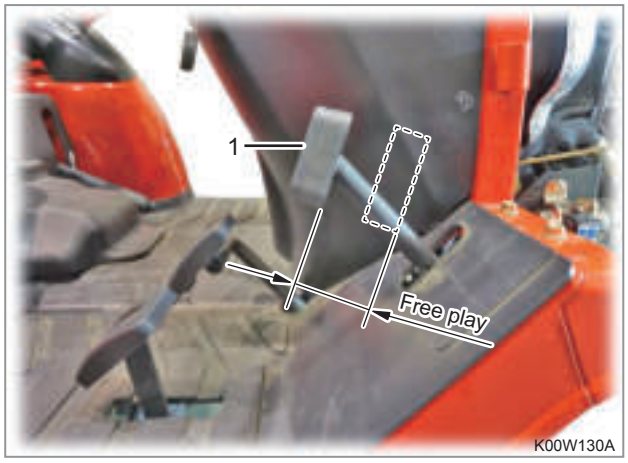
When the brake cam lever (1) is pulled by transferred power, which is fit to the groove of the actuator (2), the actuators are rotated as well.

On the other side, the differential gear shaft (3) is fixed to the differential side gear with splines, rotating together, and its other side is fixed to 3 discs (5) with splines as one unit. Also, the friction plates (6) are installed in between the friction discs and these friction plates are fixed to the rear axle housing.

Therefore, when the brake pedal is depressed, the brake cam lever is moved to rotate the actuator. Then, the steel ball (7) installed in the groove on the slant of the actuator pushes the actuator inward, producing driving force. This driving force compresses the friction discs and plates. As the friction plates are fixed by the rear axle housing, they stop rotating.

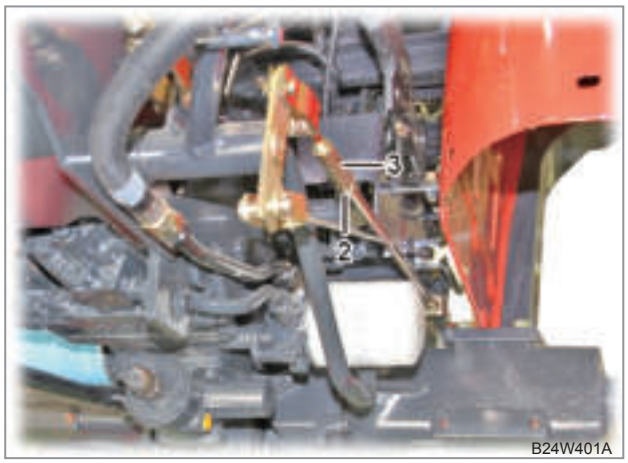
As a result, the differential gear shaft fixed to the brake discs stop rotating as well, leading to stop of the vehicle.

3.2.3 BRAKE PEDAL FREE PLAY ADJUSTMENT



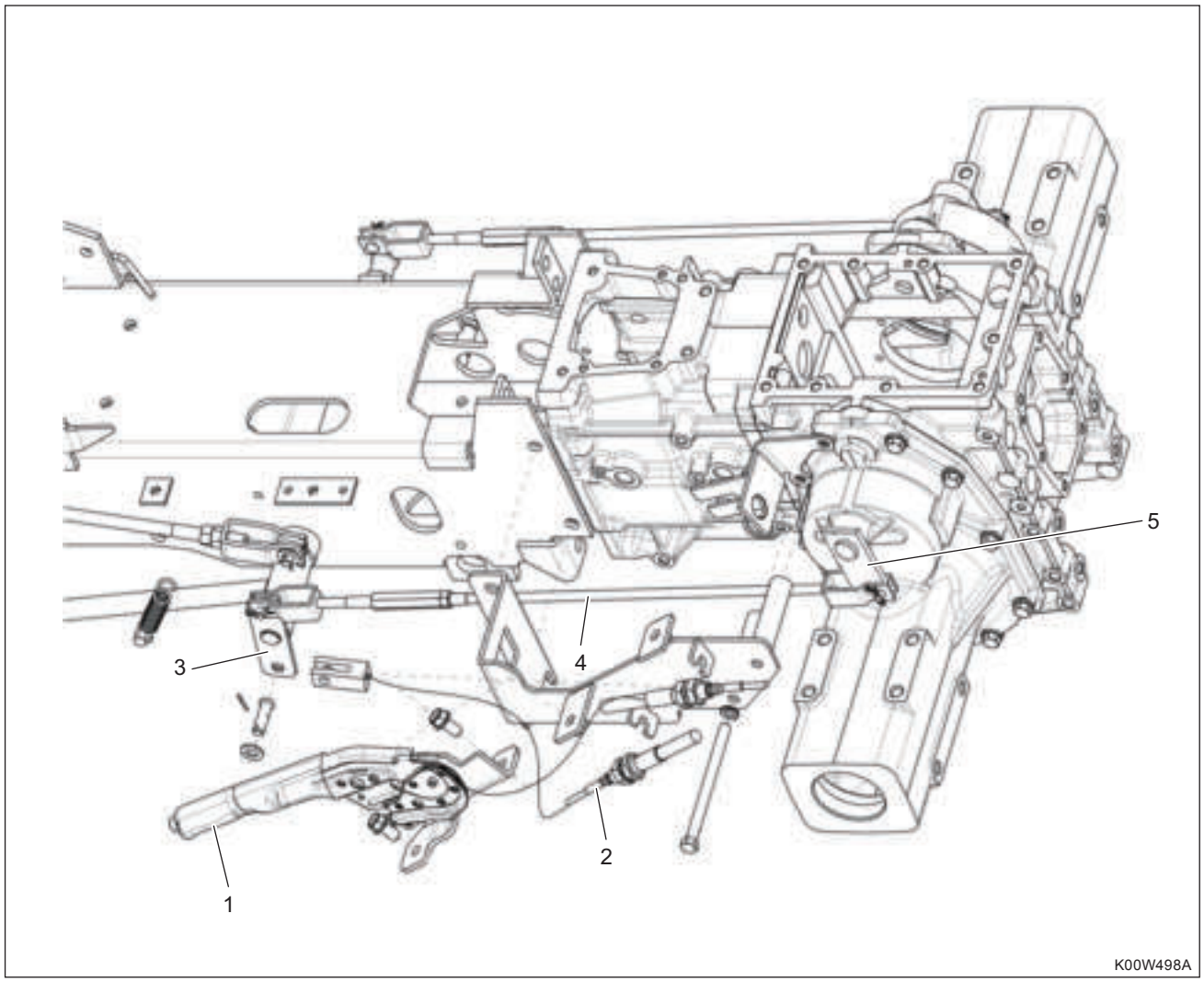
1. Depress the brake pedal (1) slightly. Then, release it.
2. Measure its free play.

ITEM	STANDARD
Brake pedal free play	30 - 40 mm (1.2 - 1.5 in)
* The free play for both pedals should be identical.	



3. If the free play is out of the standard, unscrew the mounting nuts (2) of the brake rods (LH/RH) on the brake shaft section and use the turnbuckle (3) to adjust the free play. After adjusting the free play of the both sides, tighten the mounting nuts.

3.3 PARKING BRAKE OPERATION

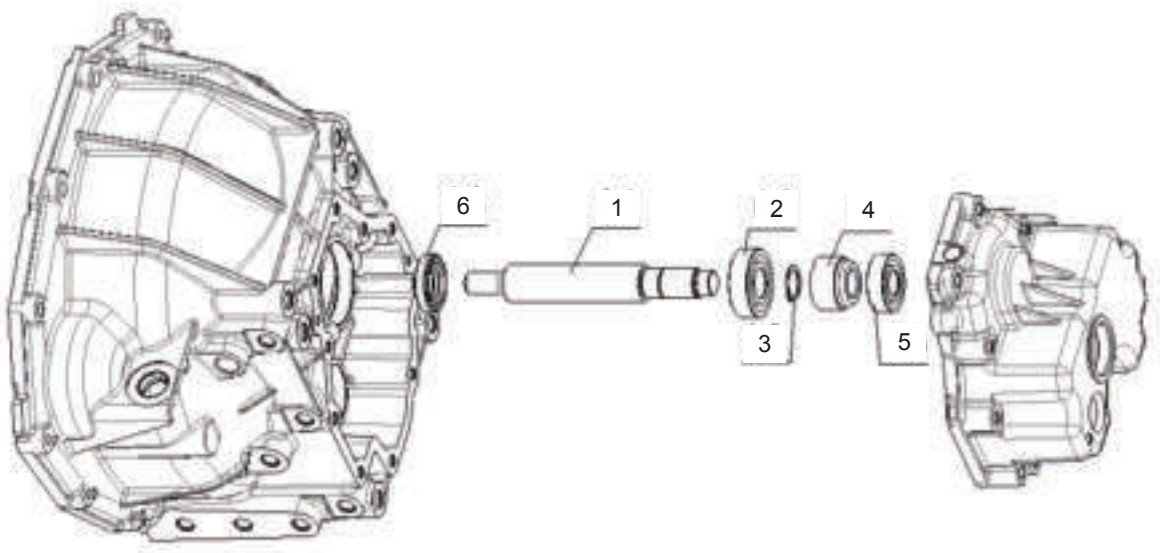


(1) Parking brake lever
(2) Parking brake cable
(3) Pedal shaft
(4) Brake rod
(5) Brake cam lever

When the parking brake lever (1) is pulled, the parking brake cable (2) pulls the pedal shaft (3). Then, the left brake rod (4), which is connected to the pedal shaft, activates the left brake cam lever (5) while the right brake rod on the brake pedal side, which is fixed to the pedal shaft with the joint pin, activates the right brake cam lever to produce braking force for each brake. Therefore, pulling the parking brake lever with the brake pedal depressed can achieve sufficient braking force more easily.

4. SECTIONAL VIEW FOR MAJOR COMPONENTS

4.1 CLUTCH SHAFT



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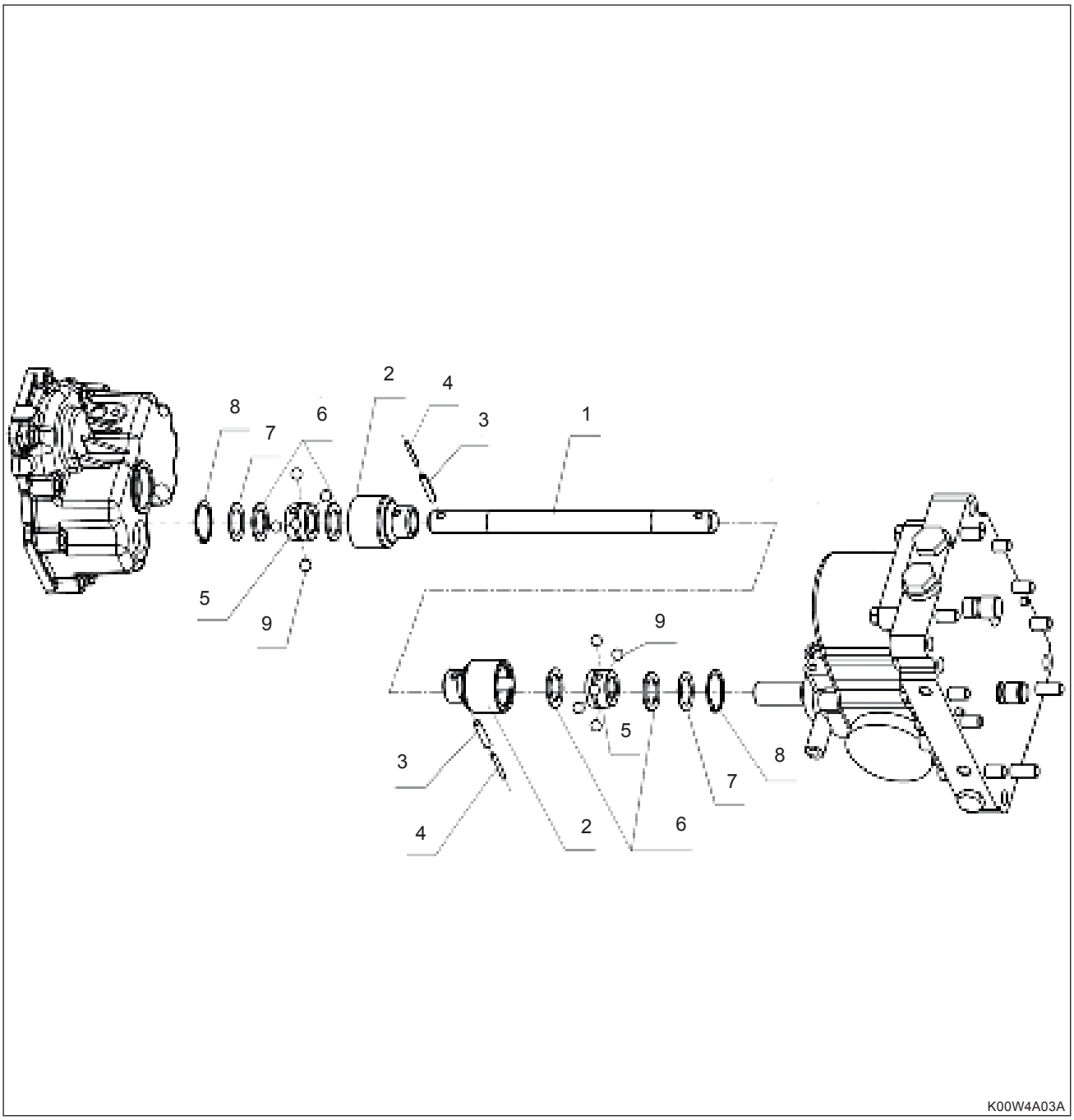
COMPONENTS

(1) Shaft, clutch
(2) Bearing, ball
(3) Cir clip, external
(4) Gear, clutch shaft
(5) Bearing, ball
(6) Seal, oil

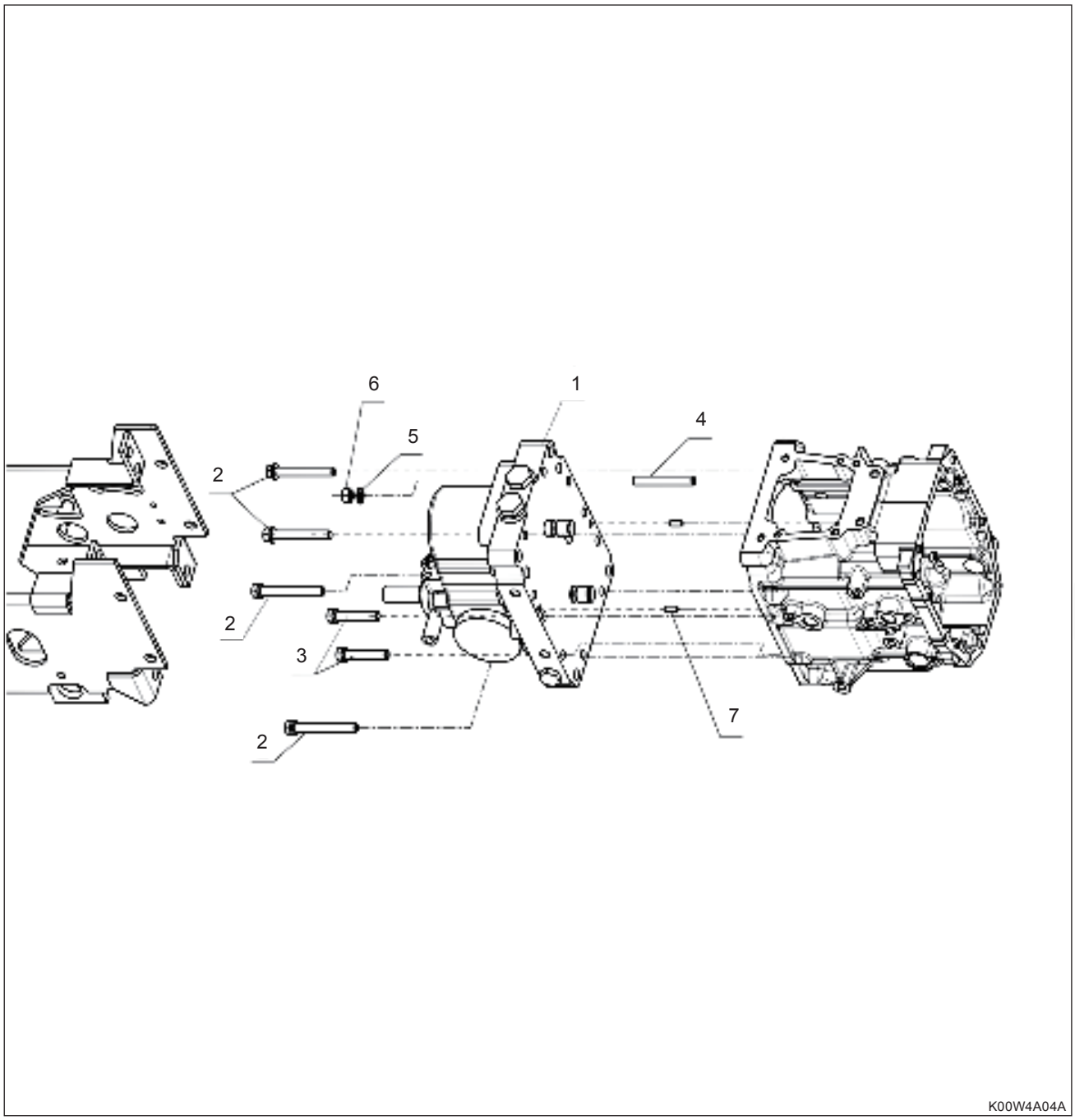
4.2 PROPELLER SHAFT



COMPONENTS

(1) Shaft, propeller
(2) Coupling, ball outer
(3) Pin, spring
(4) Pin, spring
(5) Coupling, ball inner
(6) Gasket, ball joint
(7) Support, gasket
(8) Cir clip, internal
(9) Ball

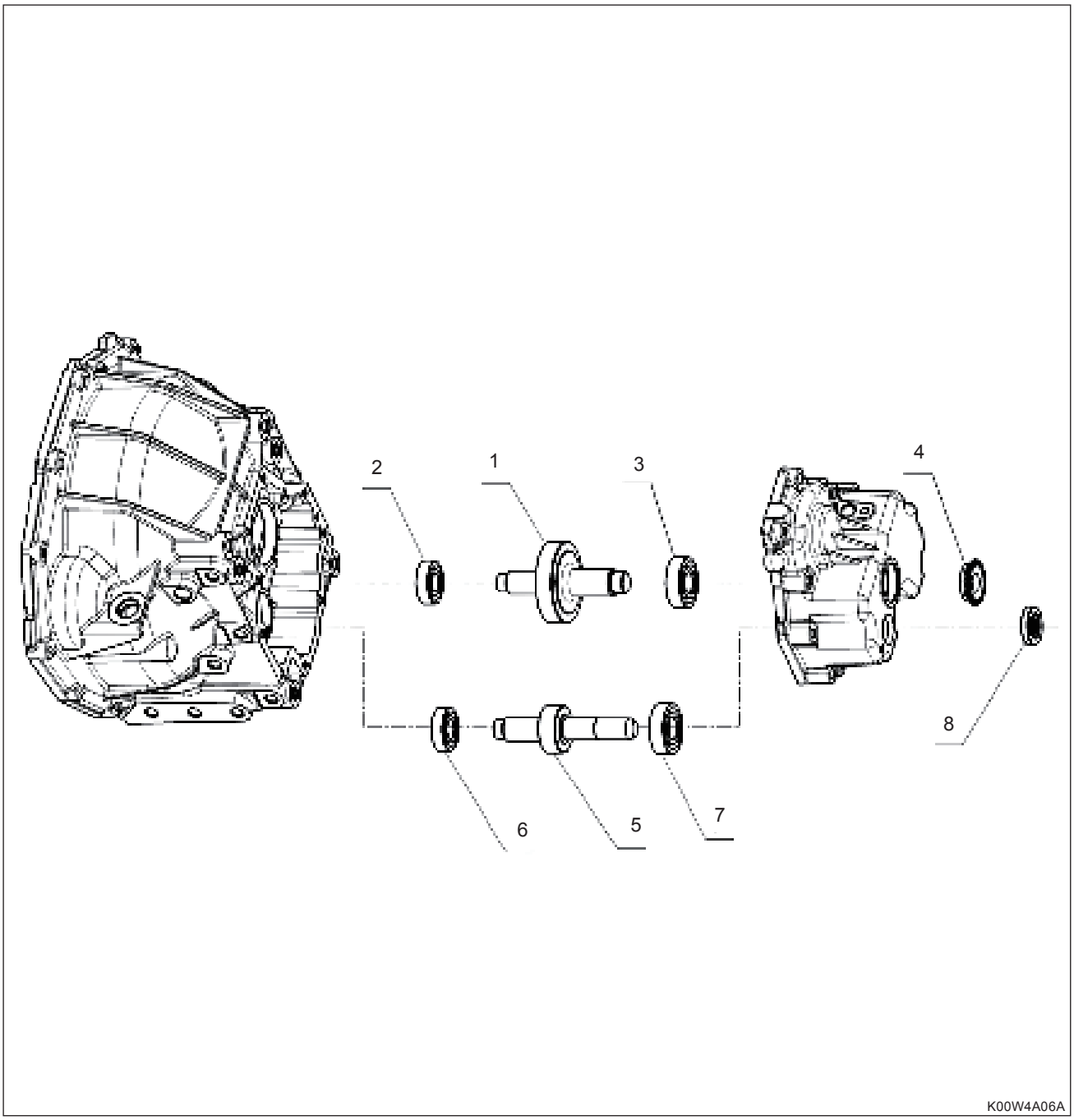
4.3 HST



COMPONENTS

(1) Assy HST
(2) Bolt
(3) Bolt
(4) Stud,bolt
(5) Washer, spring
(6) Nut
(7) Pin, straight

4.4 FRONT SHAFT

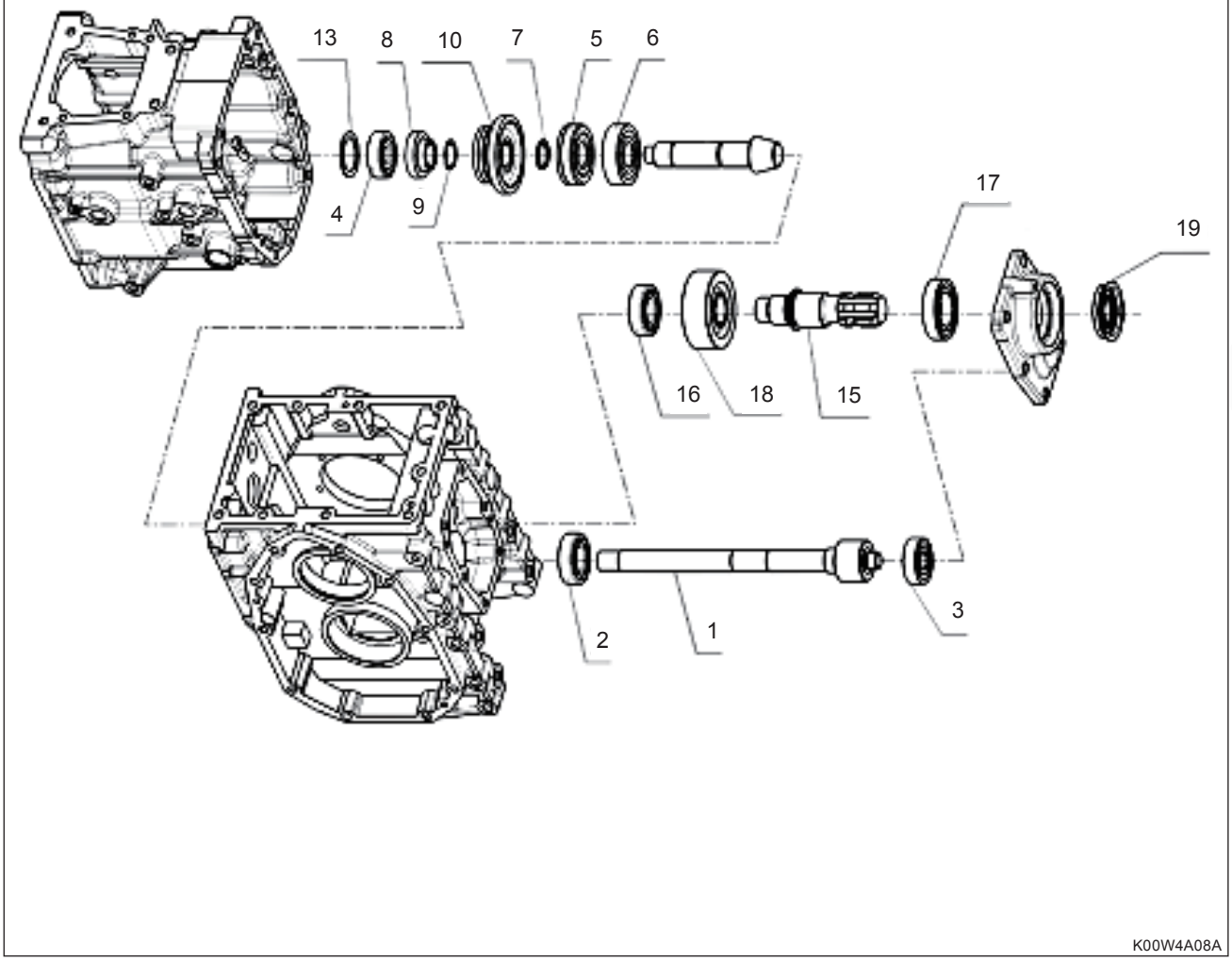


COMPONENTS

(1) Shaft, front
(2) Bearing, ball
(3) Bearing, ball
(4) Seal, cap
(5) Shaft, front
(6) Bearing, ball
(7) Bearing, ball
(8) Seal, oil

4.5 PTO SHAFT

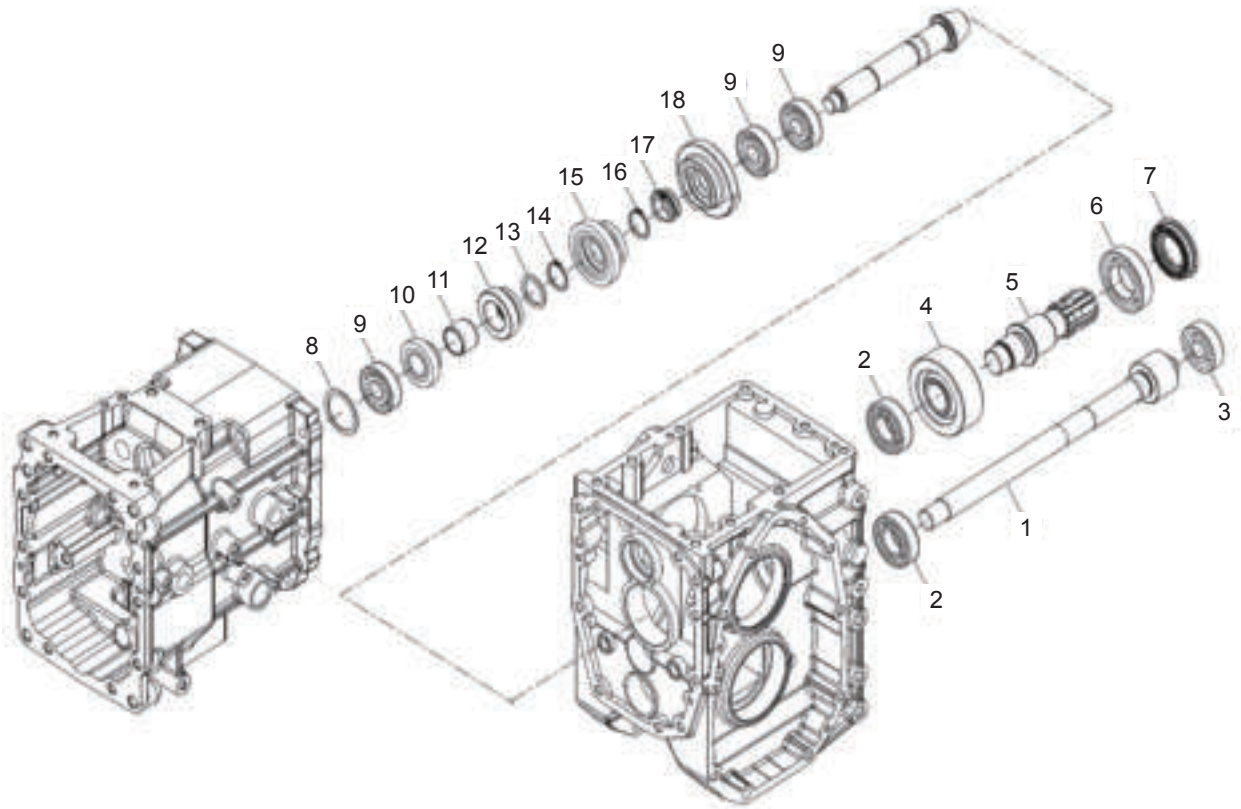
2024H



COMPONENTS

(1) Gear-shaft
(2) Bearing, ball
(3) Bearing, ball
(4) Bearing, ball
(5) Bearing, ball
(6) Bearing, ball
(7) Cir clip, external
(8) Gear, 4WD
(9) Cir clip, external
(10) Gear
(13) Washer
(15) Shaft, PTO
(16) Bearing, ball
(17) Bearing, ball
(18) Gear
(19) Seal, oil

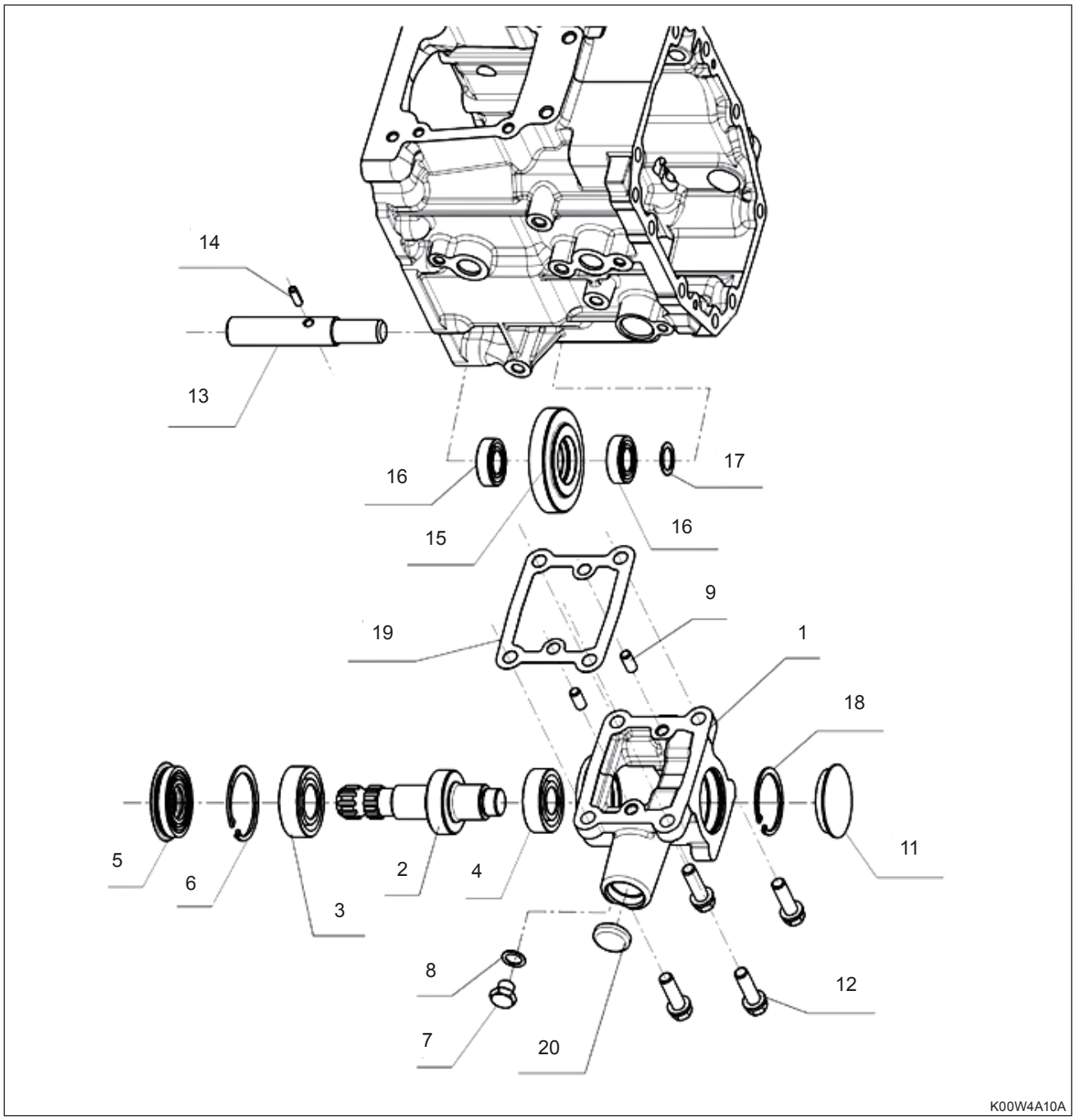
3026H



COMPONENTS

(1) Gear-shaft
(2) Bearing, ball
(3) Bearing, ball
(4) Gear
(5) Shaft, PTO
(6) Bearing, ball
(7) Seal, oil
(8) Washer
(9) Bearing, ball
(10) Gear, 4WD
(11) Bush(H)
(12) Gear
(13) Washer
(14) Cir clip, external
(15) Gear
(16) Cir clip
(17) Cir clip
(18) Bush(L)

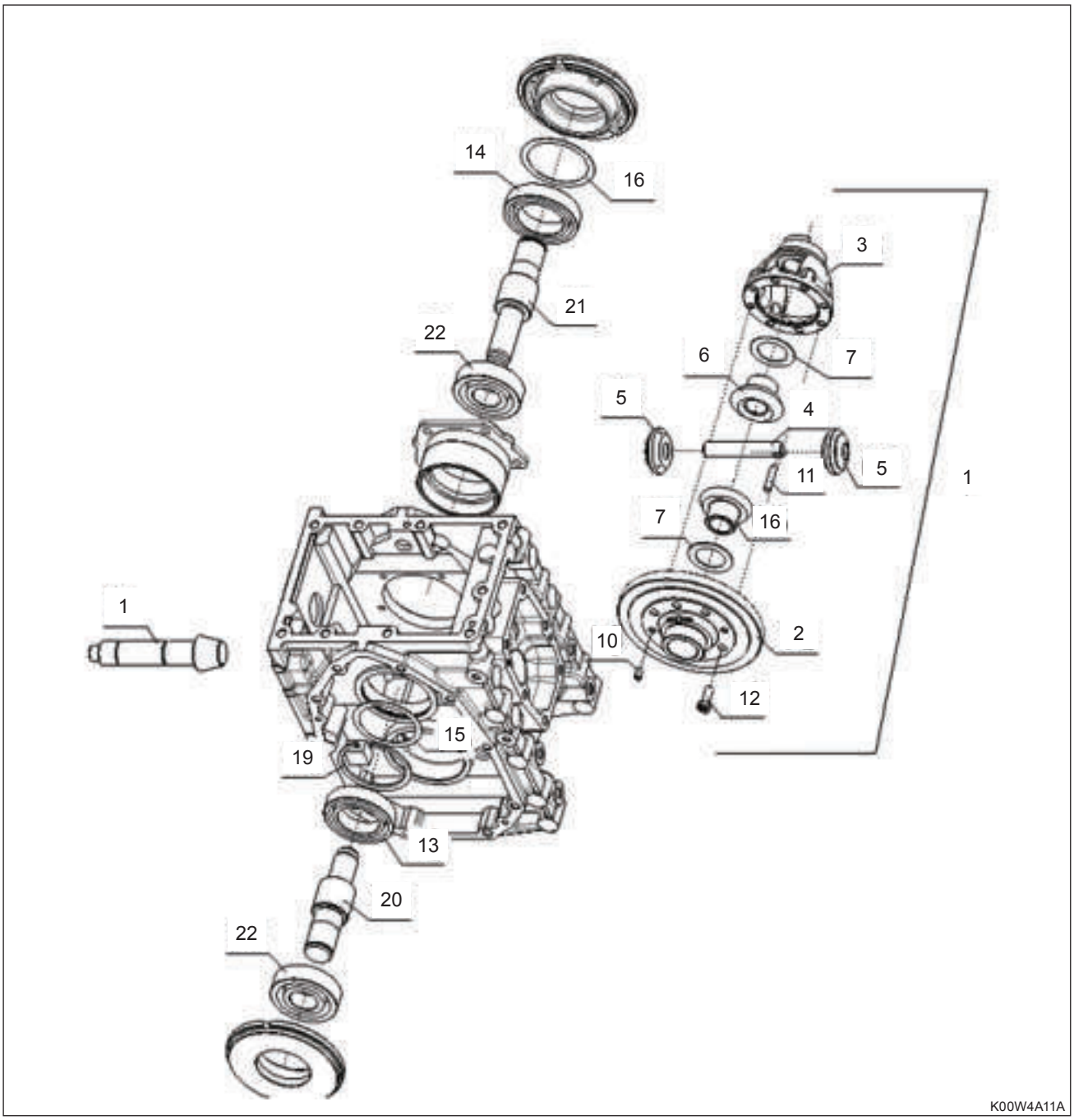
4.6 MID PTO



COMPONENTS

(1) Case, mid PTO
(2) Shaft, gear
(3) Bearing, ball
(4) Bearing, ball
(5) Seal, mid PTO
(6) Cir clip, internal
(7) Plug
(8) Packing
(9) Pin, straight
(11) Seal cap
(12) Bolt
(13) Shaft, idle
(14) Pin, spring
(15) Gear, M-PTO
(16) Bearing, ball
(17) Collar, thrust
(18) Cir clip, internal
(19) Packing
(20) Seal cap

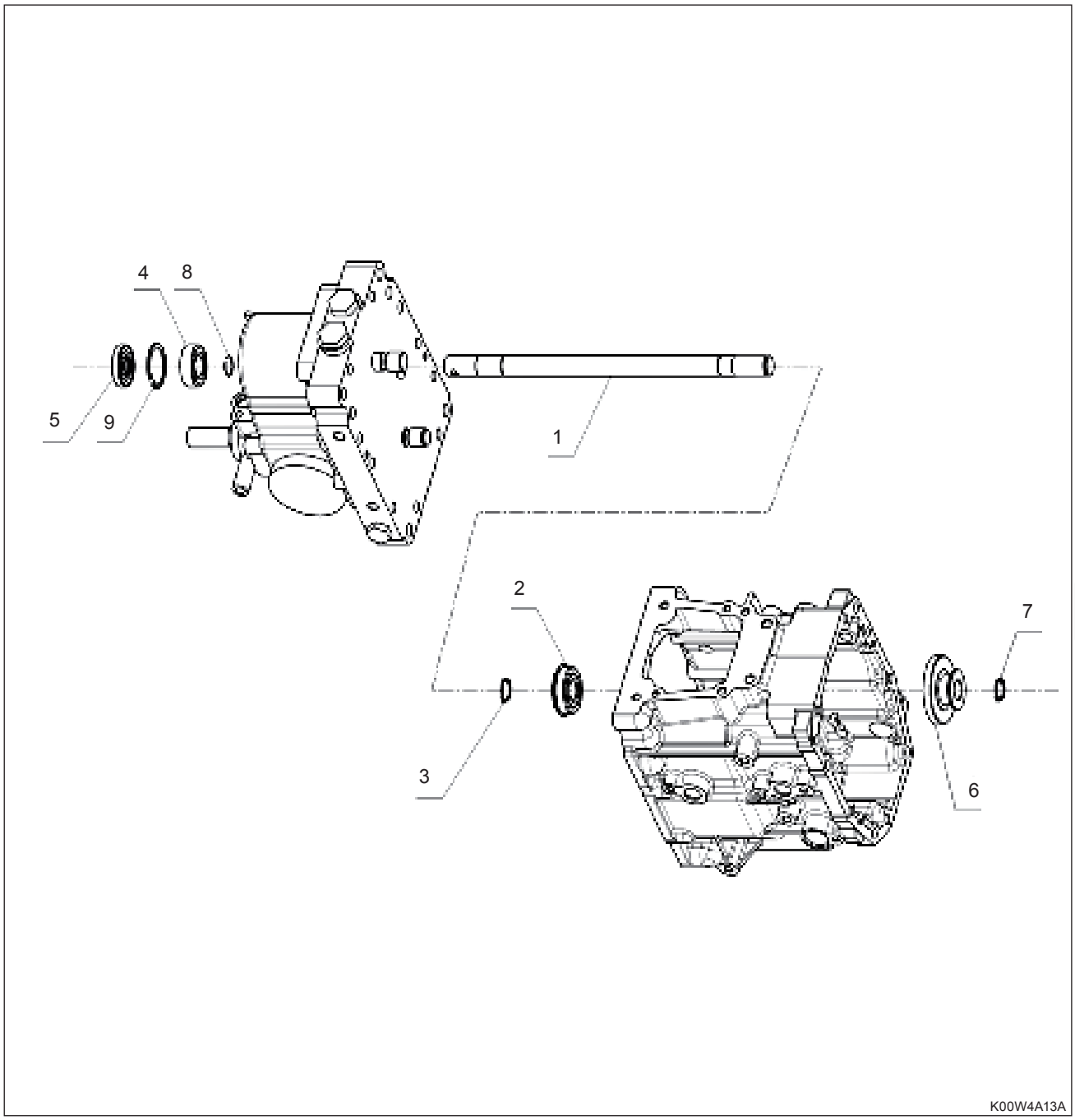
4.7 REAR DIFFERNTIAL



COMPONENTS

(1) Assy,bevel gear
(1-1) Drive pinion
(1-2) Ring gear
(1-3) Case, differential
(1-4) Shaft, diff. Pinion
(1-5) Pinion, diff.
(1-6) Gear, diff. Side
(1-7) Shim
(1-10) Pin, lock
(1-11) Pin, straight
(1-12) Bolt, ubs
(13) Bearing, ball
(14) Bearing, ball
(15-2) Shim, diff. Side
(15-3) Shim, diff. Side
(16-1) Shim, diff. Side
(16-2) Shim, diff. Side
(19) Cir clip, internal
(20) Shaft, diff. Gear LH
(21) Shaft, diff. Gear RH
(22) Bearing, ball

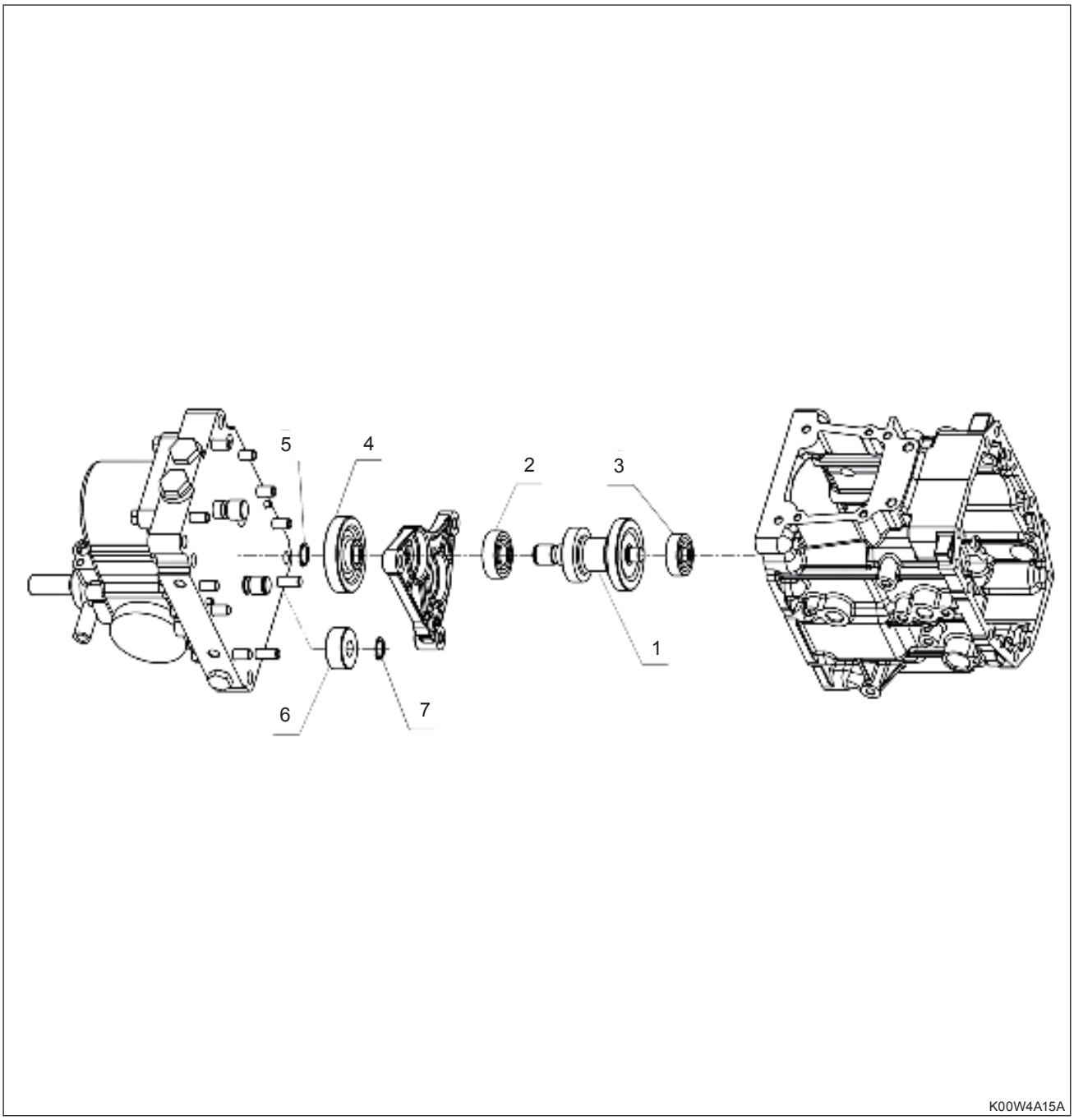
4.8 FRONT WHEEL PROPELLER SHAFT



COMPONENTS

(1) Shaft, 4WD
(2) Bearing, ball
(3) Cir clip, external
(4) Bearing
(5) Seal, oil
(6) Gear, 4WD
(7) Cir clip, external
(8) Cir clip, external
(9) Cir clip, internal

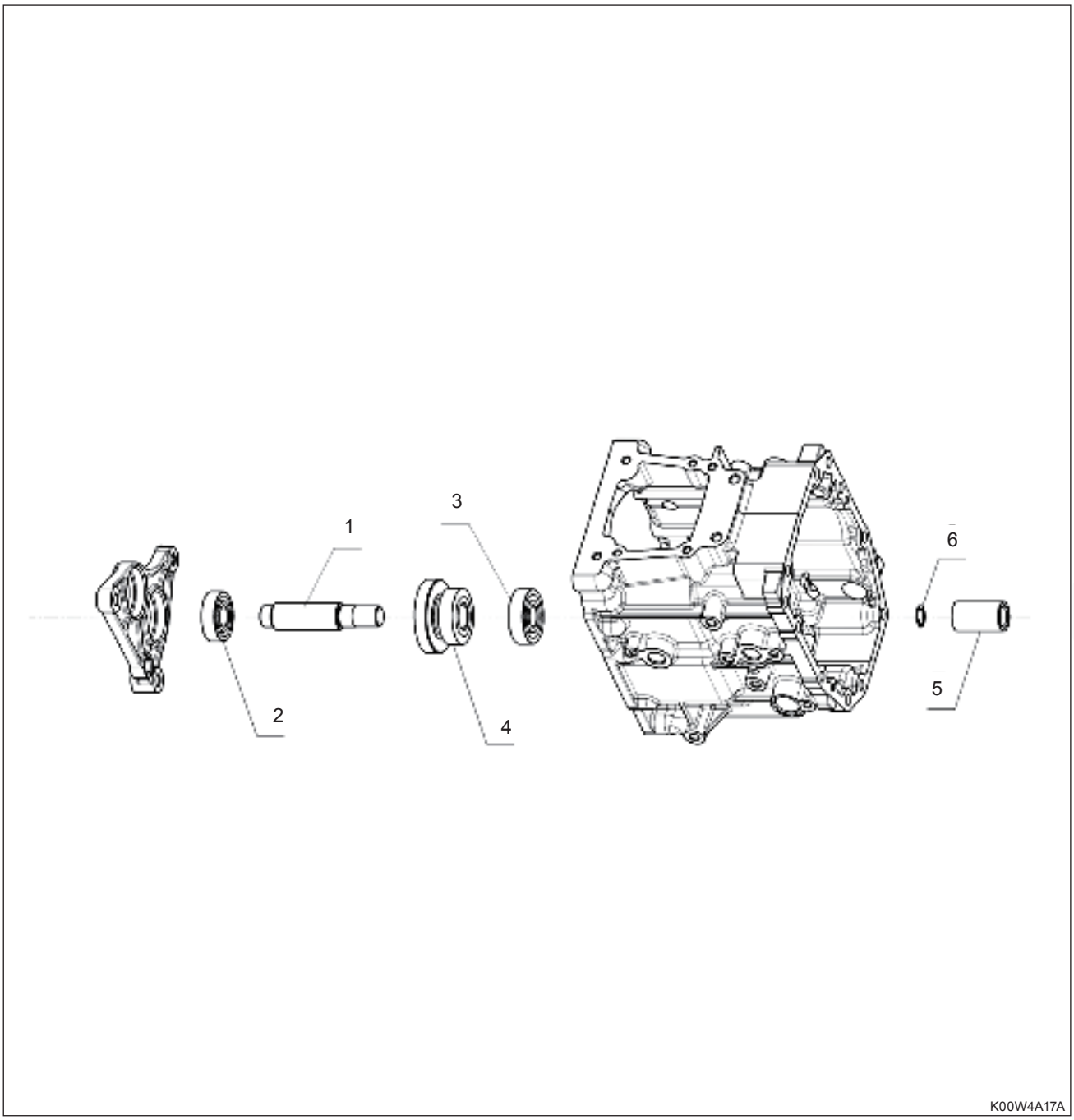
4.9 2ND SHAFT



COMPONENTS

(1) Gear-shaft
(2) Bearing, ball
(3) Bearing, ball
(4) Gear
(5) Cir clip, external
(6) Gear
(7) Cir clip, external

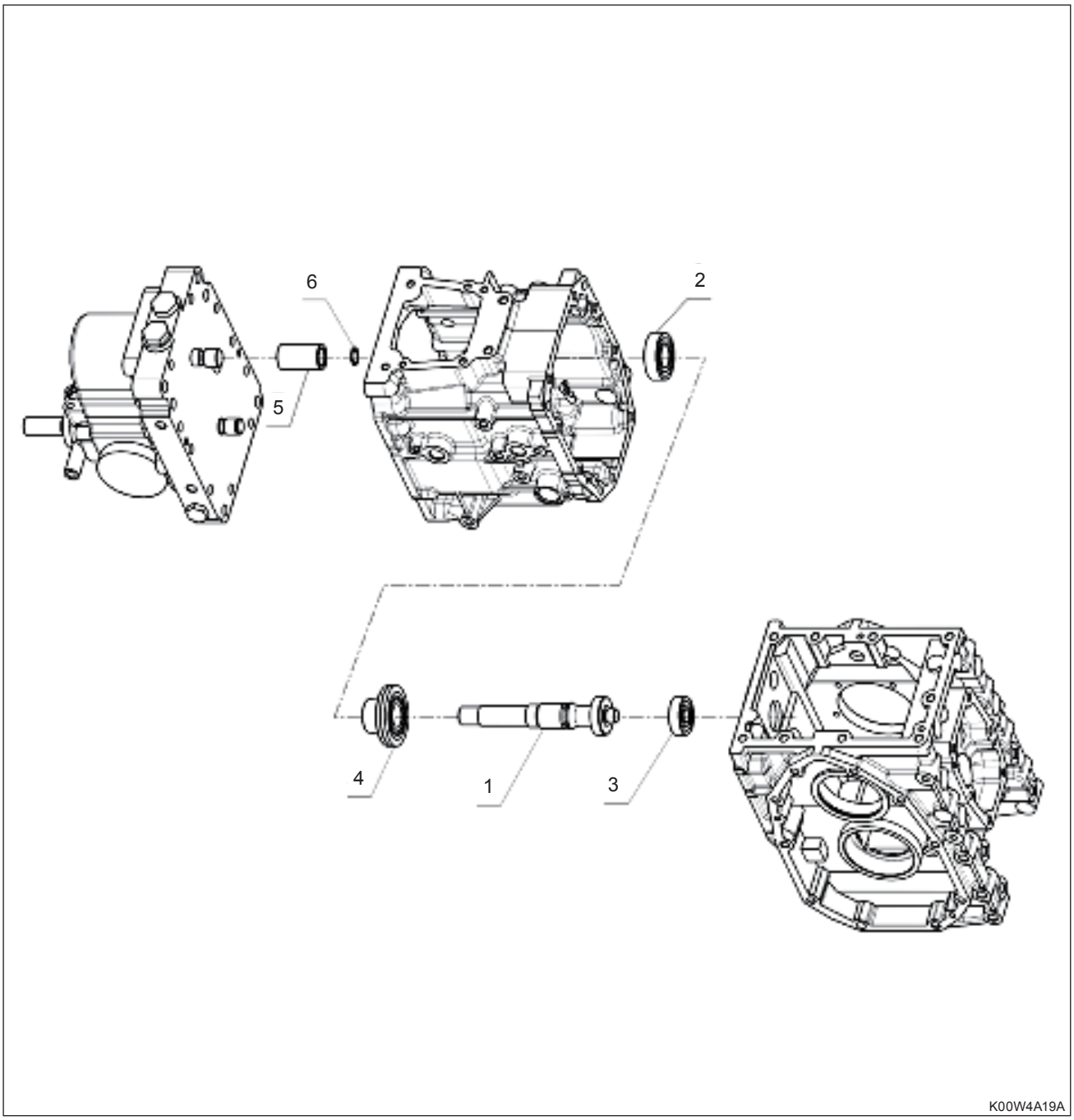
4.10 3RD SHAFT



COMPONENTS

(1) Shaft
(2) Bearing, ball
(3) Bearing, ball
(4) Gear
(5) Coupling
(6) Cir clip, internal

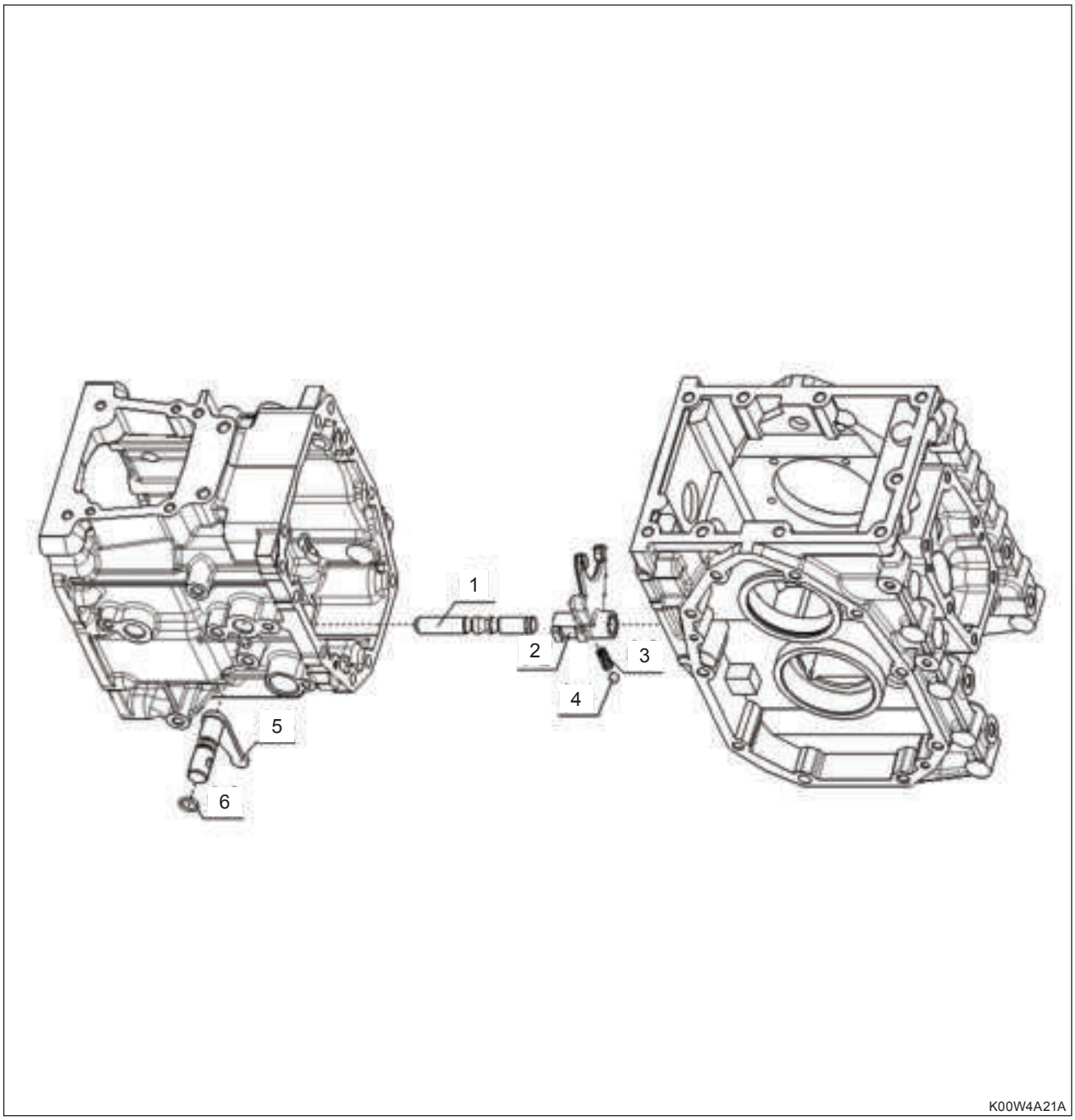
4.11 4TH SHAFT



COMPONENTS

(1) Gear-shaft
(2) Bearing, ball
(3) Bearing, ball
(4) Gear
(5) Coupling
(6) Cir clip, internal

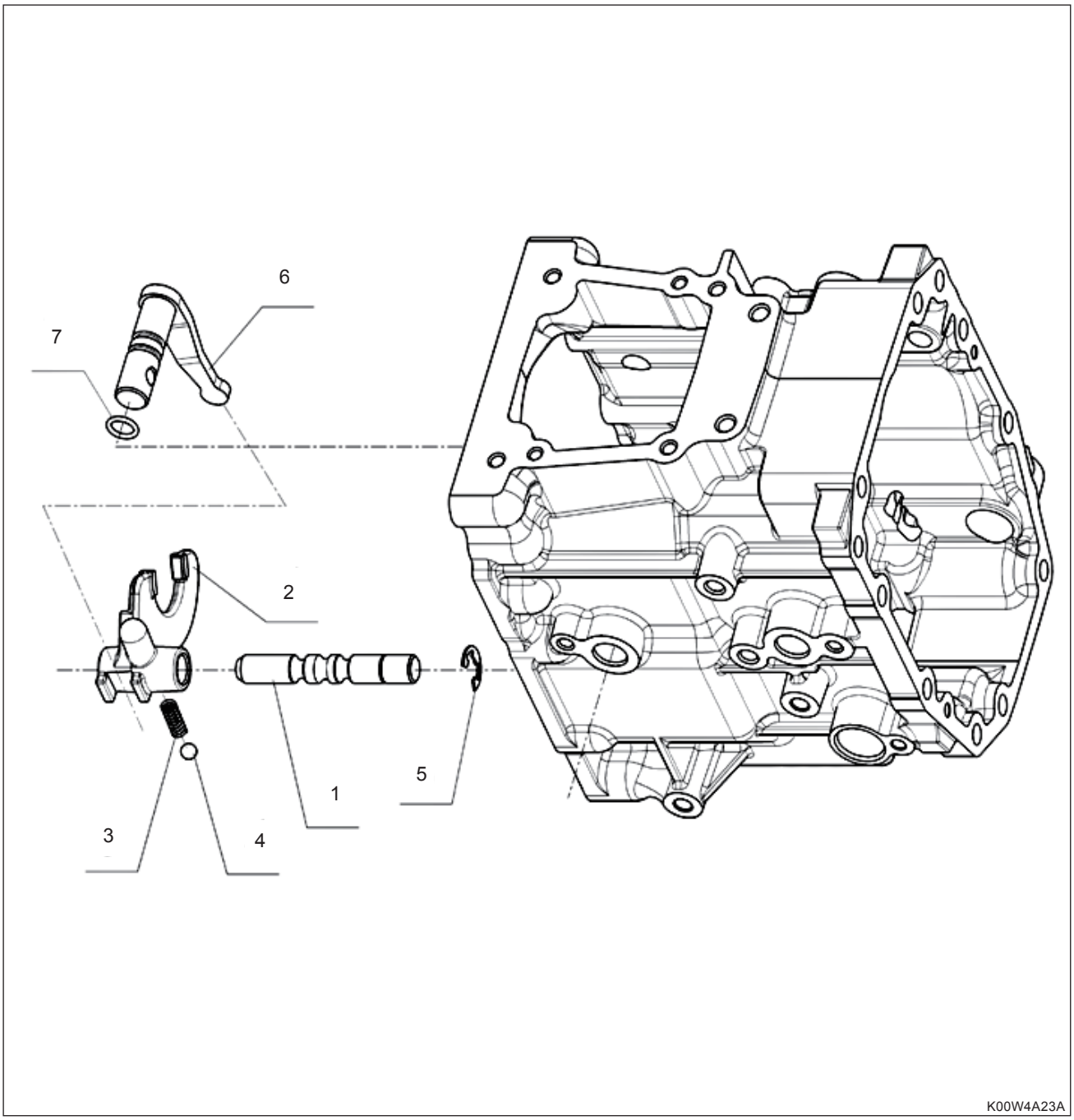
4.12 RANGE GEAR SHIFT FORK



COMPONENTS

(1) Rod, fork
(2) Fork, range shift
(3) Spring, stopper
(4) Ball
(5) Arm, range shift
(6) O-ring

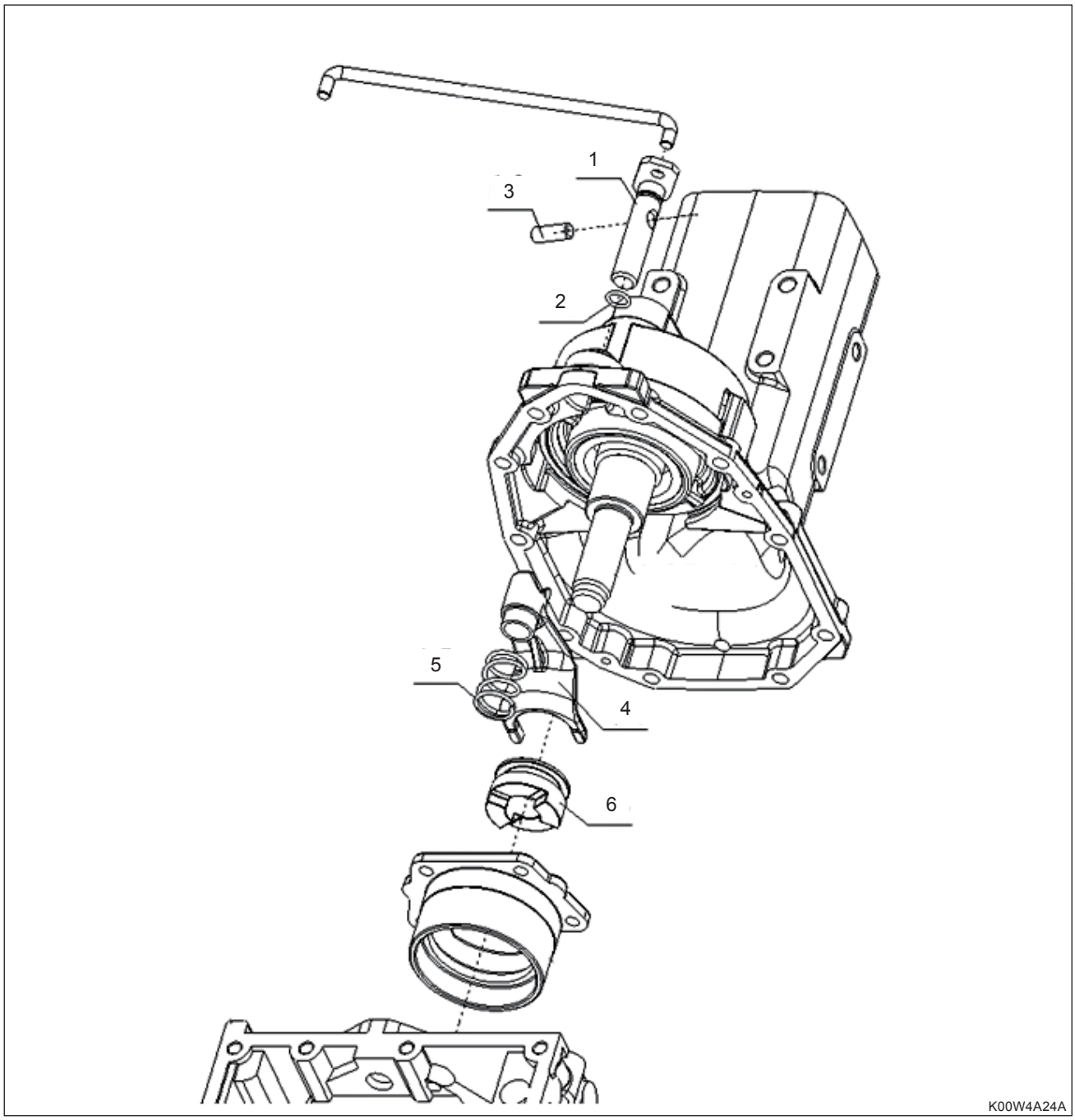
4.13 PTO GEAR SHIFT FORK



COMPONENTS

(1) Rod, fork
(2) Fork, PTO shift
(3) Spring, stopper
(4) Ball
(5) Snap,ring
(6) Arm, PTO shift
(7) O-ring

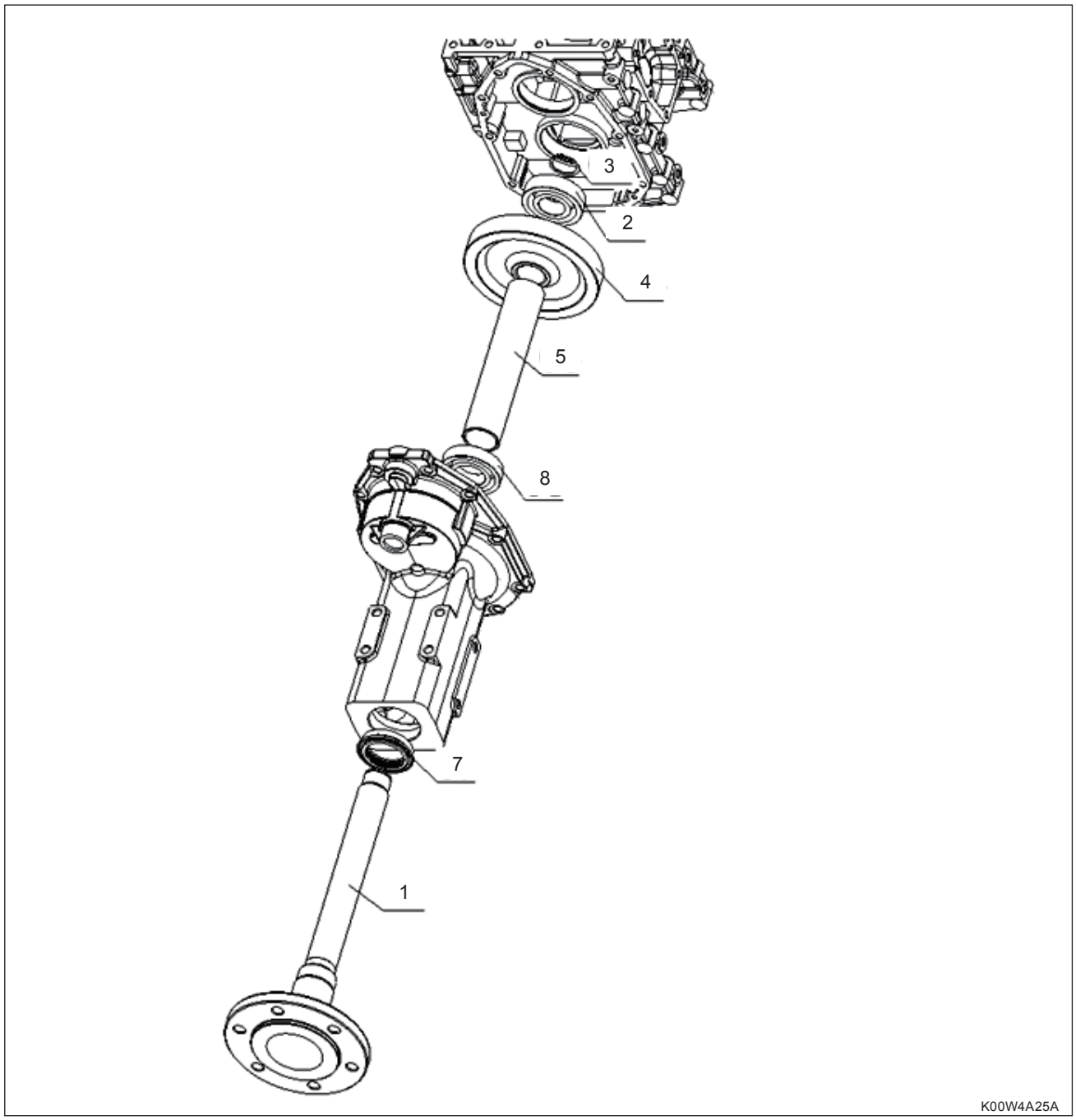
4.14 DIFFERENTIAL LOCK SHIFT FORK



COMPONENTS

(1) Rod, fork
(2) O-ring
(3) Pin, straight
(4) Fork, diff. Lock shift
(5) Spring
(6) Clutch, diff. Lock

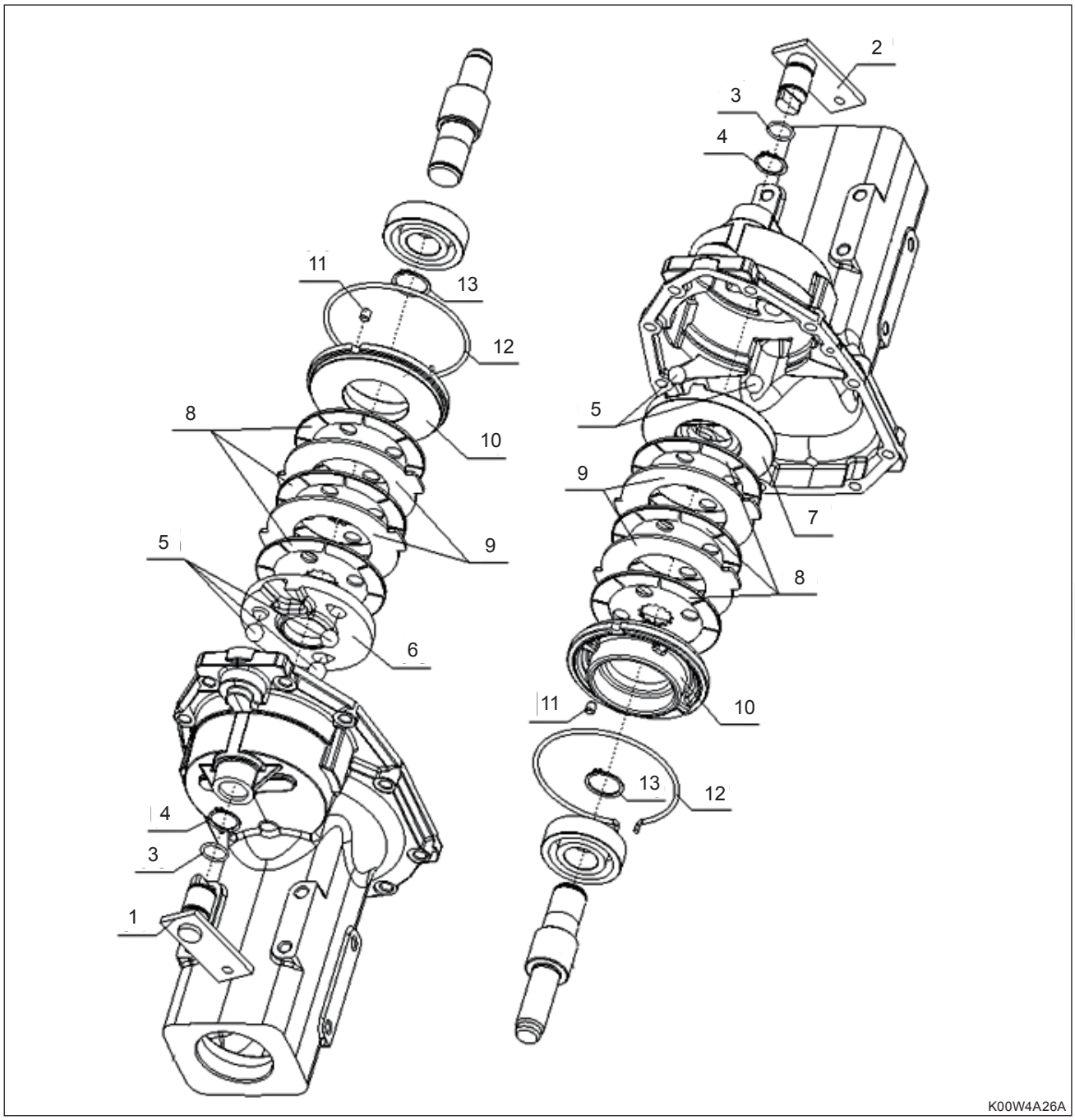
4.15 REAR AXLE



COMPONENTS

(1) Axle, rear
(2) Bearing, ball
(3) Cir clip, external
(4) Gear
(5) Collar
(7) Seal, oil
(8) Bearing, ball

4.16 BRAKE

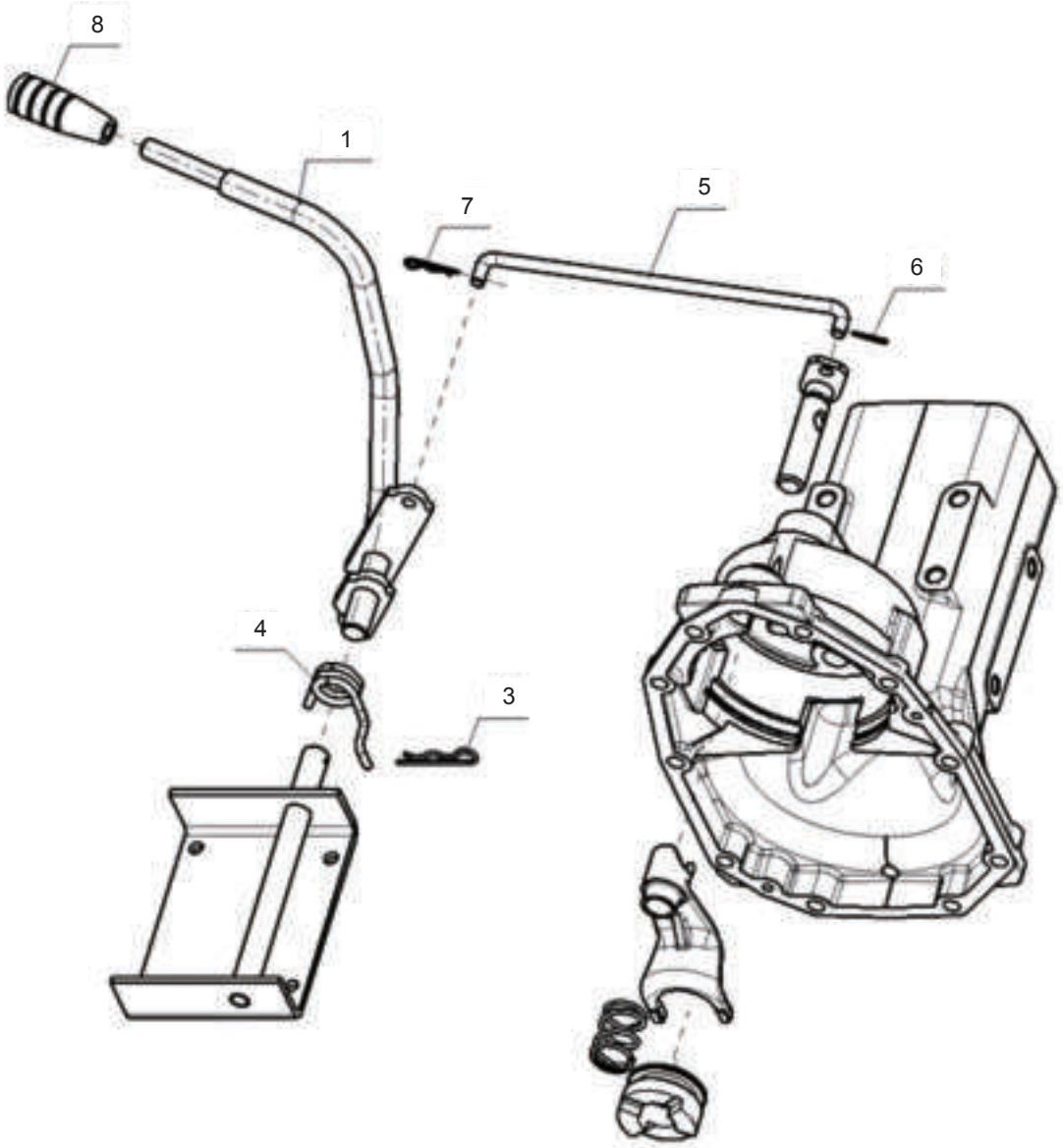


COMPONENTS

(1) Level, cam LH
(2) Level, cam RH
(3) O-ring
(4) Cir-clip
(5) Ball
(6) Actuator LH
(7) Actuator RH
(8) Disc, brake
(9) Plate friction
(10) Holder, bearing
(11) Pin
(12) Clip
(13) Cir-clip

4.17 DIFFERENTIAL LOCK PEDAL

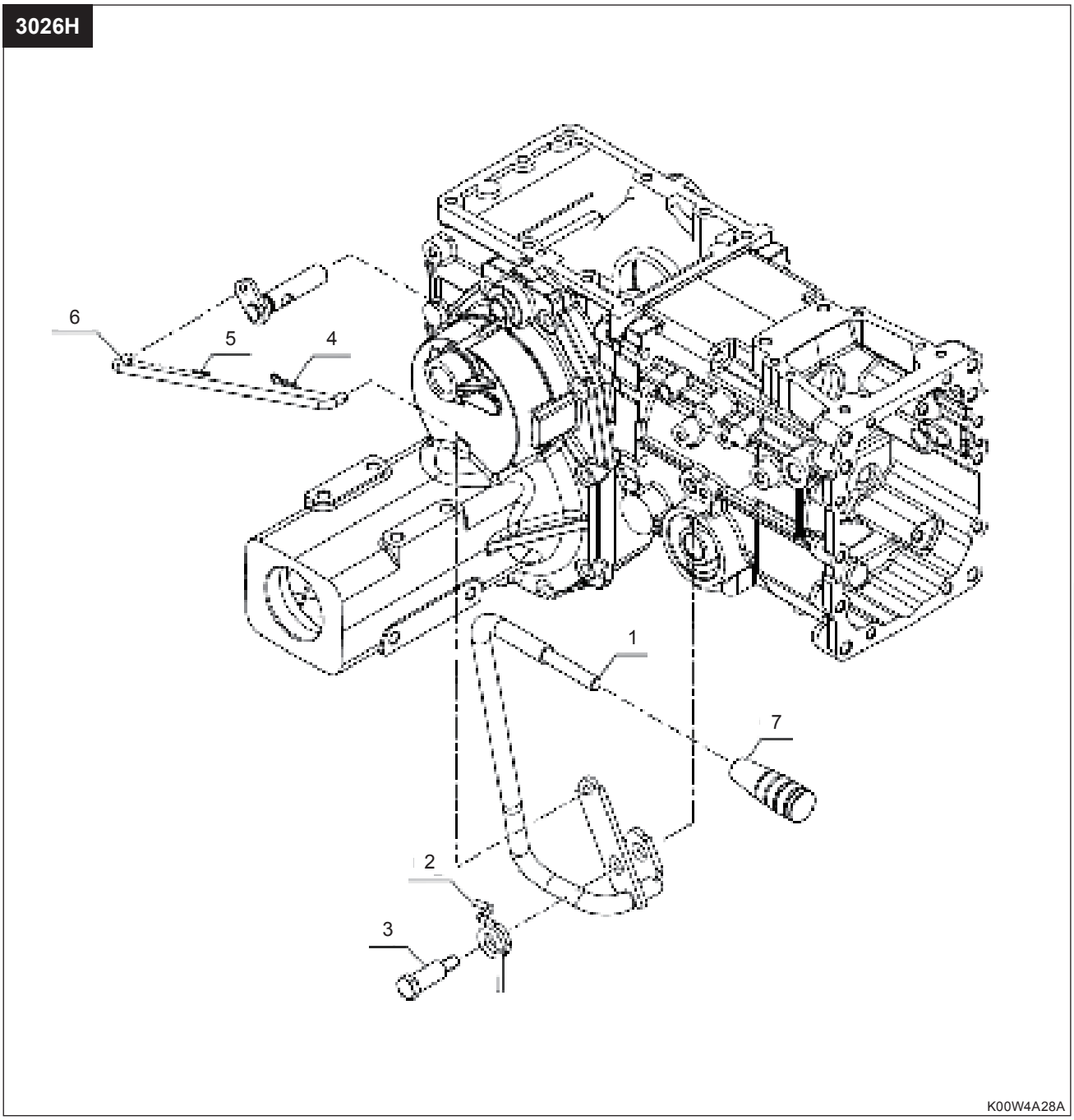
2024H



COMPONENTS

(1) Lever, diff. Lock
(3) Pin, snap
(4) Spring
(5) Rod, diff. Lock
(6) Cotter pin
(7) Pin, snap
(8) Grip

3026H



COMPONENTS

(1) Lever, diff. Lock
(2) Spring
(3) Bolt
(4) Pin, snap
(5) Cotter pin
(6) Rod, diff. Lock
(7) Grip

5. DISASSEMBLY AND SERVICE

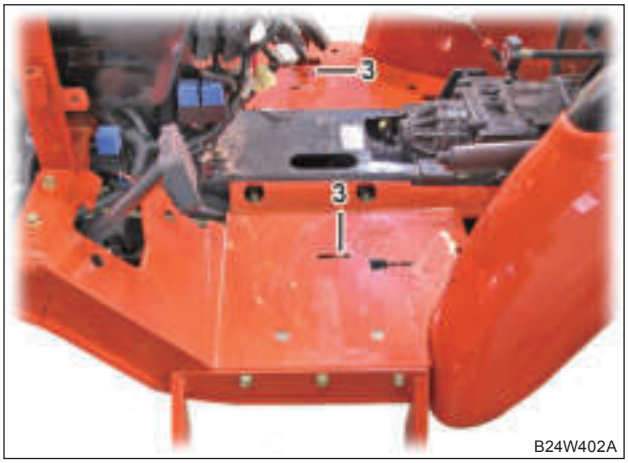
5.1 CLUTCH HOUSING REMOVAL

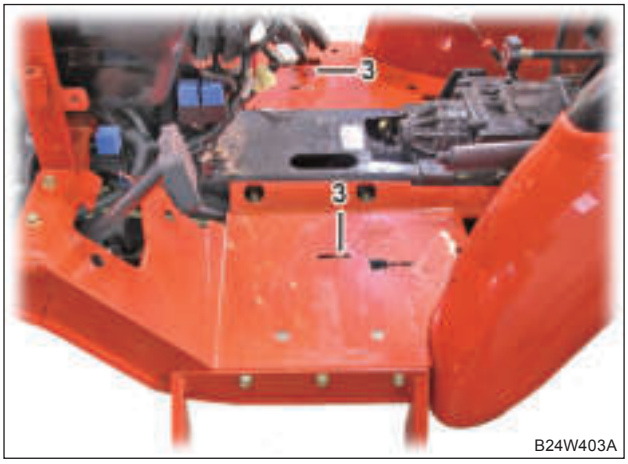
1. Remove the engine assembly. (See the engine removal instructions in chapter 2.)

2. Remove the accelerator lever (1) and steering wheel assembly (2).

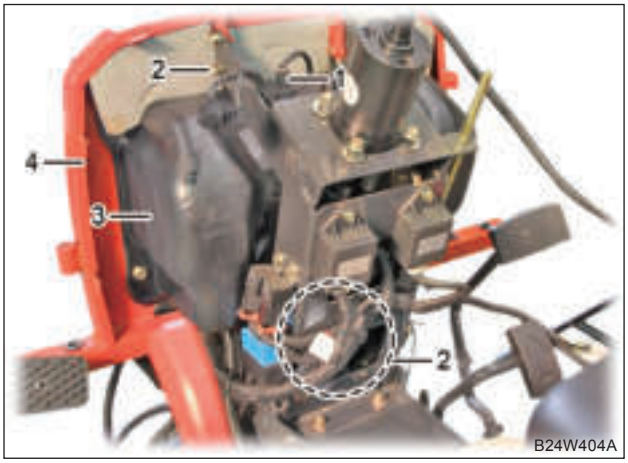
3. Remove the upper dashboard (1) and lower dashboard (2).

4. Remove the seat cover (under) (1) and step mat (2).

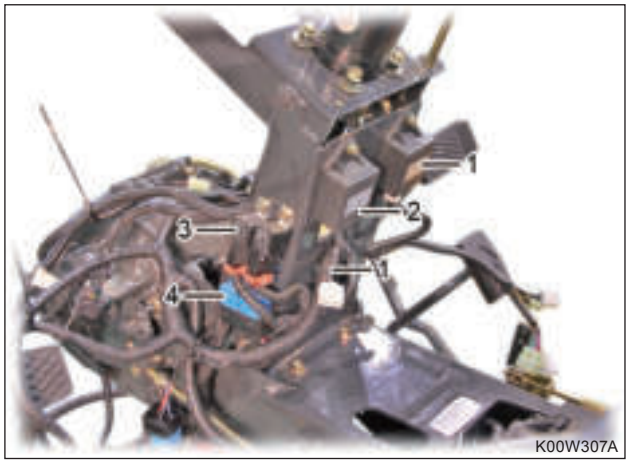




5. Remove the HST pedal (reverse) (2) and brake pedal return spring (3) and disconnect the brake lamp connector (4) from the step (RH) (1). Then, remove the step (RH) (1) and step (LH) (5).

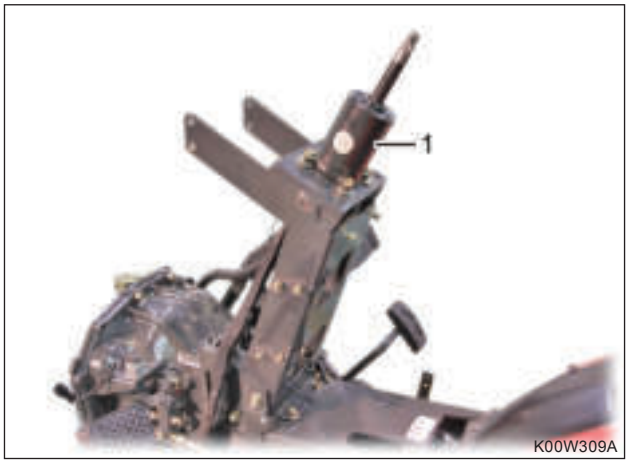


6. Disconnect the fuel sensor connector (1) and unscrew the center pillar mounting bolts (6 EA) (2) to remove the fuel tank (3) and center pillar (4).



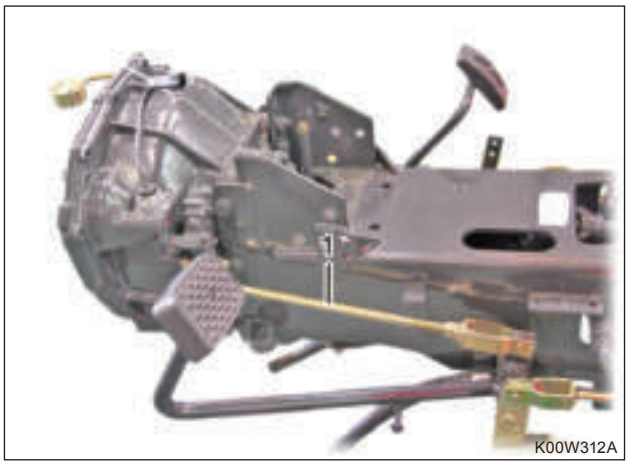
7. Remove the control units (1), flasher unit (2), glow relay (3) and 5P relay (4) from the steering support. Then, remove the wiring harness assembly.

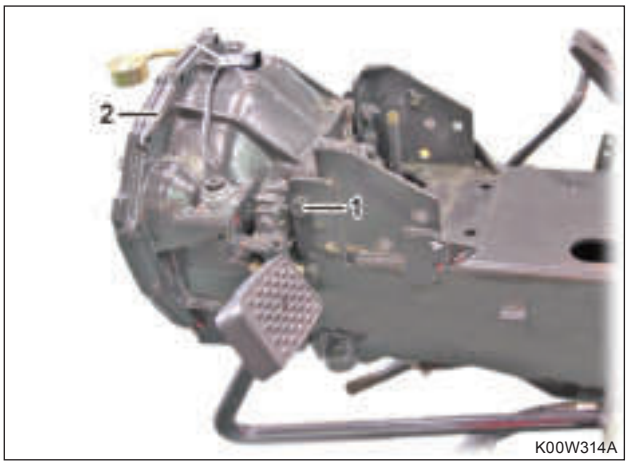
8. Remove the clutch housing air breather (1) and accelerator rod (2).

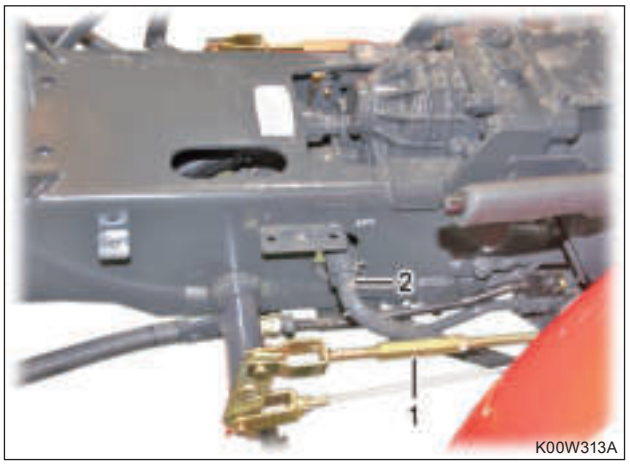


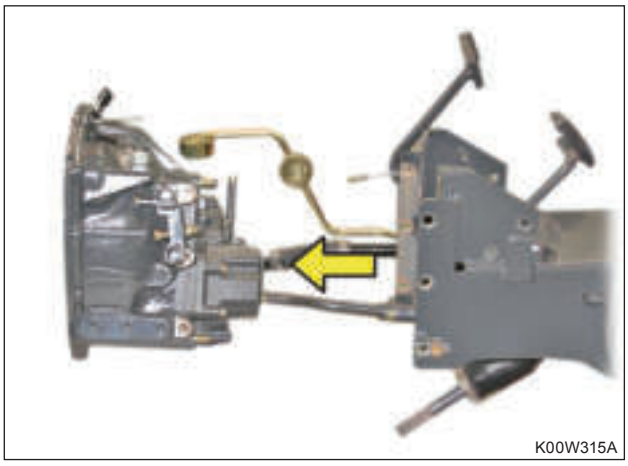
9. Remove the steering unit assembly (1).

10. Remove the steering support assembly (1).





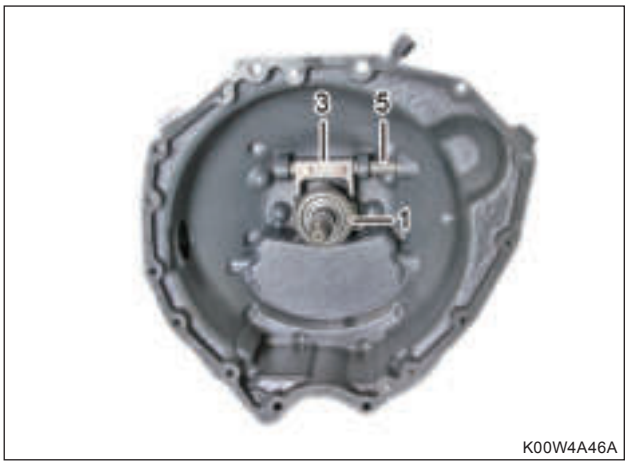


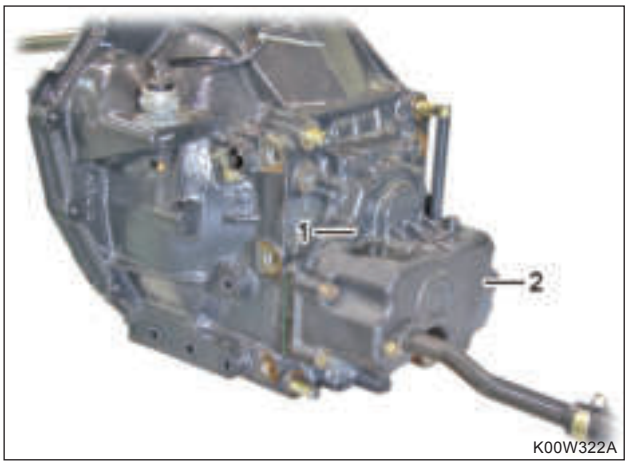


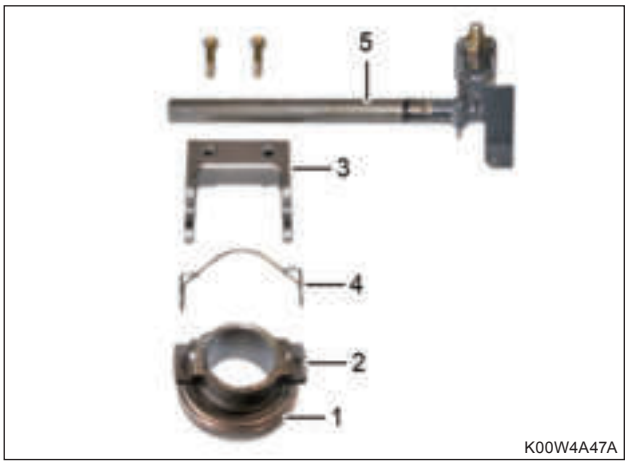
11. Remove the clutch rods (1) and disconnect the clutch hydraulic hose (2: Clutch - Transmission).

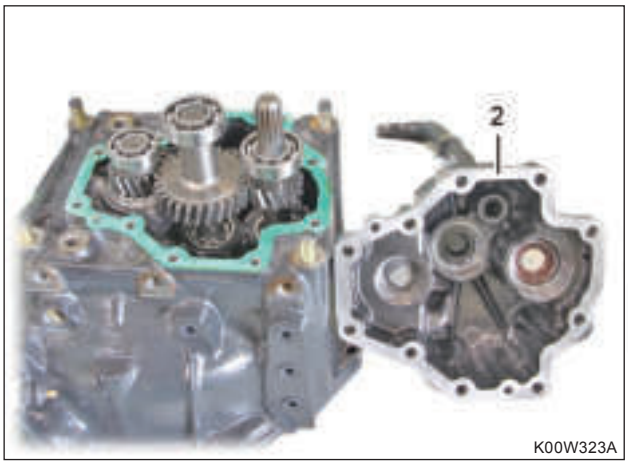
12. Unscrew the clutch housing mounting bolts and nuts (1) (Bolt: 8 EA, Nut: 4 EA) to remove the clutch housing assembly (2) from the ball coupling and center frame assembly.

5.2 CLUTCH HOUSING DISASSEMBLY



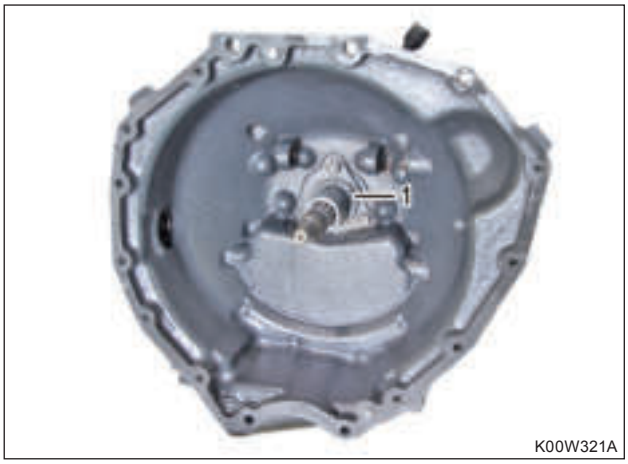




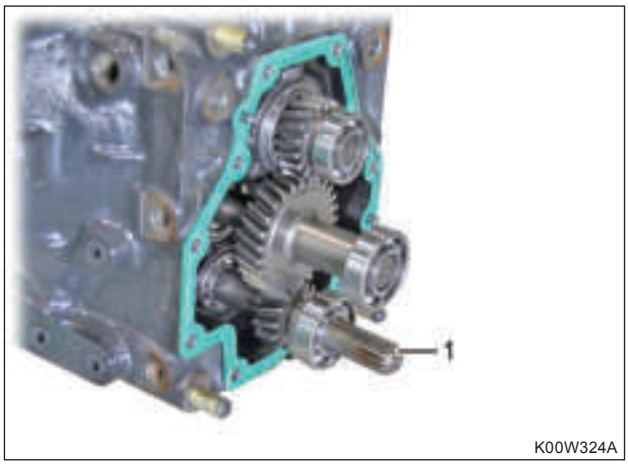


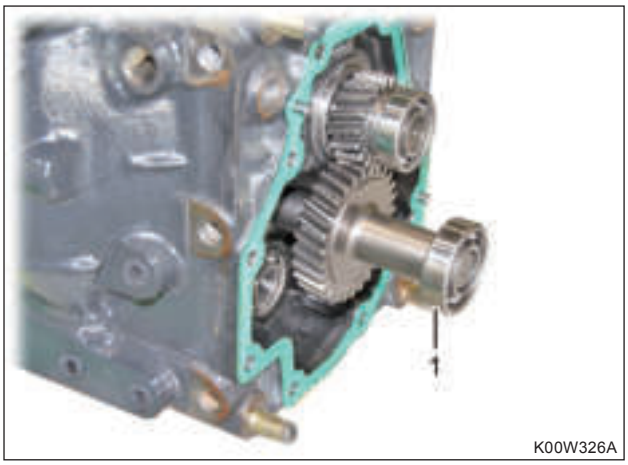
1. Remove the release bearing (1), bearing holder (2), clutch, release fork (3), release spring (4) and clutch rod shaft assembly (5) from the clutch housing.

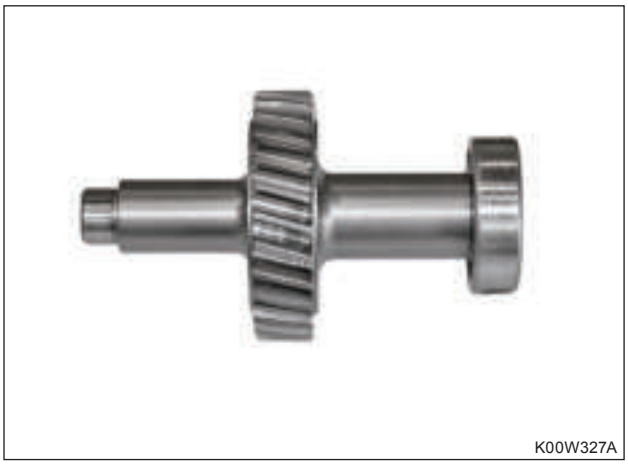
3. Unscrew the clutch housing cover mounting bolts (1) to remove the clutch housing cover (2).



2. Remove the bearing case (1).

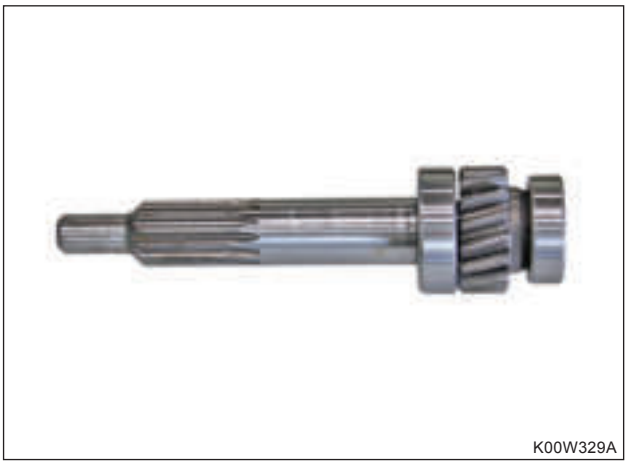






4. Remove the front shaft (1) (14T).

5. Remove the front shaft (1) (27T).

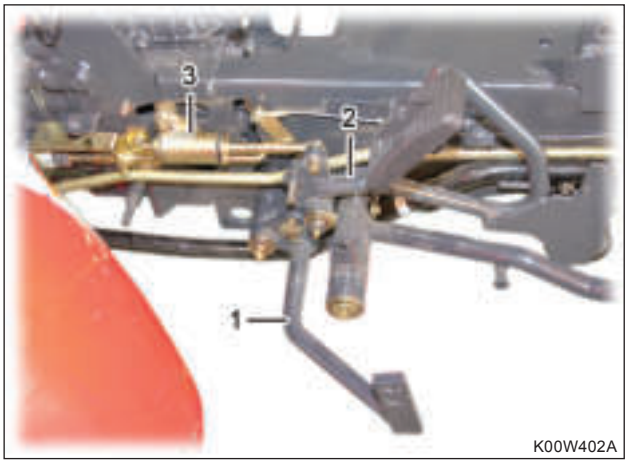


6. Remove the clutch shaft (1) (27T).

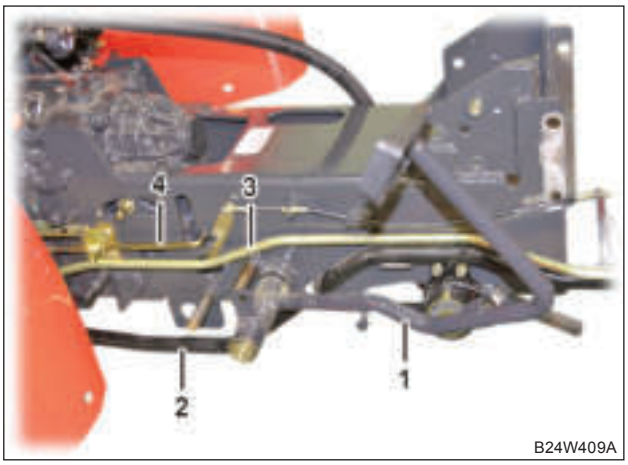
5.3 CENTER FRAME REMOVAL

1. Remove the clutch housing.

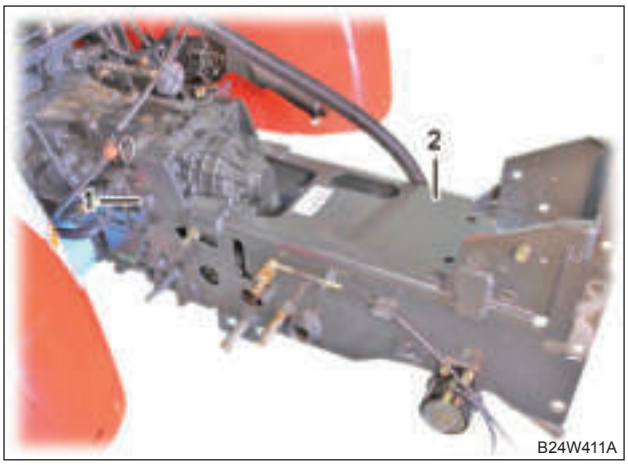
2. Remove the brake rod (RH) (1) and HST damper (2) from the right side of the center frame.



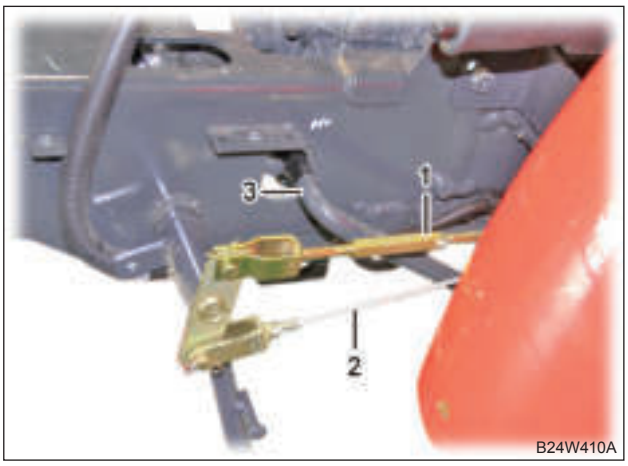
3. Remove the HST reverse pedal (1), HST forward pedal (2) and HST rod B (3).



4. Remove the brake pedal (1) and disconnect the suction hydraulic pipe (2), delivery hydraulic pipe (3) and HST neutral rod (4).



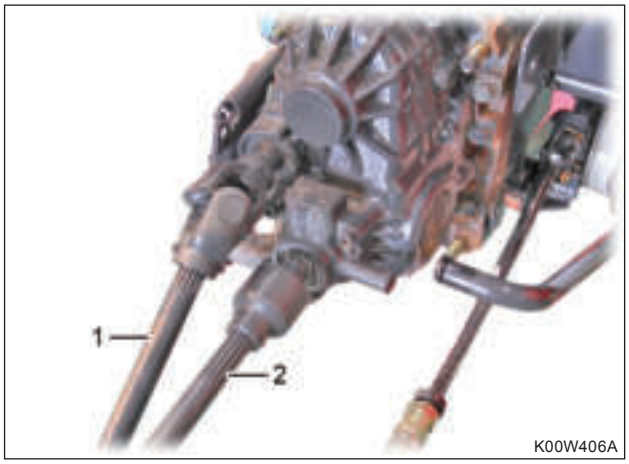
6. Place a support under the transmission case and unscrew the center frame mounting bolts (1) (8 EA) to remove the center frame (2).



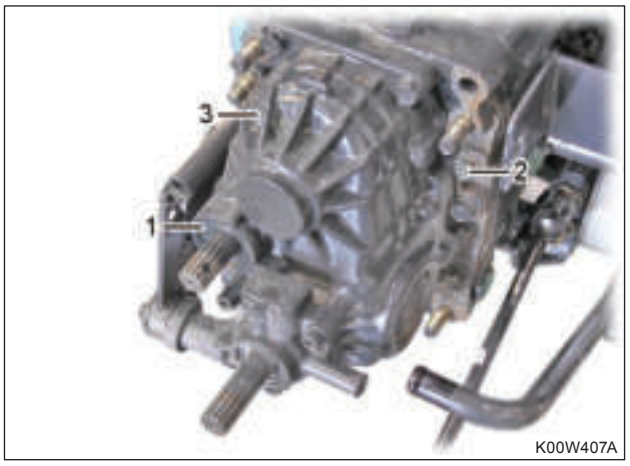
5. Disconnect the brake rod (1), parking brake wiring (2) and hydraulic pipe (3) from the left side of the center frame.

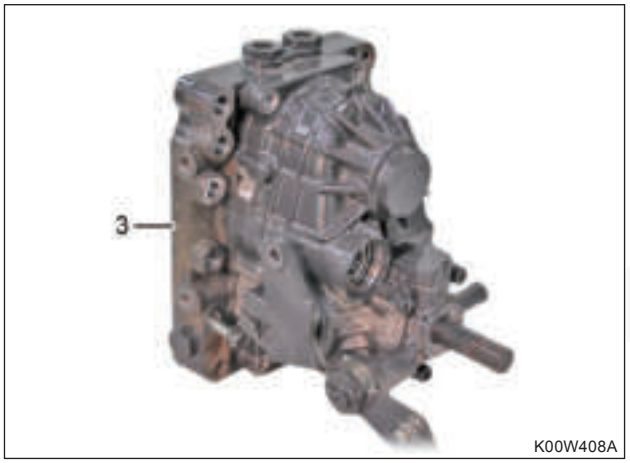
5.4 HST REMOVAL

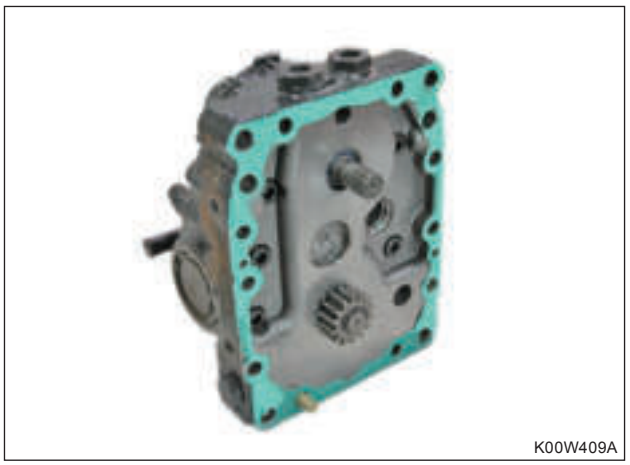
1. Remove the center frame.



2. Remove the front wheel drive shaft assembly (1) and propeller shaft (2) from the HST assembly.





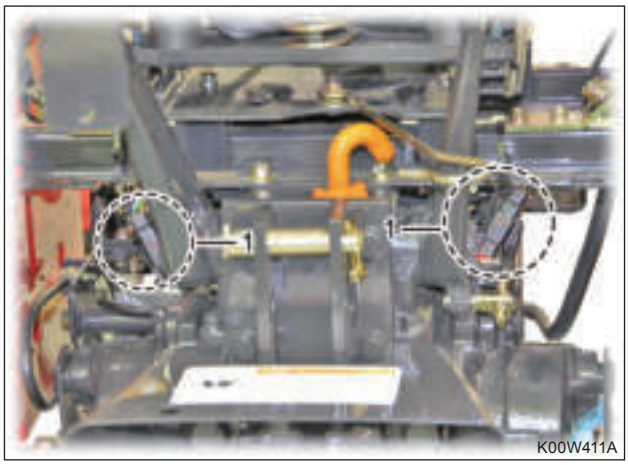


3. Remove the 4WD shaft oil seal (1) from the HST sub assembly. Then, unscrew the HST sub assembly mounting bolts (2) (11 EA) to remove the HST sub assembly (3) from the transmission case.

5.5 TRANSMISSION CASE REMOVAL

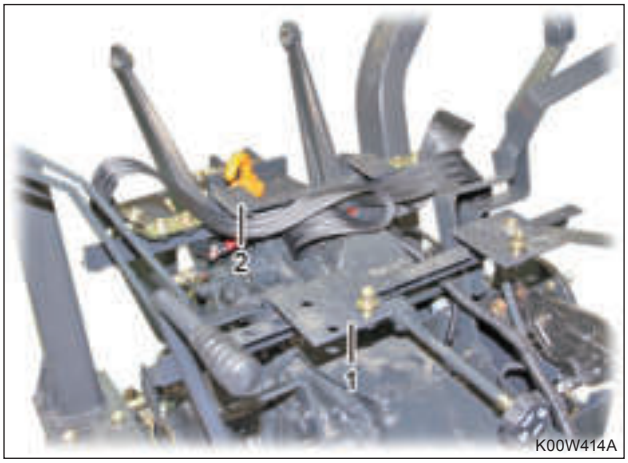
1. Remove the center frame and HST assembly.

2. Remove the hydraulic control lever grip (1) and 4WD lever grip (2) from the right fender. Remove the PTO shift lever grip (3) and range shift lever grip (4) from the left fender.

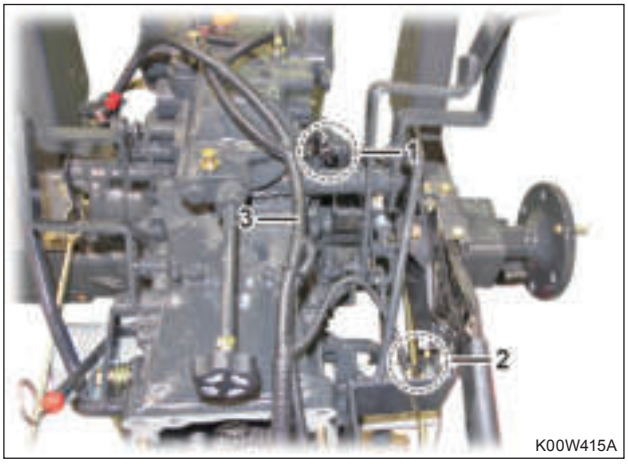


3. Disconnect the tail lamp wiring connector (1) from under the seat and remove the fender (LH) (2), (RH) (3).

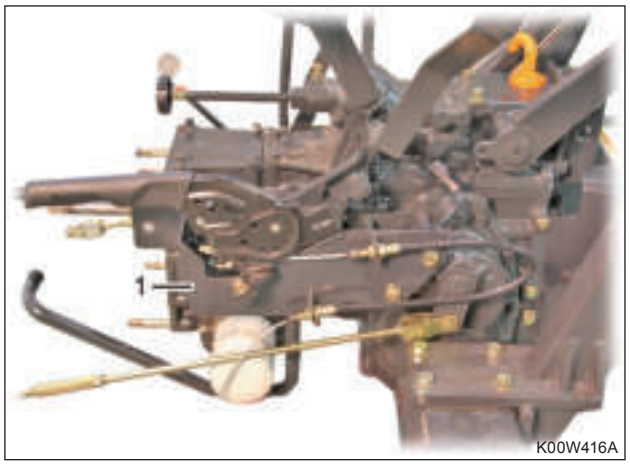
4. Disconnect the safety switch connector (1) under the seat and remove the seat assembly (2).



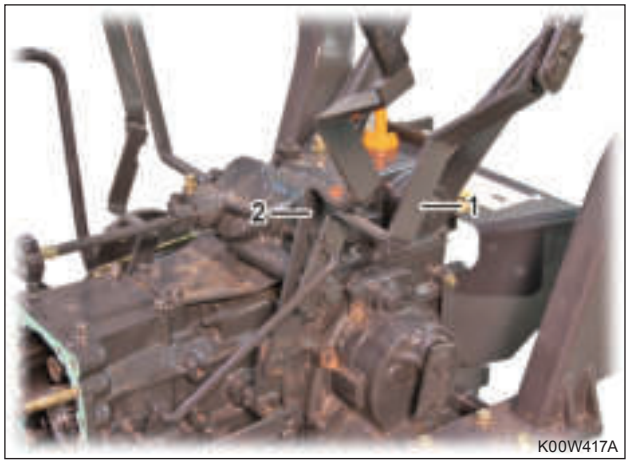
5. Remove the fender stays (front) (1) and (rear) (2).



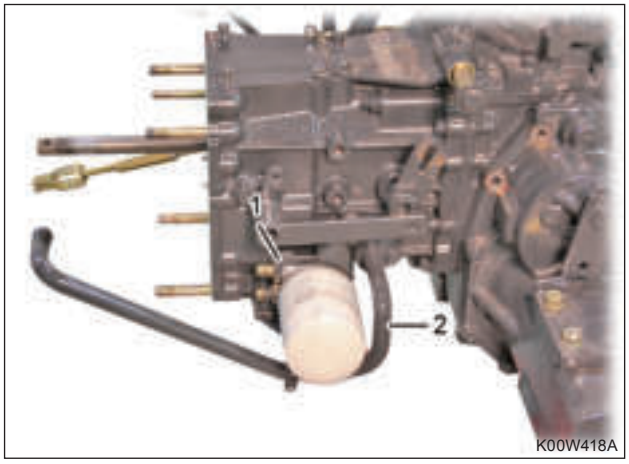
6. Disconnect the PTO safety switch connector (1) and parking brake switch connector (2) to remove the wiring harness assembly (3).



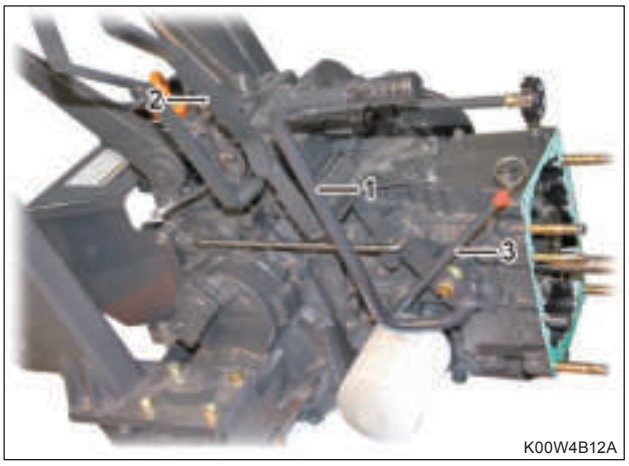
7. Remove the parking brake bracket assembly (1).



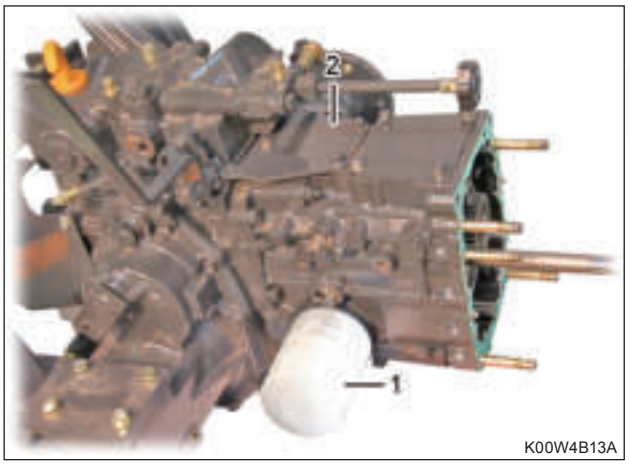
8. Remove the PTO shift lever (1) and range shift lever (2).



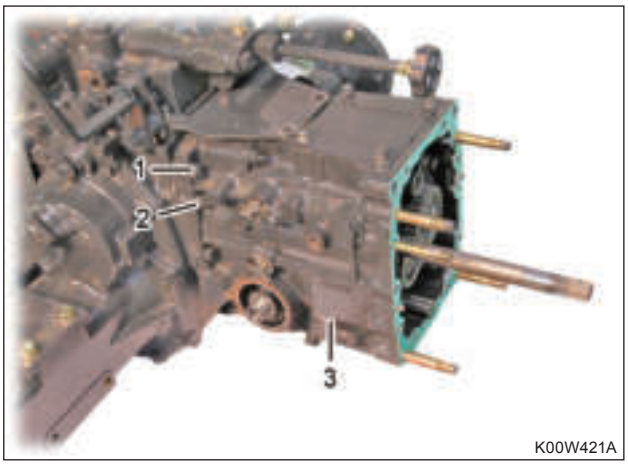
9. Remove the filter cover (1) and disconnect the oil pipe (2).

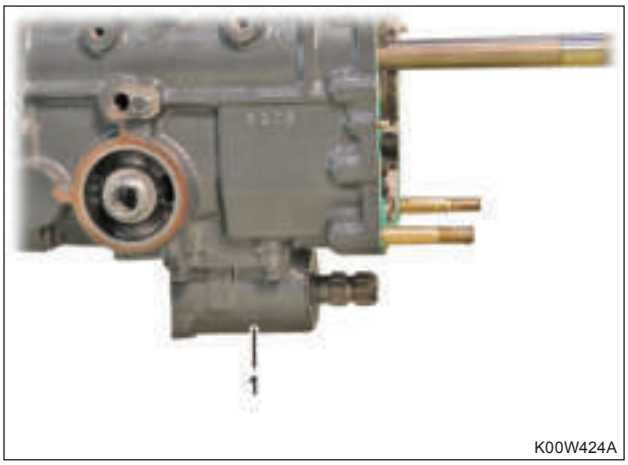


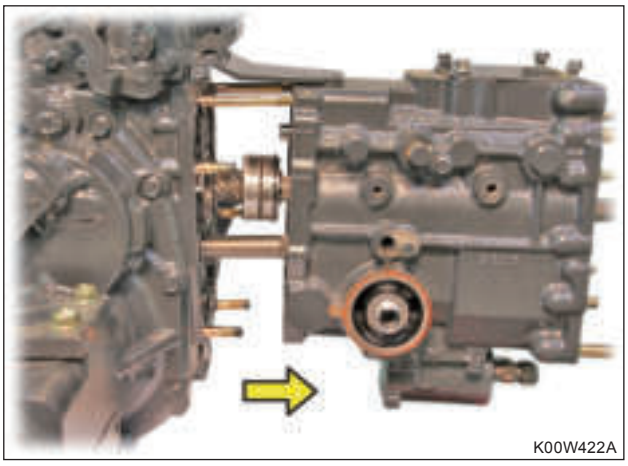
10. Remove the differential lock lever (1) and front wheel drive lever (2) and disconnect the transmission oil gauge pipe (3) from the right side of the transmission case.

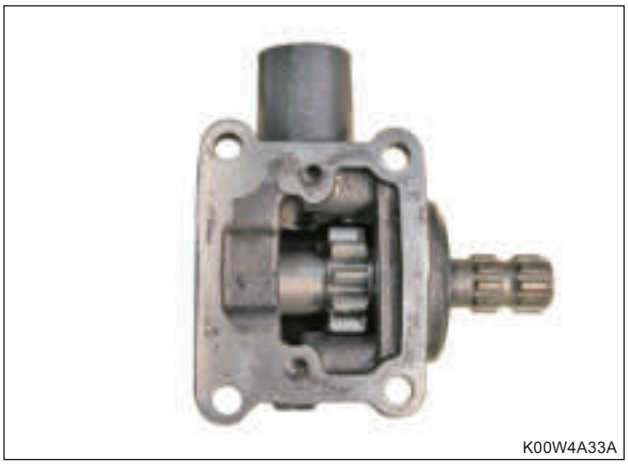


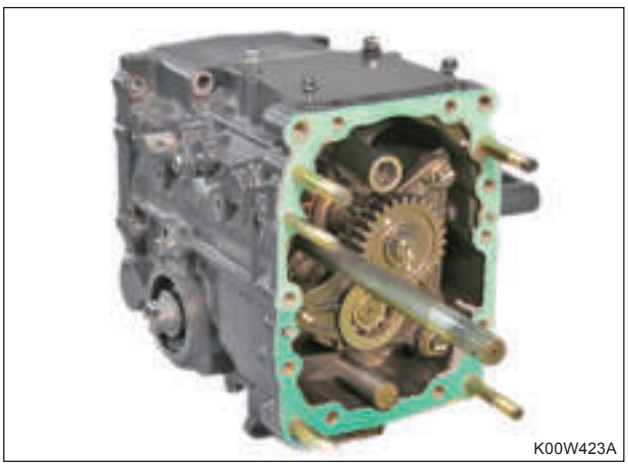
11. Remove the hydraulic oil filter (1) and transmission case upper bracket (2).







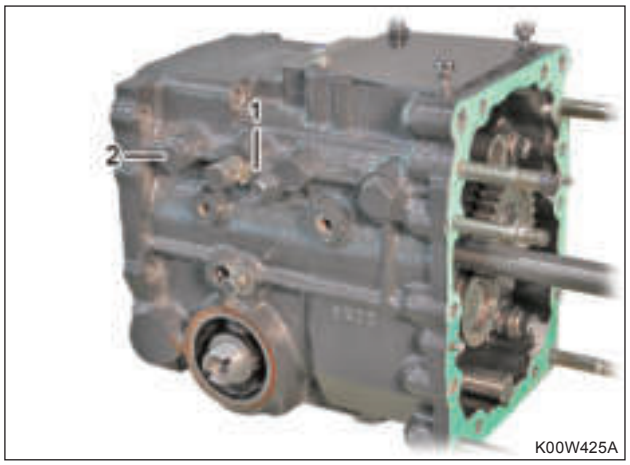


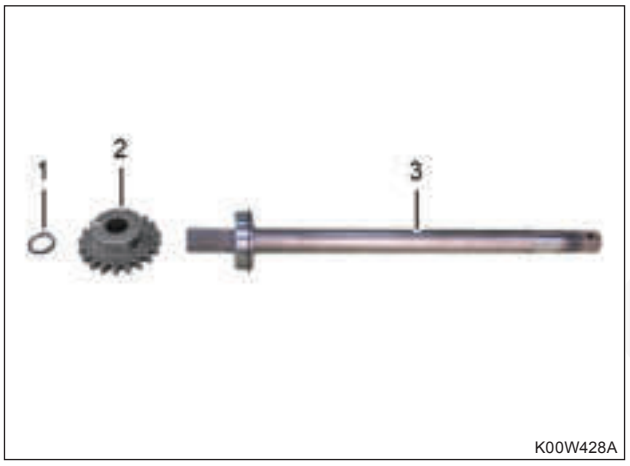


12. Unscrew the transmission case mounting bolts (1) (7 EA) and nuts (2) (7 EA) to remove the transmission case (3).

13. Remove the MID PTO case assembly (1) from the bottom of the transmission case.

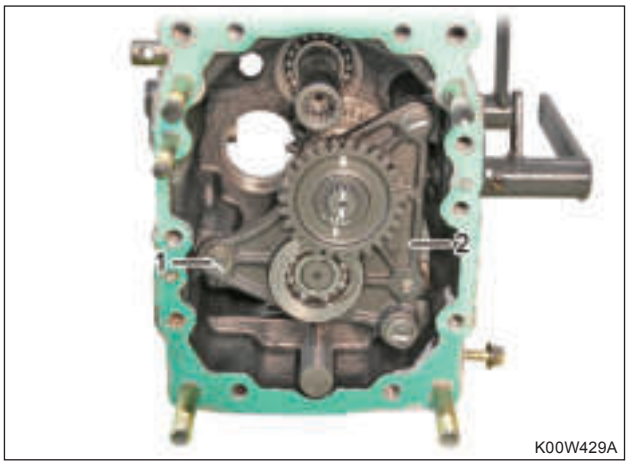
5.6 TRANSMISSION CASE DISASSEMBLY

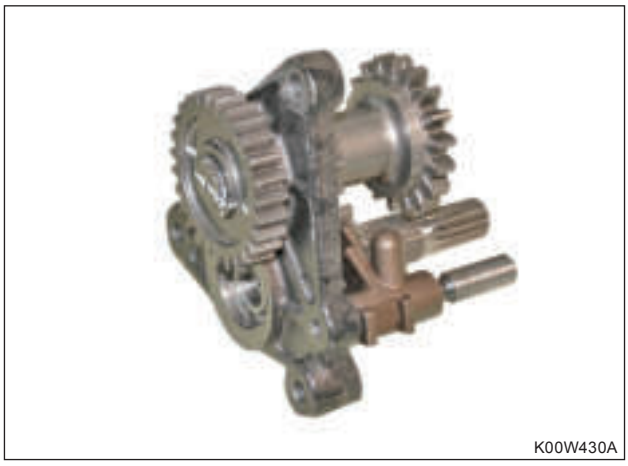


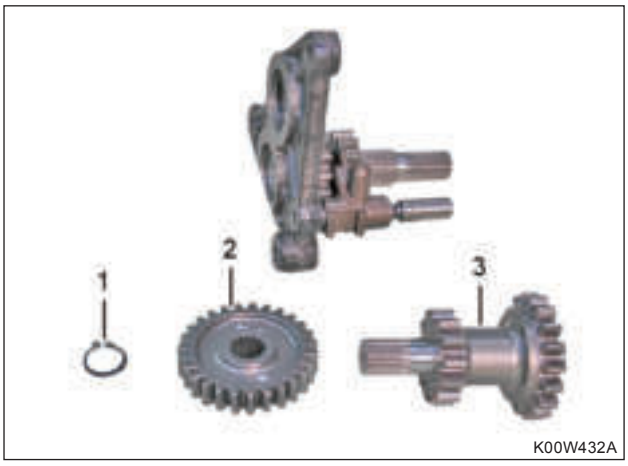


1. Unscrew the 4WD shift arm plate (1) and 4WD plug (2) to remove the range shift fork spring (3) and steel ball (4).

2. Pull out the snap ring (1) from the 4WD shaft of the 4WD shift arm to remove the 4WD gear (2) and 4WD shaft (3).

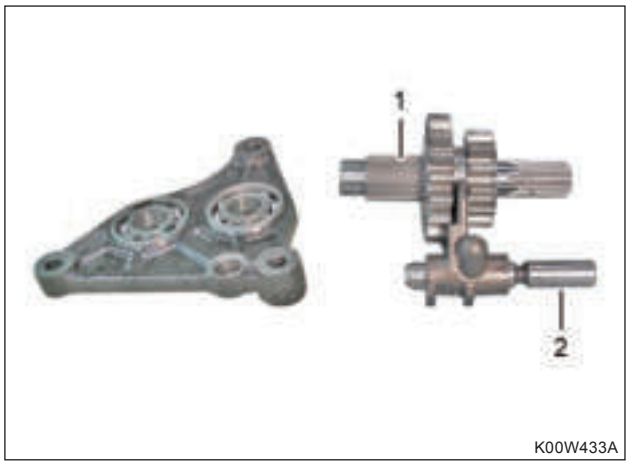




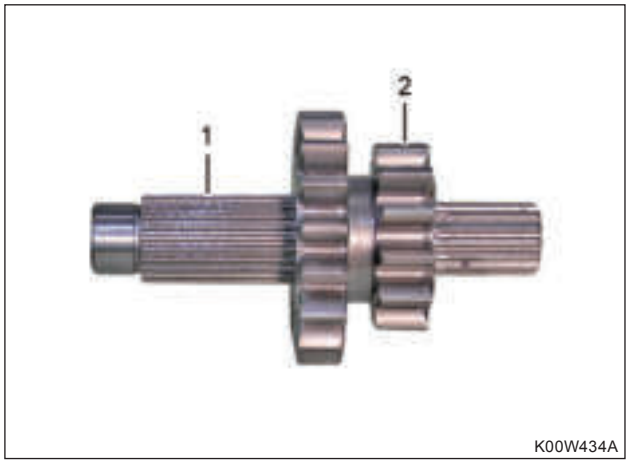


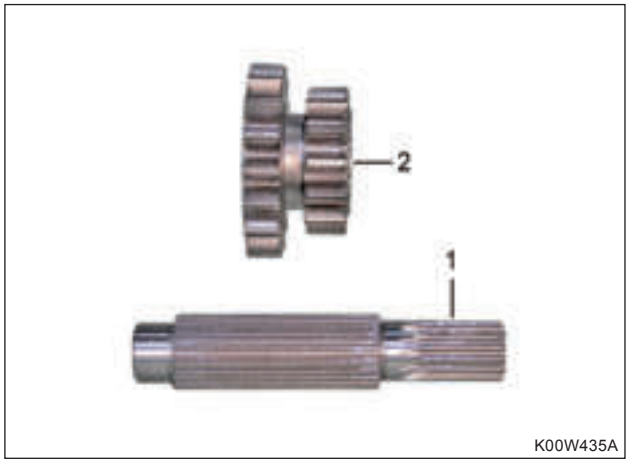
3. Unscrew the bearing holder mounting bolts (1) (3 EA) from the front section of the transmission case to remove the bearing holder assembly (2).

4. Pull out the snap ring (1) from the bearing holder assembly gear shaft to remove the 27 gear (2) and gear shaft (3) (13T-18T).

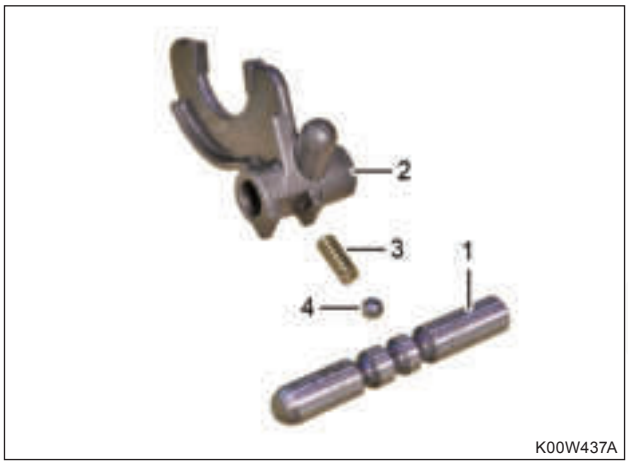


5. Remove the HST shaft (1) and PTO shift fork assembly (2) from the bearing holder assembly.

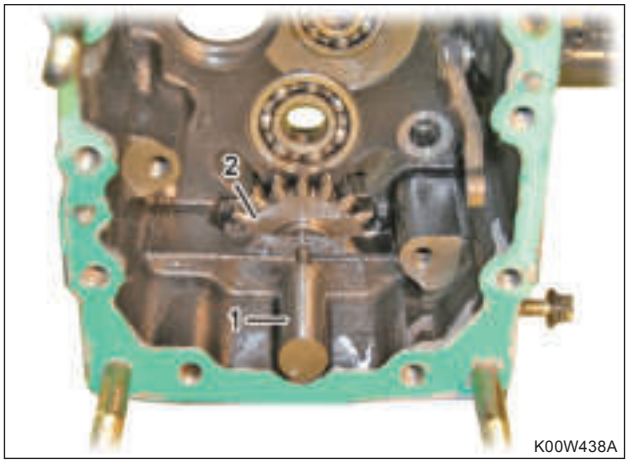


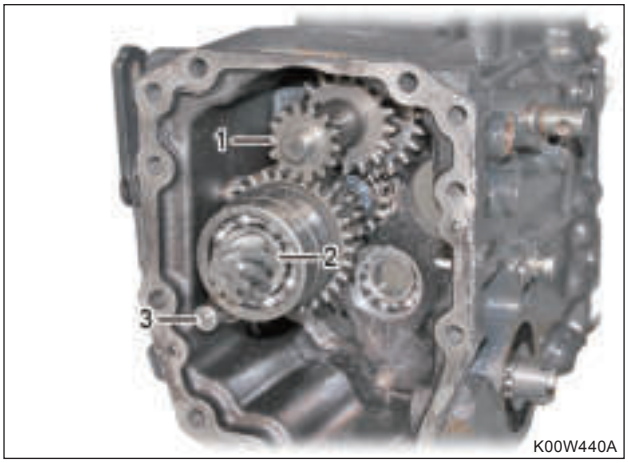


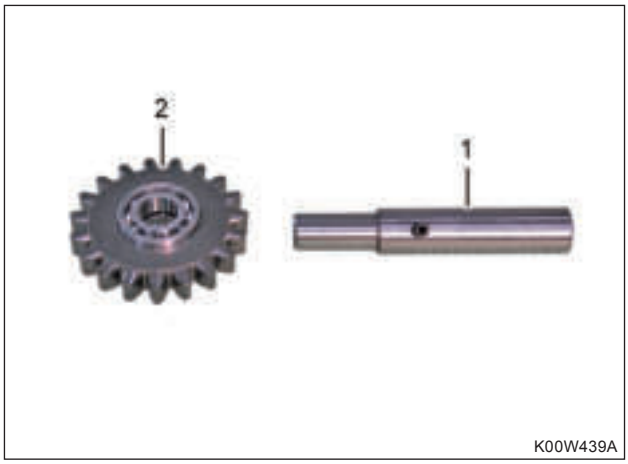
6. Remove the gear (2) (17T-13T) from the HST shaft (1).

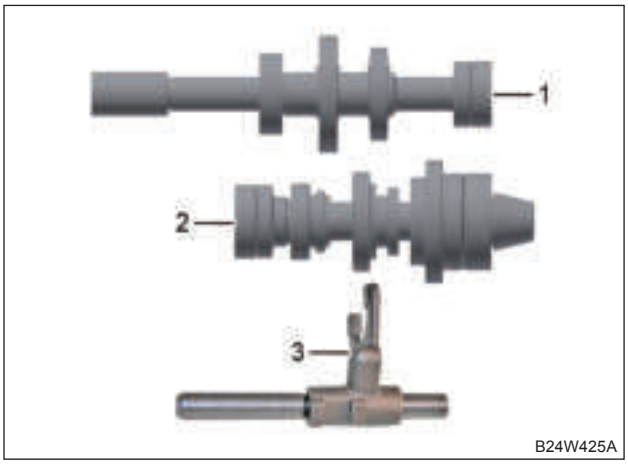


7. Remove the PTO shift fork (2), range shift fork spring (3) and steel ball (4) from the fork rod (1).



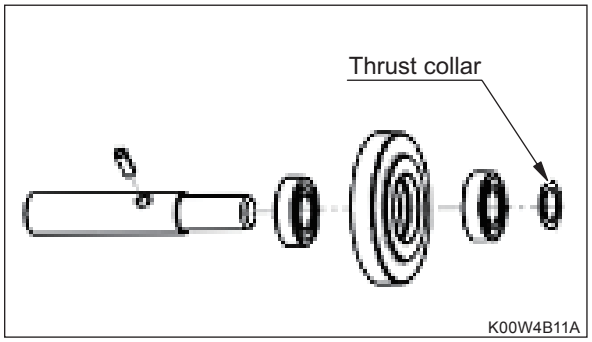






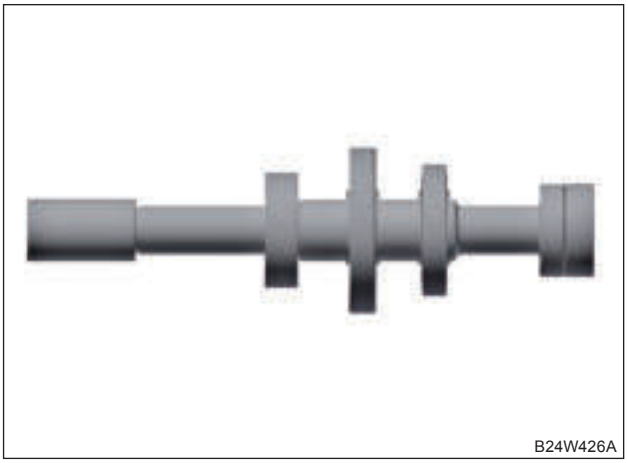
8. Remove the idle shaft (1) from the front section of the transmission case and MID PTO gear (2).

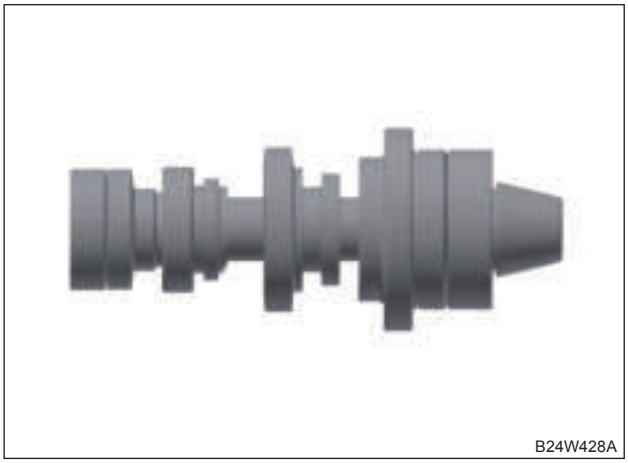
⚠ CAUTION



- **When reinstalling the MID PTO gear (2), be careful not to miss and damage the thrust collar.**

9. Remove the range shift shaft assembly (1), bevel gear sub assembly (2) and range shift fork shaft assembly (3) together from the drive pinion in the transmission case.


B24W426A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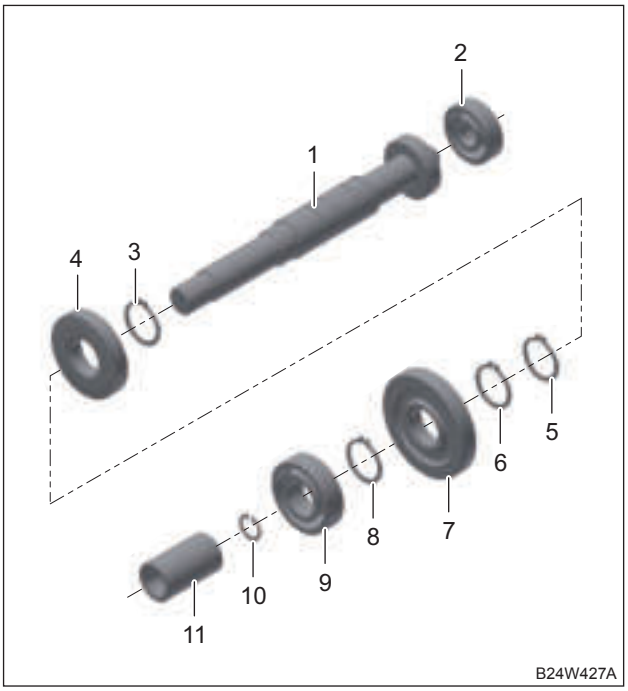
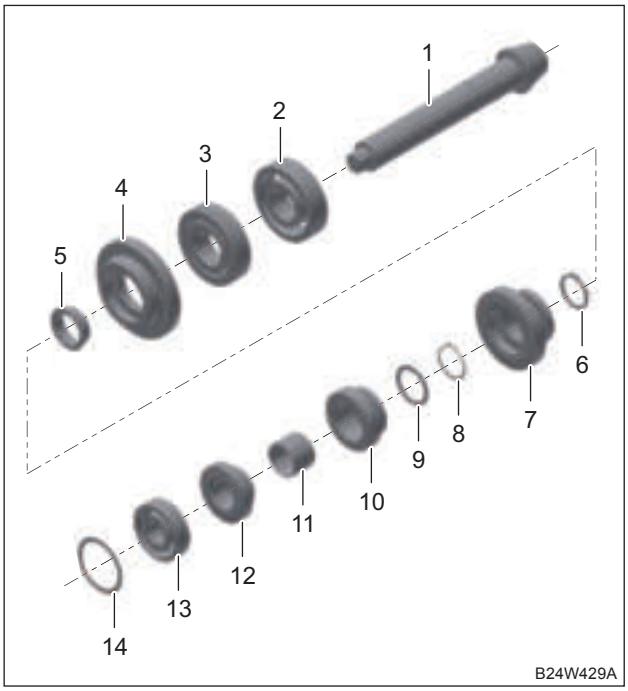


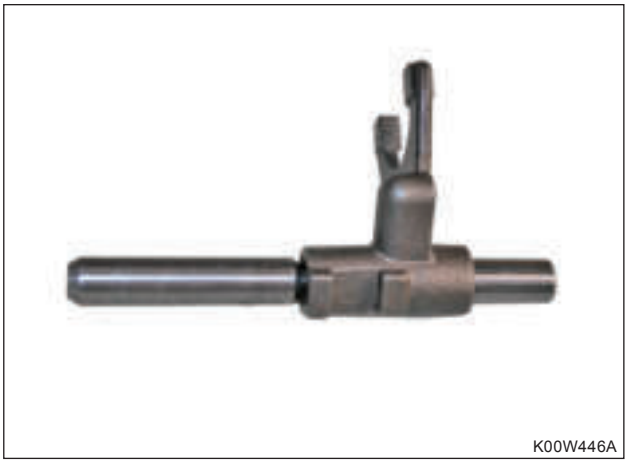
B24W427A

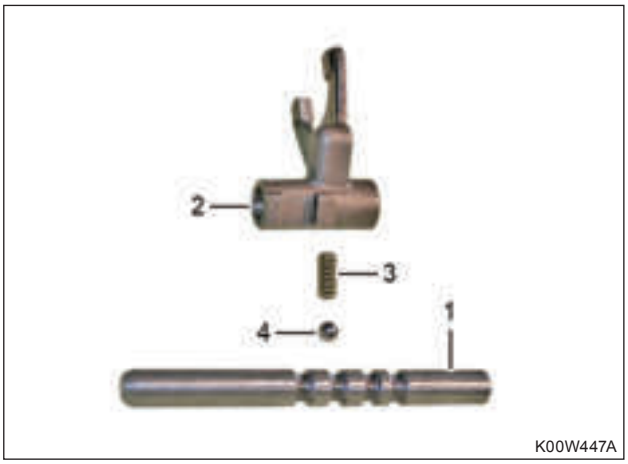


B24W429A

10. Remove the ball bearing (2), snap ring (3), ball bearing (4), snap ring (5), snap ring (6), range shfit 23 gear (7), snap ring (8), range shfit 17 gear (9), snap ring (10) and coupling (11) from the range shift gear shaft (1).

11. Remove the ball bearing (2), ball bearing (3), range shift driven 29 gear (4), bush (5), snap ring (6), range shift driven 19 gear (7), snap ring (8), washer (9), range shift driven 14 gear (10), bush (11), 4WD 13 gear (12), ball bearing (13) and washer (14) from the drive pinion shaft (1).


K00W446A

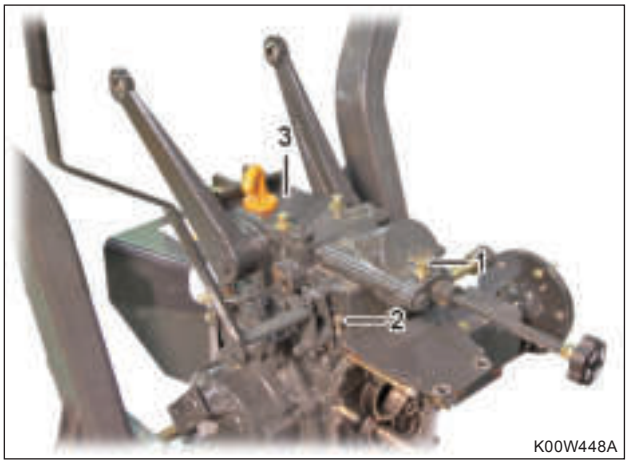


K00W447A

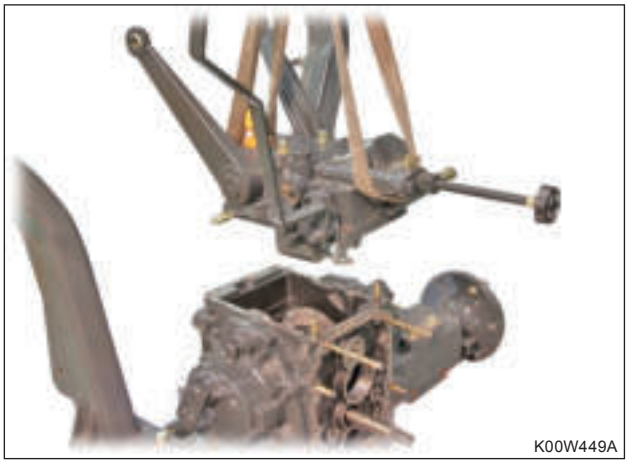
12. Remove the range shift fork (2), range shift fork spring (3) and steel ball (4) from the range shift fork shaft (1).

5.7 DIFFERENTIAL GEAR CASE REMOVAL

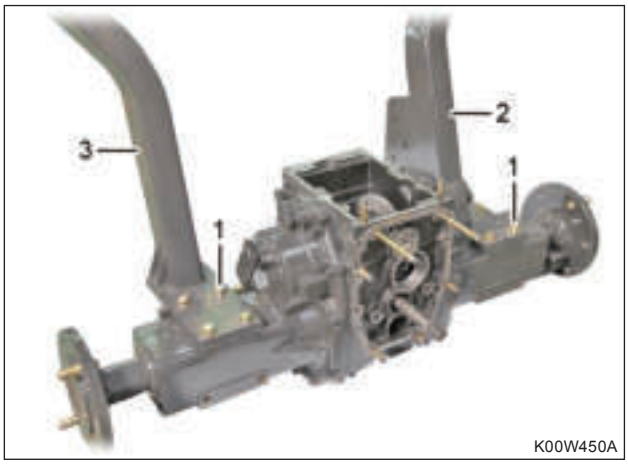
1. Remove the transmission case.



K00W448A

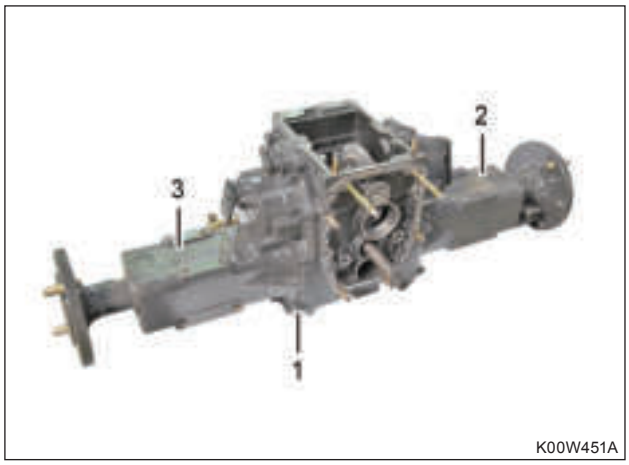

K00W449A

2. Support the hydraulic cylinder case with a hoist and unscrew the hydraulic cylinder case assembly mounting bolts (1) (7 EA) and nuts (2) (2 EA) to remove the hydraulic cylinder case assembly (3).

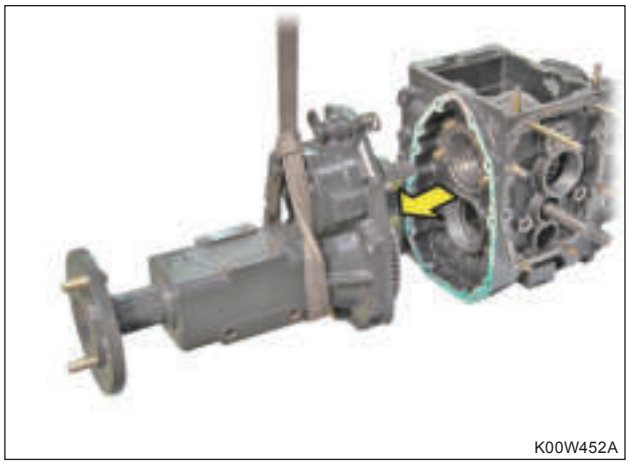


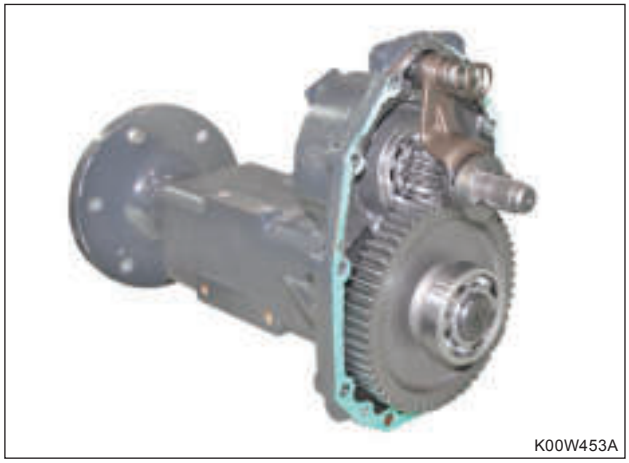
K00W450A

3. ROPS lower frame mounting bolts (1) to remove the ROPS lower frame (LH) (2), (RH) (3).



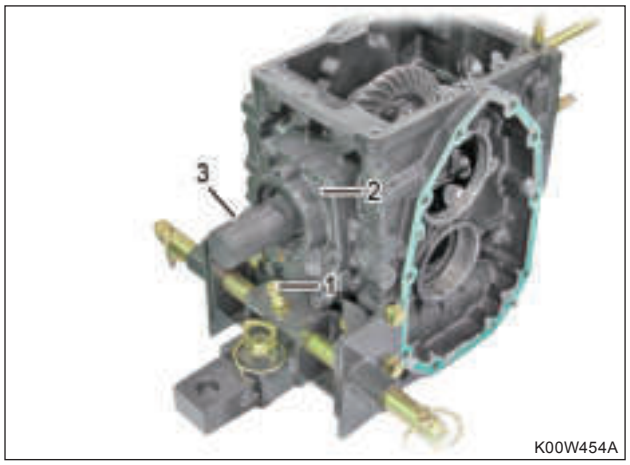
K00W451A


K00W452A

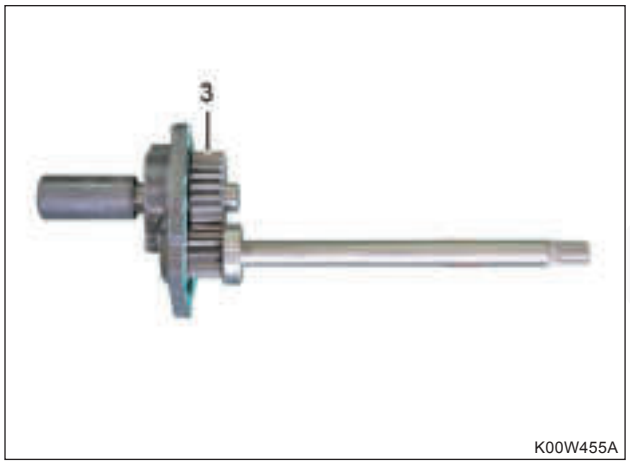

K00W453A

4. Unscrew the rear axle case mounting bolts (1) to remove the rear axle case (LH) (2), (RH) (3).

DIFFERENTIAL GEAR CASE - COMPONENTS DISASSEMBLY

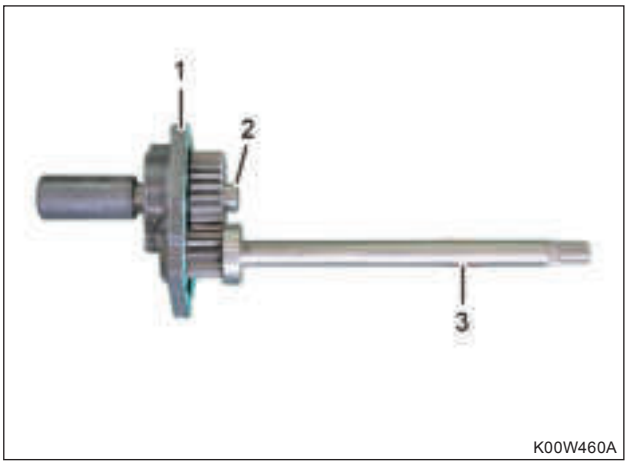


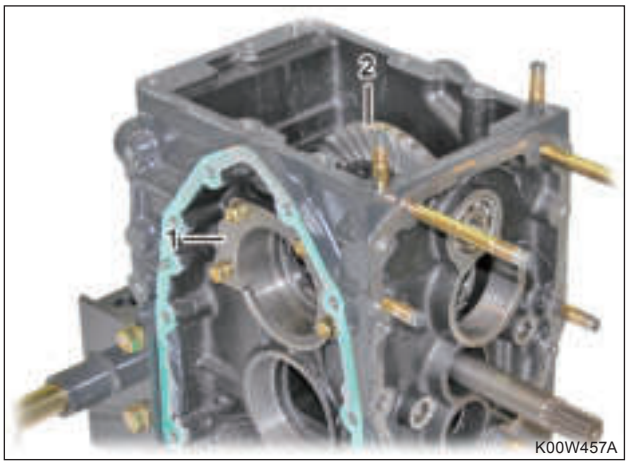
K00W454A

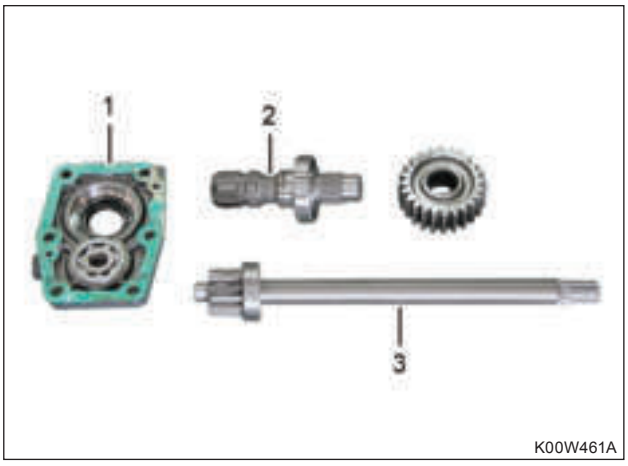


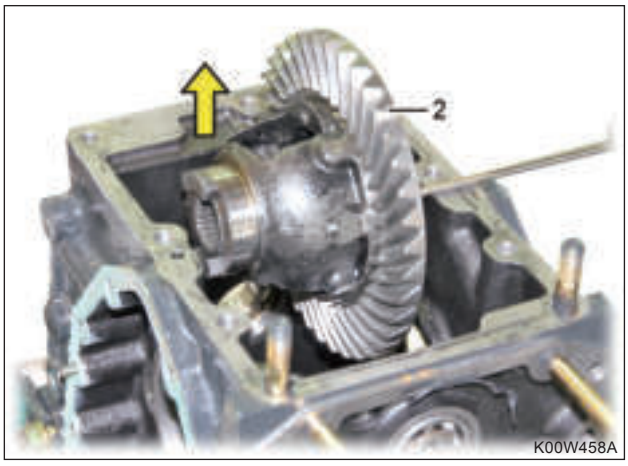
K00W455A

1. Unscrew the lower pin mounting bolt (1) and rear cover mounting bolts (2) and remove the lower pin from the rear section of the differential gear case. Then, remove the rear cover assembly (3) of the differential gear case.

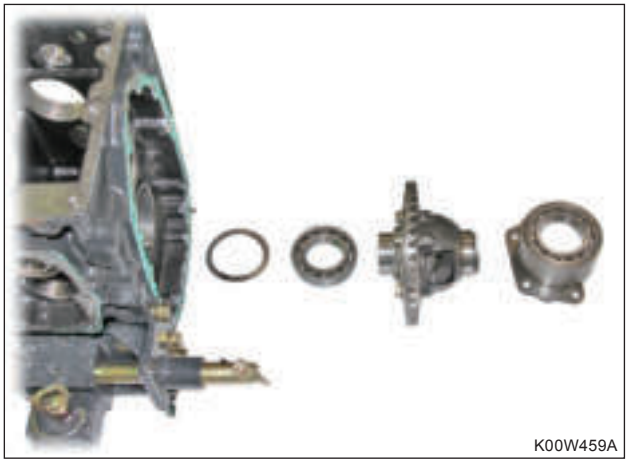






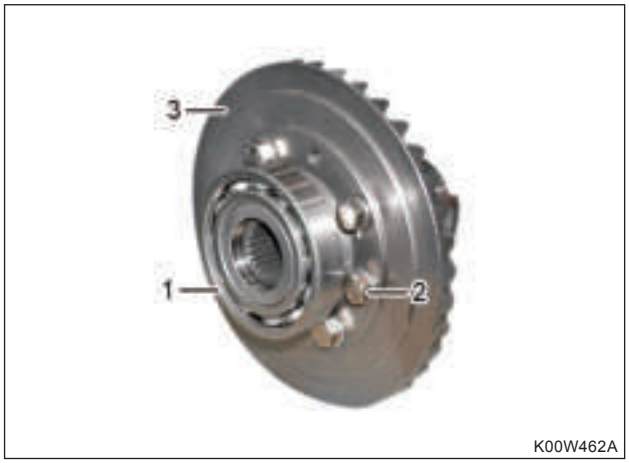


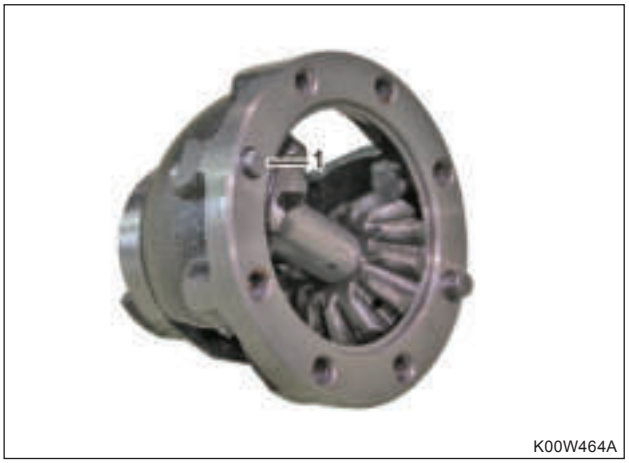
2. Remove the PTO shaft (2) and 11 gear shaft (3) from the rear cover assembly (1) of the differential gear case.

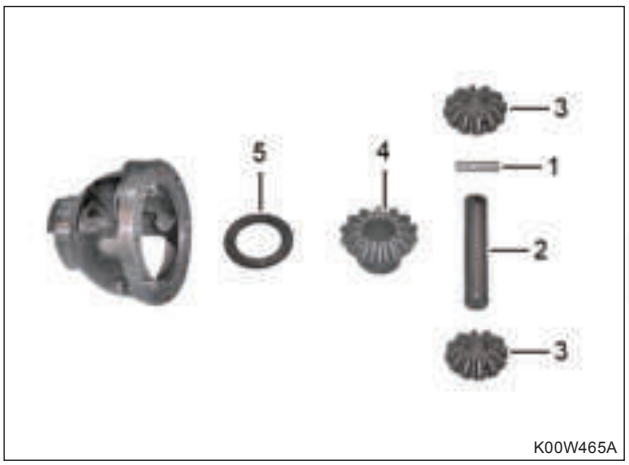


3. Remove the right differential connecting holder (1) to remove the rear wheel bevel gear sub assembly (2) by lifting it up.

REAR WHEEL BEVEL GEAR SUB ASSEMBLY - COMPONENTS DISASSEMBLY

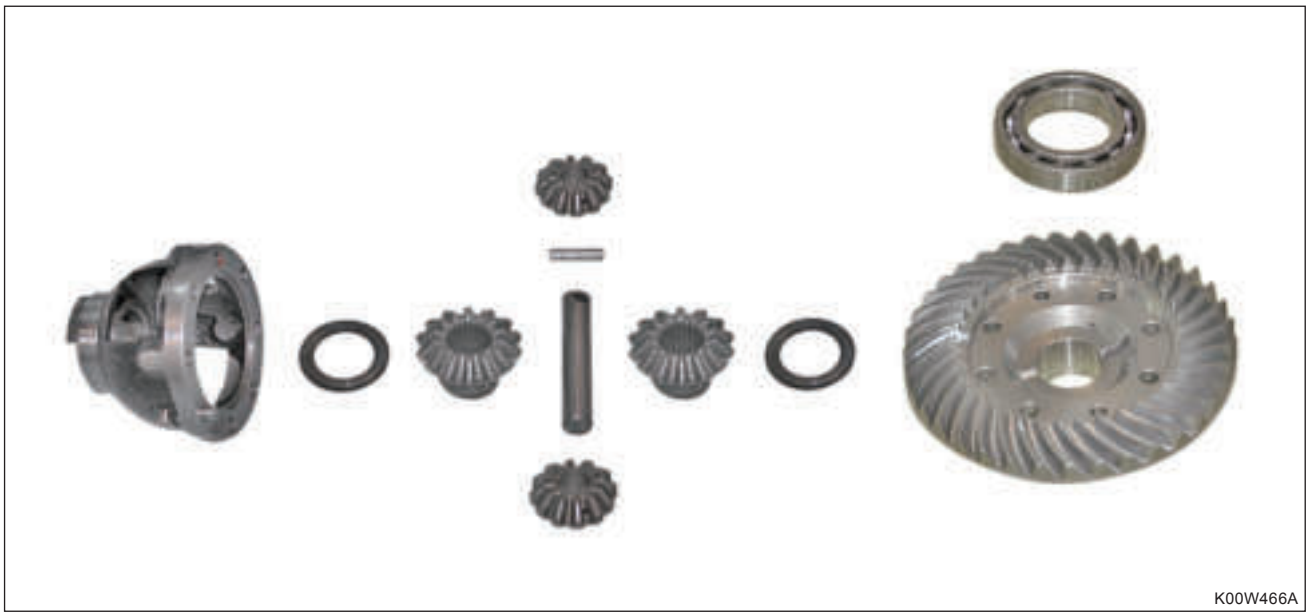






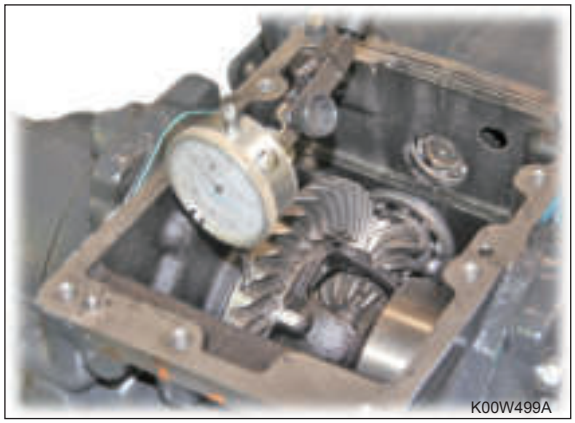
1. Remove the ball bearing (1) and unscrew the ring gear mounting hex. bolts (2) to remove the ring gear (3) and 14 differential gear (4) from the differential case.

2. Pull out the differential pinion shaft parallel pin (1) from the differential case assembly and remove the differential pinion shaft (2), 12 differential pinion (3), 14 differential gear (4) and shim (5) in order from the differential case.



3. Assemble in the reverse order of disassembly.

Notes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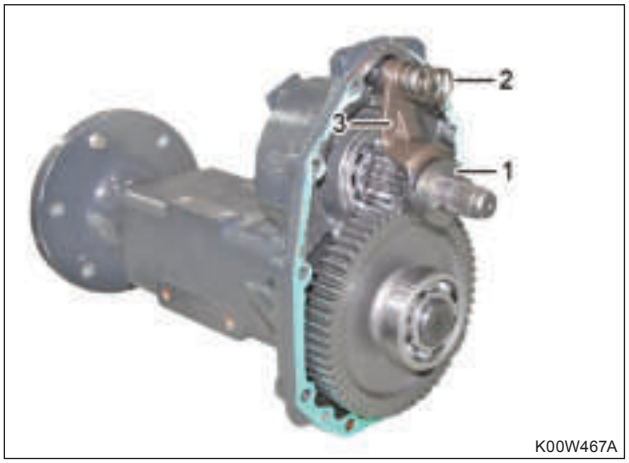
- **Check the backlash of the ring gear using a dial gauge.**
  Specified value.....0.1 ~ 0.3 mm
  (0.0039 ~ 0.012 in.)
- **After adjustment of backlash, there should be no lateral free play of the differential assembly. To adjust the backlash, use shims between the ball bearing and snap ring.**

REAR AXLE ASSEMBLY - COMPONENTS DISASSEMBLY



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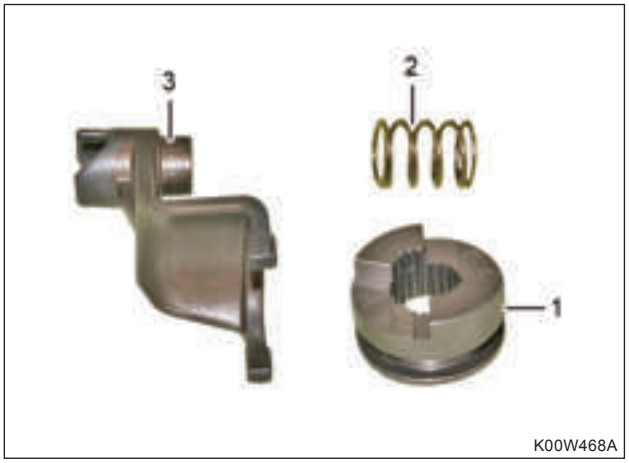

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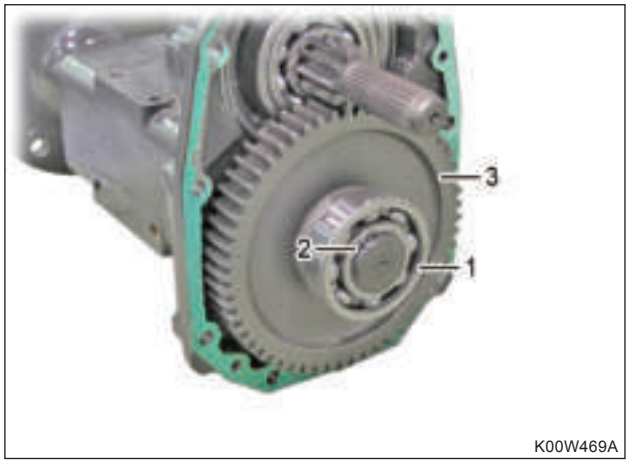
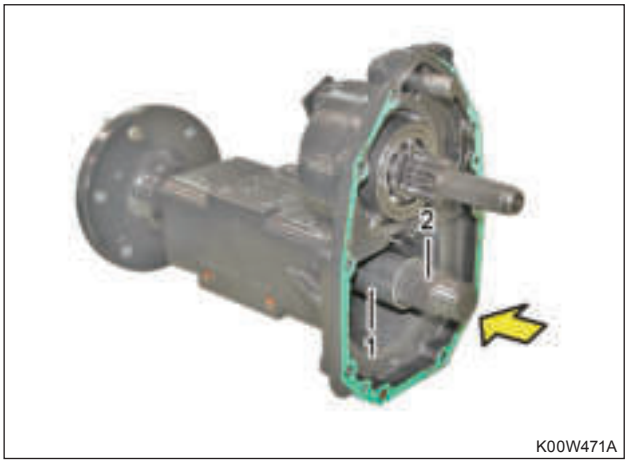
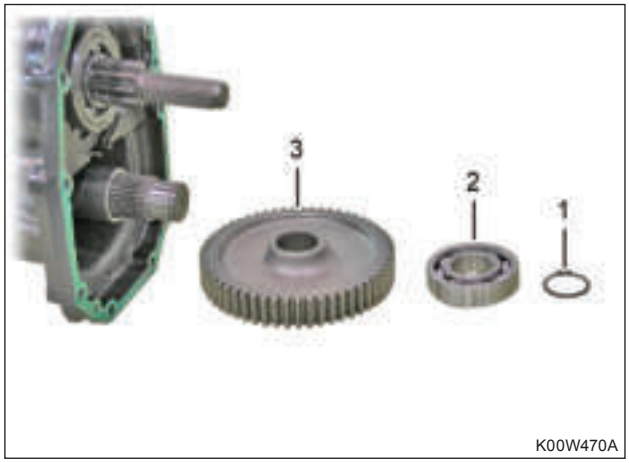
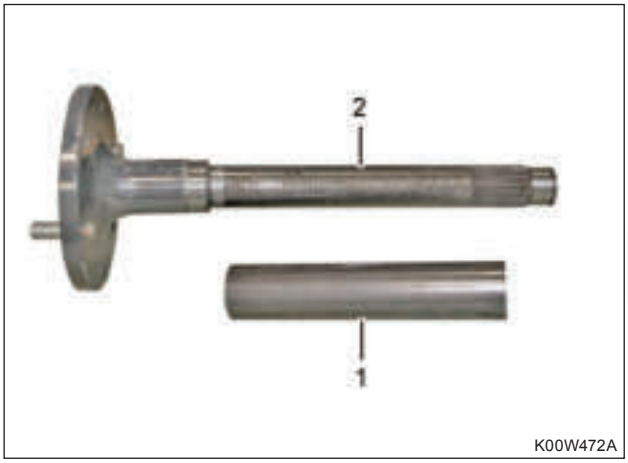
1. Remove the differential lock clutch (1), differential spring (2) and differential fork (3) in order from the differential gear shaft.







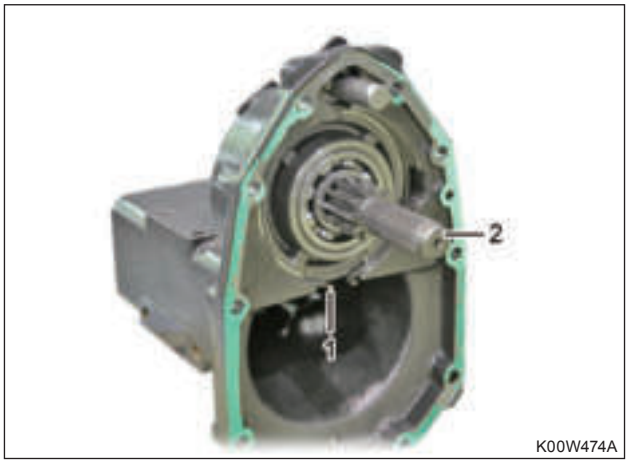


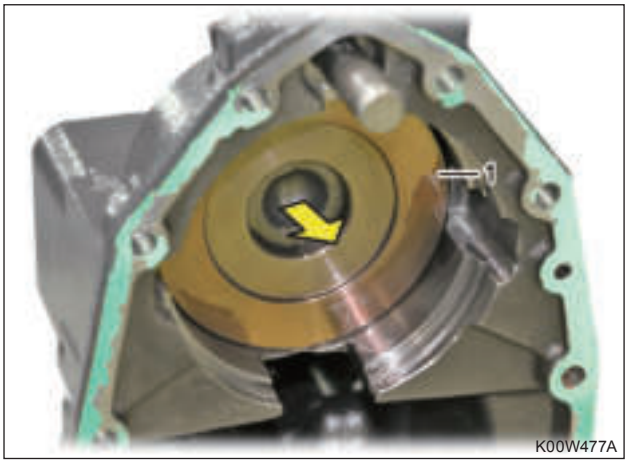
2. Pull out the snap ring (1) from the front of the rear axle and remove the ball bearing (2) and 57 gear (3).

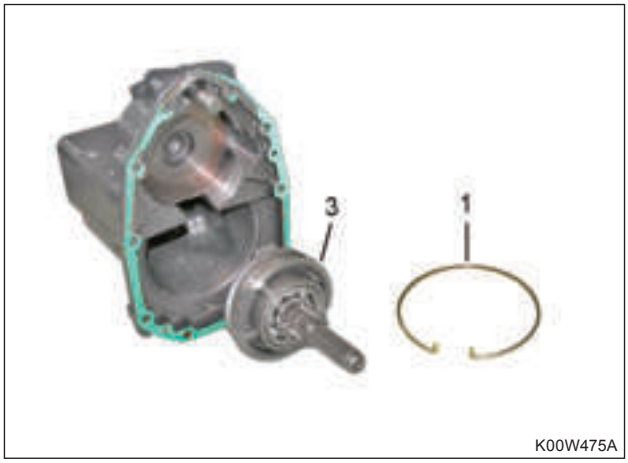
3. Remove the 242 collar (1) from the rear axle and tap the rear axle (2) toward the case outside to remove it.

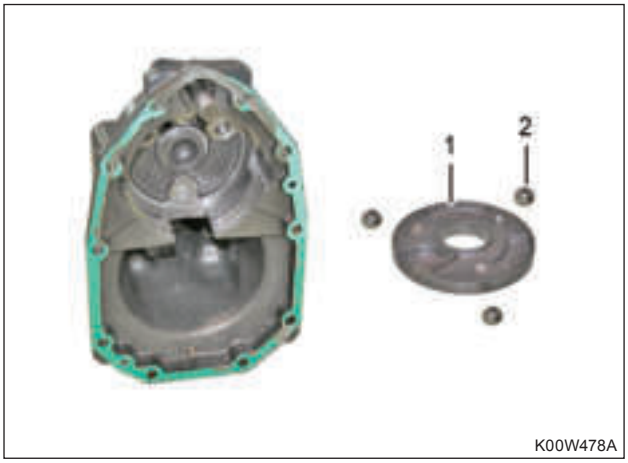
4. Remove the oil seal (1) and ball bearing (2) from the rear axle case.

BRAKE SECTION - COMPONENTS DISASSEMBLY





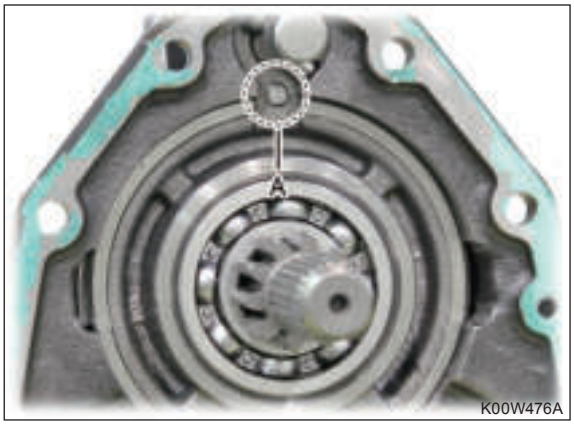




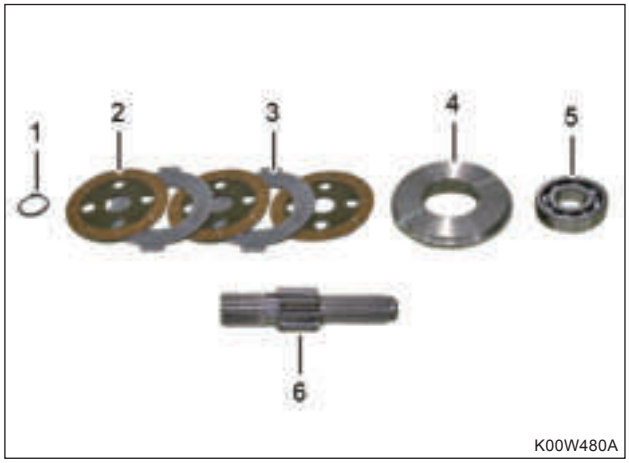
5. Pull out the retaining clip (1) from the front section of the brake to remove the differential gear shaft (2), bearing holder and brake disc assembly (3).

6. Remove the brake actuator (1) and steel ball (2) from the rear axle case.

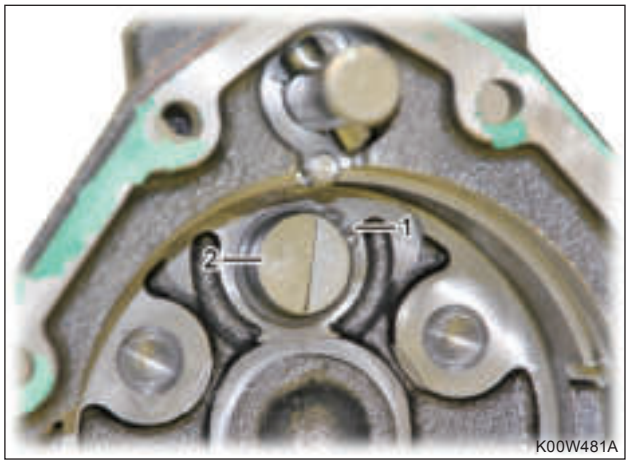
Notes



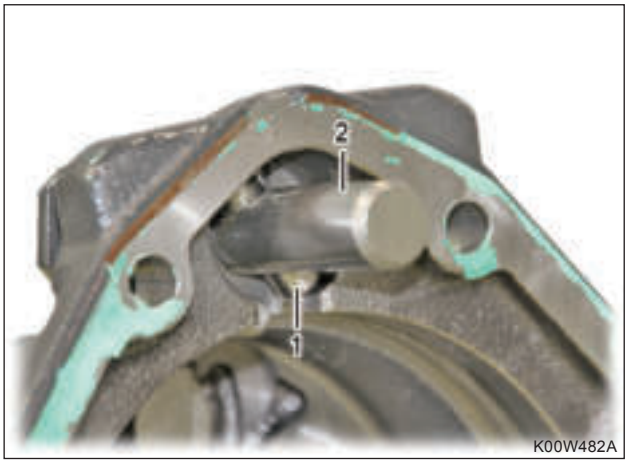
- When reinstalling the brake bearing holder, make sure to align the groove (A) of the bearing holder with the lock pin of the rear axle case.



7. Pull out the snap ring (1) from the end of the differential gear shaft (6) on the brake disc assembly and remove the brake disc (2), plate (3), ball bearing holder (4) and ball bearing (5) in order.



8. Pull out the brake cam lever snap ring (1) to remove the brake cam lever (2).



9. Remove the parallel pin (1) from the upper section of the rear axle case to remove the fork rod (2).

MEMO

CHAPTER 5 FRONT AXLE

TABLE OF CONTENTS

1. OVERVIEW

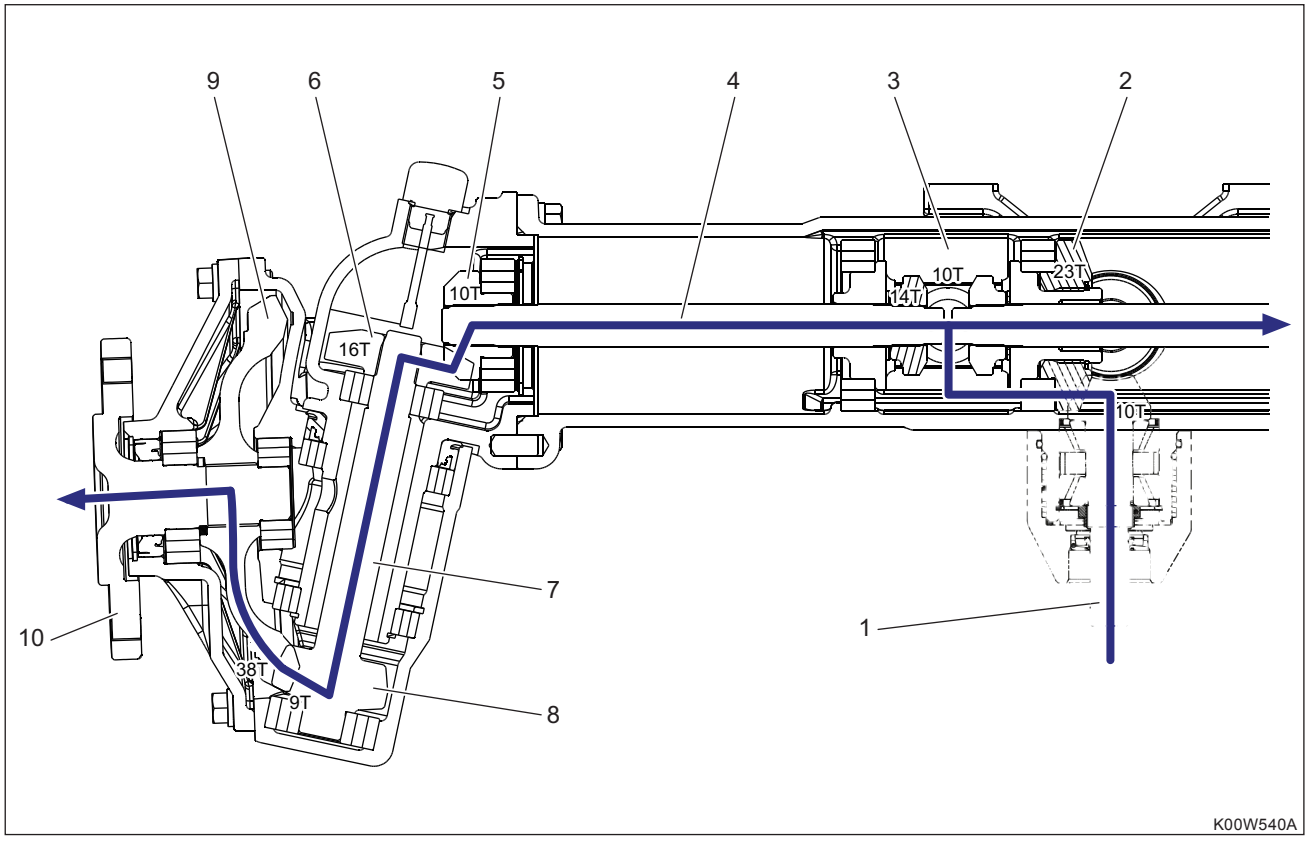
1.1 SPECIFICATIONS

1. Tread ..... 6 - 12: 853 mm (33.6 in)
2. Tire size ..... 6 - 12 4PR
3. Front wheel alignment..... Toe-in: 4 - 8 mm (0.157 - 0.315 in.)
4. Oil ..... Standard: SAE 80W90
   Capacity: 3.0 ℓ (0.79 u.s.gal)
5. Differential system ..... Pinion and ring gear backlash: 0.1 - 0.3 mm (0.004 - 0.012 in.)
   10T Bevel gear and
   16T Bevel gear backlash: 0.1 - 0.3 mm (0.004 - 0.012 in.)

1.2 TIGHTENING TORQUE FOR MAJOR COMPONENTS

MAJOR COMPONENTS	TORQUE VALUE
Drag link slotted nut	17.7 - 34.5 N.m 1.8 - 3.5 kgf.m 13.0 - 25.3 lbf.ft
Front wheel bracket mounting screw	77.5 - 90.1 N.m 7.9 - 9.2 kgf.m 57.1 - 66.5 lbf.ft
Front axle bracket mounting screw	124.0 - 147.0 N.m 12.6 - 15.0 kgf.m 91.0 - 108.0 lbf.ft
Bevel gear case mounting screw	77.5 - 90.1 N.m 7.9 - 9.2 kgf.m 57.1 - 66.5 lbf.ft
Knuckle arm mounting screw (M10)	48.0 - 56.0 N.m 4.9 - 5.7 kgf.m 35.5 - 41.2 lbf.ft
Knuckle arm mounting screw (M12)	103.0 - 117.7 N.m 10.5 - 12.0 kgf.m 76.0 - 86.8 lbf.ft
Axle flange mounting screw	48.1 - 55.9 N.m 4.9 - 5.7 kgf.m 35.5 - 41.2 lbf.ft

1.3 POWER TRANSFER



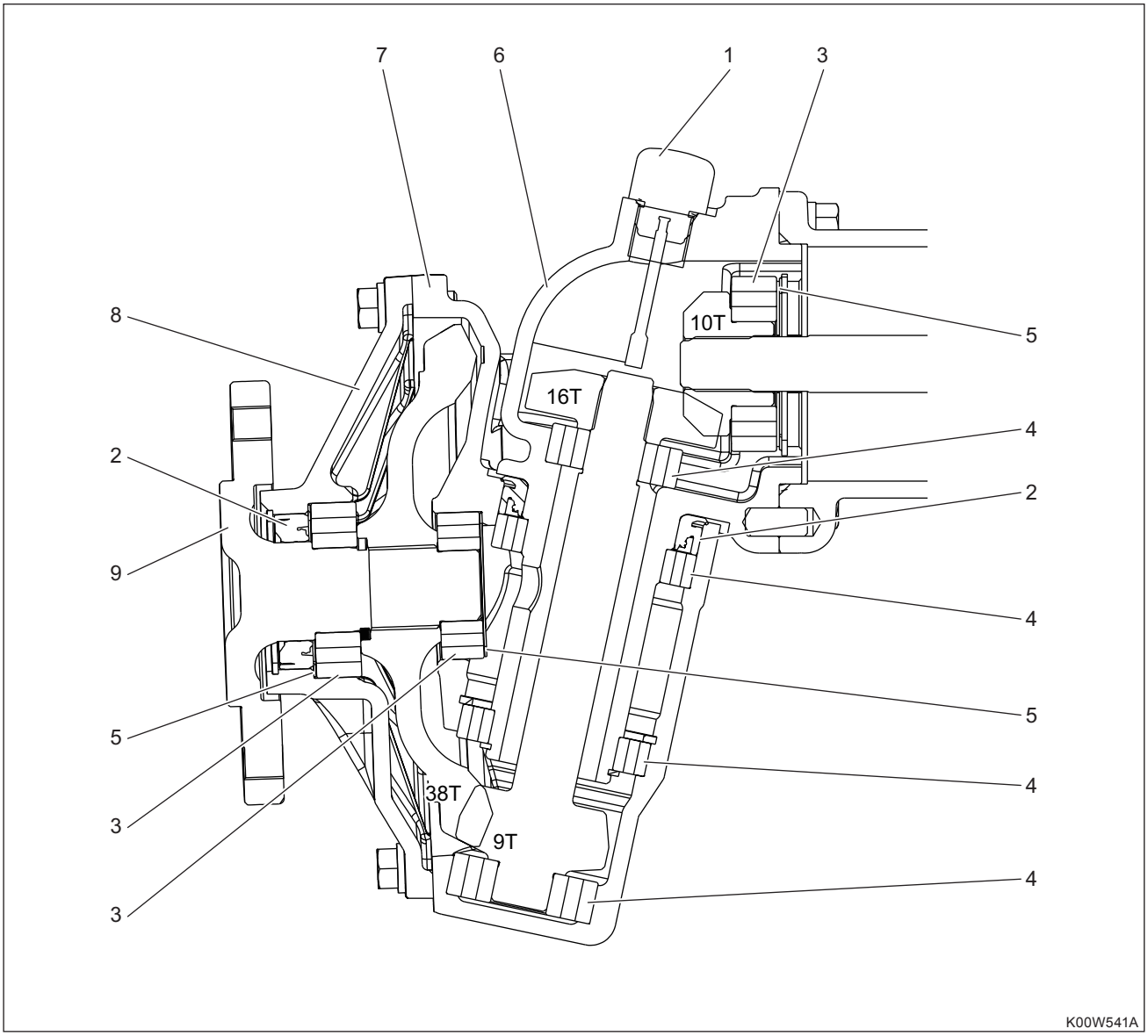
(1) Drive pinion
(2) Ring gear
(3) Differential case
(4) Front 1st shaft
(5) 10 bevel gear
(6) 16 bevel gear
(7) Front 2nd shaft
(8) 9 bevel gear
(9) 38 front final gear
(10) Front spindle

When the 4WD mode is selected, rotating force from the 4WD shaft of the transmission is passed through the propeller shaft and is delivered to the front axle section through the drive pinion (1) of the front axle case.

The 10 gear of the drive pinion is engaged with the 23 ring gear (2) of the front differential, rotating together at the reduced speed, and the differential case (3) integrated with the ring gear is rotated as well. Then, as the differential pinion shaft is rotated together, the differential pinion gear and differential side gear are engaged with each other, rotating together. Therefore, this rotating force is transmitted to the front 1st shaft (4) since it is fixed to the differential side gear with splines.

After the rotating force is passed through the front 1st shaft, it is delivered to the front gear case through the 10 bevel gear (5) and 16 bevel gear (6). Then, it is passed to the 38 front final gear (9) through the front 2nd shaft (7) and 9 bevel gear (8). Finally, this force is delivered to the front wheels installed to the 38 front final gear to turn the wheels.

1.4 KNUCKLE SECTION



(1) Oil gauge
(2) Oil seal
(3) Ball bearing
(4) Ball bearing
(5) Shim
(6) Bevel gear case
(7) Gear case
(8) Gear case cover
(9) Front spindle

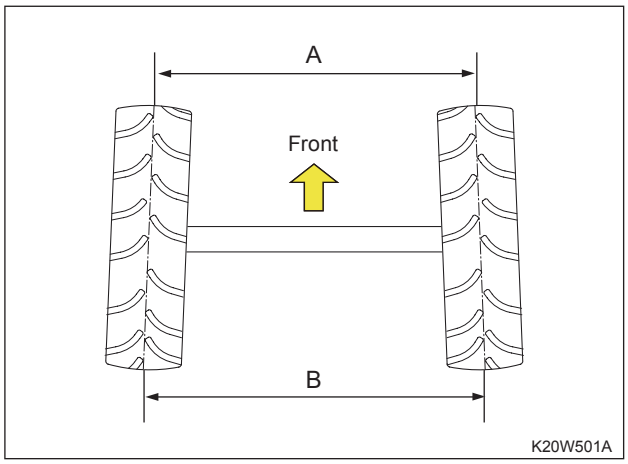
The knuckle section is a part to perform driving and steering functions in the front axle section, and it (gear case + gear case cover) revolves around the fixed king pin section (bevel gear case).

Four vertically set ball bearings (4) and three laterally set ball bearings (3) withstand vertical and lateral load applied to the front axle. Also, the rotating parts of the front spindle (9) and gear case cover (8) are equipped with oil seals to ensure superior sealing performance even in a wet condition.

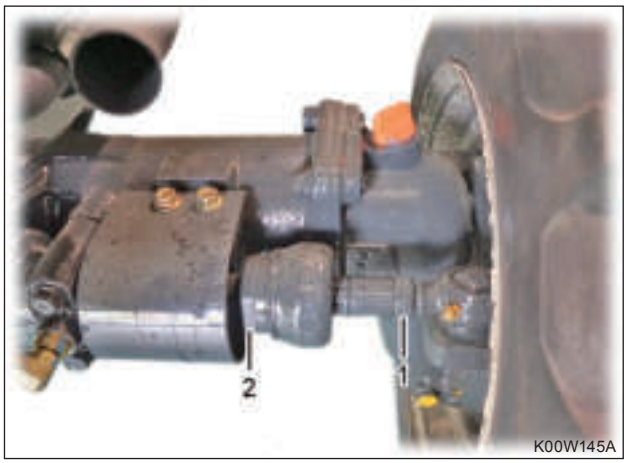
2. INSPECTION AND ADJUSTMENT

2.1 TOE-IN

1. Park the tractor on firm level ground and turn the steering wheel to set both front wheels in the straight ahead position. Then, stop the engine.



2. Measure the distance between the centers of the tires at the center of the hub of the front axle as shown in the figure.
3. Measure the rear width between the front tires with the same method.
4. Subtract the front width (A) from the rear width (B). The value should be 4 - 8 mm (0.157 - 0.315 in.).



5. If the result is out of the specification, unscrew the tie-rod end mounting nut (1) from the knuckle arm and turn the rod (2) to adjust the distance between the centers.

Notes

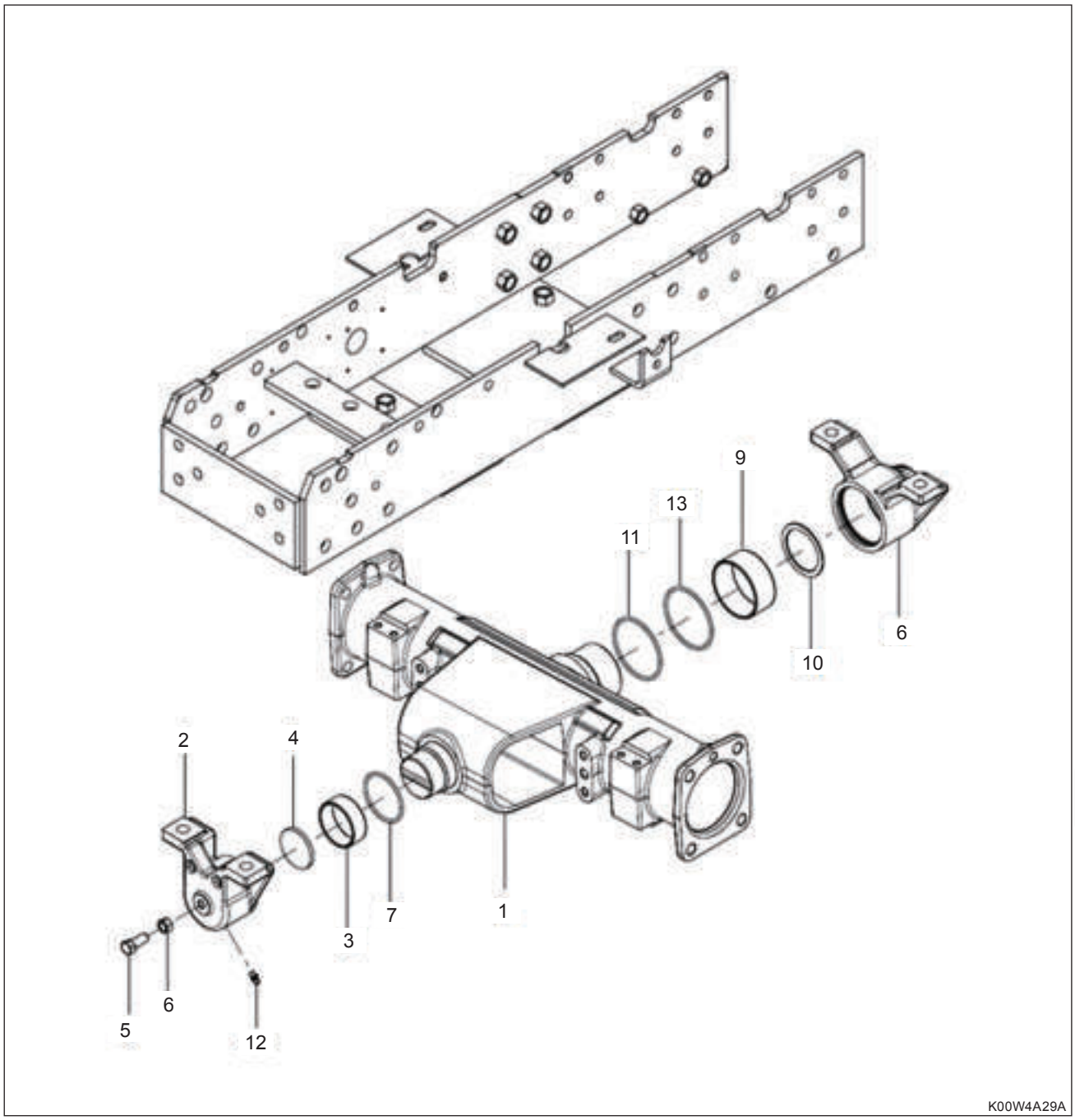
Front tire inflation pressure	Standard	2.0 kgf/cm^2 28.44 psi

3. TROUBLESHOOTING

PROBLEMS	CAUSE OR SYMPTOM	SOLUTION
The front wheels rattle.	• Poorly adjusted toe-in • Abnormal tire inflation pressure	• Adjust the toe-in (4 - 8 mm). • Inflate the tire to the proper pressure level (2.0 kgf/cm^2, 28.47 psi, 0.196 MPa).
The front tires are worn excessively.	• Poorly adjusted toe-in • Excessive inflation pressure	• Adjust the toe-in. • Adjust the tire pressure to the proper level.
It is hard to steer the vehicle.	• Poorly adjusted toe-in • Damaged tie rod • Defective steering cylinder connection and PST valve	• Adjust the toe-in. • Replace the tie rod. • Check and repair the hydraulic line.
Noise is generated from the front axle.	• Damaged internal gear • Insufficient front axle oil • Improper backlash	• Disassemble, inspect and repair • Add fluid. • Adjust the backlash.

4. SECTIONAL VIEW FOR MAJOR COMPONENTS

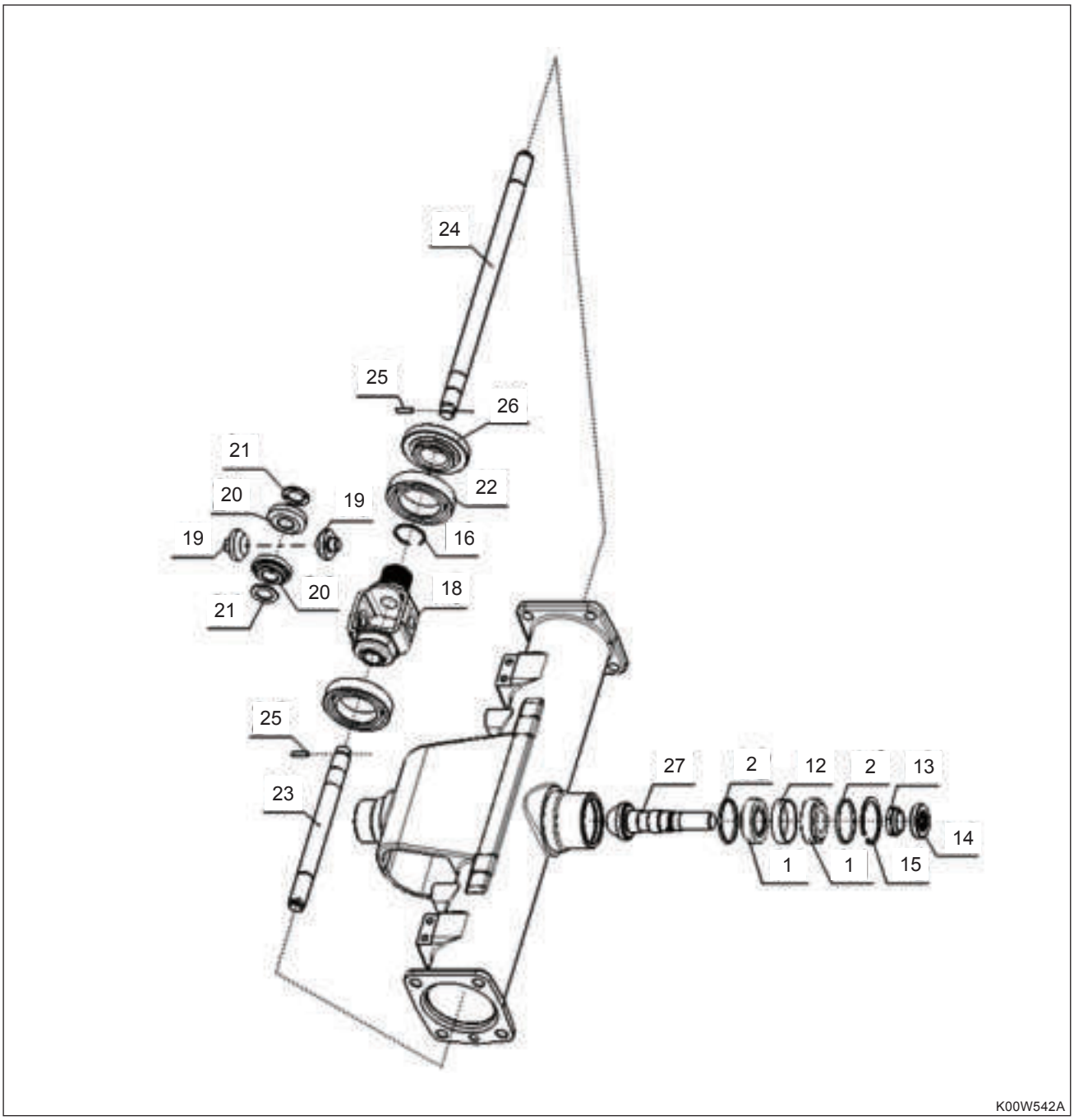
4.1 FRONT AXLE CASE



COMPONENTS

(1) Case, front axle
(2) Assy holder
(3) Bush
(4) Collar, thrust
(5) Bolt
(6) Nut
(7) O-ring
(8) Assy holder
(9) Bush
(10) Collar, thrust
(11) O-ring
(12) Nipple
(13) O-ring

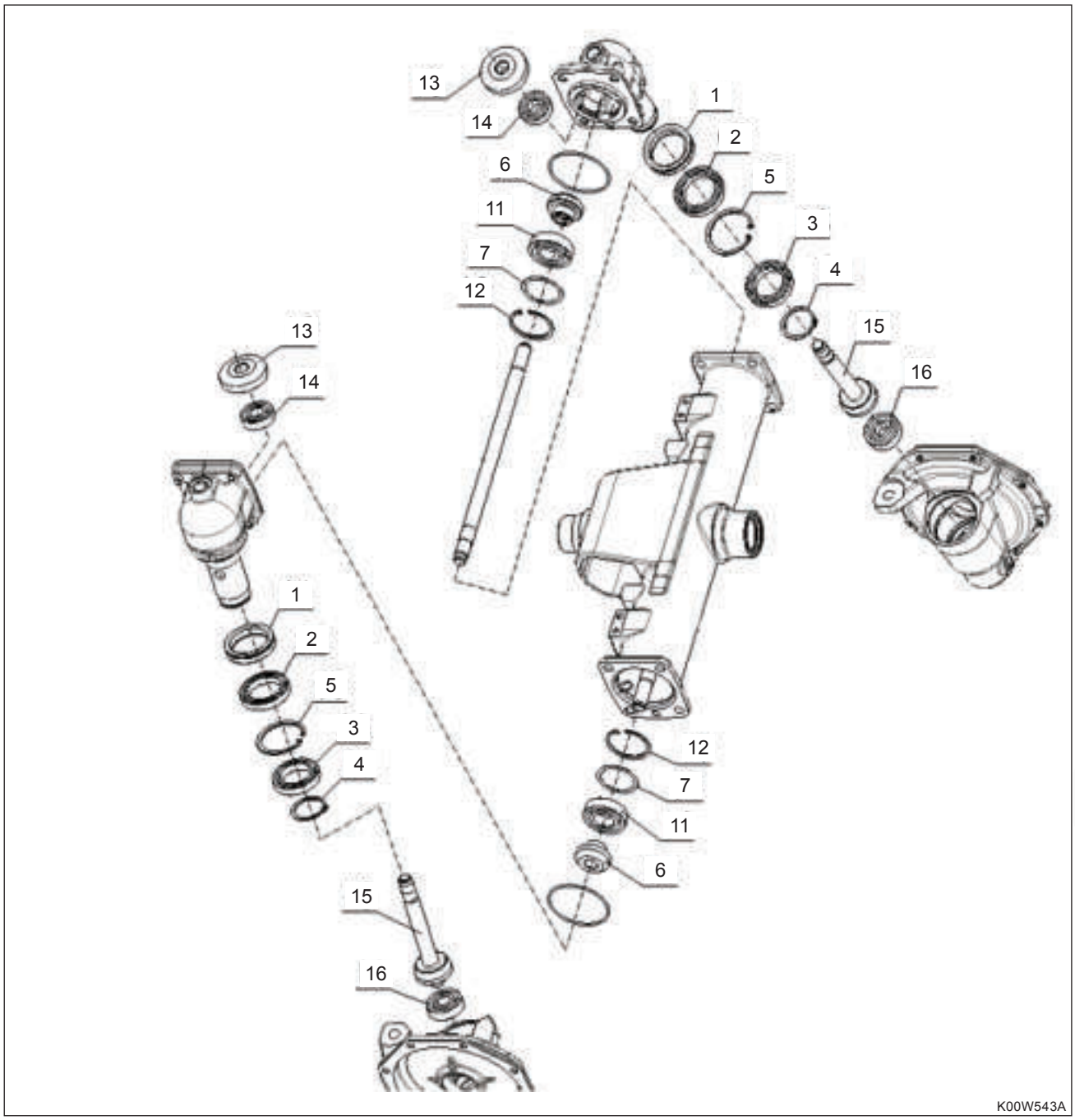
4.2 FRONT DIFFERENTIAL



COMPONENTS

(1) Bearing, taper-roller
(2-1) Collar
(2-2) Collar
(2-3) Collar
(2-4) Collar
(2-5) Collar
(2-6) Collar
(2-7) Collar
(2-8) Collar
(2-9) Collar
(2-10) Collar
(12) Collar
(13) Nut
(14) Seal, oil
(15) Cir clip, internal
(16) Cir clip, external
(18) Case, diff. Front
(19) Pinion, bevel gear
(20) Gear, bevel 14t
(21) Collar
(22) Bearing, ball
(23) Shaft, yoke LH
(24) Shaft, yoke RH
(25) Pin, spring
(26) Gear, bevel
(27) Gear, bevel

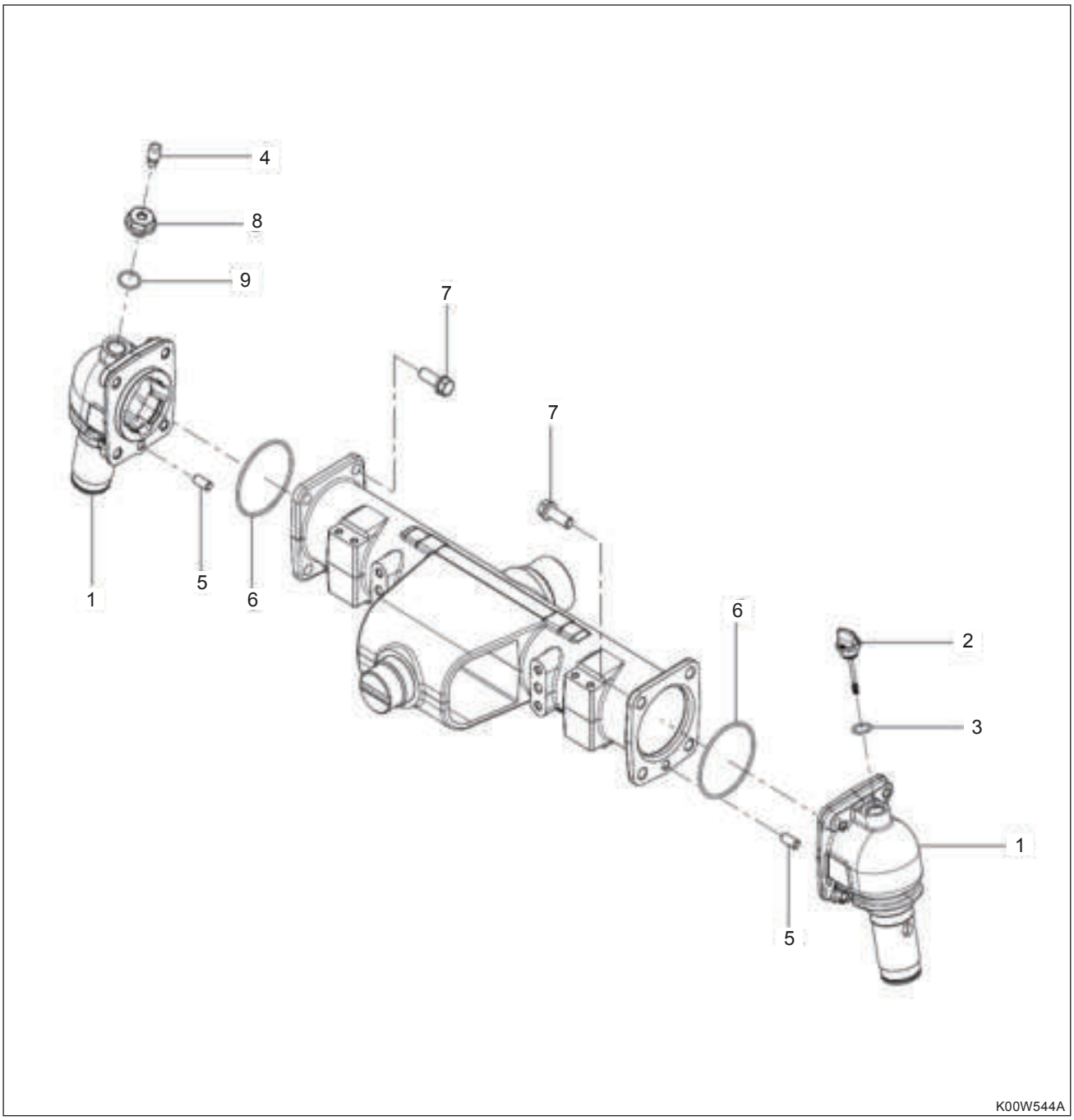
4.3 DIFFERENTIAL GEAR SHAFT



COMPONENTS

(1) Seal, oil
(2) Bearing, ball
(3) Bearing, ball
(4) Cir clip, external
(5) Cir clip, internal
(6) Gear, bevel f
(7-1) Shim
(7-2) Shim
(7-3) Shim
(7-4) Shim
(11) Bearing, ball
(12) Cir clip, internal
(13) Gear, bevel f
(14) Bearing, ball
(15) Shaft, bevel gear
(16) Bearing, ball

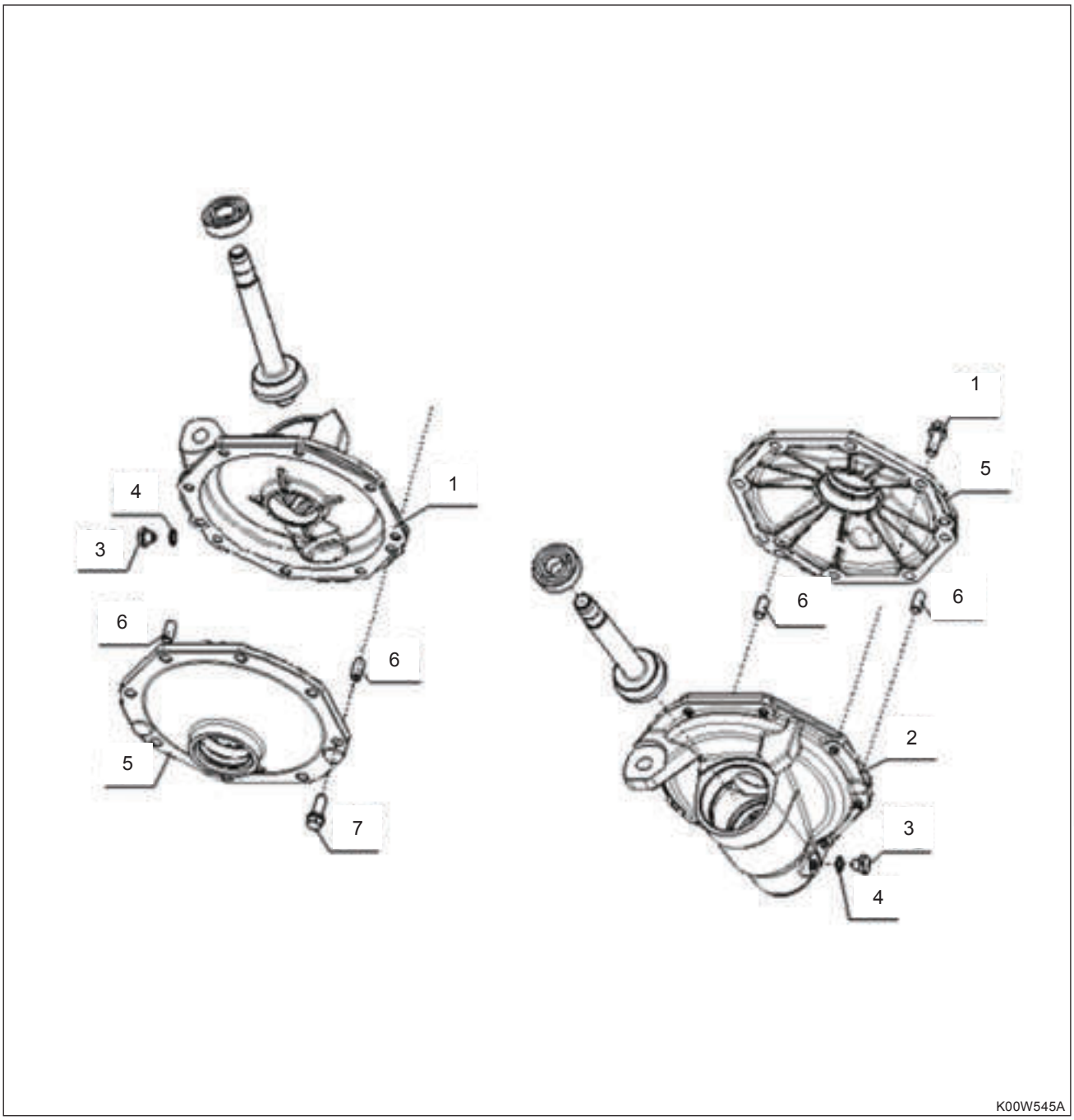
4.4 BEVEL GEAR CASE



COMPONENTS

(1) Case, bevel gear
(2) Gage, oil
(3) O-ring
(4) Air breather(steel)
(5) Pin, straight
(6) O-ring
(7) Bolt
(8) Plug
(9) O-ring

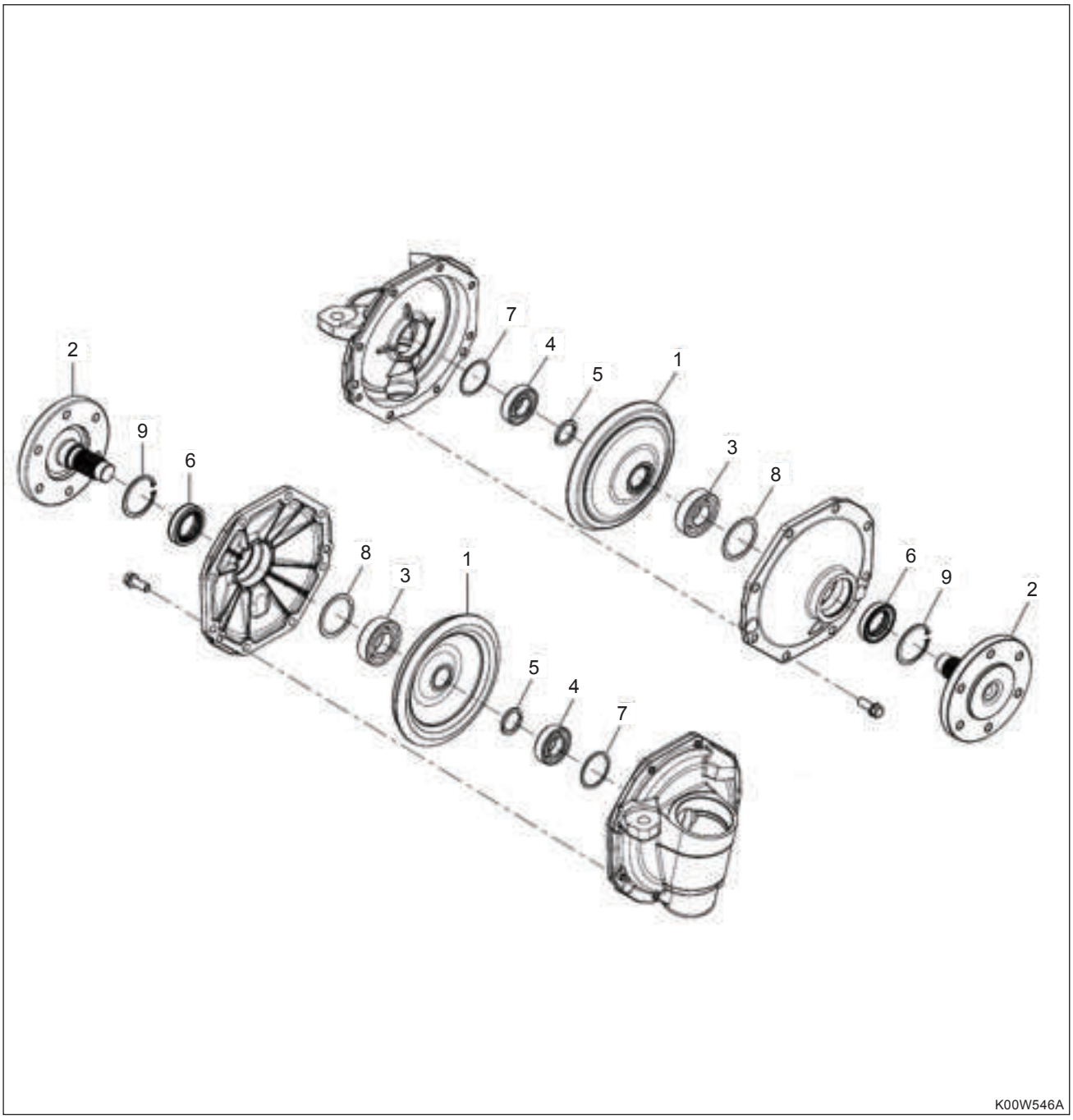
4.5 FRONT AXLE CASE



COMPONENTS

(1) Case, gear LH
(2) Case, gear RH
(3) Plug
(4) Packing
(5) Cover, gear case
(6) Pin, straight
(7) Bolt

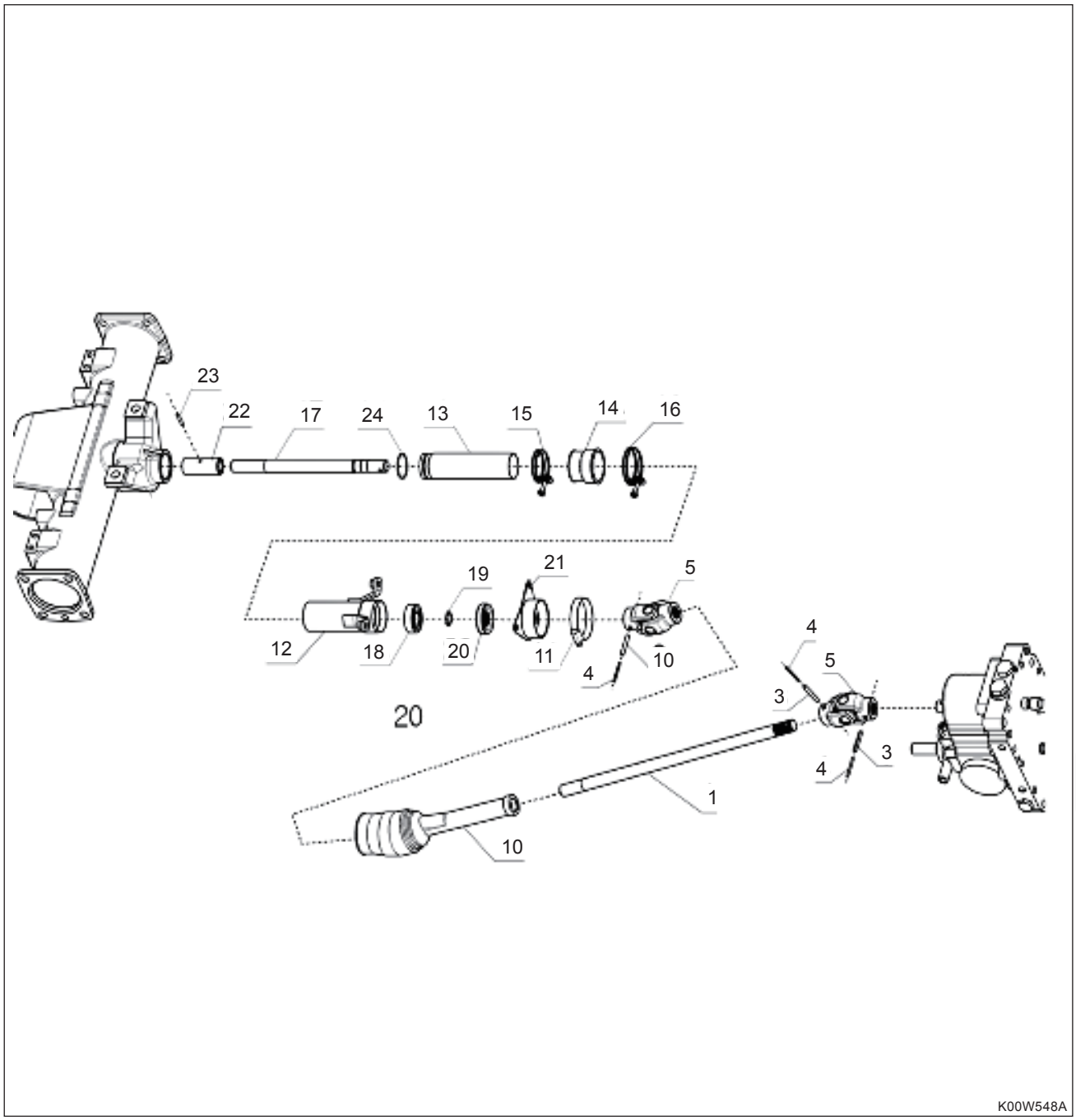
4.6 FRONT AXLE



COMPONENTS

(1) Gear, bevel
(2) Assy shaft, f.Axle
(3) Bearing, ball
(4) Bearing, ball
(5) Collar, set
(6) Seal, oil
(7-1) Shim
(7-2) Shim, shaft
(7-3) Shim
(8-1) Shim
(8-2) Shim
(8-3) Shim
(8-4) Shim
(9) Snap ring

4.7 FRONT DRIVE SHAFT



COMPONENTS

(1) Shaft, drive rear
(3) Pin, spring
(4) Pin, spring
(5) Assy joint, universal
(10) Cover
(11) Clamp
(12) Cover, front shaft a
(13) Cover, front shaft b
(14) Bandcover, front shaft c
(15) Band
(16) Band
(17) Shaft, front drive
(18) Bearing, ball
(19) Cir clip, external
(20) Seal, oil
(21) Support
(22) Coupling
(23) Pin, spring
(24) O-ring

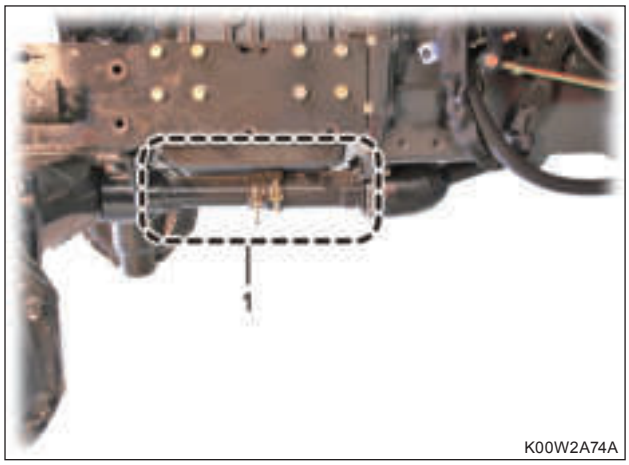
5. DISASSEMBLY AND SERVICE

5.1 FRONT AXLE CASE ASSEMBLY REMOVAL

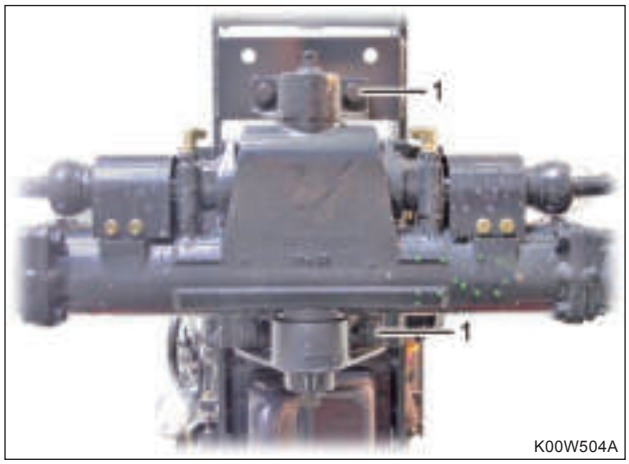
1. Park the tractor on firm and level ground.

2. Disconnect the left and right hydraulic hoses (1) from the PST cylinder.

3. Place a support under the engine and remove the left and right front wheels. Then, unscrew the front axle gear case drain plug (1) to drain oil in the front axle case.

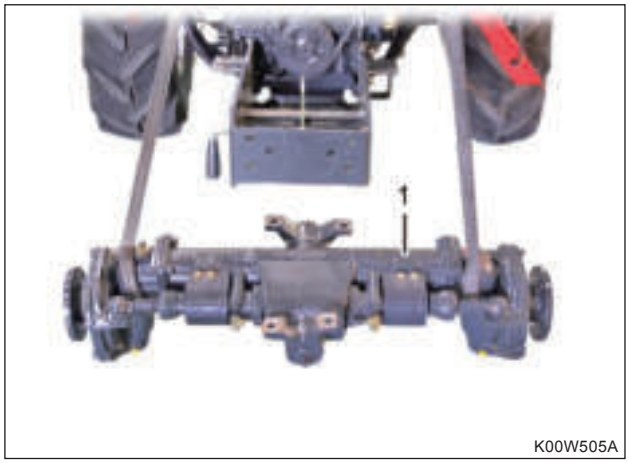


4. Remove the front wheel drive shaft (1). (See the engine removal instructions in chapter 2.)



5. Support the front axle case with a hydraulic jack or hoist and unscrew the mounting bolts (1) to remove the support (front) and support (rear) from the front axle bracket.

ITEM	TORQUE VALUE
Mounting bolt	392 N.m 40 kgf.m 288 lbf.ft



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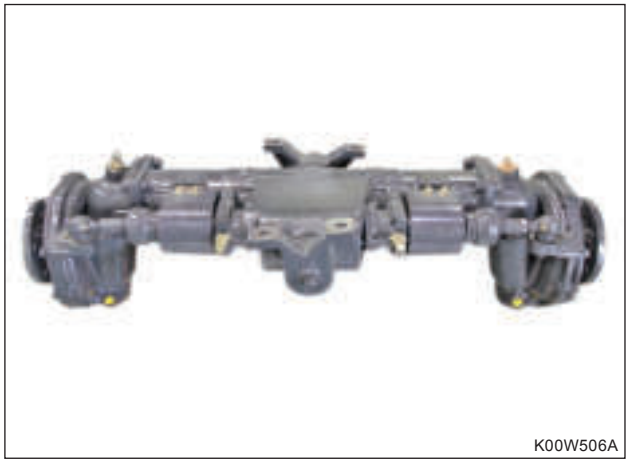
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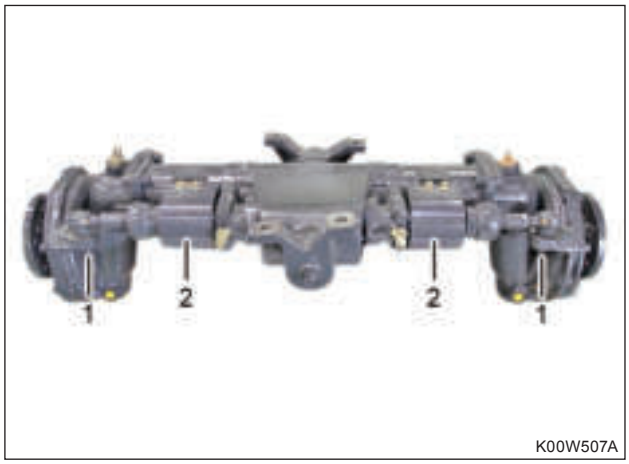
6. Remove the front axle case assembly (1) safely.



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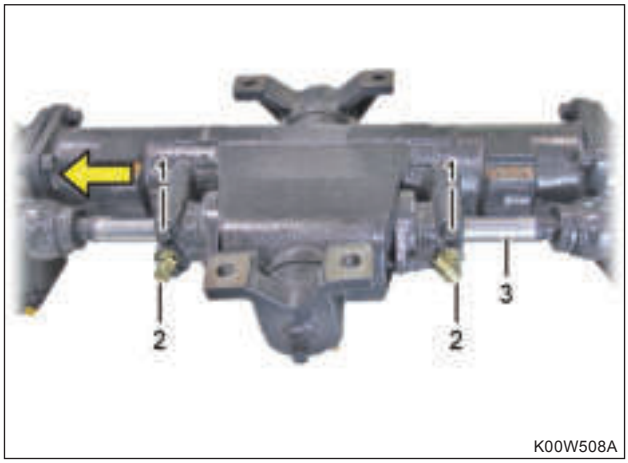
7. Unscrew the slotted nuts (1) of the tie-rod ends from the front axle case assembly to remove the tie-rod ends. Then, remove the PST cylinder covers (2).



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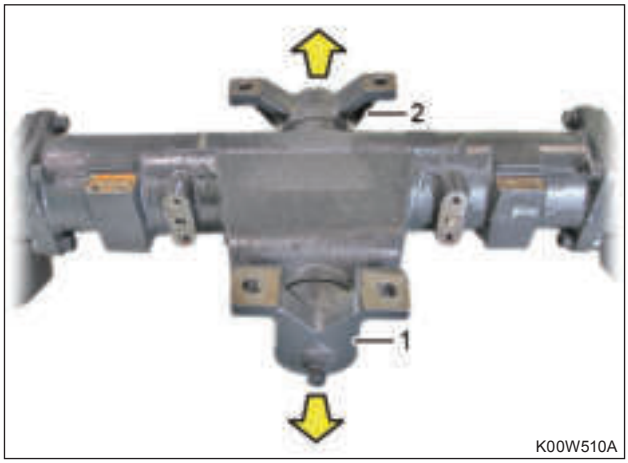
8. Unscrew the PST cylinder mounting bolts (1) and PST hydraulic hose elbows (2) to remove the PST cylinder (3).



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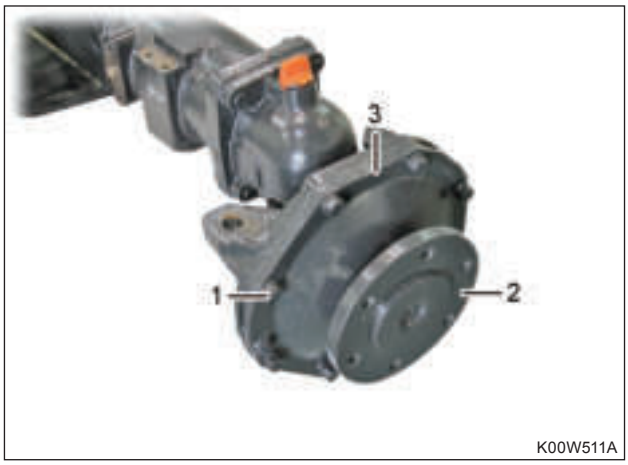
9. Remove the support (front) (1) and support (rear) (2) by pulling them from the front axle case assembly.

5.2 FRONT AXLE CASE ASSEMBLY - COMPONENTS DISASSEMBLY

5.2.1 FRONT AXLE CASE SECTION



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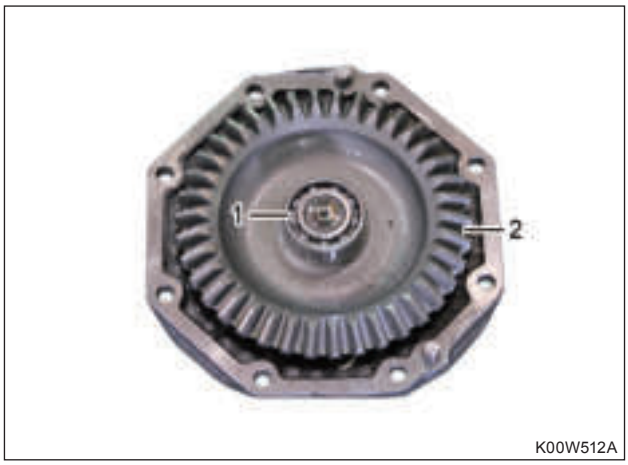
1. Unscrew the gear case cover mounting bolts (1) to remove the front spindle (2) and gear case cover (3) assembly together.

ITEM	TORQUE VALUE
Mounting bolt	51.9±6.9 N.m 5.3±0.7 kgf.m 38.2±5.0 lbf.ft



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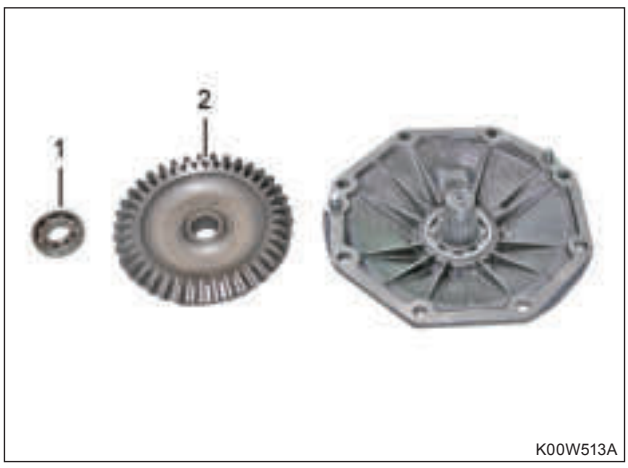

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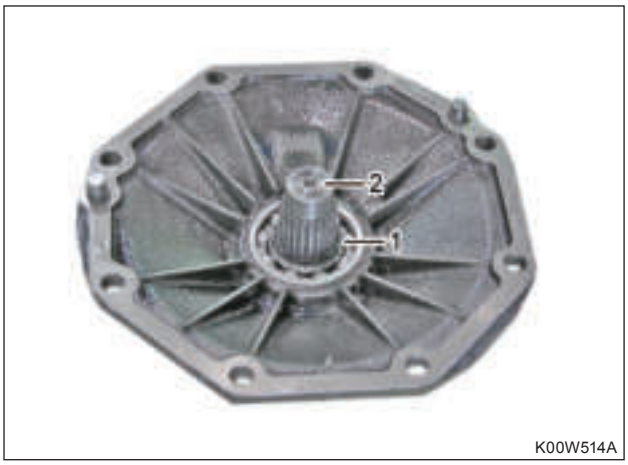
2. Remove the ball bearing (1) from the gear case cover assembly to remove the bevel gear (2).



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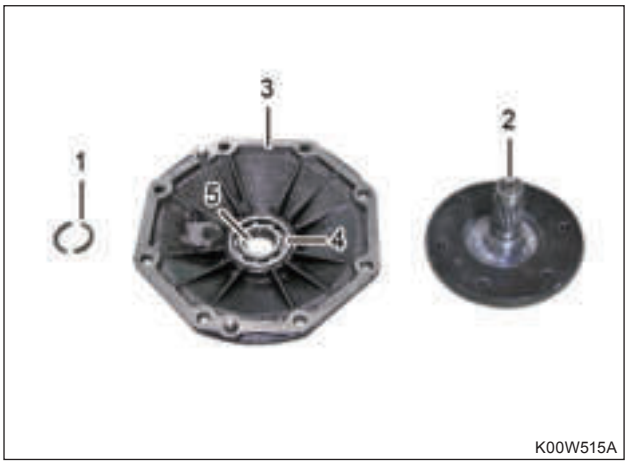

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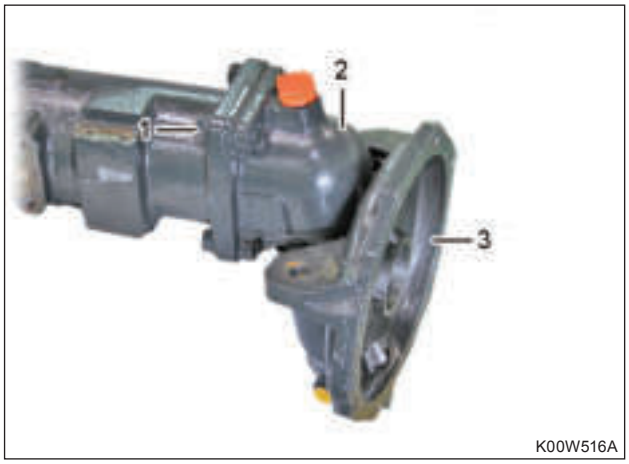
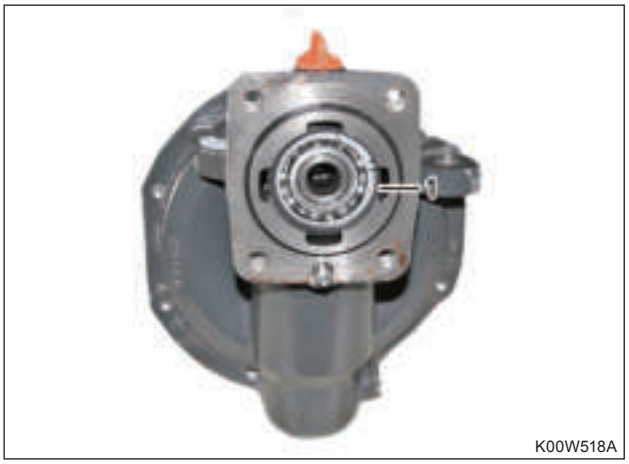
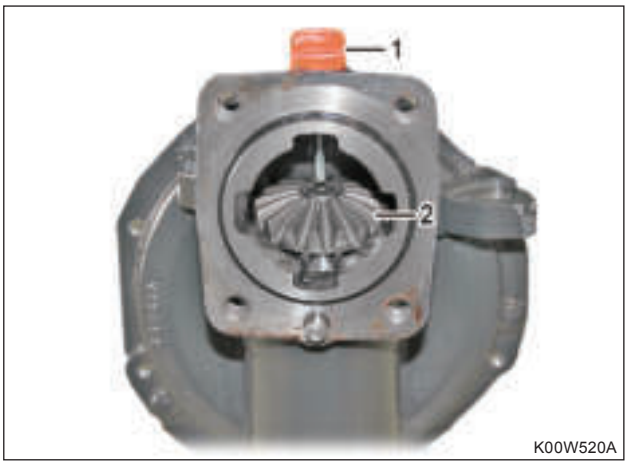
3. Remove the front spindle set collar(1) and front spindle (2) by tapping it. Then, remove the ball bearing (4) and oil seal (5) from the gear case cover (3).

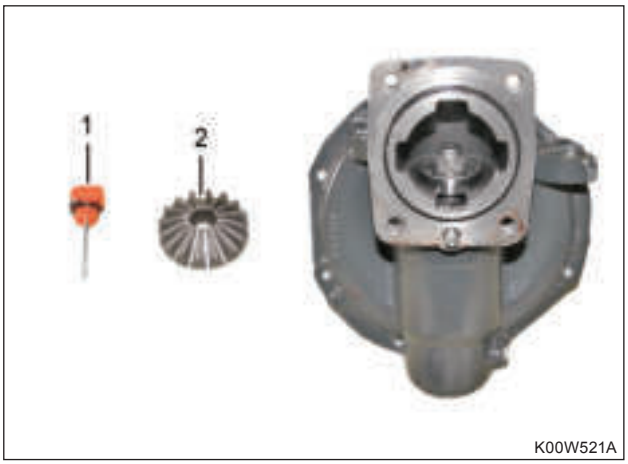


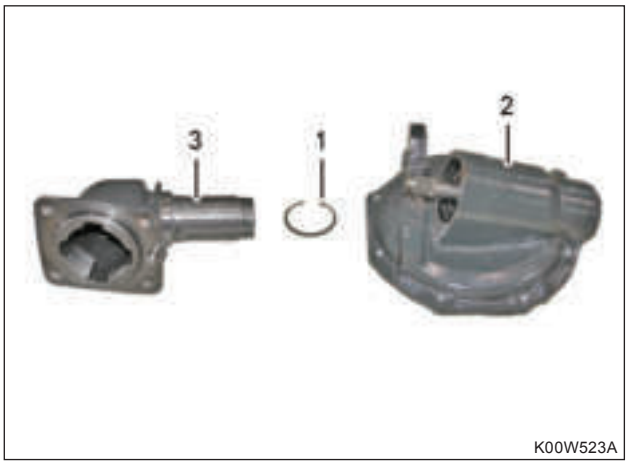


4. Unscrew the bevel gear case mounting bolts (1) to remove the bevel gear case (2) and gear case assembly (3).

5. Pull out the ball bearing fixing snap ring (1) from the bevel gear case to remove the shim (2), ball bearing (3) and 10 bevel gear (4).



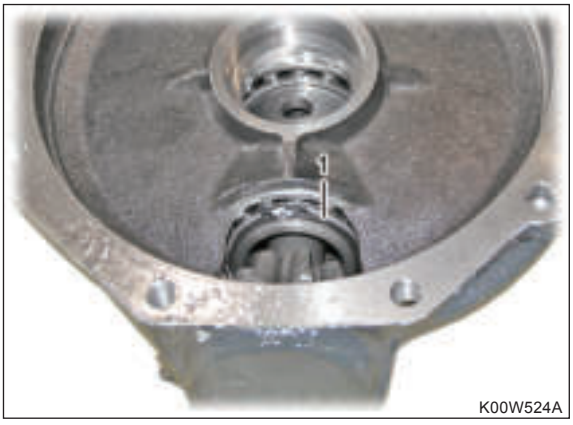




6. Pull out the oil gauge (1) from the top of the bevel gear case and remove the 16 bevel gear (2) from the inside of the case.

7. Pull out the snap ring (1) from the inside of the front axle gear case to separate the front axle gear case (2) and bevel gear case (3).

Notes



- The snap ring (1) of the front axle gear case should be disassembled and assembled simultaneously with the 9 bevel gear shaft.

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K00W526A

8. Remove the oil seal (1), ball bearing (2), snap ring (3), ball bearing (4) and 9 bevel gear shaft (5) in order from the front axle gear case assembly.

5.3 FRONT DIFFERENTIAL DISASSEMBLY

K00W527A

1. Remove the bevel gear case (RH) (1) from the front axle case assembly.

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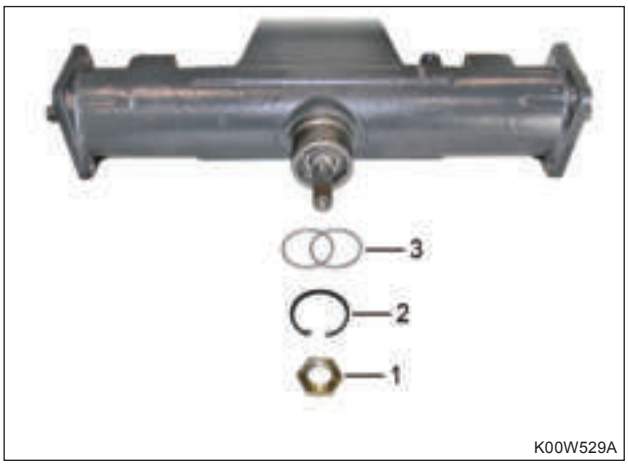

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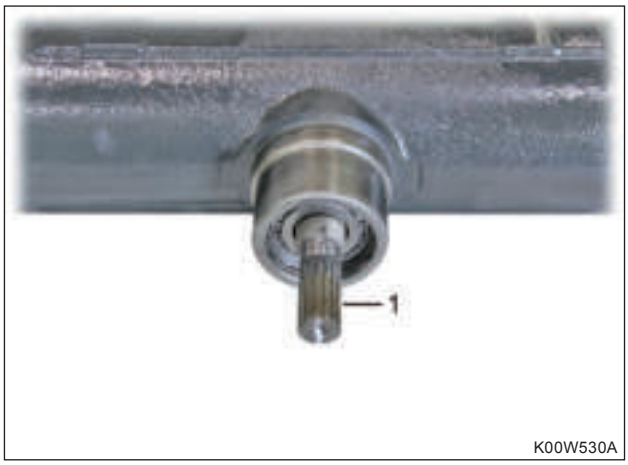
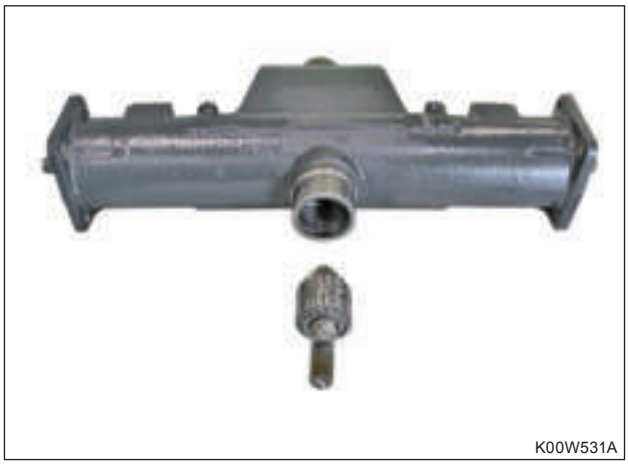
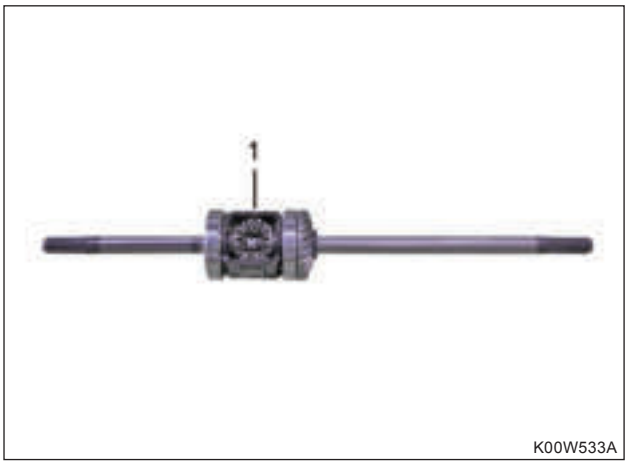
2. Unfold the bent section (A) of the lock nut (1) on the drive pinion shaft to remove the snap ring (2) and collar (3).



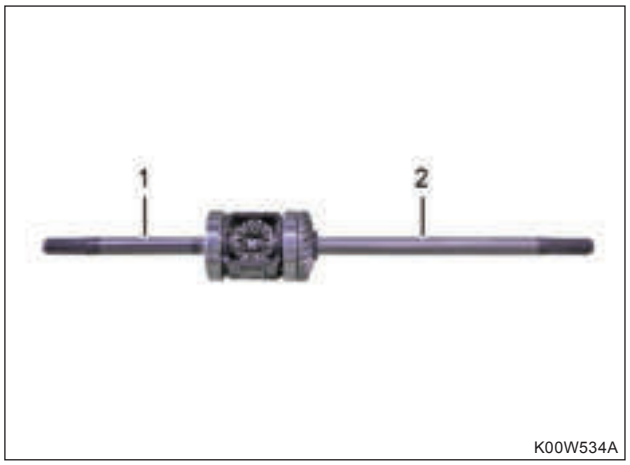


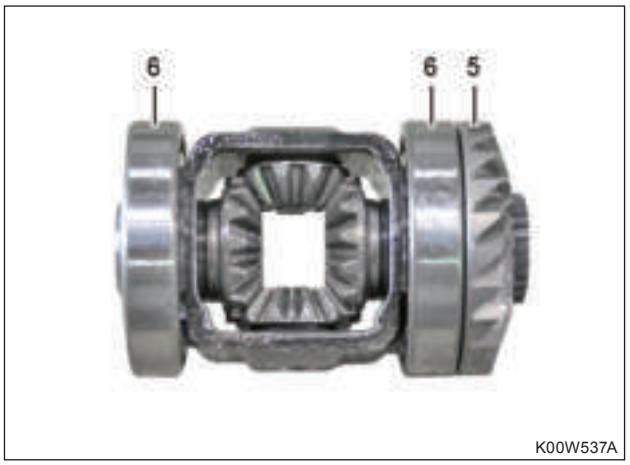


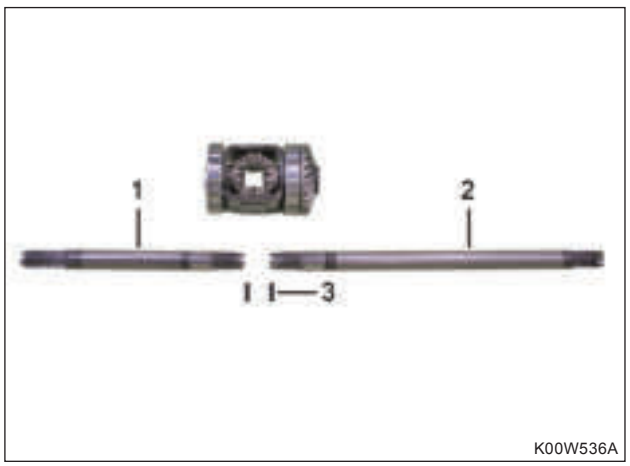
3. Remove the drive pinion assembly (1) by pulling it from the front axle case.

4. Remove the front wheel differential case assembly (1) by pulling it from the right side of the front axle case.

5.4 FRONT DIFFERENTIAL - COMPONENTS DISASSEMBLY



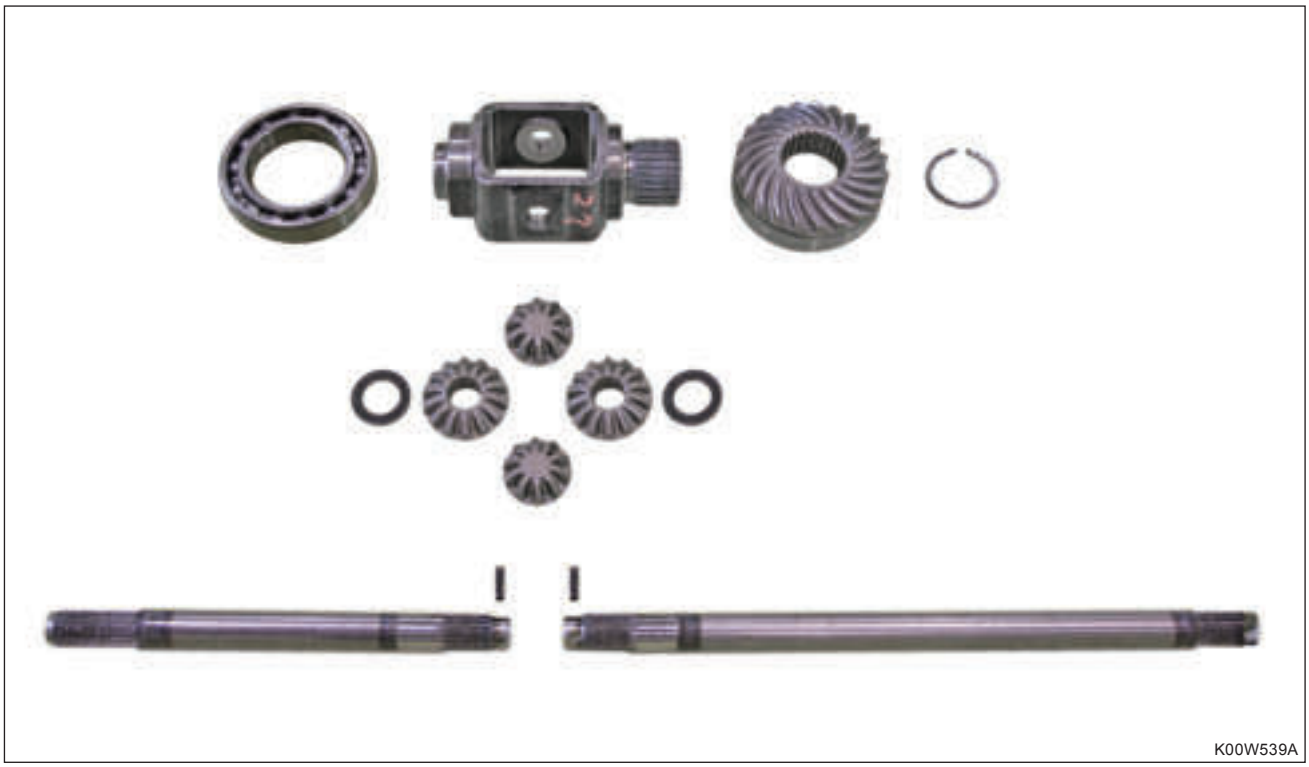




1. Pull out the spring pins (3) of the yoke shafts (LH/RH) from the front wheel differential case assembly to remove the yoke shaft (LH) (1) and (RH) (2)

2. Remove the collar (1), 14 bevel gear (2) and 10 bevel gear pinion (3) from the front wheel differential case.

3. Pull out the needle bearing fixing snap ring (4) to remove the ring gear (5) and ball bearing (6) from the front wheel differential case.



4. Assemble in the reverse order of disassembly.

CHAPTER 6 HYDRAULIC SYSTEM

TABLE OF CONTENTS

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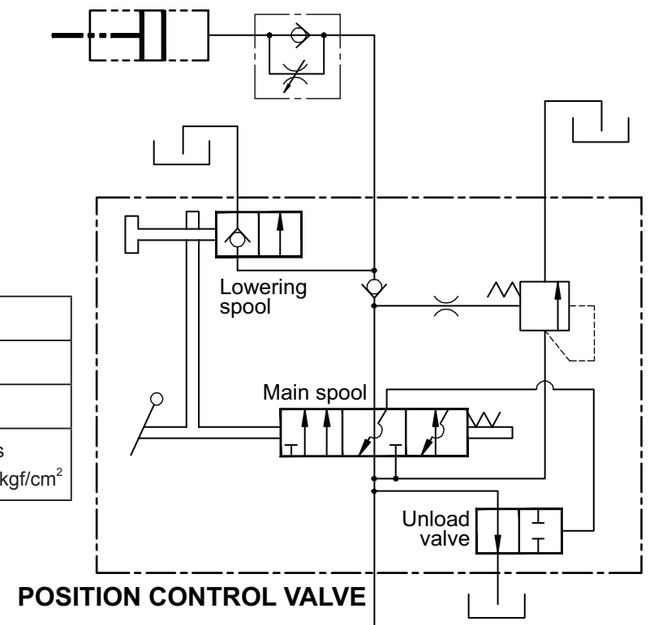
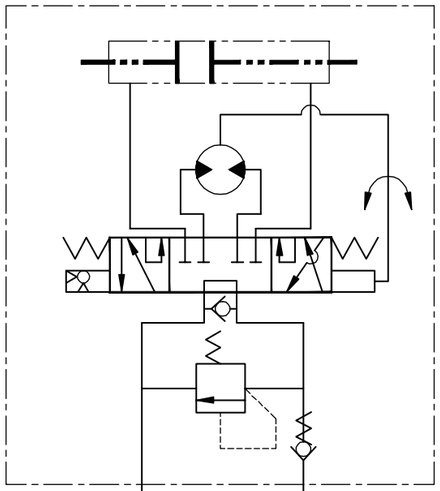
1. CIRCUIT DIAGRAM FOR HYDRAULIC SYSTEM

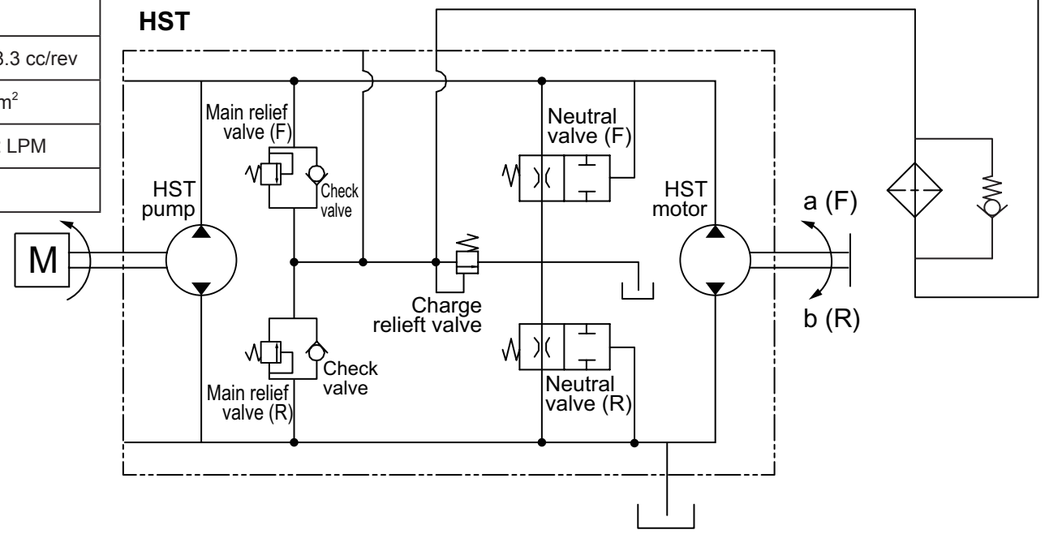
POSITION CONTROL VALVE	
Max. operating flow	16 L/min
Max. operating pressure	160 kgf/cm^2
Leak capacity (When neutral)	5 cc/min or less (at oil temp. 45°C, 80 kgf/cm^2

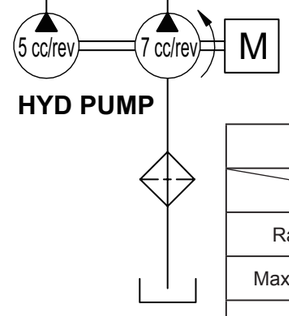




POWER STEERING UNIT	
Max. Impact pressure	130 kgf/cm^2
Rated flow	16 L/min
Max. temperature	95°C
Displacement	63 cc/rev
Input torque	0.1 ~ 0.2 kgf·m 1.0 ~ 2.0 N·m 0.7 ~ 1.4 lb·ft
Reliref valve pressure	130 kgf/cm^2 at 16 lpm
Filter	Nominal 10 μm
Max. back pressure	("T" Port) 10 kgf/cm^2
Slippage	Max. 2 rpm Input torque 1.2 kgf·m 11.8 N·m 8.7 lb·ft
Steering system	Open center non load reaction

HST SEPC	
Pump & Motor spec	0 ~ 18.3 cc/rev & 18.3 cc/rev
Charge relief	6 ± 0.5 kgf/cm^2
Cranking pressure	350 kgf/cm^2 at 2 LPM
Swash plate angle	0 ~ ± 17°





PUMP SPEC		
	PUMP 1	PUMP 2
Rated flow(cc/rev)	7.0	5.0
Max pressure(kgf/cm^2)	180	
RPM	600 ~ 3,500	
Rotation direction (Viewed from shaft end)	C.C.W	

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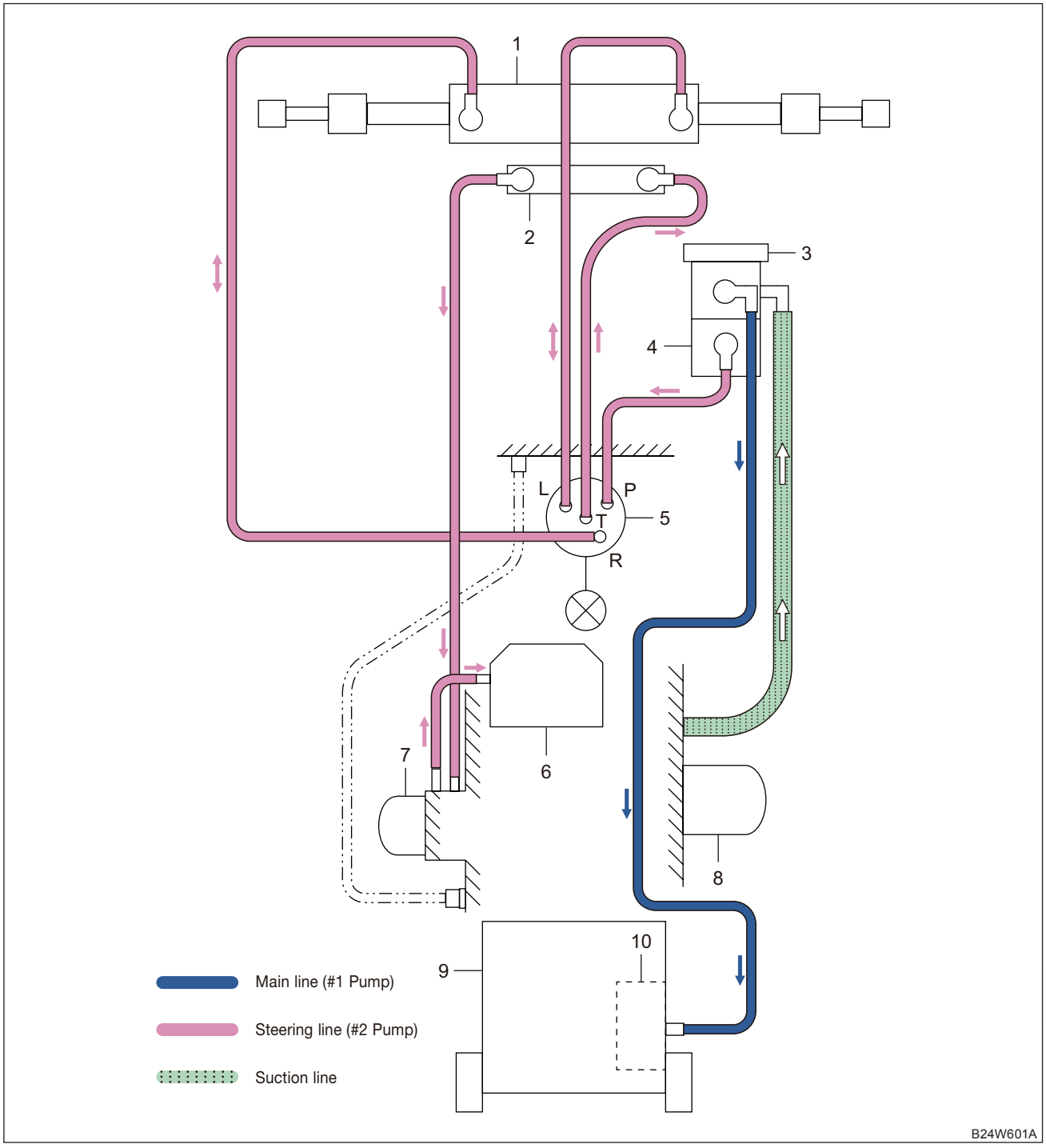
2. DIAGRAM FOR HYDRAULIC SYSTEM



(1) PST cylinder
(2) Oil cooler
(3) Hydraulic pump (#1: 3-point link)
(4) Hydraulic pump (#2: Steering)
(5) PST unit
(6) HST
(7) HST filter
(8) Hydraulic oil filter
(9) Hydraulic cylinder case
(10) Position control valve

The hydraulic system can be divided into two parts; 3-point link section and steering section. Firstly, the 3-point link section receives hydraulic oil from the primary gear pump (7.0 cc/rev.) and supplies this oil to the position control valve for rear implement operation.

Secondly, the steering section receives hydraulic oil from the secondary gear pump (5.0 cc/rev.) and supplies this oil to the PST unit for power steering.

Hydraulic oil supplied from the secondary gear pump is used to operate the PST valve. Then, it is carried from the PST valve into the oil cooler to be cooled down to a sufficient level. After cooled, it is led into the HST filter to be filtered and it is delivered to the HST for HST operation.

3. MAJOR COMPONENT SPECIFICATIONS

3.1 PST UNIT

TYPE	OPEN CENTER, NON-LOAD REACTION TYPE INTEGRAL RELIEF VALVE	
Relief valve setting pressure	12.7 MPa 130 kgf/cm^2 1,849 psi	at 16 ℓ/min
Capacity	63 cc/rev	
Rated flow	16 ℓ/min	
Max. impact pressure	12.7 MPa 130 kgf/cm^2 1,849 psi	
Maximum back pressure	0.98 MPa 10 kgf/cm^2 142 psi	
Max. temperature	95 °C 203 °F	
Steering input torque (when energized)	0.98 - 1.96 N.m 0.1 - 0.2 kgf.m 0.72 - 1.44 lbf.ft	Reference
Filter	Nominal 10 μm	

3.2 HYDRAULIC PUMP

	Primary pump	Secondary pump
Theoretical discharge volume	7.0 cc/rev	5.0 cc/rev
Maximum pressure	180 kgf/cm^2	
Revolving speed	600 - 3,500 rpm	
Turning direction (when seeing from end of shaft)	Counterclockwise	
Relief setting pressure	140 kgf/cm^2	

3.3 POSITION CONTROL VALVE

Max. operating flow	16 ℓ/min.
Max. operating pressure	160 kgf/cm^2

3.4 HST

Displacement	Pump	0 ~ 18.3 cc/rev
	Motor	18.3 cc/rev
Pump swash plate angle		0 ~ ± 17°
Power input rotate direction		C.W (View on shaft end)
Charge relief set pressure		6 ± 0.5 kgf/cm^2
Filter		10 μm
Cranking pressure		350 kgf/cm^2 at 2 ℓ/min

3.5 PST CYLINDER

Type	Double-rod double acting type
Rod O.D.	Ø 25 mm
Cylinder I.D.	Ø 50 mm
Stroke	135 mm
Relief setting pressure	110 kgf/cm^2

3.6 HYDRAULIC FILTER

Filtering area	1,963 cm^2
Max. fineness	120 ± 5 μm
Rated flow	30 LPM

3.7 HST FILTER

Filtering area	1,344 cm^2
Max. fineness	110 ± 8 μm

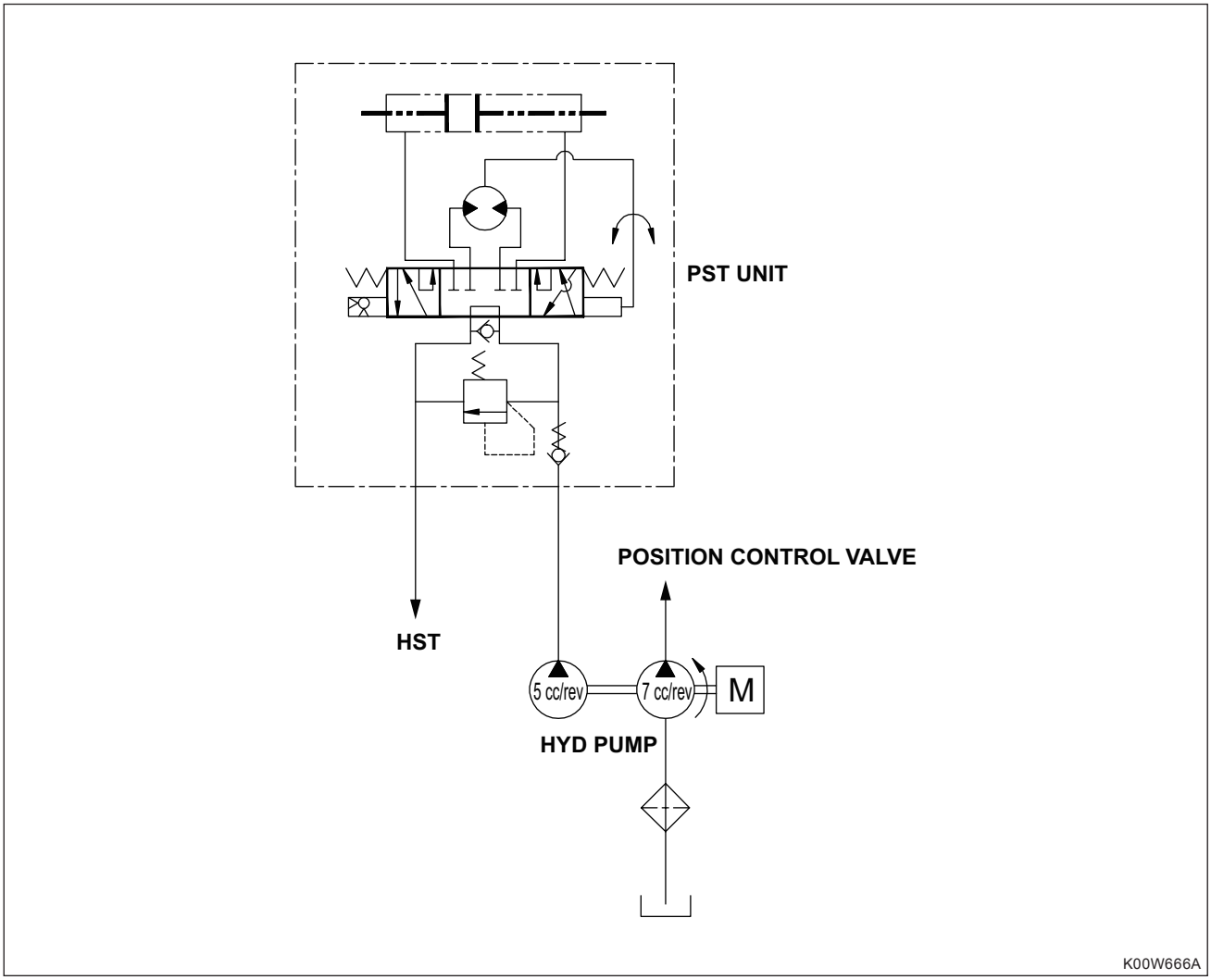
4. TIGHTENING TORQUE FOR MAJOR COMPONENTS

MAJOR COMPONENTS		TORQUE VALUE
Power Steering Body	Steering column mounting screw	48.1 N.m 4.9 kgf.m 35.4 lbf.ft
	Valve housing mounting hex. Head screw	23.5 - 27.5 N.m 2.4 - 2.8 kgf.m 17.4 - 20.3 lbf.ft
	Delivery pipe nut for power steering	65.0 - 75.0 N.m 6.6 - 7.7 kgf.m 47.9 - 55.3 lbf.ft
Hydraulic Pump	Cover mounting screw	23.5 - 27.5 N.m 2.4 - 2.8 kgf.m 17.4 - 20.3 lbf.ft
Hydraulic Cylinder	Connecting plate mounting screw	48.1 - 55.9 N.m 4.9 - 5.7 kgf.m 35.4 - 41.2 lbf.ft
	Hydraulic cylinder mounting screw and nut	48.1 - 55.9 N.m 4.9 - 5.7 kgf.m 35.4 - 41.2 lbf.ft
	Delivery pipe joint bolt	33.3 - 38.2 N.m 3.4 - 3.9 kgf.m 24.6 - 28.2 lbf.ft
	Control valve mounting screw	23.6 - 27.4 N.m 2.4 - 2.8 kgf.m 17.4 - 20.2 lbf.ft
	Relief valve plug	49.0 - 68.6 N.m 5.0 - 7.0 kgf.m 36.2 - 50.6 lbf.ft

5. STRUCTURE AND OPERATION

5.1 STEERING UNIT

5.1.1 OVERVIEW



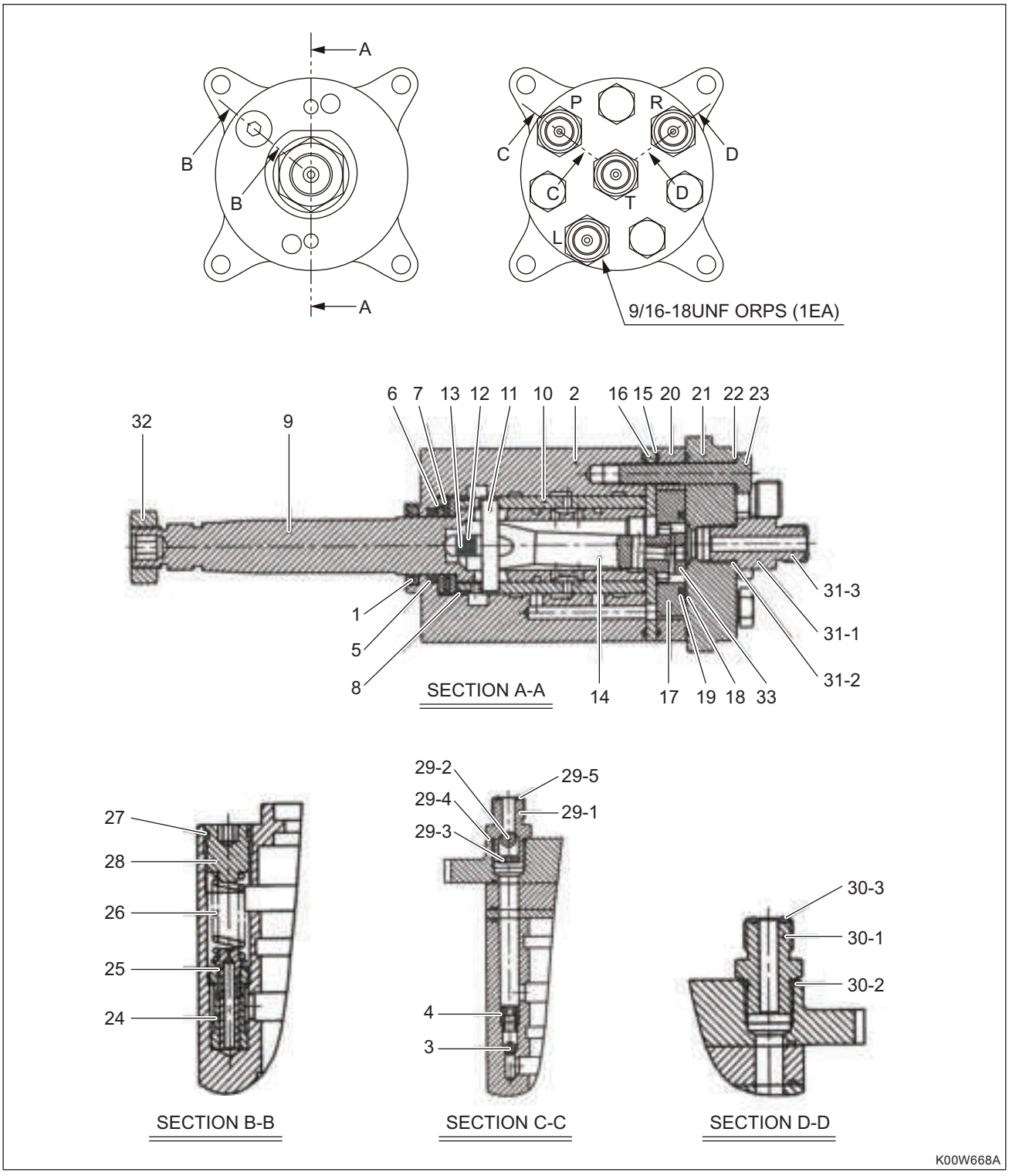
Hydraulic oil from the hydraulic pump (secondary) is supplied to the steering unit (1) which is installed under the steering wheel.

When the engine is started, oil is supplied to the left or right of the PST cylinder according to the turning direction of the steering wheel. Then, the corresponding PST cylinder is extended or retracted to turn the vehicle to the desired direction.

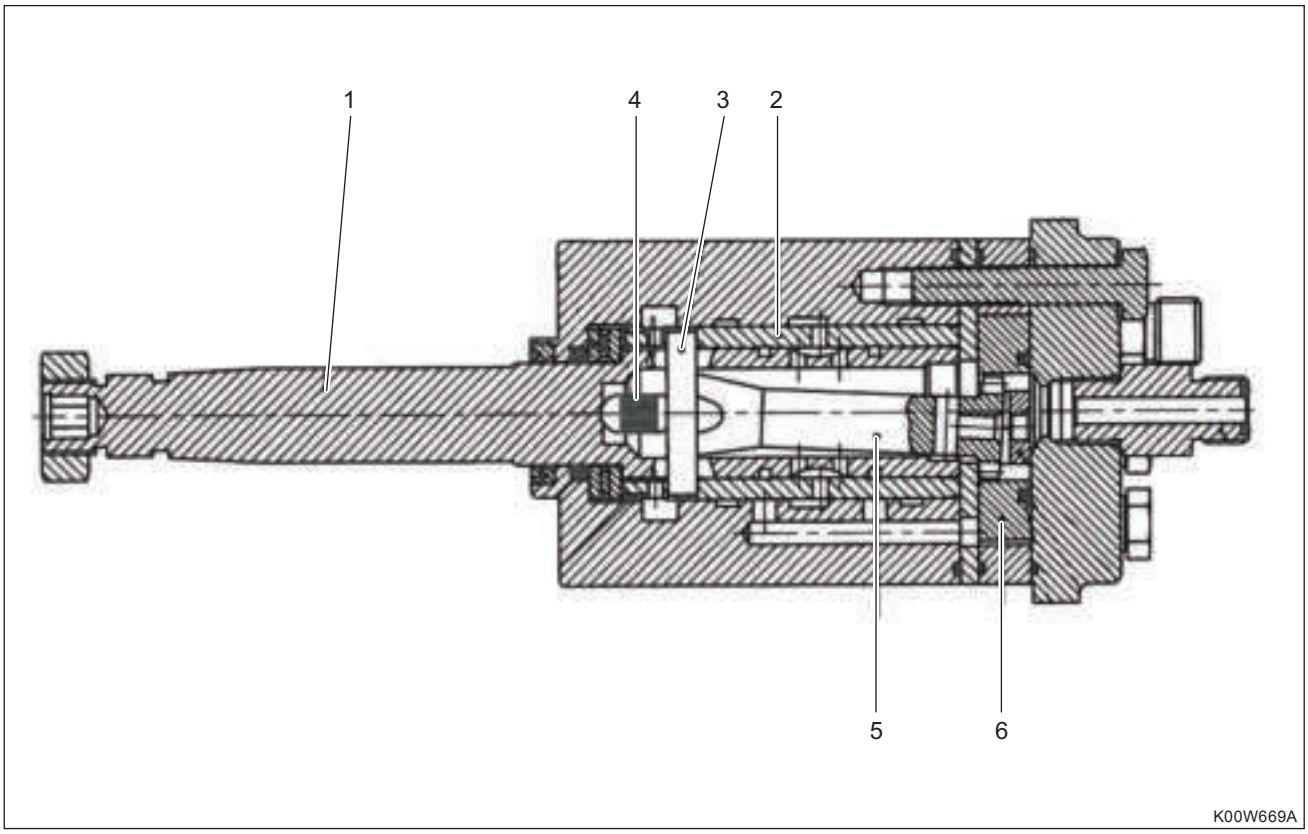
Then, oil used from the PST cylinder is returned to the tank through the steering unit, return hose and HST and it is recirculated by the pump to be used again.

This steering unit is a non-load reaction type which means that the steering wheel is not returned automatically once it is turned to one side.

5.1.2 INTERNAL STRUCTURE AND OPERATING PRINCIPLE



(1) Dust seal
(2) Housing
(3) Ball
(4) Thread pin
(5) Cap seal
(6) Bearing race
(7) Thrust bearing
(8) Ring-sleeve
(9) Spool
(10) Sleeve
(11) Pin
(12) Centering spring
(13) Plate spring
(14) Drive
(15) O-ring
(16) Plate
(17) Inner rotor
(18) Slide ring
(19) O-ring
(20) Outer rotor
(21) End plate
(22) Washer
(23) Cap screw
(24) Relief bushing
(25) Relief spool
(26) Spring
(27) O-ring
(28) Control screw
(29) Port check valve
(29-1) Body check
(29-2) Ball
(29-3) Retainer
(29-4) O-ring
(29-5) O-ring
(30) Port connector
(30-1) Body-port
(30-2) O-ring
(30-3) O-ring
(31) T-port connector
(31-1) Body T-port
(31-2) O-ring
(31-3) O-ring
(32) Nut
(33) Spacer



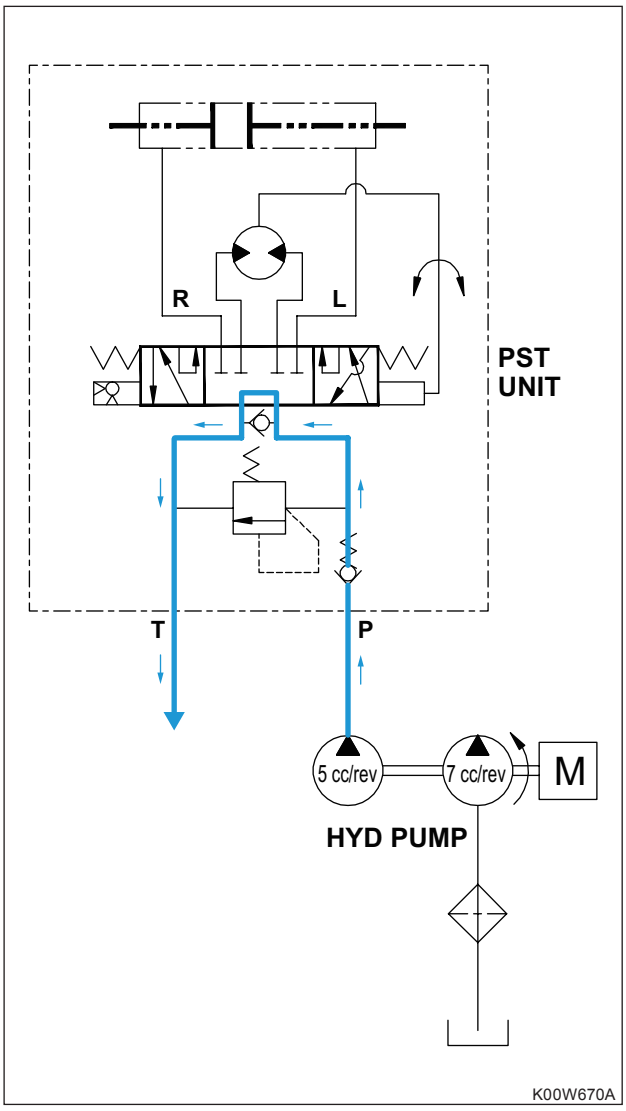
(1) Spool
(2) Sleeve
(3) Pin
(4) Plate spring
(5) Drive shaft
(6) Gerotor (inner rotor)

The steering wheel is engaged with the steering unit spool (1) with splines. Therefore, when the steering wheel is turned, the spool is turned as well. The spool (1) is covered with the sleeve (2) and these are fixed by the pin (3). Therefore, when the spool is turned by the steering wheel, this pin is rotated as well to turn the sleeve. The inside diameter of the pin hole of the sleeve is matched to the outside diameter of the pin, so the pin fits to the hole tightly. However, the pin hole of the spool is larger than the pin. Therefore, when the spool is rotated, the sleeve cannot be rotated with the spool immediately, but it is rotated approx. 10 degrees (the amount of free play of the spool pin hole) behind the spool. For example, when the steering wheel is being turned clockwise, the sleeve is turned approx. 10 degrees behind the spool, so the holes for the right turn among the holes of the sleeve and spool are aligned to supply hydraulic oil to the steering cylinder for right turn. When the steering wheel is stopped, the spool is stopped simultaneously but the sleeve turns 10 degrees further before stopping. This is because the plate spring (4) binds the spool and sleeve and it exerts a force to return the relative positions of the spool and sleeve to the neutral positions. Since force of this spring is not so strong, so it does not have any effect when the steering wheel is being turned. However, when the steering wheel is stopped, it returns the spool and sleeve to the neutral position. Then, the neutral holes among the several holes of the spool and sleeve are aligned, so the steering cylinder does not move, keeping its original position.

On the other side, when the steering wheel is turned, the spool rotates and turns the sleeve through the pin, but it turns the drive shaft (5) as well. Then, this drive shaft turns the inner rotor (6) of the Gerotor pump under the steering unit. This Gerotor pump is to enable steering even when the engine is stopped. When the steering wheel is turned, the rotor in the Gerotor is rotated to produce and supply hydraulic oil to the steering cylinder.

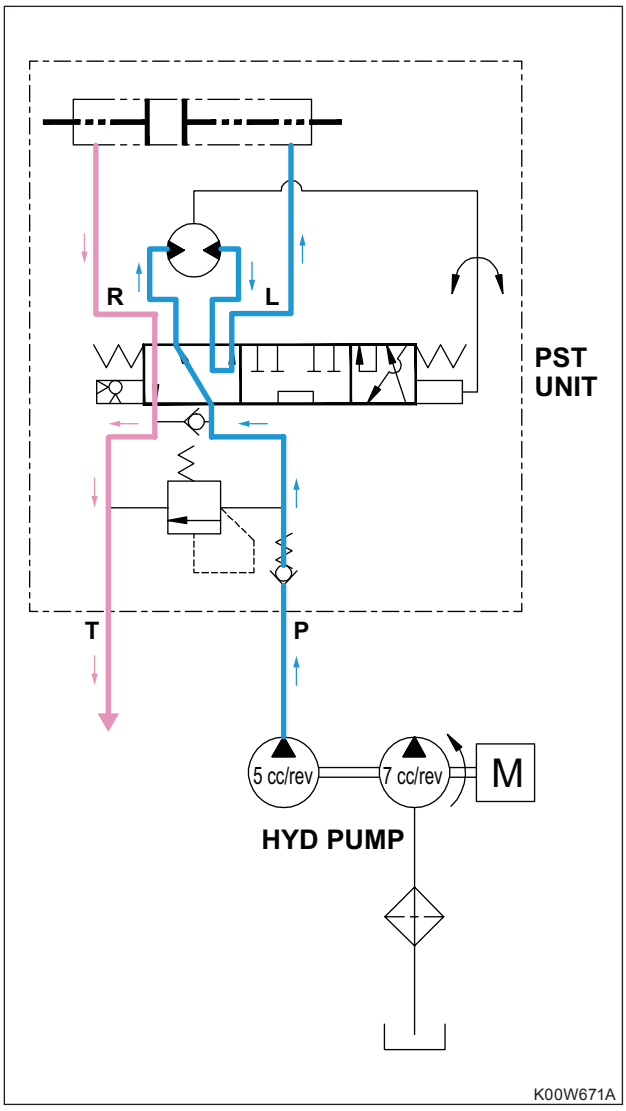
5.1.3 EXAMPLES OF STEERING WHEEL OPERATION

NEUTRAL



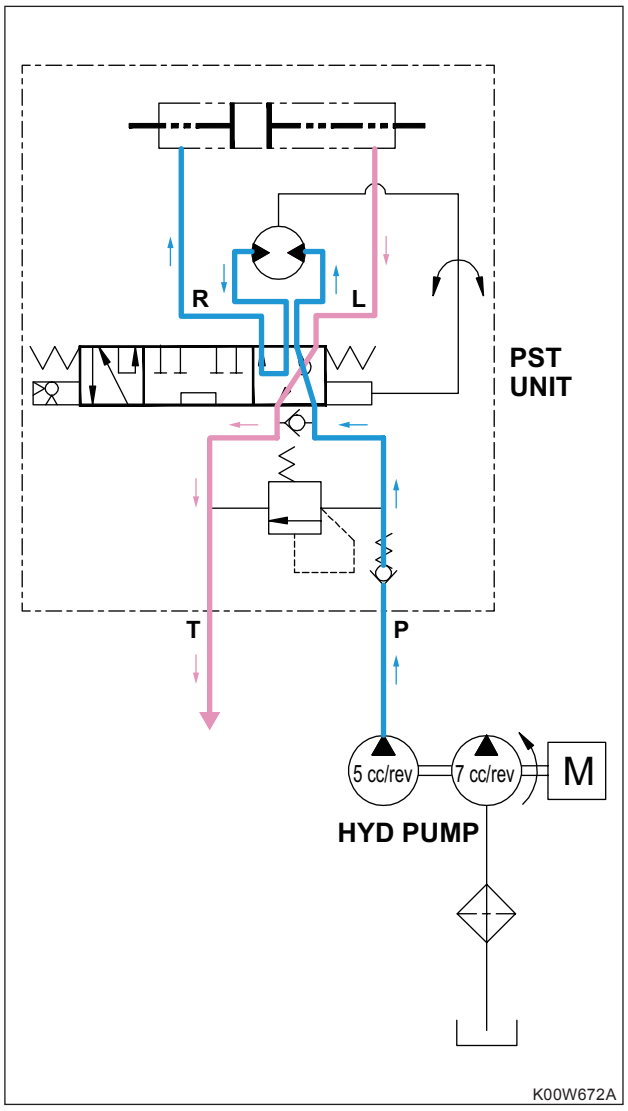
Hydraulic oil delivered from the secondary gear pump is sent to the PST unit through the port P. When the steering wheel is stopped, only the neutral holes of the spool and sleeve of the PST unit are aligned, so hydraulic oil at the port P is returned through the port T and is supplied to the HST side.

LEFT TURN



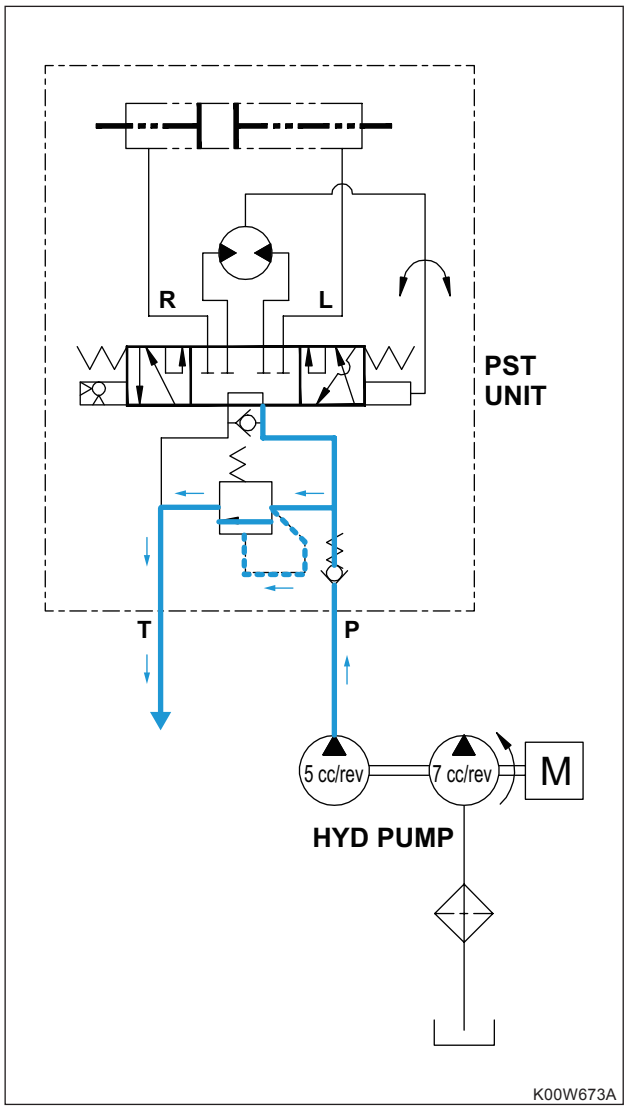
When the steering wheel is turned counterclockwise, the sleeve is turned counterclockwise approx. 10 degrees behind the spool, so the oil holes of the spool and sleeve for the left turn operation are aligned. Therefore, hydraulic oil at the port P is passed through the spool, sleeve and Gerotor and is supplied to the right port of the PST cylinder through the port L. On the other hand, hydraulic oil at the left port of the PST cylinder is flowed through the port R, returned through the return holes of the spool and sleeve for left turn and port T, and delivered to the HST. Therefore, the HST receives the same amount of hydraulic oil whether the steering wheel is turned or not.

RIGHT TURN



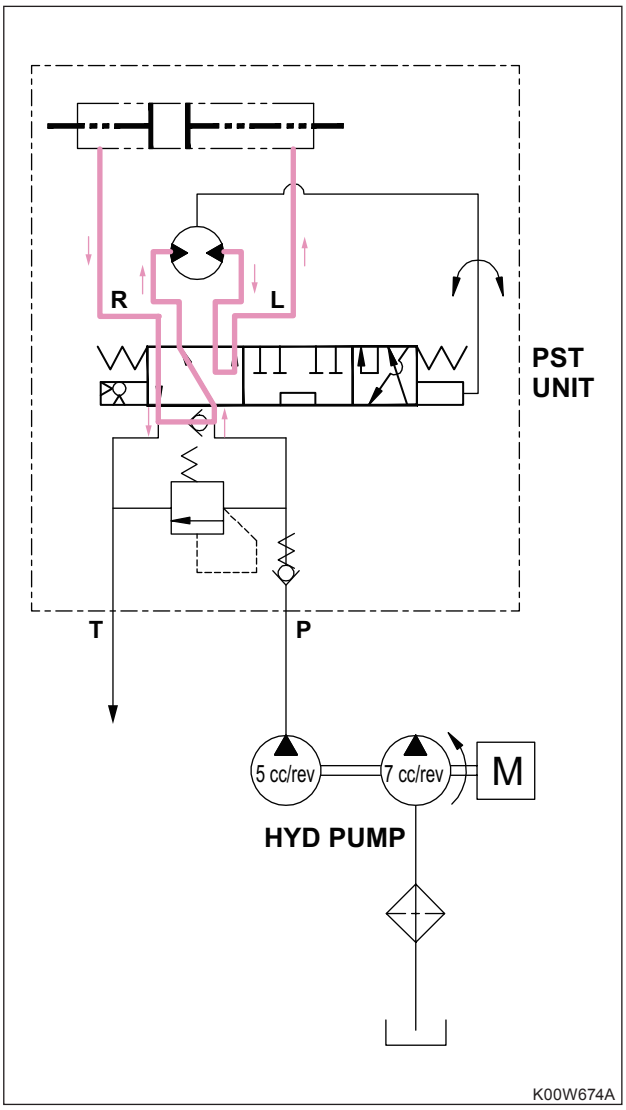
When the steering wheel is turned clockwise, the sleeve is turned clockwise approx. 10 degrees behind the spool, so the oil holes of the spool and sleeve for the right turn operation are aligned. Therefore, hydraulic oil at the port P is passed through the spool, sleeve and Gerotor and is supplied to the left port of the PST cylinder through the port R. On the other hand, hydraulic oil at the right port of the PST cylinder is flowed through the port L, returned through the return holes of the spool and sleeve for right turn and port T, and delivered to the HST.

OPENING RELIEF VALVE



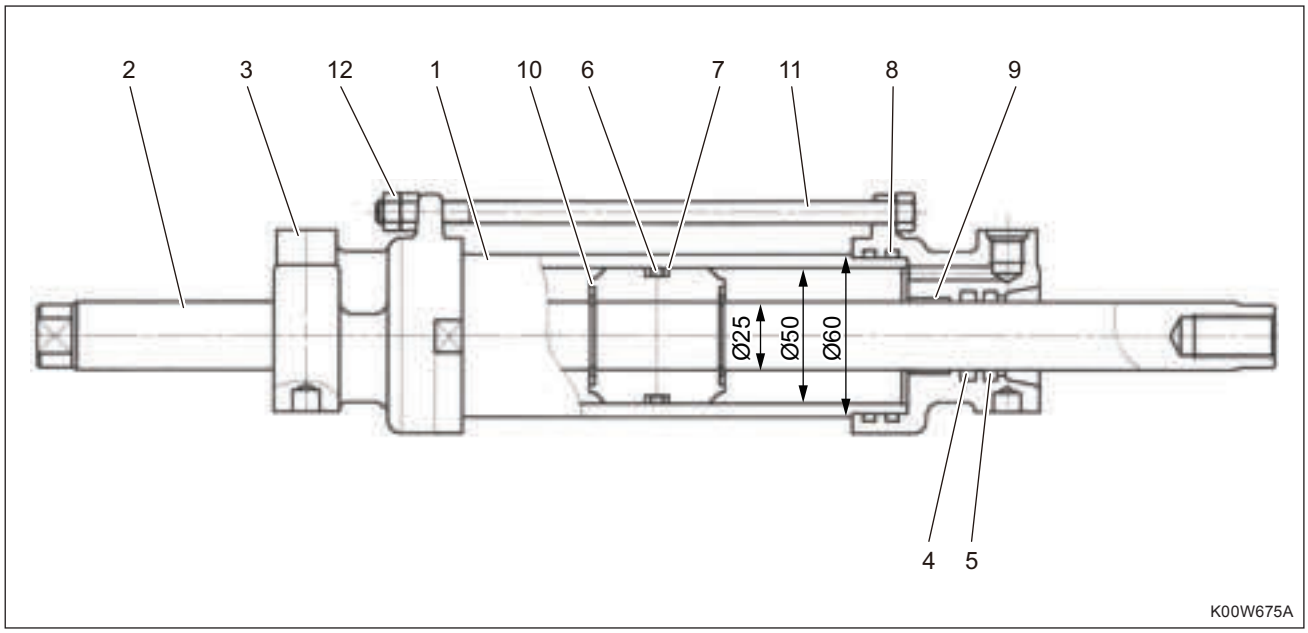
When the PST cylinder is moved to the left or right end and there is no more space to move further, pressure of hydraulic oil flowed through the port P increases over the relief valve setting pressure, 130 kgf/cm^2, resulting in opening of the relief valve. Then, hydraulic oil flowed through the port P is passed through the relief valve, returned through the port T, and delivered to the HST.

MANUAL STEERING (LEFT TURN)



When the steering wheel is turned with the engine stopped, the spool, sleeve and Gerotor pump are rotated as described previously. For example, when the steering wheel is manually turned counterclockwise, hydraulic oil at the left side of the PST cylinder is sucked through the port R and is flowed to the Gerotor through the sleeve and spool. Then, after hydraulic oil is pressurized in the Gerotor, it is flowed into the left side of the check valve through the spool and sleeve and leaves the right side of the unit. Finally, it passes through the spool, sleeve and port L and flows into the right port of the PST cylinder to complete the manual left turn operation. For right turn, hydraulic oil is sucked through the port L from the right port of the PST cylinder and is flowed into the left port of the PST cylinder through the port R to complete the manual right turn operation.

5.2 PST CYLINDER

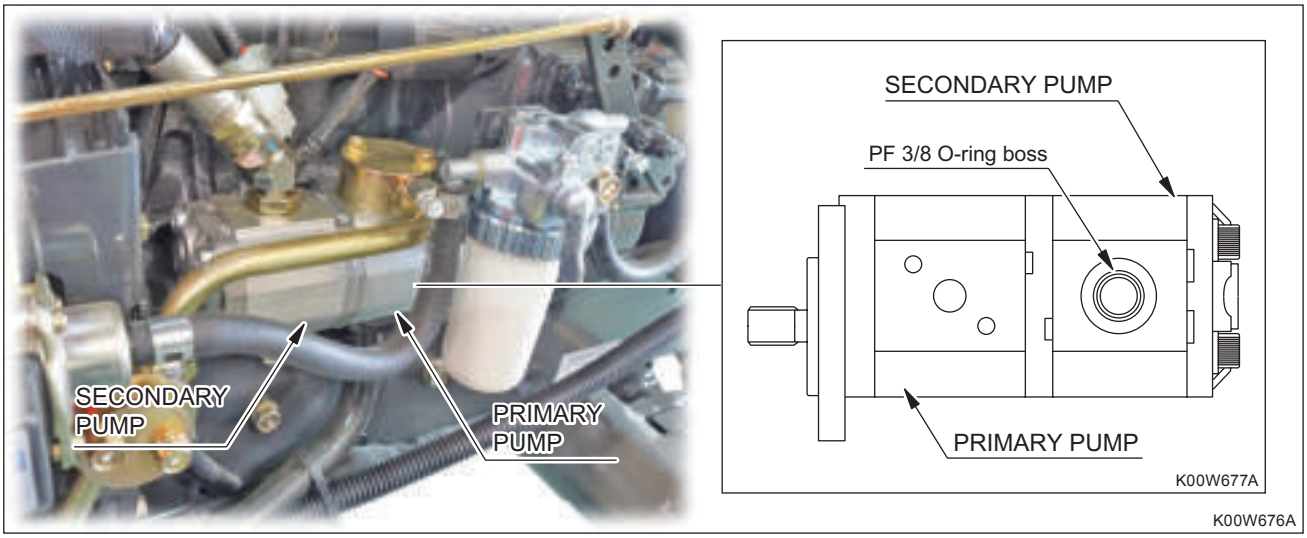


(1) Tube (Honing pipe)
(2) Piston rod assembly
(3) Cylinder cap
(4) U-packing
(5) Dust seal
(6) O-ring
(7) Backup ring
(8) O-ring
(9) Bush (25 x 15)
(10) Stop ring (type C)
(11) Bolt
(12) Nut

The PST cylinder is a double-rod double acting type cylinder which performs double rod operation for steering without a need of a separate tie rod.

ITEM	SPECIFICATIONS
Type	Double-rod double acting piston
Rod O.D. (mm)	Ø 25
Cylinder I.D. (mm)	Ø 50
Cylinder O.D. (mm)	Ø 60
Stroke (mm)	135
Relief setting pressure	110 kgf/cm^2

5.3 HYDRAULIC PUMP



The hydraulic pump is a gear type and consists of the primary pump as the main pump (7.0 cc/rev) and secondary pump as the steering pump (5.0 cc/rev). The drive shaft receives engine power directly through the drive gear of the engine crankcase.

- Pump capacity (at rated engine RPM)

  Primary pump: 7.0 cc/rev. X 2,600 rpm = 18.2 lpm

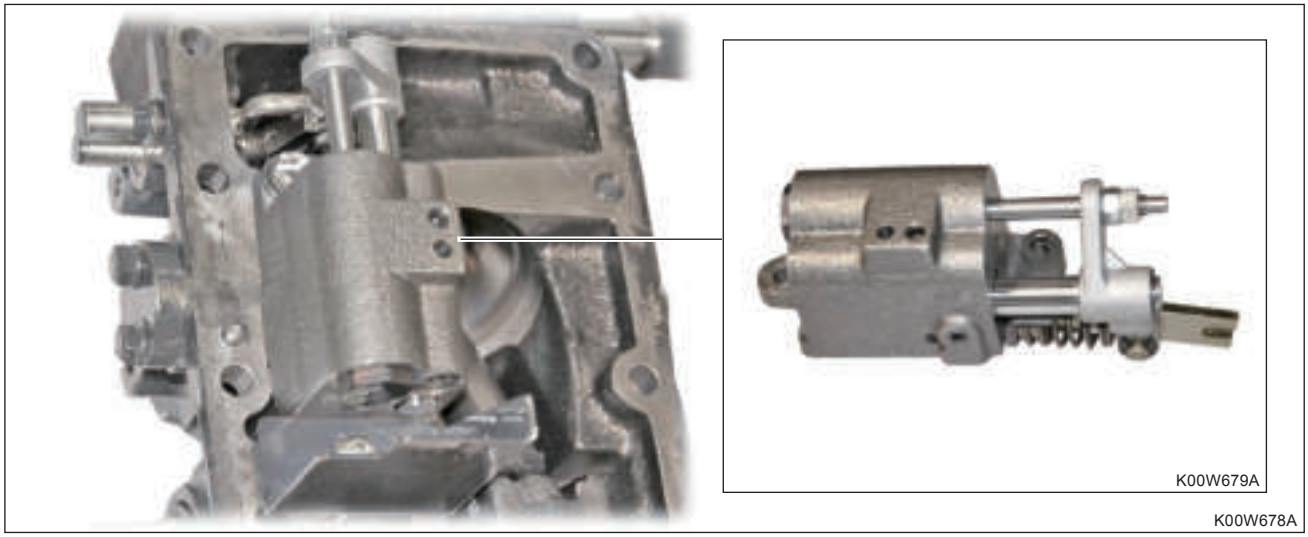
  Secondary pump: 5.0 cc/rev. X 2,600 rpm = 13.0 lpm

▶ PUMP SPECIFICATIONS

ITEM	MAIN PUMP (PRIMARY PUMP)	STEERING PUMP (SECONDARY PUMP)
Theoretical discharge volume	7.0 cc/rev	5.0 cc/rev
Maximum pressure	180 kgf/cm^2	←
Rotating direction	Counterclockwise	←
Operating oil	TF 500	←
Usable oil temperature range	-20 ~ 90 ℃	←
Relief setting pressure	140 kgf/cm^2	←
Max. usable turning speed	2,194 rpm	←
Pressure on suction side	-0.2 - 1.0 kgf/cm^2	←

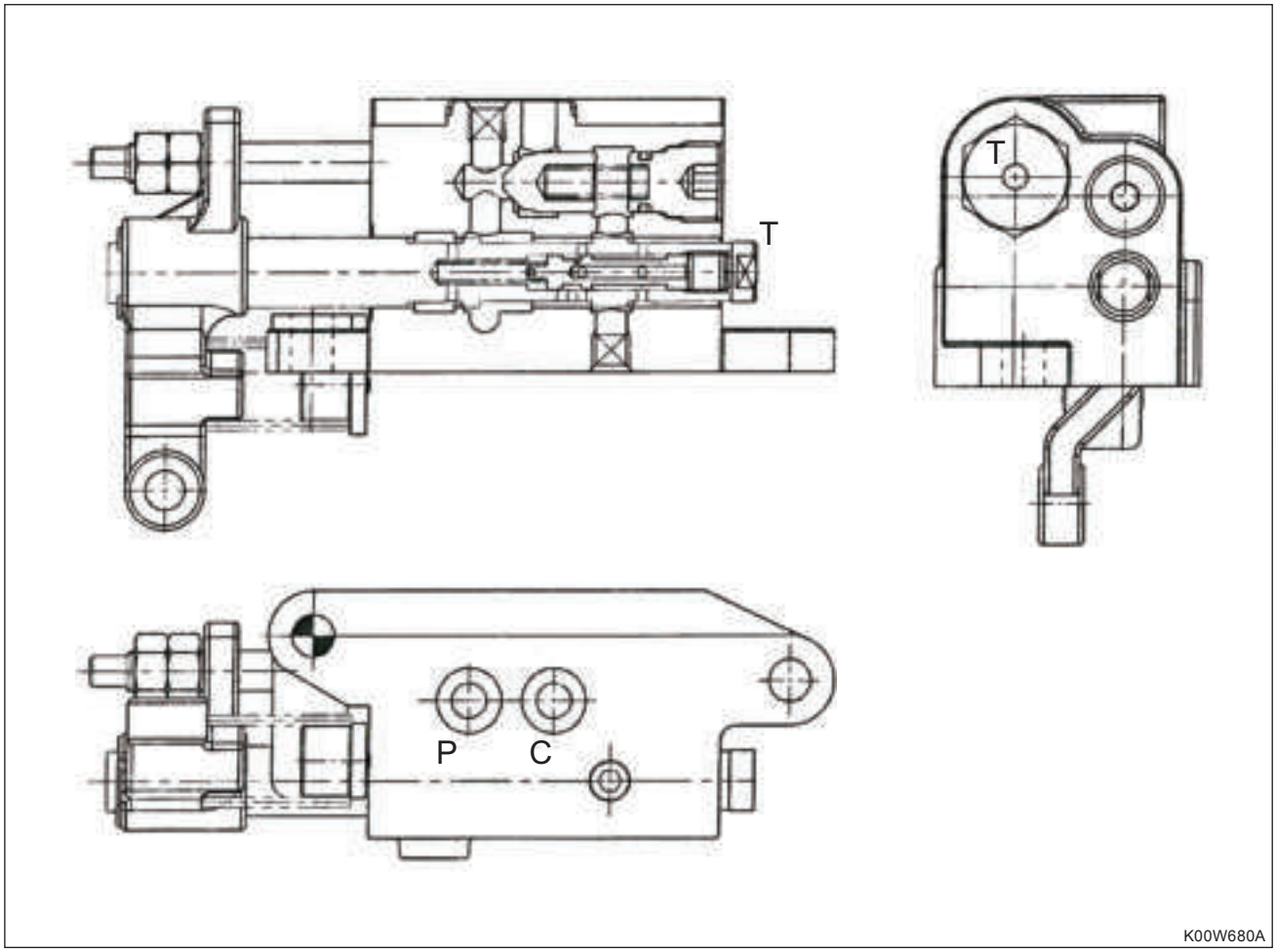
5.4 POSITION CONTROL VALVE

▶ OVERVIEW

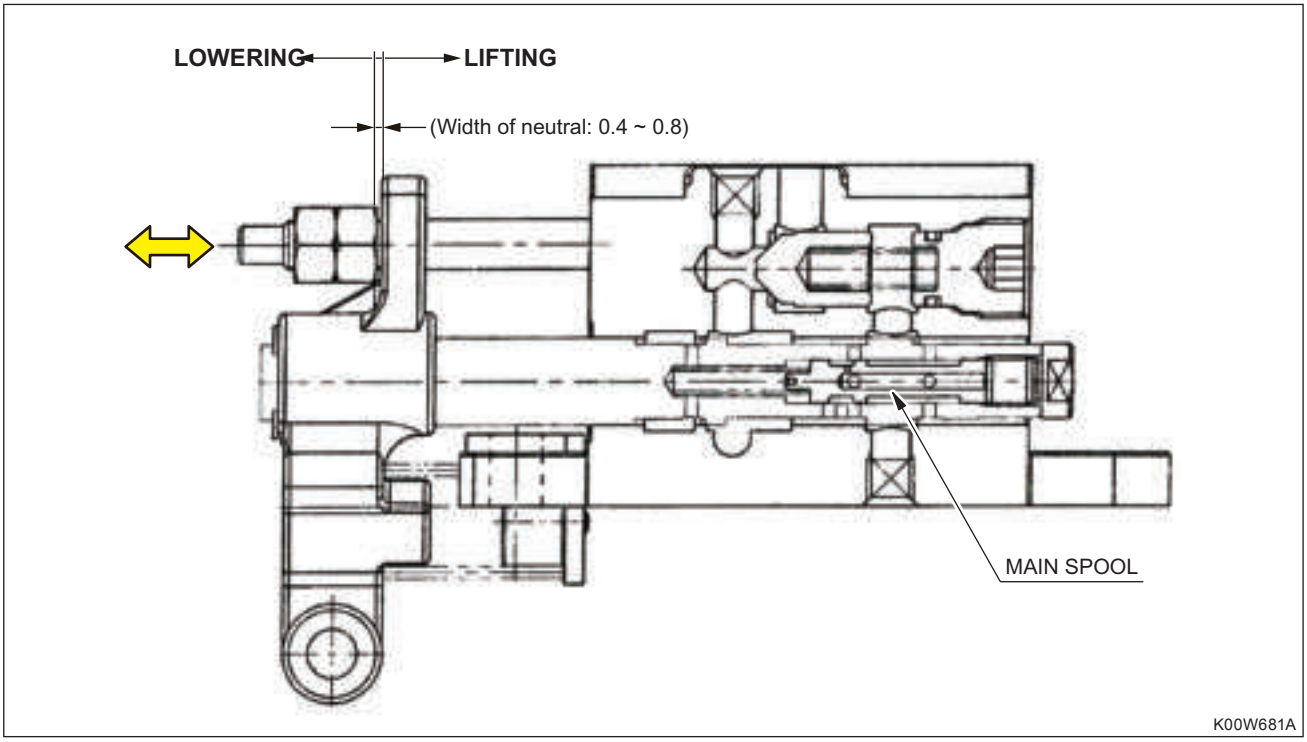


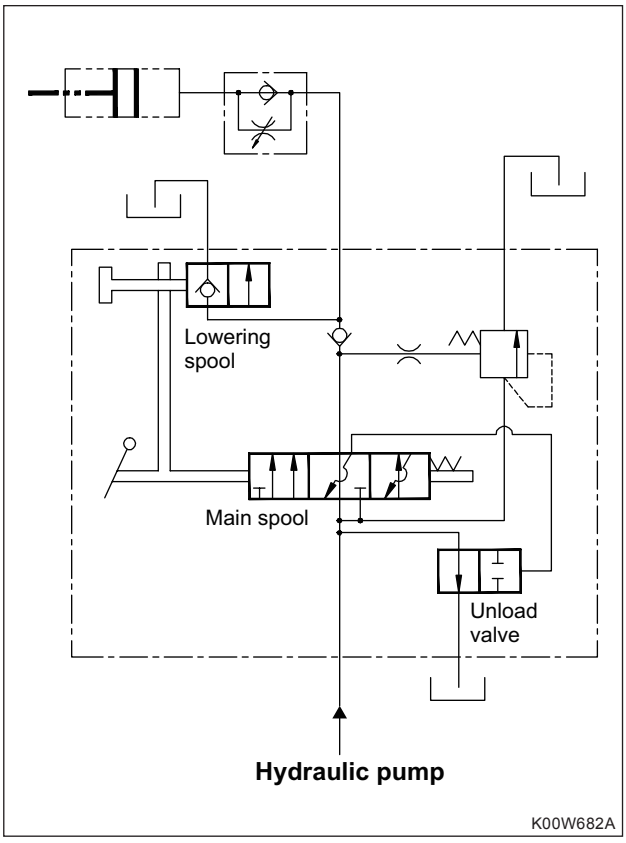
The control valve is installed in the hydraulic cylinder cover and it receives oil at a high pressure from the hydraulic pump. The internal spool is operated according to the position of the control lever to lift or lower the lift arm or set it in the neutral status.

▶ STRUCTURE



▶ OPERATING PRINCIPLE





This valve is operated by connecting the link in the lift cylinder mechanically to the position lever that the driver operates. The main spool of the control valve is pushed in or out according to the position of the lever in order to lift or lower the lift arm.

For example, if the position ordered by the position control lever is higher than the current position of the lower link, the main spool of the valve is pushed in by the link structure set in the hydraulic cylinder case. Then, hydraulic oil is supplied to the cylinder to lift the lift arm and lower link.

On the contrary, if the position ordered by the position control lever is lower than the current position of the lower link, the main spool of the control valve is pushed out by the link structure set in the hydraulic cylinder case. Then, the lowering spool is operated to drain hydraulic oil in the lift cylinder in order to lower the lower link.

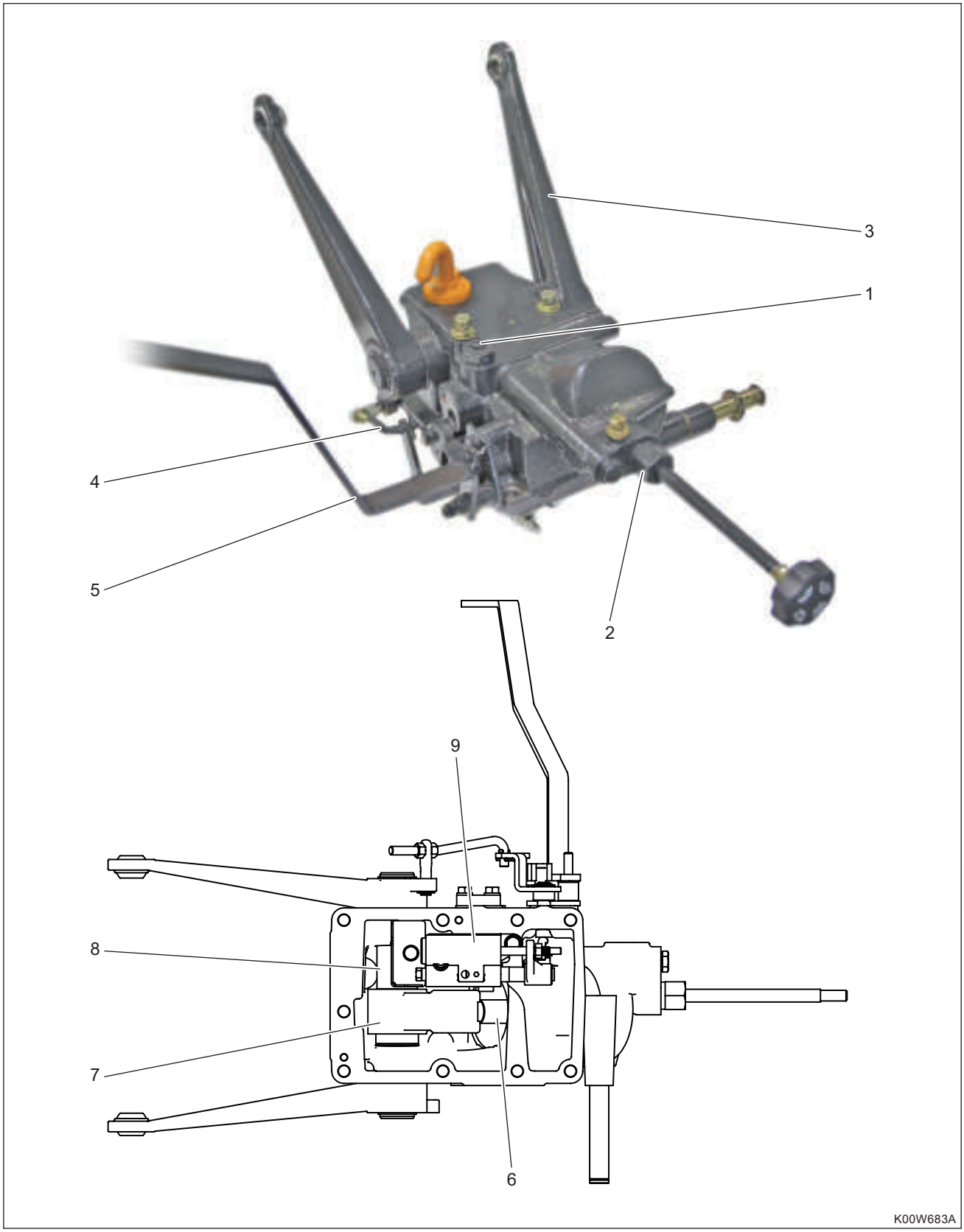
When the position ordered by the position control lever is matched to the actual position of the lower link after lifting or lowering operation, the spool of the control valve is kept in the neutral position by the link structure set in the hydraulic cylinder case. Therefore, the lower link is maintained in the current position.

▶ VALVE SPECIFICATIONS

ITEM	SPECIFICATION
Max. operating flow	16 ℓ/min.
Operating oil	TF500
Max. operating pressure	160 kgf/cm^2

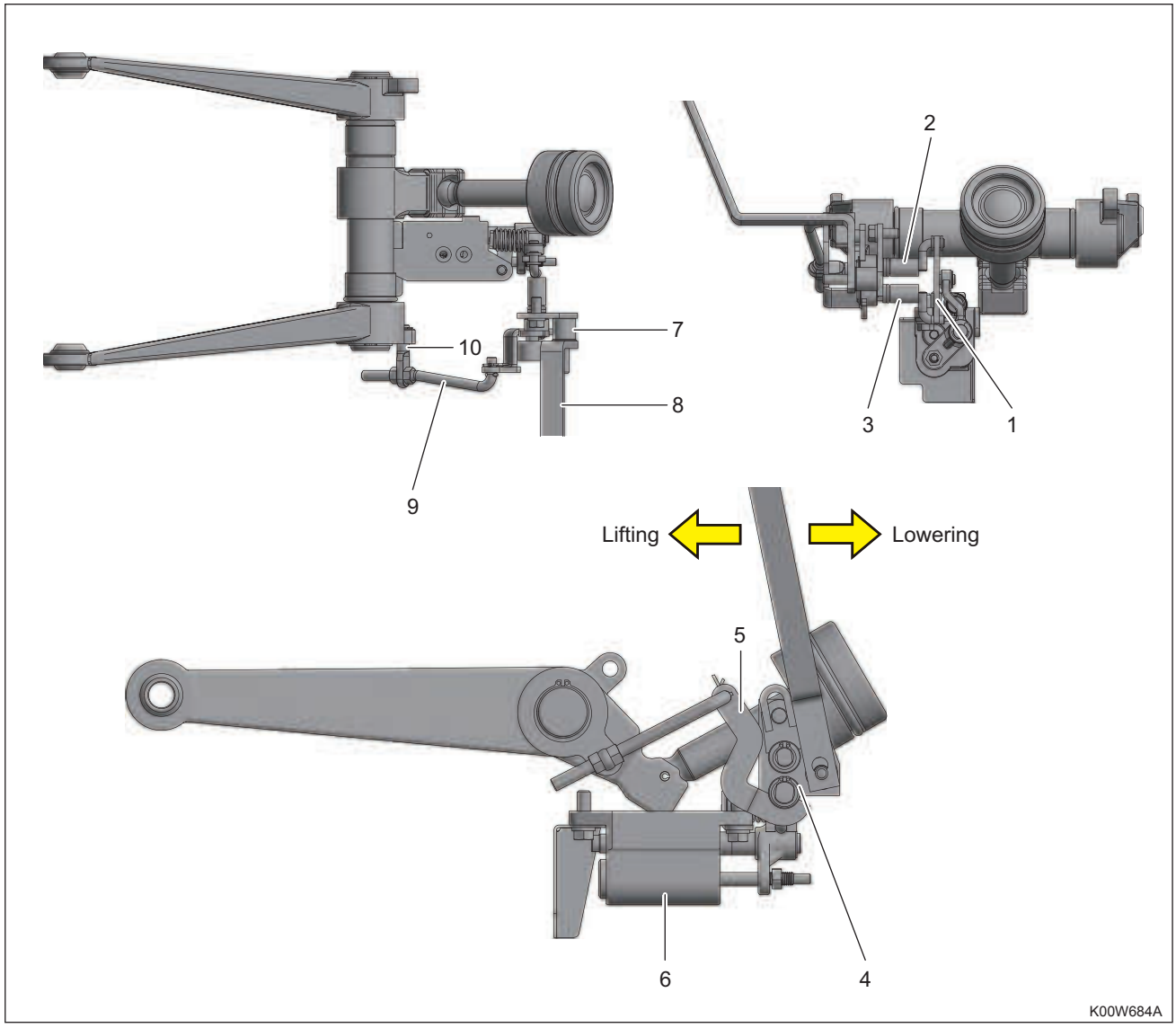
5.5 HYDRAULIC CYLINDER CASE ASSEMBLY

5.5.1 STRUCTURE & COMPONENTS



(1) Safety valve
(2) Lowering speed control valve
(3) Lift arm
(4) Feedback link
(5) Position control lever
(6) Piston rod
(7) Lift crank
(8) Hydraulic arm shaft
(9) Position control valve

5.5.2 LIFTING & LOWERING OPERATION



(1) Link
(2) Shift control lever
(3) Feedback shaft assy
(4) Plate assy
(5) Feedback arm
(6) Position control valve
(7) Control arm assy
(8) Position control lever
(9) Feedback rod
(10) Feedback pin

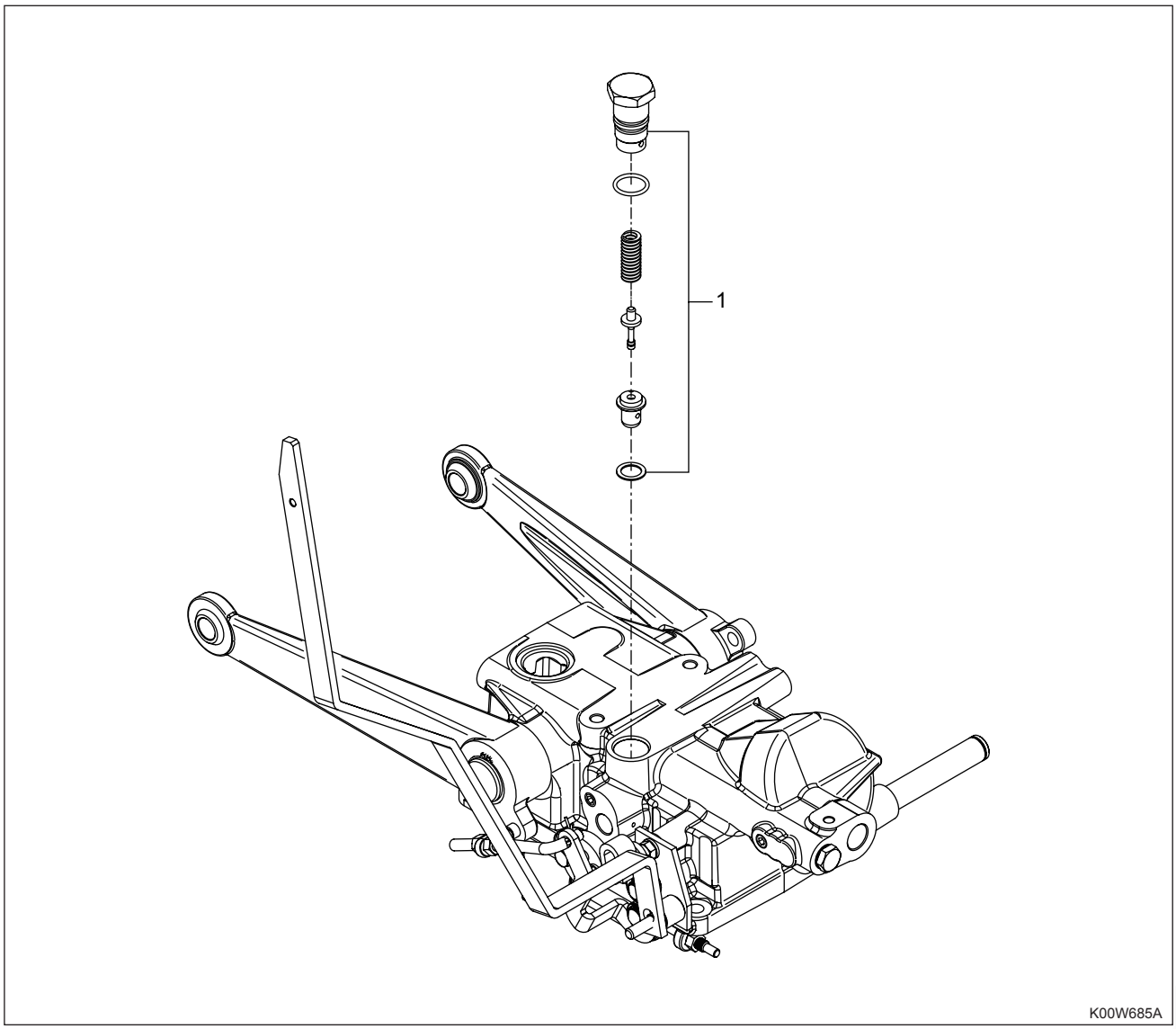
When the position control lever (8) is pulled backwards, the shift control lever (2) pulls the link (1) towards the rear and pushes the spool shaft on the position control valve (6) inwards. Then, the spool inside the position control valve moves, allowing hydraulic fluid to flow towards the cylinder head; this pushes the piston, and the lift arm is raised by the piston rod and lift crank.

When the lift arm is raised, the feedback arm (5) turns counterclockwise again from the perspective of the plate assembly (4); the resulting force is applied in the direction in which the spool shaft inside the position control valve is pulled by the feedback shaft assembly. Accordingly, if the position control lever is pulled to a certain point and then stops, the spool automatically returns to the neutral position and the lift arm stops rising in that position.

In addition, when the position control lever (8) is pushed forward, the shift control lever (2) is pulled forward, thereby pulling the spool shaft inside the position control valve (6) forward. Then, the spool moves and a drain passage is formed, allowing the hydraulic fluid between the cylinder head and piston to drain, and causing the lift arm to be lowered by its own weight. Likewise, when it rises, the spool automatically stops in the neutral position by means of the feedback link when the lever is stopped.

5.5.3 INNER VALVES COMPONENTS

SAFETY VALVE



The piston of the hydraulic cylinder case is supplied with hydraulic oil through the main spool of the position control valve. If the lift arm is overloaded by this oil, pressure in the circuit rises continuously.

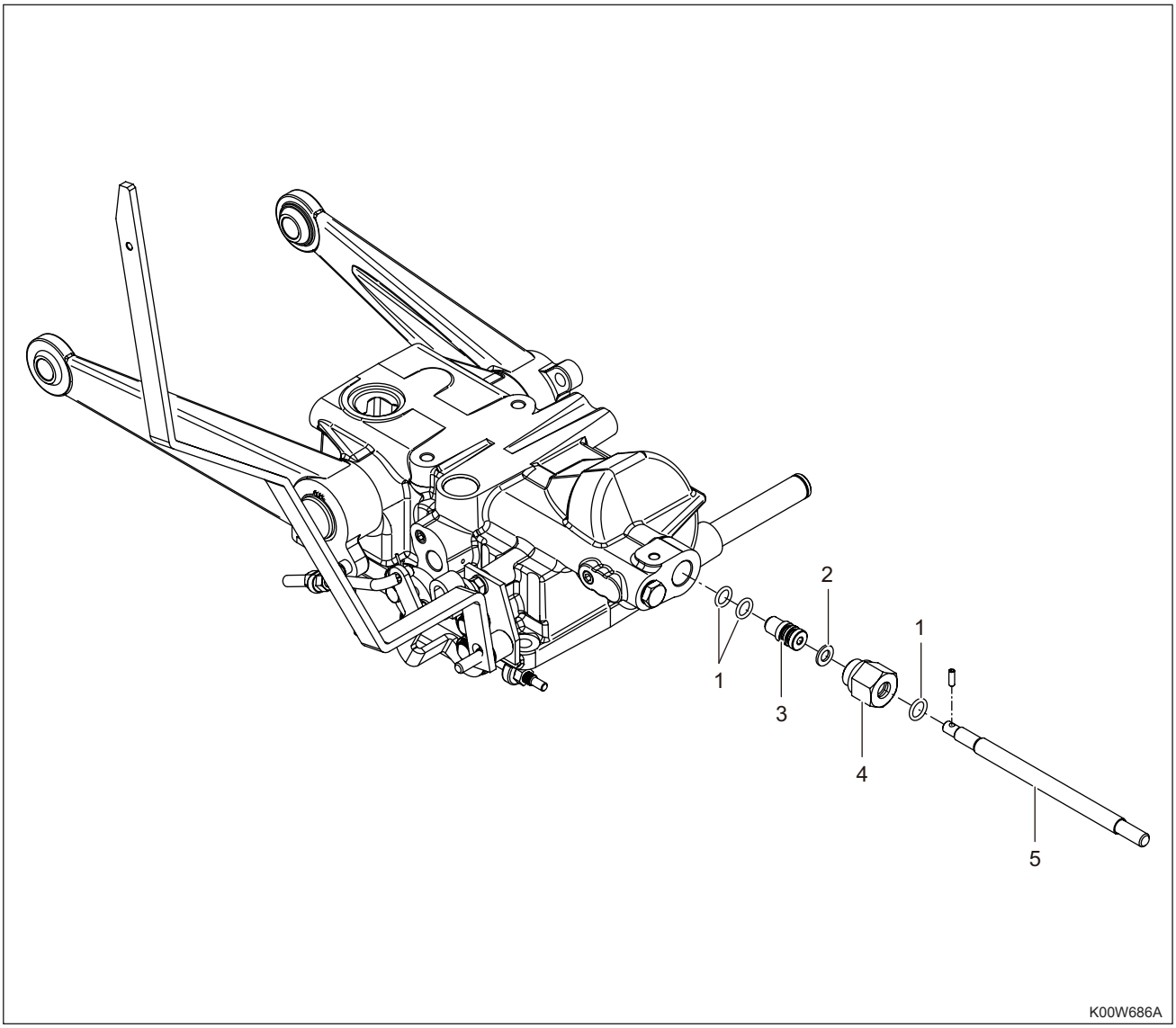
In other words, if impact pressure is applied from an external source to an implement and this pressure is over a certain limit, the safety valve is opened to drain oil back to the tank in order to protect the internal circuit of the hydraulic implement.

RELIEF VALVE SETTING PRESSURE	160 kgf/cm^2

If the operating pressure value is beyond the specified range of relief valve setting pressure, adjust the safety valve (1) to the setting pressure by turning it.

- Turning clockwise - Increasing pressure
- Turning counterclockwise - Decreasing pressure

STOP VALVE (ALSO AS SLOW RETURN VALVE)

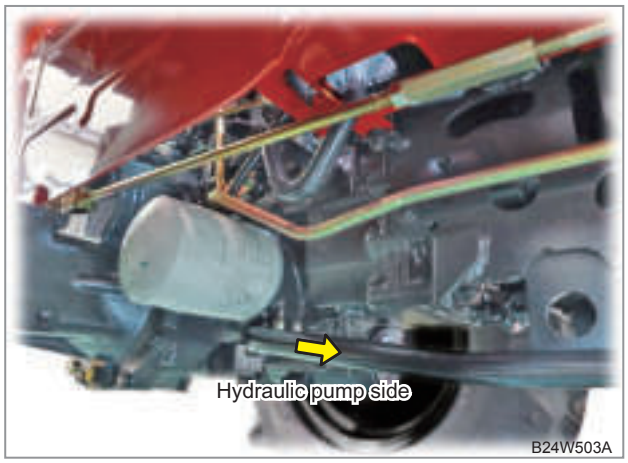


(1) O-ring
(2) Plain washer
(3) Stop valve
(4) Holder
(5) Hydraulic adjust shaft

Stop valve is used to stop lowering or adjust the lowering speed of the hydraulic lift. When turning the handle counterclockwise, the lowering speed of the lift arm increases. Turning it clockwise slows down the lowering speed. Also, when turning it clockwise to its end, the oil flow passage is blocked so the lift arm is stopped at the current position.

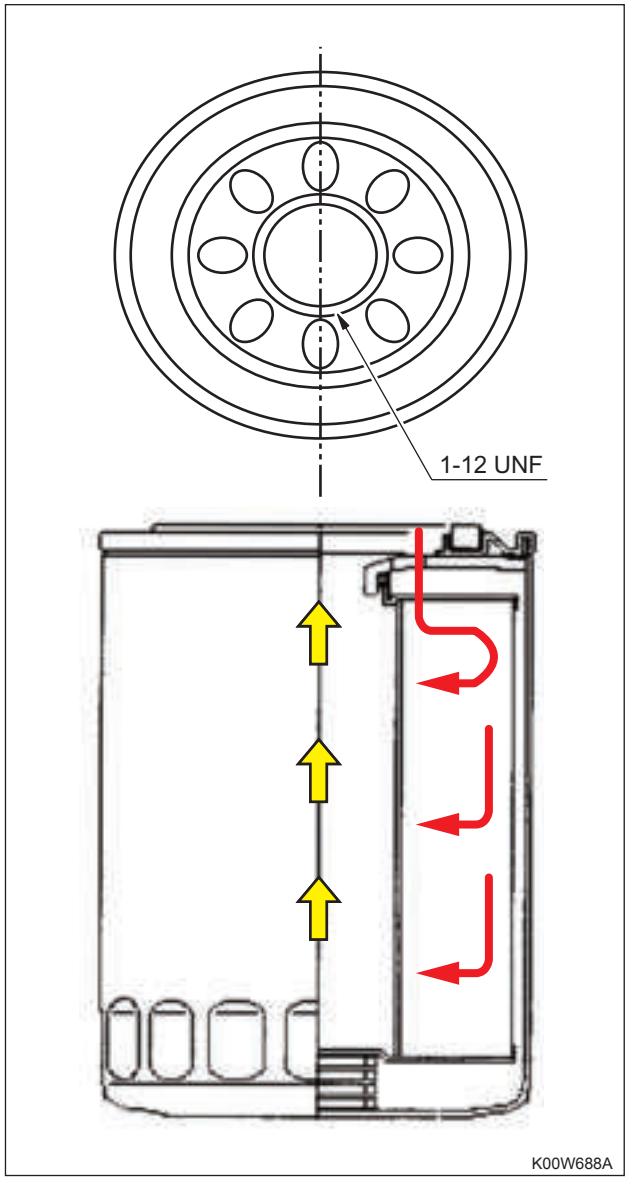
5.6 HYDRAULIC FILTER AND STRAINER

5.6.1 HYDRAULIC FILTER



The hydraulic filter is installed beside the transmission right side to filter oil in the oil tank (transmission) before this oil is delivered to the hydraulic pump.

Hydraulic oil is flown through the hole on the top of the oil filter cartridge and is passed from the outside to the inside of the filter. Then, it is flowed in through the hole in the middle of the cartridge.

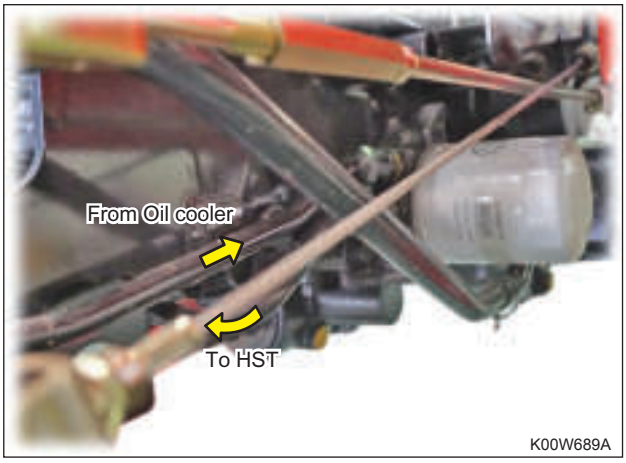


▶ **FILTER ELEMENT SPECIFICATIONS**

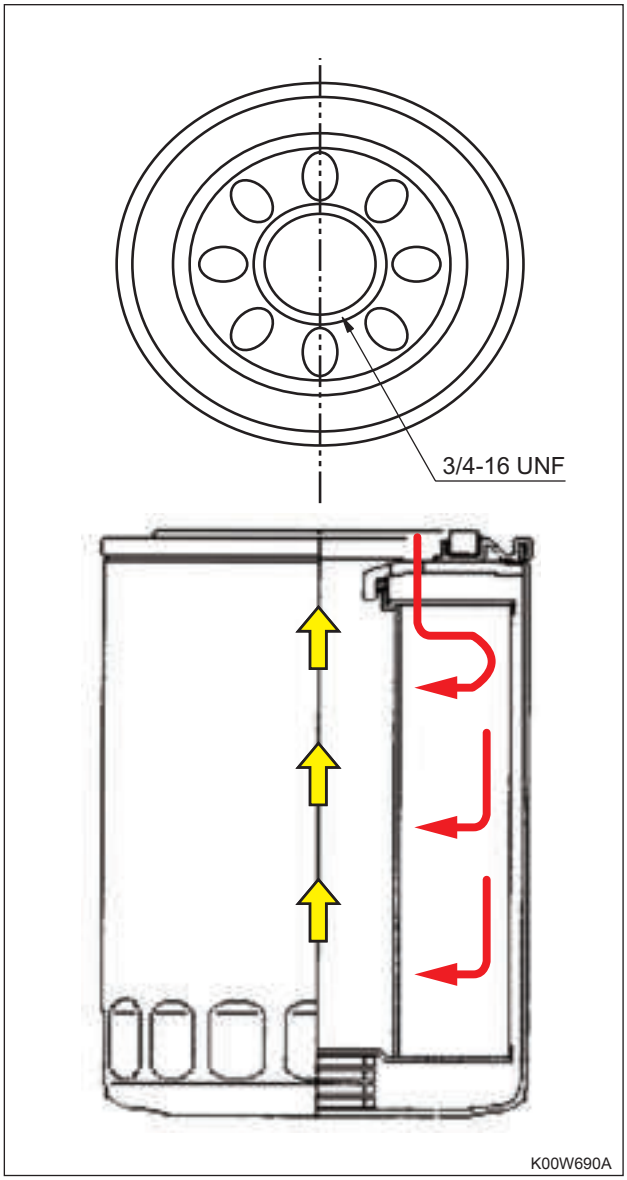
Filtering area	1,963 cm^2
Number of folds	55
Folding width	105 × 77 × 55 folds
Bursting strength	4.5 bar
Max. fineness	120 ± 5 μm

Notes
• **Hydraulic filter replacement: after initial 50 hours, and then every 300 hours of use**

5.6.2 HST FILTER



The HST filter is installed beside the transmission left side. As oil delivered from the oil cooler side passes through the HST filter, it is filtered before it flows into the HST.

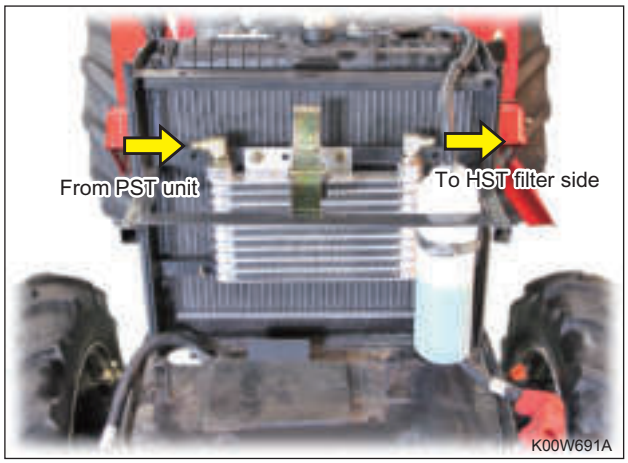


▶ **SPECIFICATIONS**

Filtering area	1,344 cm^2
Number of folds	60
Folding width	80 × 17 × 60 folds
Bursting strength	7 kgf/cm^2
Max. fineness	110 ± 2 μm
Min. fineness	92 ± 8 μm

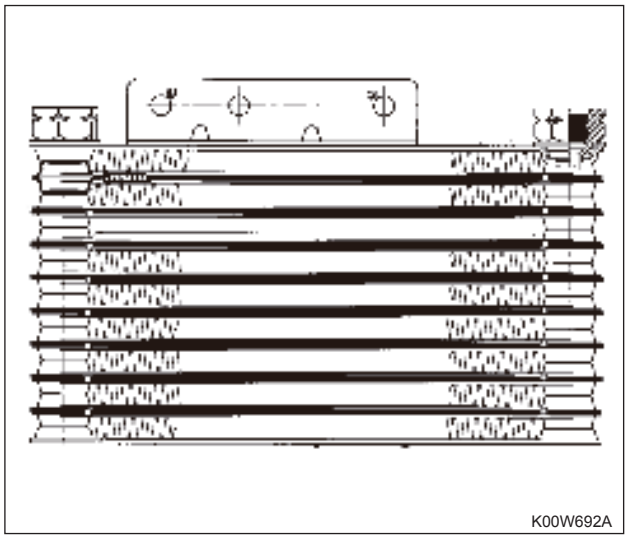
Notes
• **Replace after initial 50 hours, and then every 300 hours of use**

5.7 OIL COOLER



Installed on the front of the engine room radiator, the oil cooler is responsible for cooling hydraulic oil.

Oil discharged from the PST unit is cooled by the oil cooler. Then, it is sent back to the HST filter through an outlet and enters the HST.

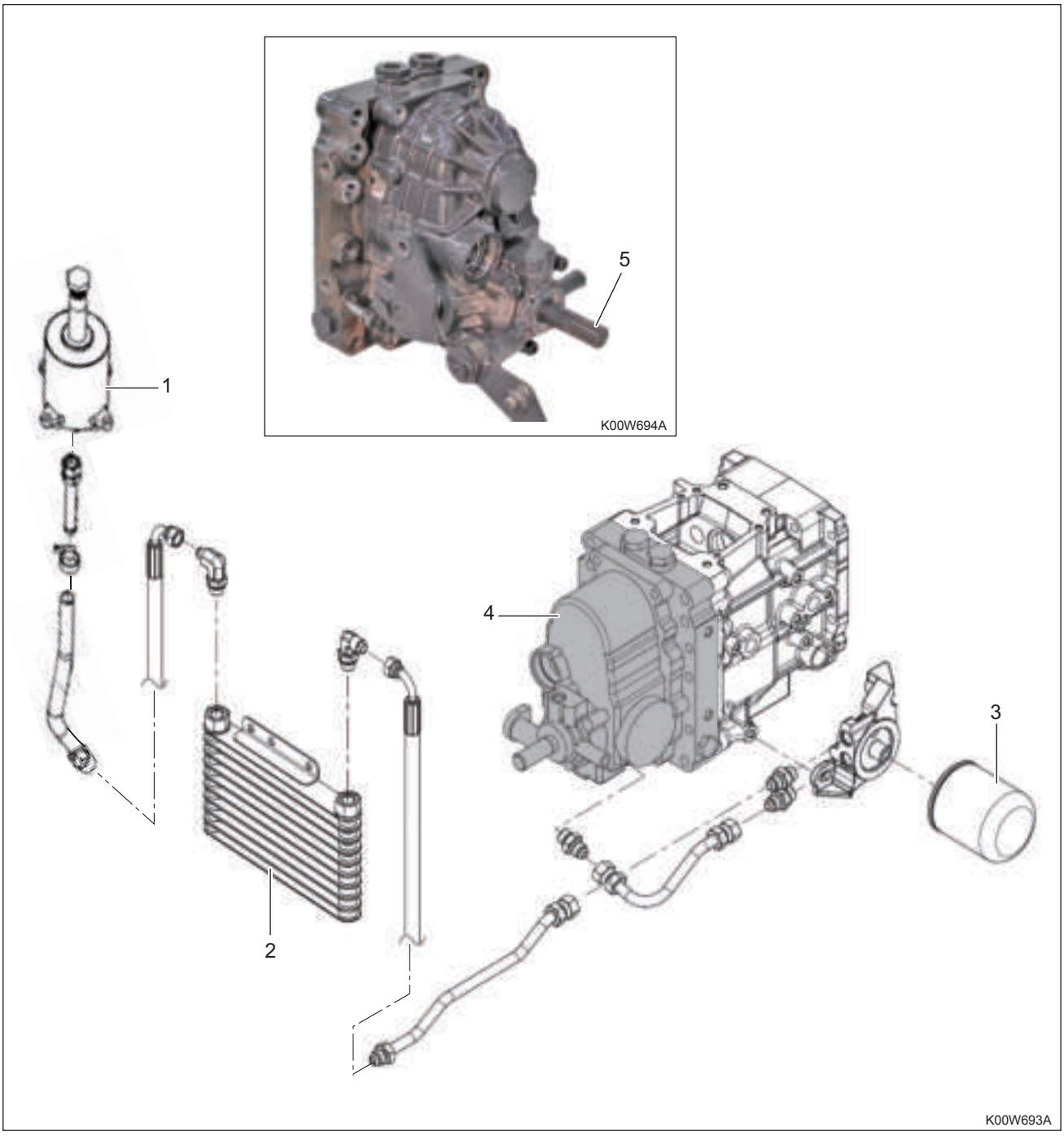


▶ SPECIFICATIONS

Heat rejection capacity	2,500 kcal/h (Min.)
Oil flow	18 lpm
Core type	DRAWN CUP WAVE PIN

5.8 HST(HYDROSTATIC TRANSMISSION)

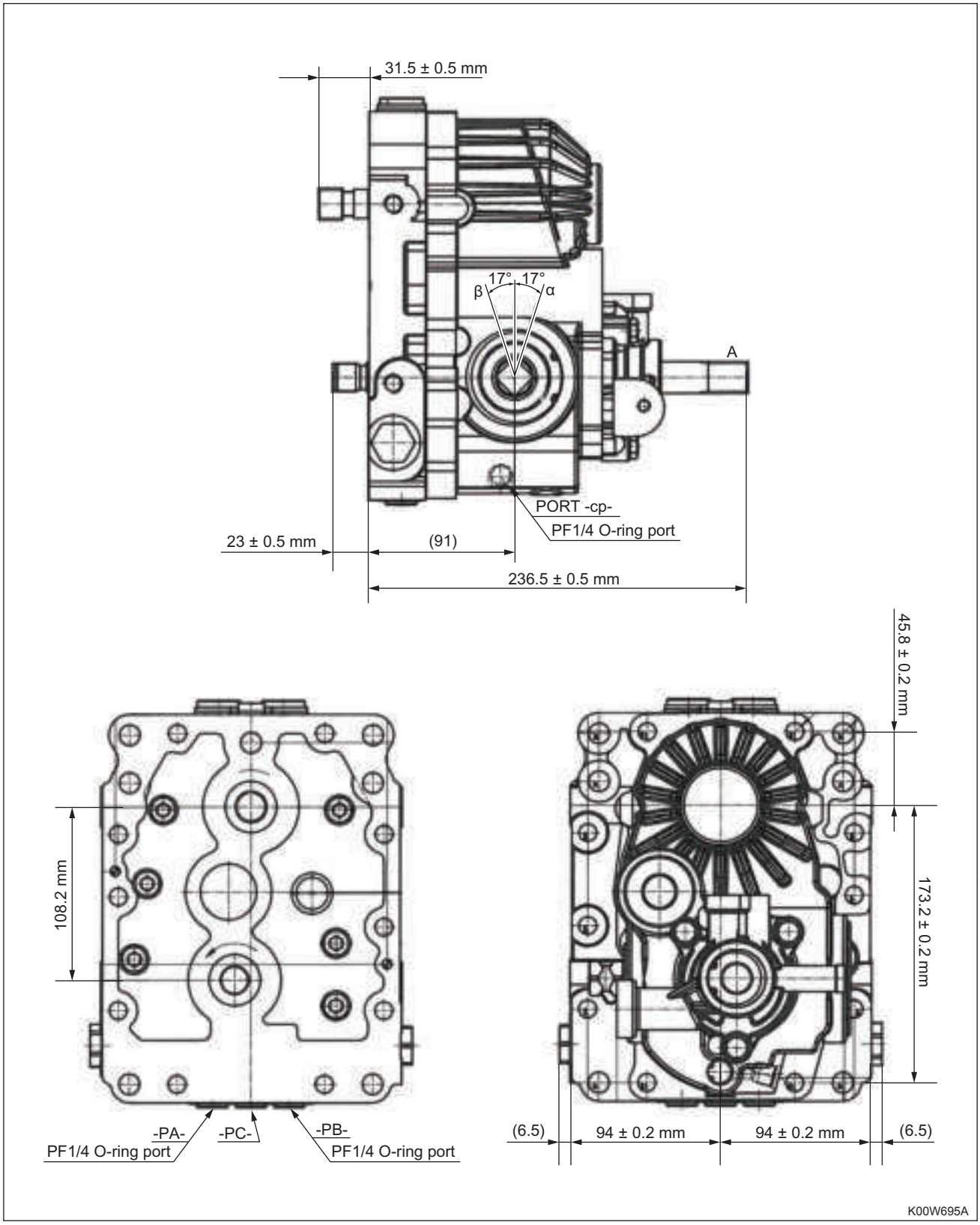
5.8.1 HST PASSAGE COMPOSITION



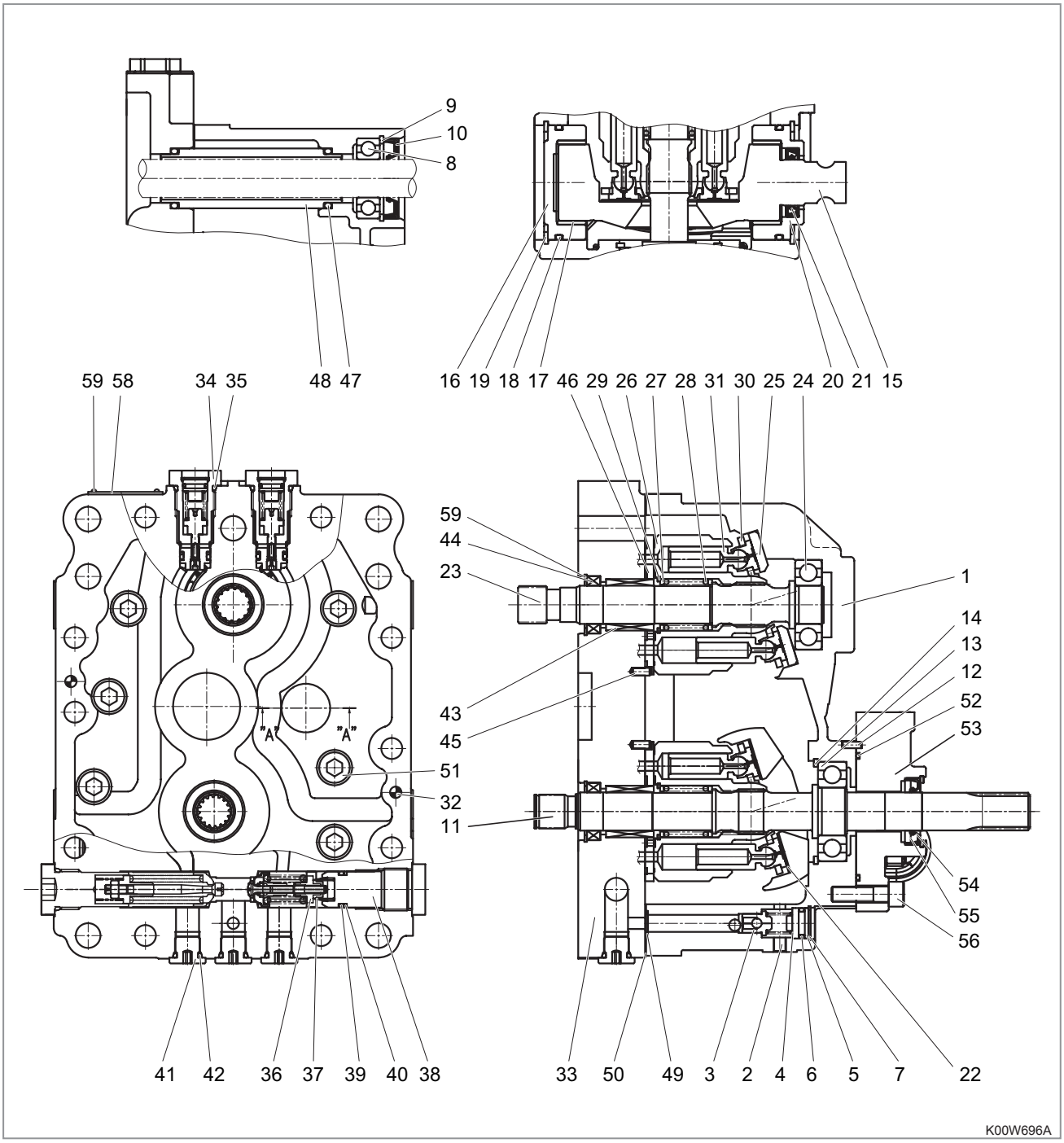
(1) PST unit
(2) Oil cooler
(3) HST filter
(4) HST
(5) Input shaft

The HST (Hydro-Static Transmission) consists of the variable capacity pump, fixed capacity motor, check valve, high-pressure relief valve, etc. and it is installed to the transmission to supply turning force to the transmission. The input shaft (5) of the HST is connected to the shaft of the clutch housing section to receive turning force from the engine. Its HST pump is driven by receiving this turning force through the input shaft of the HST, and hydraulic oil led into the HST is sent to the hydraulic motor to supply new rotating force to the transmission. As the HST pump can adjust hydraulic flow variably, it can adjust the speed of the HST motor variably and the rotating direction of the motor through the internal swash plate for forward and reverse driving.

5.8.2 EXTERIOR DIMENSION

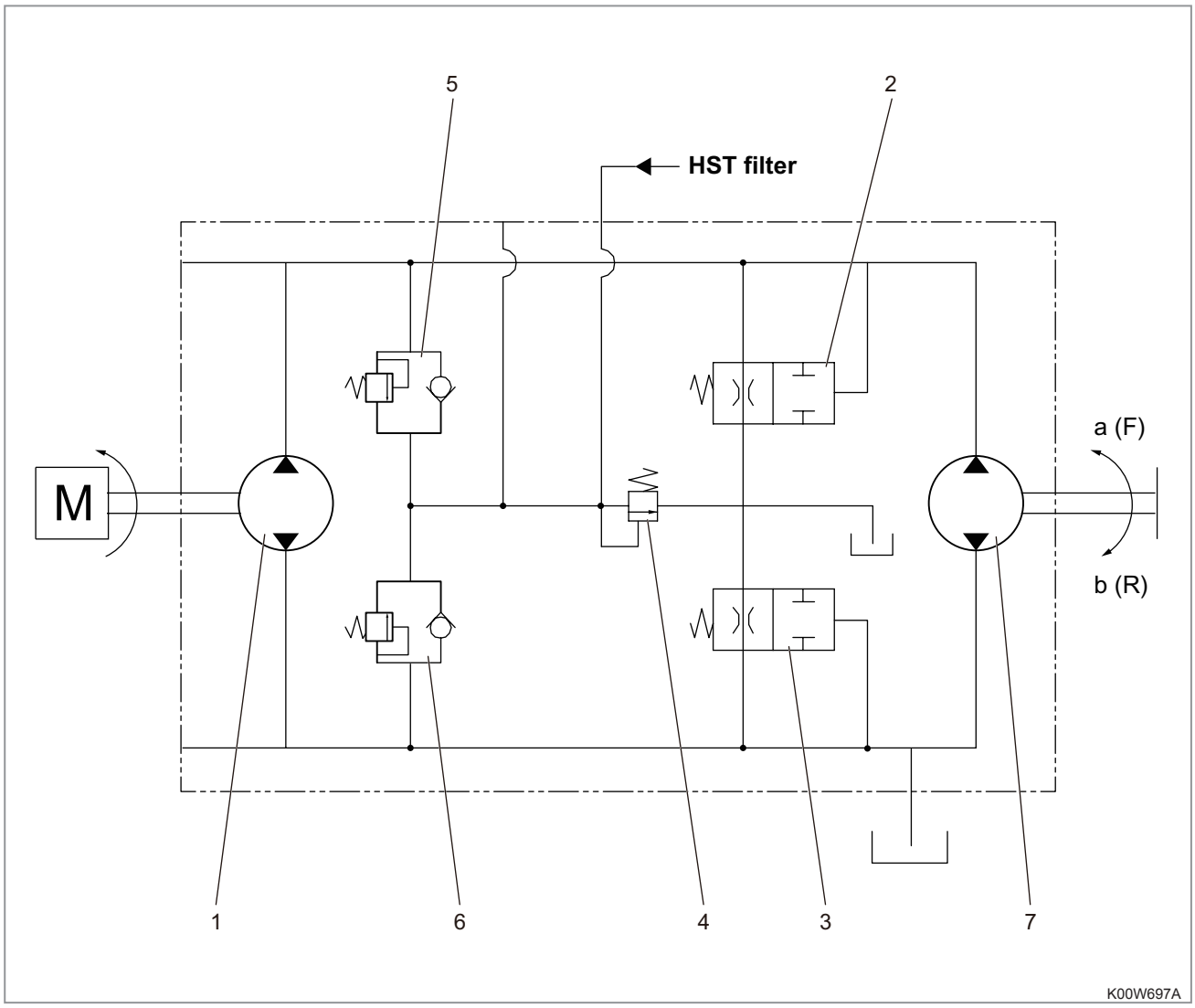


5.8.3 STRUCTURE ANC COMPONENTS



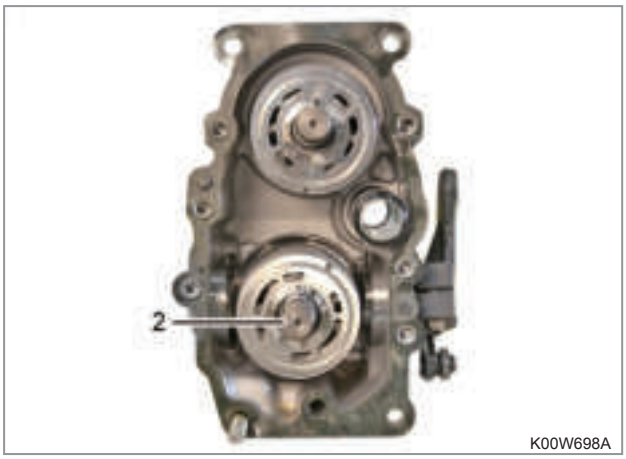
(1) Housing
(2) Plug
(3) Poppet
(4) Spring : charge
(5) Spring seat
(6) O-Ring
(7) Snap ring
(8) Bearing
(9) Snap ring
(10) Oil seal
(11) Shaft : pump
(12) Pin
(13) Bearing
(14) Snap ring
(15) Swash
(16) Boss1 : swash
(17) Bush
(18) O-Ring
(19) Snap ring
(20) Boss2 : swash
(21) Oil seal
(22) Shoe plate : pump
(23) Shaft : motor
(24) Bearing
(25) Shoe plate : motor
(26) Cylinder block
(27) Spring seat
(28) Spring
(29) Snap ring
(30) Set plate
(31) Piston assy
(32) Pin
(33) Rear cover
(34) Neutral valve assy
(35) O-Ring
(36) Relief valve assy
(37) Spring
(38) Plug
(39) O-Ring
(40) Back up ring
(41) Plug
(42) O-Ring
(43) Needle bearing
(44) Oil seal
(45) Spring pin
(46) Valve plate
(47) O-Ring
(48) Pipe
(49) O-Ring
(50) Gasket
(51) Wrench bolt
(52) O-Ring
(53) Hosing : charge pump
(54) Oil seal
(55) Snap ring
(56) Wrench bolt
(57) Name plate
(58) Rivet
(59) Snap ring

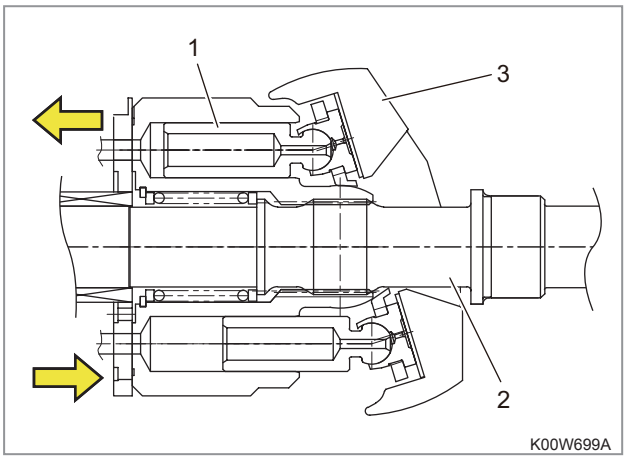
5.8.4 CIRCUIT DIAGRAM



(1) HST pump
(2) Neutral valve (F)
(3) Neutral valve (R)
(4) Charge relief valve
(5) Main relief valve (F)
(7) Main relief valve (R)
(7) HST motor

5.8.5 HST PUMP





(1) Piston (3) Swash plate
(2) Shaft

The pump in the HST is equipped with several pistons (1) to control hydraulic flow with reciprocating motion. Also, it uses its swash plate (3) to hydraulic flow and flow direction. The piston attached to its cylinder is in contact with the inclined surface of the swash plate, sliding on this surface in reciprocating motion in the cylinder.

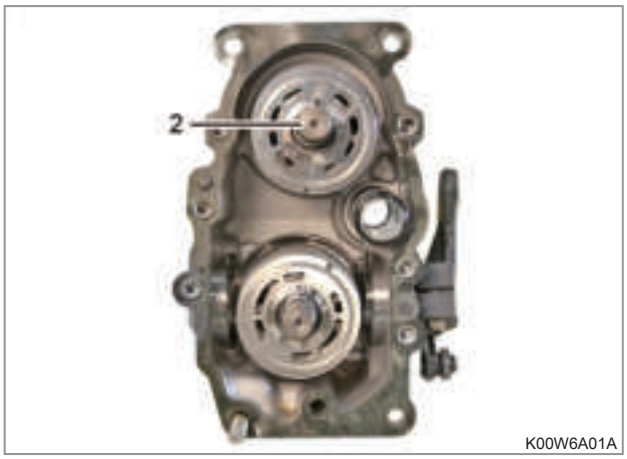
Therefore, Every time the shaft (2) rotates once, the pistons reciprocate once as well. The pistons on one side in the cylinder suck oil while the pistons on the other side in the cylinder discharge oil, forming one cycle.

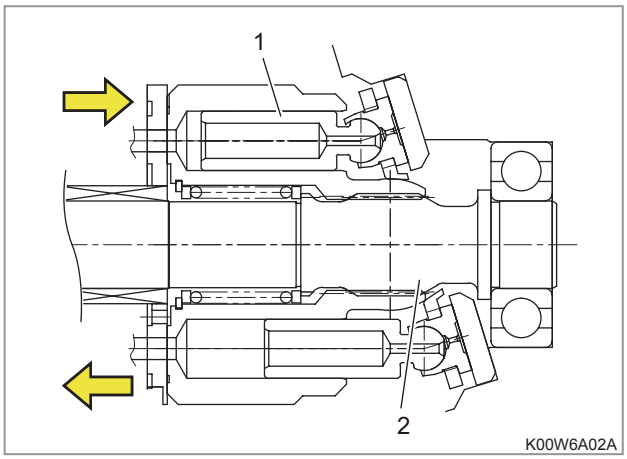
Therefore, the cylinder is divided into the high-pressure side and low-pressure side. When, the inclined side of the swash plate is changed, these sides are switched.

This is where the direction of flow changes when the HST pedal is depressed the "forward" or "reverse". Then, the rotating direction of the motor shaft in the HST is changed to enable forward or reverse driving.

The inclination of the swash plate in the pump is adjusted within the range of -17° - +17°, and its angle determines the driving direction and vehicle speed.

5.8.6 HST MOTOR





(1) Piston (2) Shaft

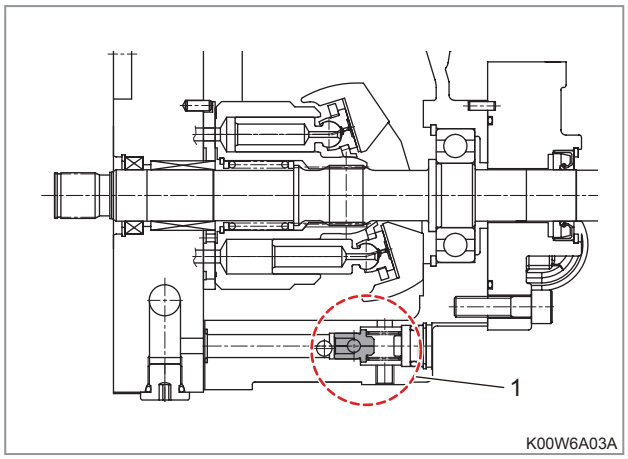
The motor in the HST has a shape similar to the pump, but it is equipped with the fixed swash plate, making it a fixed capacity type.

After hydraulic oil is compressed in the pump, it is led into the motor to drive it. The piston in the motor has a structure similar to a pump, but the swash plate of the motor is fixed at the angle of 17°. Therefore, when each piston receives high-pressure oil, it is extended to push out the swash plate. However, as the swash plate is fixed, this force is blocked by the swash plate and rotates the cylinder assembly instead.

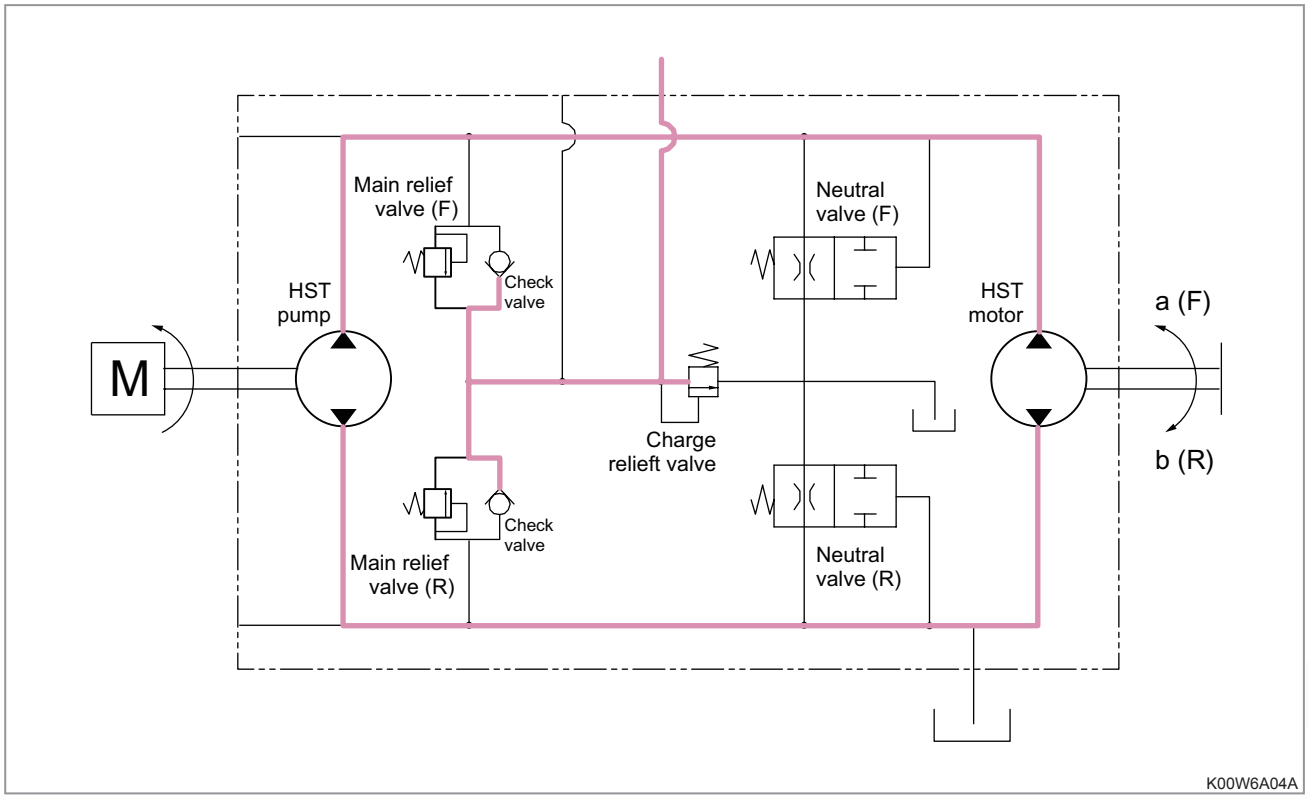
Therefore, one half of the cylinder space expands while the other half of the cylinder space contacts. Oil discharged in this state is returned to the suction line toward the pump, completing one cycle.

The speed of the motor is determined by the amount of oil flow of the pump, and the rotating direction of the motor is determined by the direction of oil flow.

5.8.7 CHARGE RELIEF VALVE



(1) Charge relief valve



Most of oil is circulated in between the pump and motor in the HST. There is no separate charge pump. Instead, the gear pump of the vehicle body supplies hydraulic oil through the passage.

Most of oil is circulated through the circuit, but oil leakage occurs in the process. Therefore, this amount of oil loss should be supplemented in the circuit continuously. For this, the pump for charge continuously supplies oil to the low-pressure side circuit in which oil is returned from the motor. The setting pressure of the charge relief valve is 6 ± 0.5 kgf/cm^2 . When pressure rises due to surplus oil or load in the high-pressure side, the charge relief valve opens to send oil to the oil tank.

During forward or reverse driving, high pressure is formed in the compression side of the pump while low pressure is formed in the suction side, leading to oil loss in the low pressure side. If this leads to pressure drop, the charge relief valve is closed and oil is supplemented through the check valve.

5.8.8 NEUTRAL VALVE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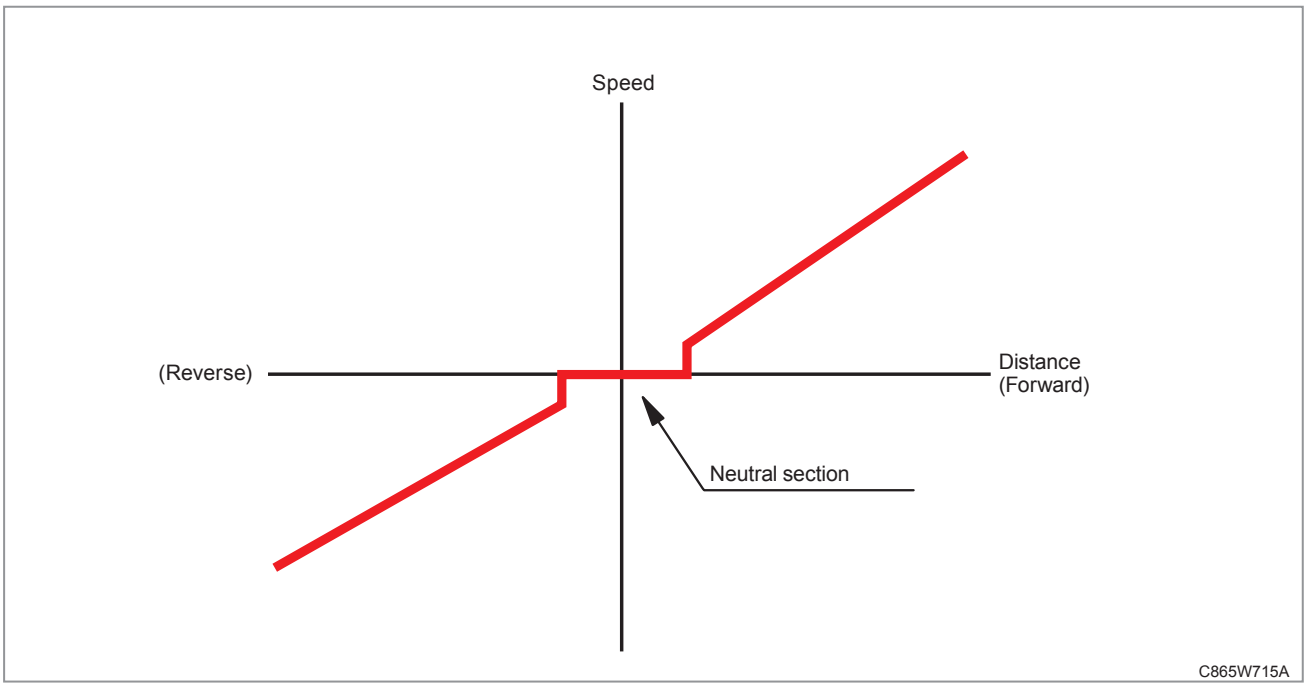

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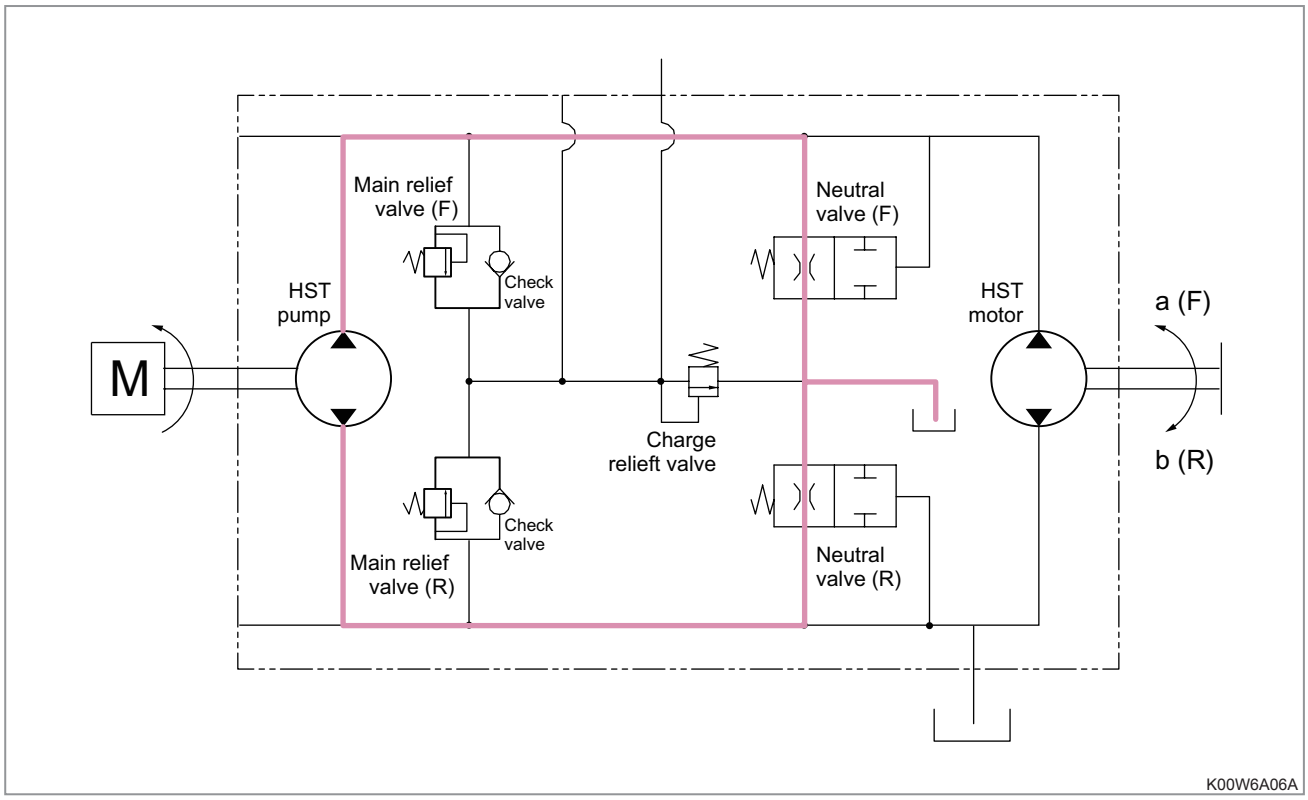
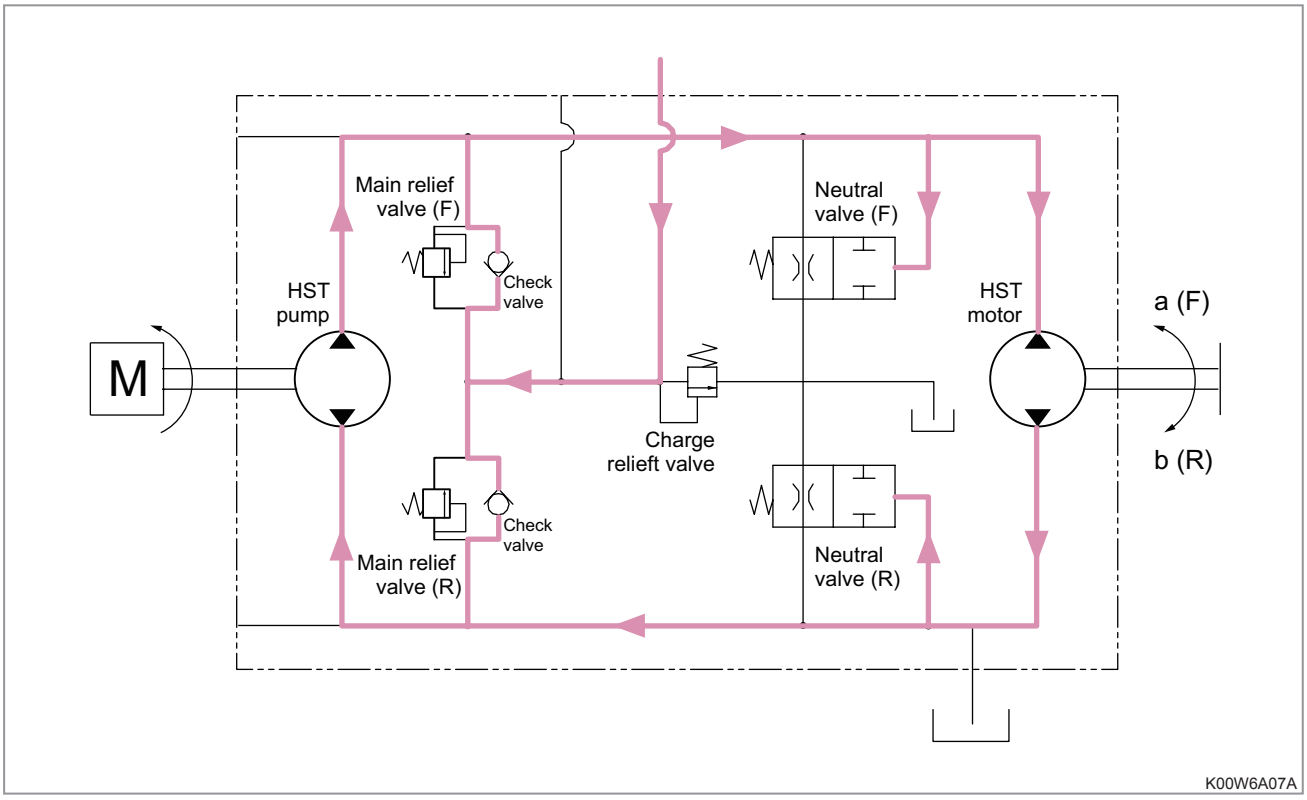
NEUTRAL



In the HST pump operation process, it is almost impossible to set the swash plate at 0° exactly to keep the neutral state (no oil flow). Also, it is impossible for the driver to set the angle of the swash plate to 0° for the neutral setting. To solve this problem, the neutral valve is installed to obtain the minimum range to keep the neutral state.

When the angle of the swash plate is close to, but not exactly 0°, a small amount of oil is discharged to the motor. In this case, the neutral valve drains this oil through its orifice to prevent internal pressure rise before it reaches the motor. This also prevents minute operation of the hydraulic motor.

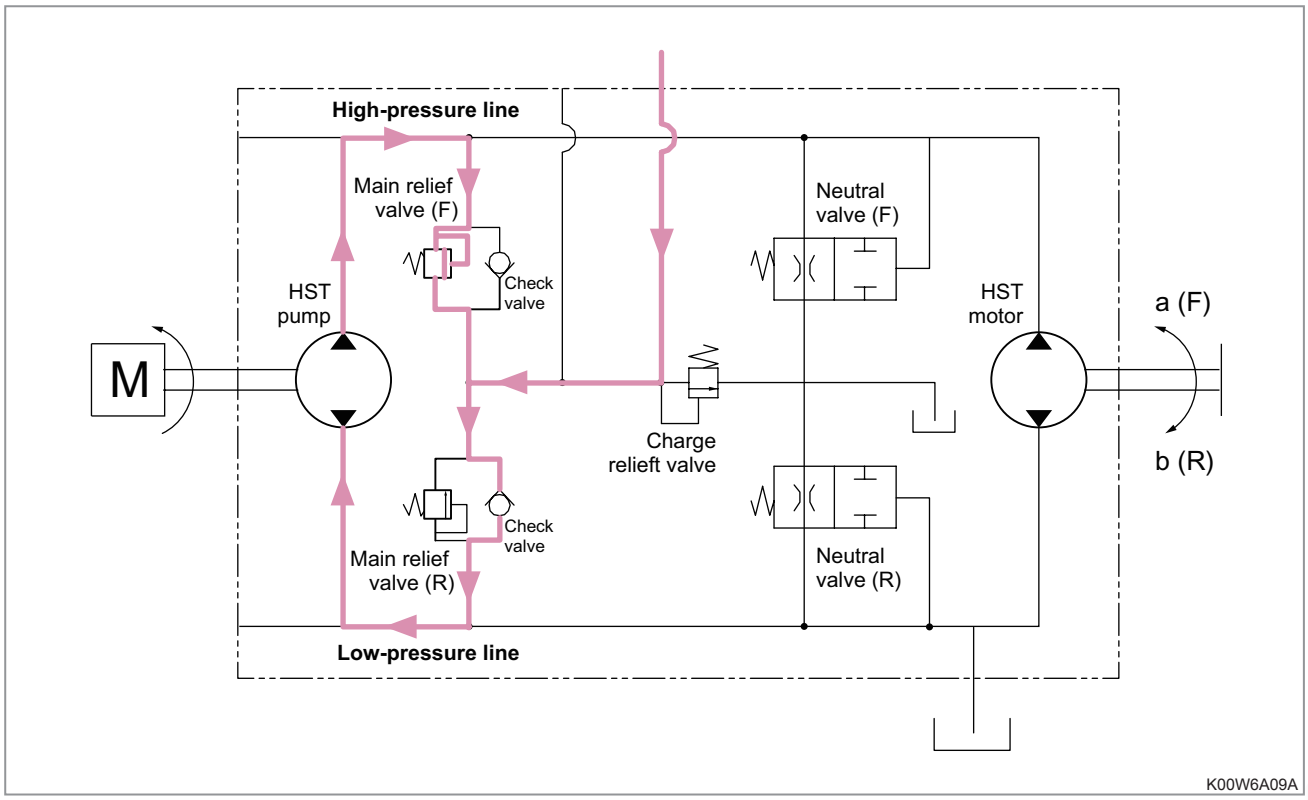
FORWARD/REVERSE DRIVING



When operating the forward/reverse pedal for forward or reverse driving, the angle of the swash plate is increased so oil flow toward the pump is also increased. As a result, hydraulic pressure rises gradually and eventually exceeds the setting pressure of the return spring of the neutral valve. Then, the spool of the neutral valve is moved to close the orifice, leading oil to the motor through the internal circuit.

Also, in reverse drive, hydraulic fluid flows in the opposite direction of forward drive; everything else in the description remains the same as in forward drive.

5.8.9 MAIN RELIEF VALVE



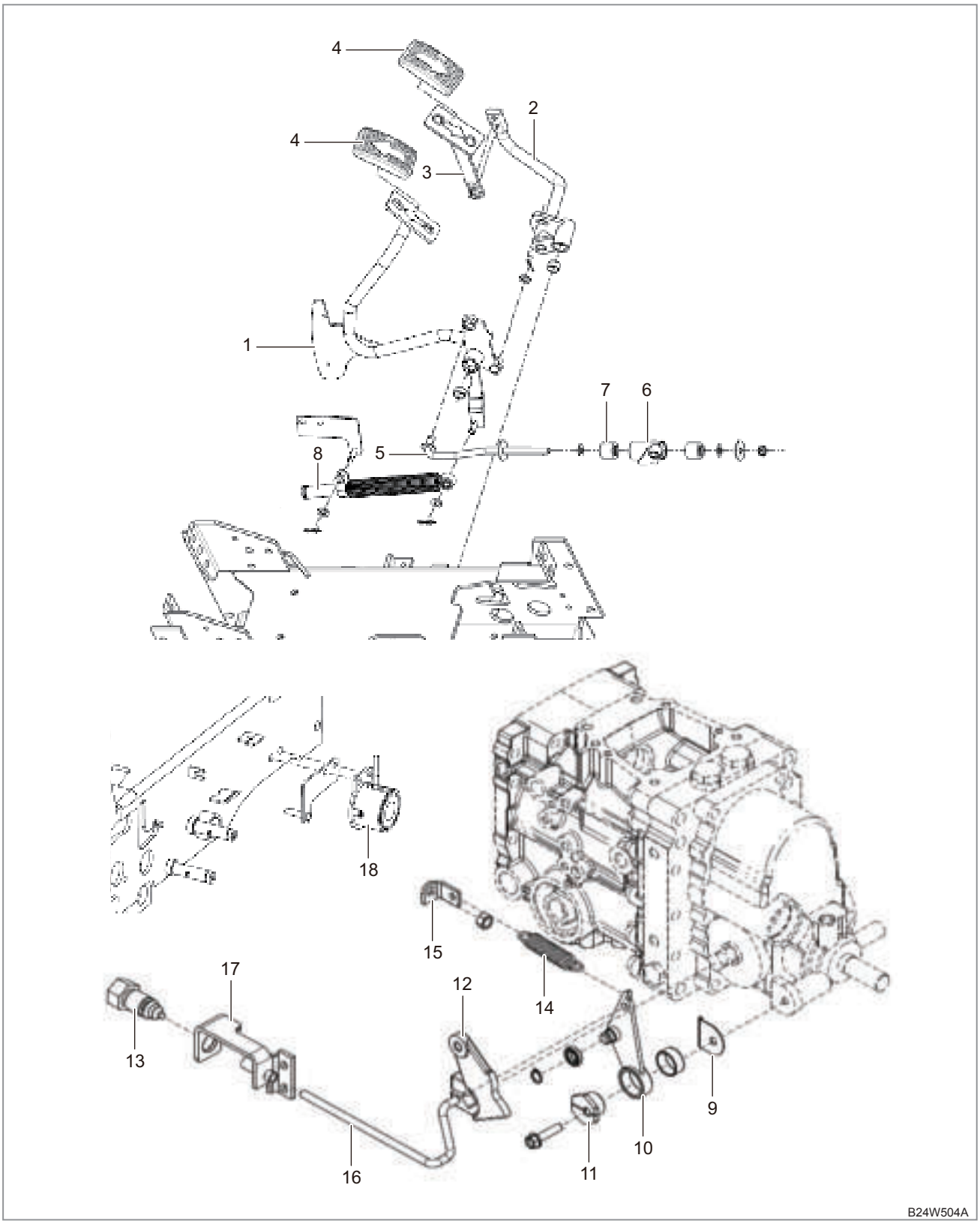
The setting pressure of the main relief valve is 350 kgf/cm^2 (34.3 MPa) to protect the internal circuit in case of HST overload.

When the main relief valve is activated during forward or reverse driving, oil in the high-pressure side circuit is delivered to the low-pressure side circuit to prevent damage of the internal circuit due to load.

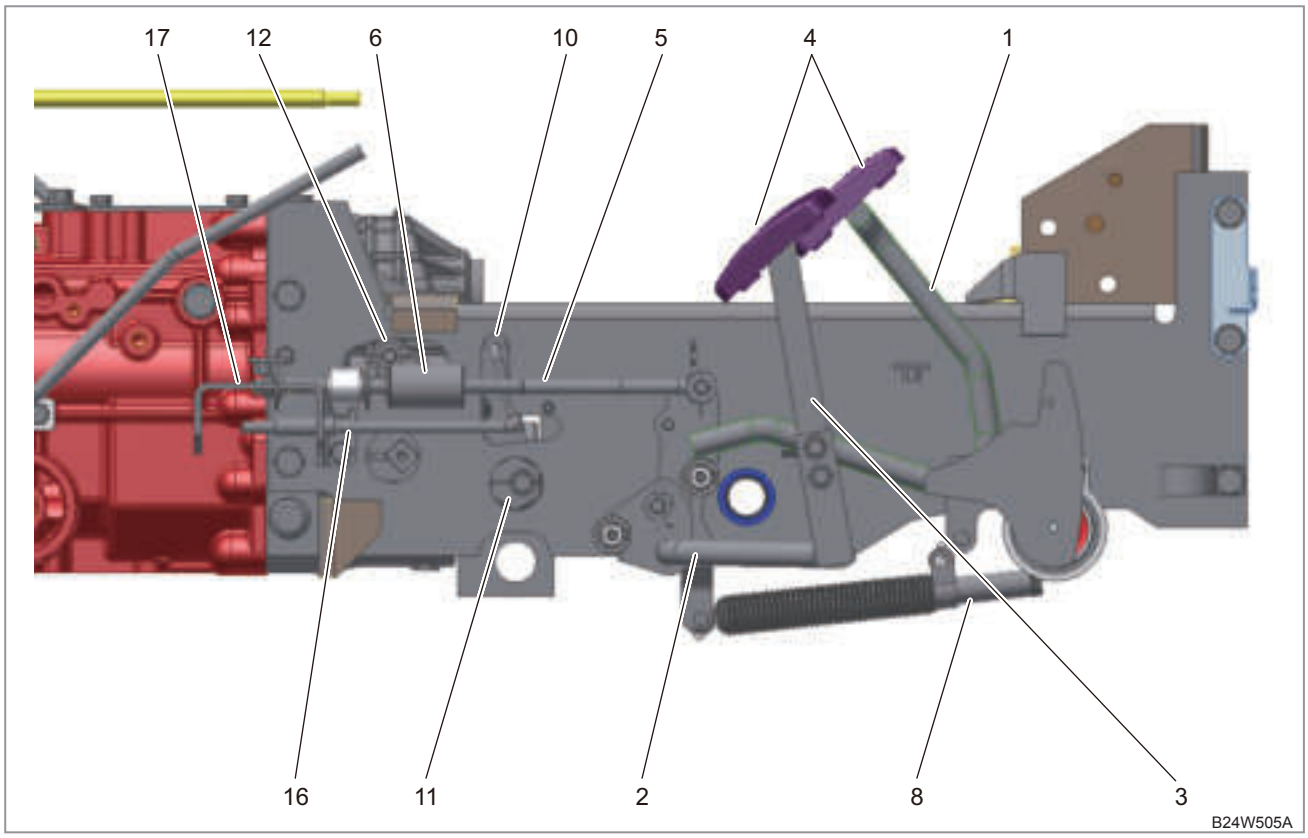
On the other hand, oil supplied by the charge pump is sent to the low-pressure circuit through the check valve on the main relief valve of low-pressure side

5.8.10 HST PEDAL AND LINK

COMPONENTS



(1) Forward driving pedal assy
(2) Reverse driving pedal assy B
(3) Reverse driving pedal assy A
(4) F-R pedal cover
(5) Rod A assy
(6) Rod B assy
(7) Rubber cushion
(8) HST damper
(9) Spacer
(10) Neutral arm assy
(11) Holder shaft
(12) Neutral holder
(13) Safe start neutral switch
(14) Spring
(15) Bracket
(16) HST neutral rod
(17) Neutral switch stay
(18) Cruise magnet



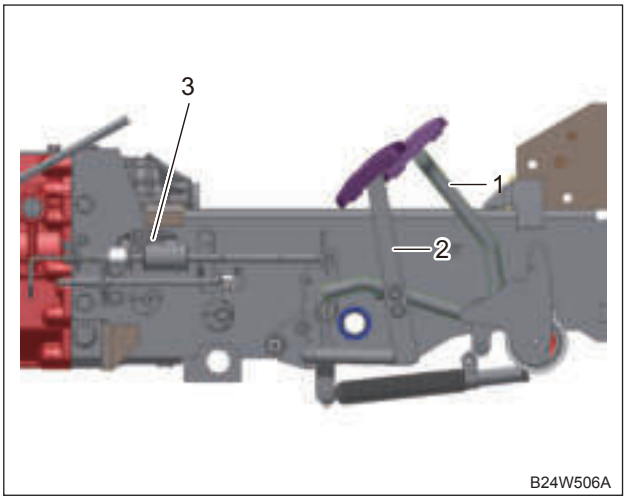
The forward and reverse driving pedals are installed at different hinge point shafts and they are interlinked.

Therefore, when the forward driving pedal is depressed, the reverse driving pedal is lifted and vice versa. There is the rod A (5) between the forward driving pedal and neutral holder (12). The neutral holder is rotated for the amount of movement of the pedal in the direction for the forward/backward driving.

The neutral holder (12) is connected to the swash plate of the HST. While it is turned clockwise or counterclockwise, it determines the driving direction (forward/reverse) and driving speed. Also, the neutral holder (12) is engaged with the neutral arm (10). This neutral arm has the ball bearing which slides along the curve of the neutral holder according to the rotating direction of the neutral holder, moving the neutral arm accordingly. Then, its motion in the same direction for the neutral holder pulls or release the HST accelerator cable, which is connected to the neutral arm, to determine the engine speed.

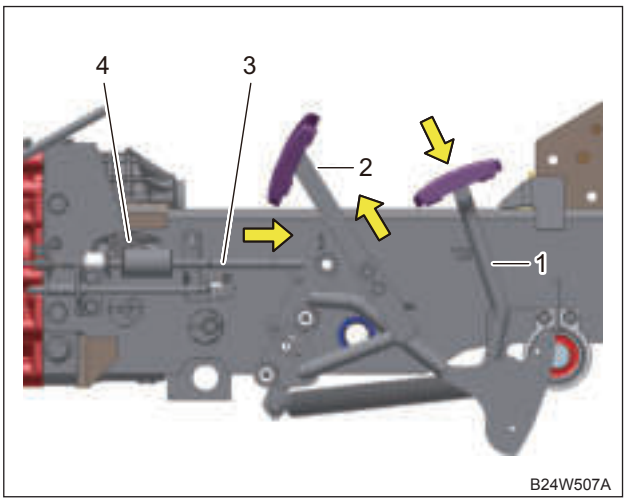
Also, the safe start neutral switch (13) is installed to the neutral switch stay (17) to detect the neutral position. The cruise magnet (18) is attached with the forward driving pedal at the specified position in the cruise control mode to maintain the constant driving speed.

NEUTRAL



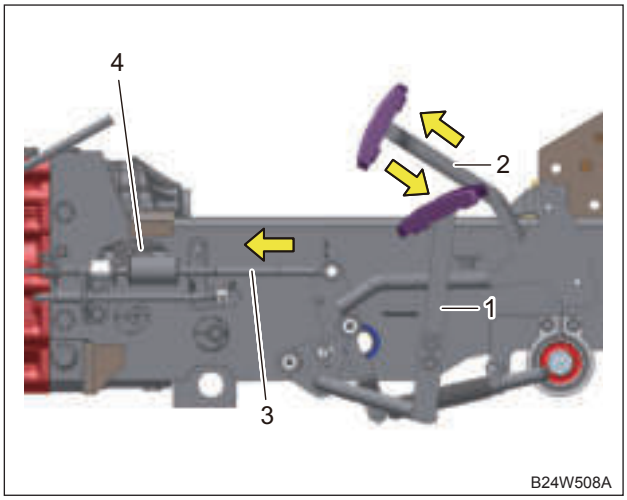
- Align the forward pedal (1) and reverse pedal (2).
- Maintaining the neutral holder (3) in the neutral state.
- Detecting the neutral condition of the safe start neutral switch.
- Maintaining the idle state of the HST accelerator cable.

FORWARD DRIVING



- Lowering the forward driving pedal (1) and lifting the reverse driving pedal (2).
- The rod A (3) is pulled forward.
- Turning the neutral holder (4) clockwise
  - Changing the angle of the HST swash plate (0 - +17˚)
- Detecting the forward condition of the safe start neutral switch.
- Pulling the HST accelerator cable - Increase of the engine speed.

REVERSE DRIVING



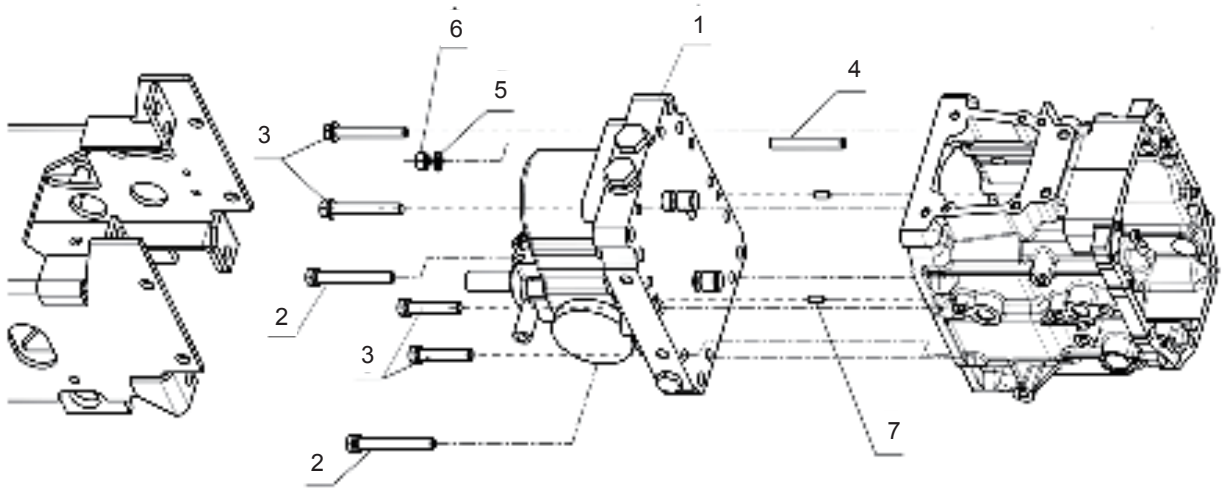
- Lowering the reverse driving pedal (1) and lifting the forward driving pedal (2)
- The rod A (3) is pushed backward.
- Turning the neutral holder (4) counterclockwise
  - Changing the angle of the HST swash plate (0 - +17˚)
- Detecting the reverse condition of the safe start neutral switch.
- Pulling the HST accelerator cable - Increase of the engine speed.

6. TROUBLESHOOTING

PROBLEMS	CAUSE OR SYMPTOM	SOLUTION
The 3-point hitch cannot be lifted.	• Improperly installed position control valve	• Remove and re-install it.
	• Damaged position control valve	• Replace it with a new one.
	• Foreign material stuck in position control valve or spool stuck	• Remove, clean and repair it.
	• Insufficient transmission fluid	• Add transmission fluid.
	• Clogged oil filter	• Clean or replace it.
	• Damaged hydraulic pump	• Repair or replace it.
	• Damaged cylinder piston ring of hydraulic cylinder case	• Check the backup ring and O-ring and replace it as necessary.
The 3-point hitch cannot be lowered.	• Damaged stop valve	• Check and repair the stop valve.
	• Foreign material stuck in position control valve	• Remove and clean the position control valve.
Impossible to drive forward or backward	• Damaged power train	• Check and adjust the power train
	• Clogged HST internal circuit	• Check if the check valve, relief valve, etc. and clean them accordingly.
	• Incorrectly set neutral position of HST pedal	• Set the HST neutral range correctly
	• Insufficient hydraulic oil amount	• Add oil
	• Clogged HST filter	• Clean or replace
	• Faulty HST	• Replace the HST
Excessively heated oil	• Insufficient oil in transmission	• Add oil
	• Low setting pressure of relief valve	• Set the setting pressure properly or replace the relief valve
	• Low discharge pressure of gear pump	• Check and repair the gear pump, Clean the filter
	• Clogged oil cooler	• Clean
Impossible to stop with lever in HST pedal neutral position	• Incorrectly set neutral position of HST	• Adjust the neutral position correctly
	• Faulty neutral valve	• Clean and remove foreign materials

7. SECTIONAL VIEW FOR MAJOR COMPONENTS

7.1 HST



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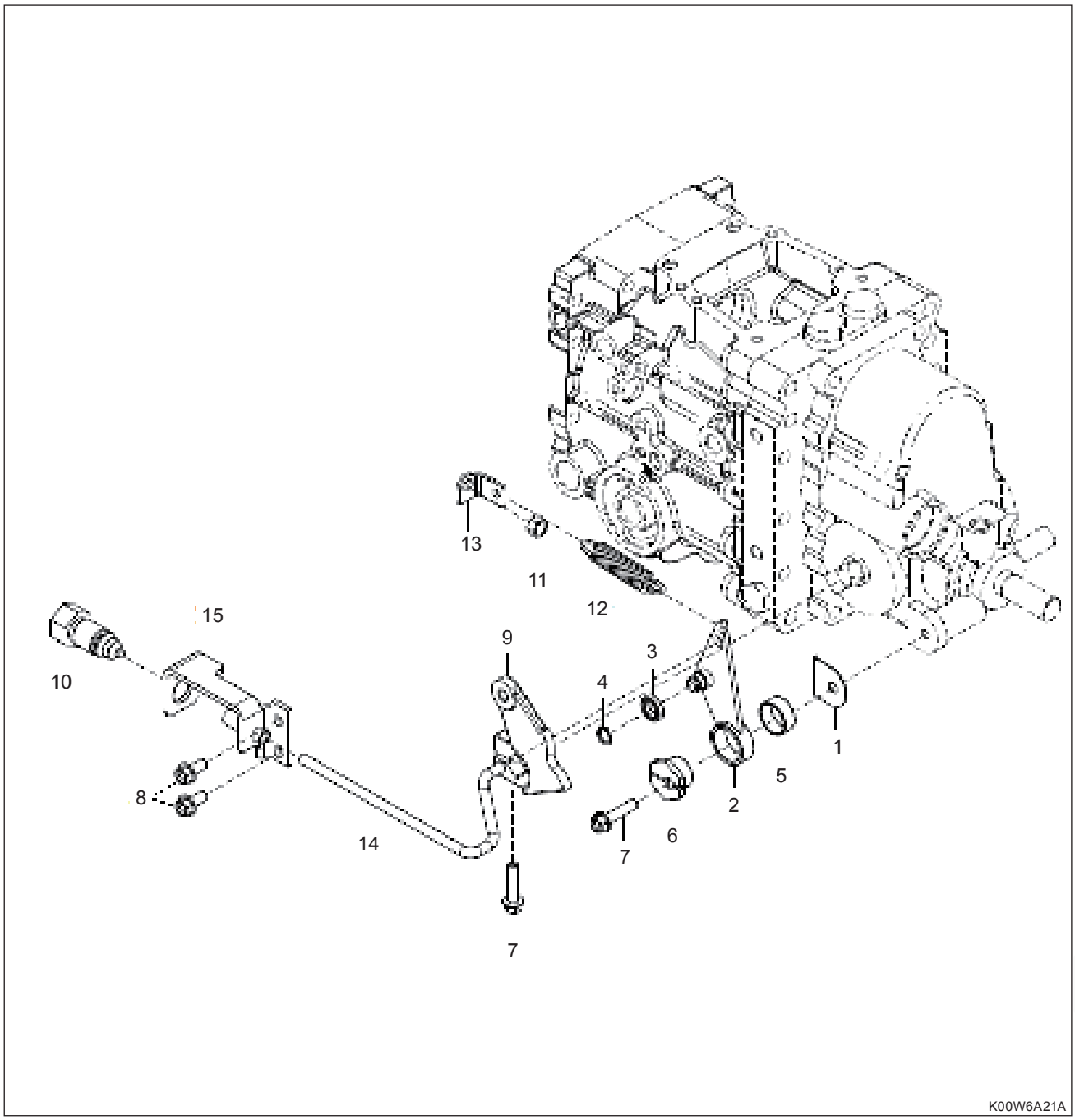
COMPONENTS

(1) HST assy
(2) Bolt
(3) Bolt
(4) Stud,bolt
(5) Washer, spring
(6) Nut
(7) Pin, straight

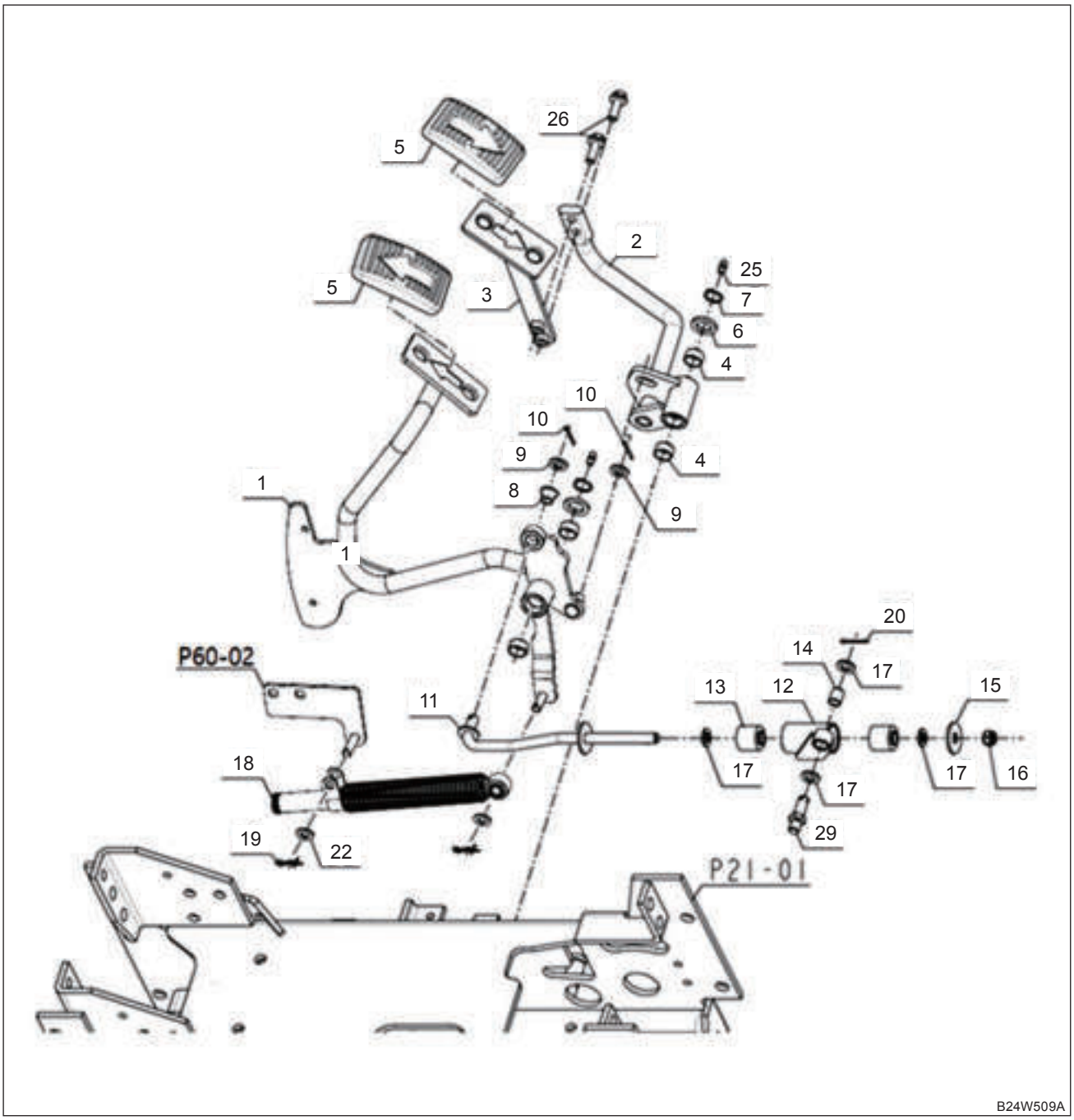
7.2 NEUTRAL HOLDER LINK



COMPONENTS

(1) Spacer
(2) Assy arm, neutral
(3) Bearing, ball
(4) Cir clip, external
(5) Bush
(6) Shaft, holder
(7) Bolt
(8) Bolt
(9) Holder, neutral
(10) Switch, safety
(11) Nut
(12) Spring
(13) Bracket
(14) Rod, HST neutral
(15) Stay, neutral switch

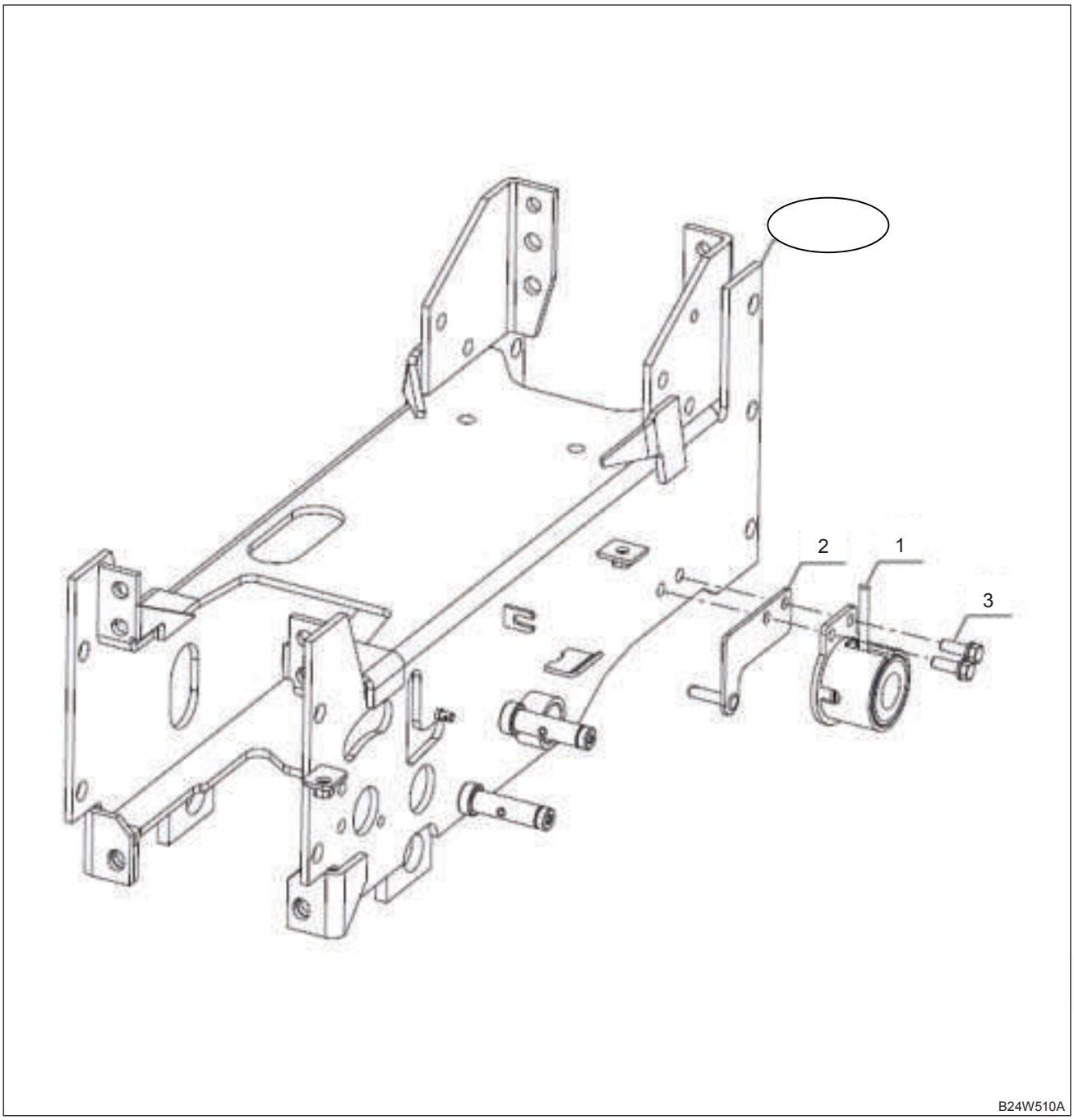
7.3 F-R PEDAL



COMPONENTS

(1) Assy pedal, HST
(2) Assy pedal, HST
(3) Assy pedal, HST
(4) Bush
(5) Cover, pedal
(6) Washer
(7) Cir clip, external
(8) Bush
(9) Washer, plain
(10) Cotter pin
(11) Rod, A
(12) Rod, B
(13) Cushion, robber
(14) Bush
(15) Washer, plain
(16) U nut
(17) Washer, plain
(18) Damper, HST
(19) Washer, plain
(20) Cotter pin
(22) Pin, snap
(25) Nipple, grease
(26) Bolt
(29) Stud, bolt

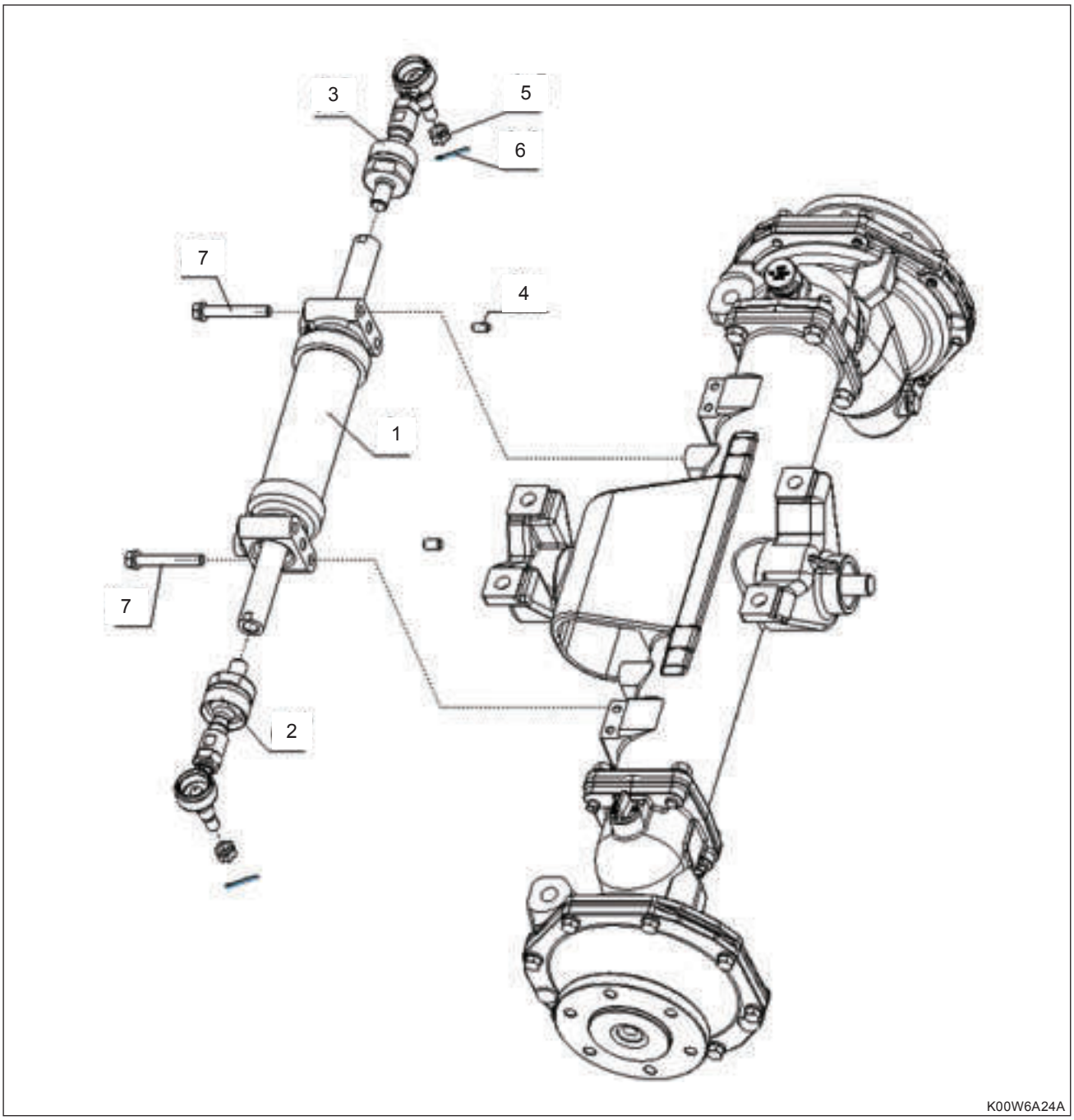
7.4 CRUISE LEVER



COMPONENTS

(1) Cruise magnet (2) Washer, plain (3) Bolt

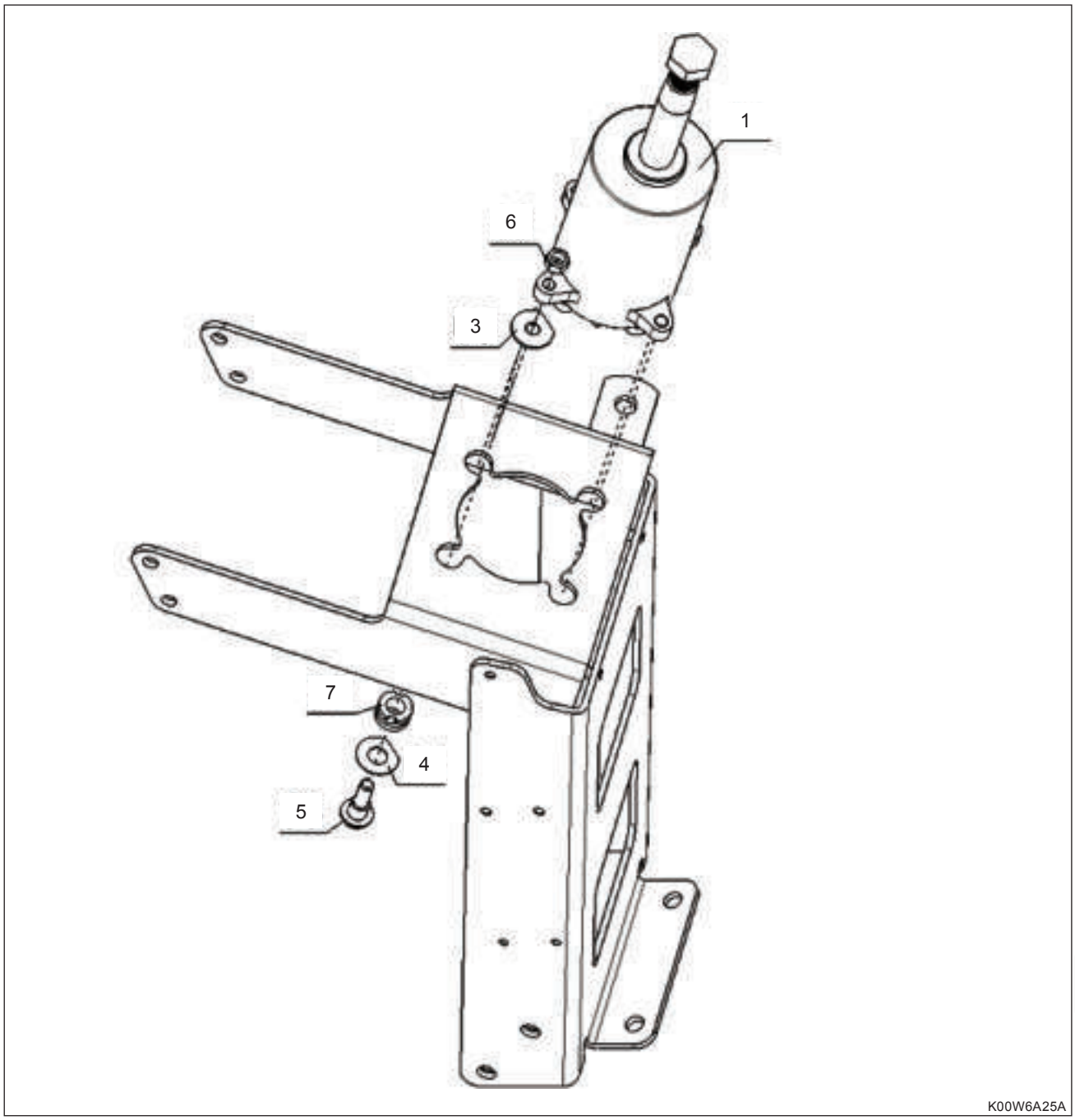
7.5 TIE ROD



COMPONENTS

(1) Pst cylinder
(2) Tie rod l ass'y
(3) Tie rod r ass'y
(4) Pin straight
(5) Nut
(6) Cotter pin
(7) Bolt

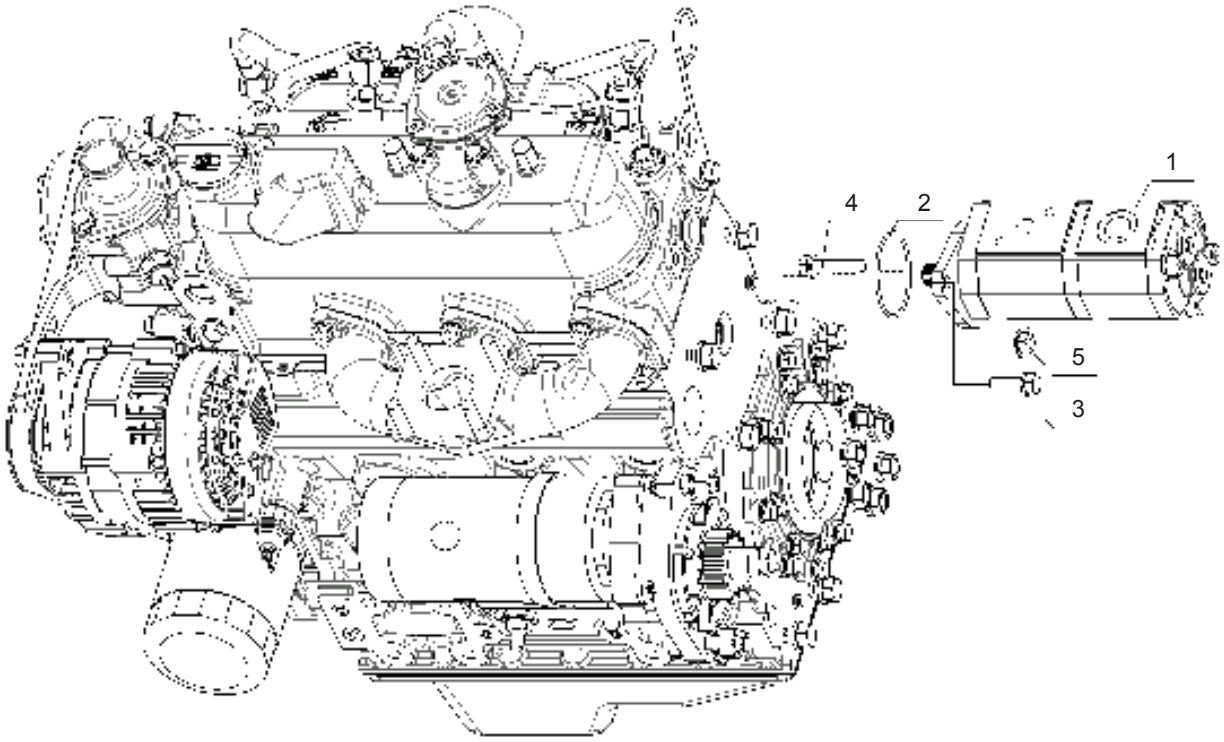
7.6 HYDRAULIC STEERING VALVE



COMPONENTS

(1) Assy steering, power
(3) Washer
(4) Washer
(5) Bolt
(6) Nut
(7) Cushion

7.7 HYDRAULIC PUMP



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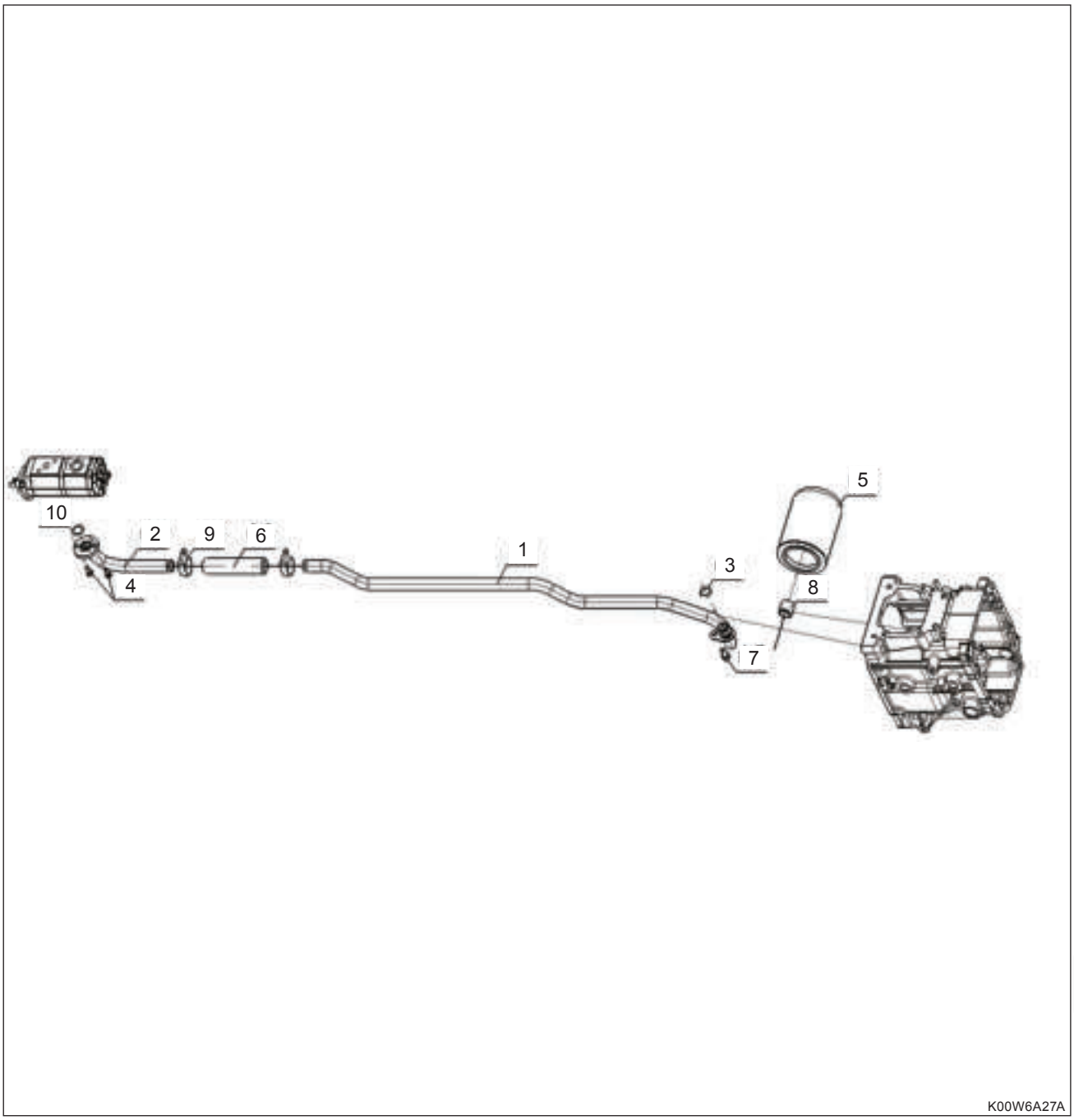
COMPONENTS

(1) Assy pump, hydraulic
(2) O-ring
(3) Bolt
(4) Bolt
(5) Nut

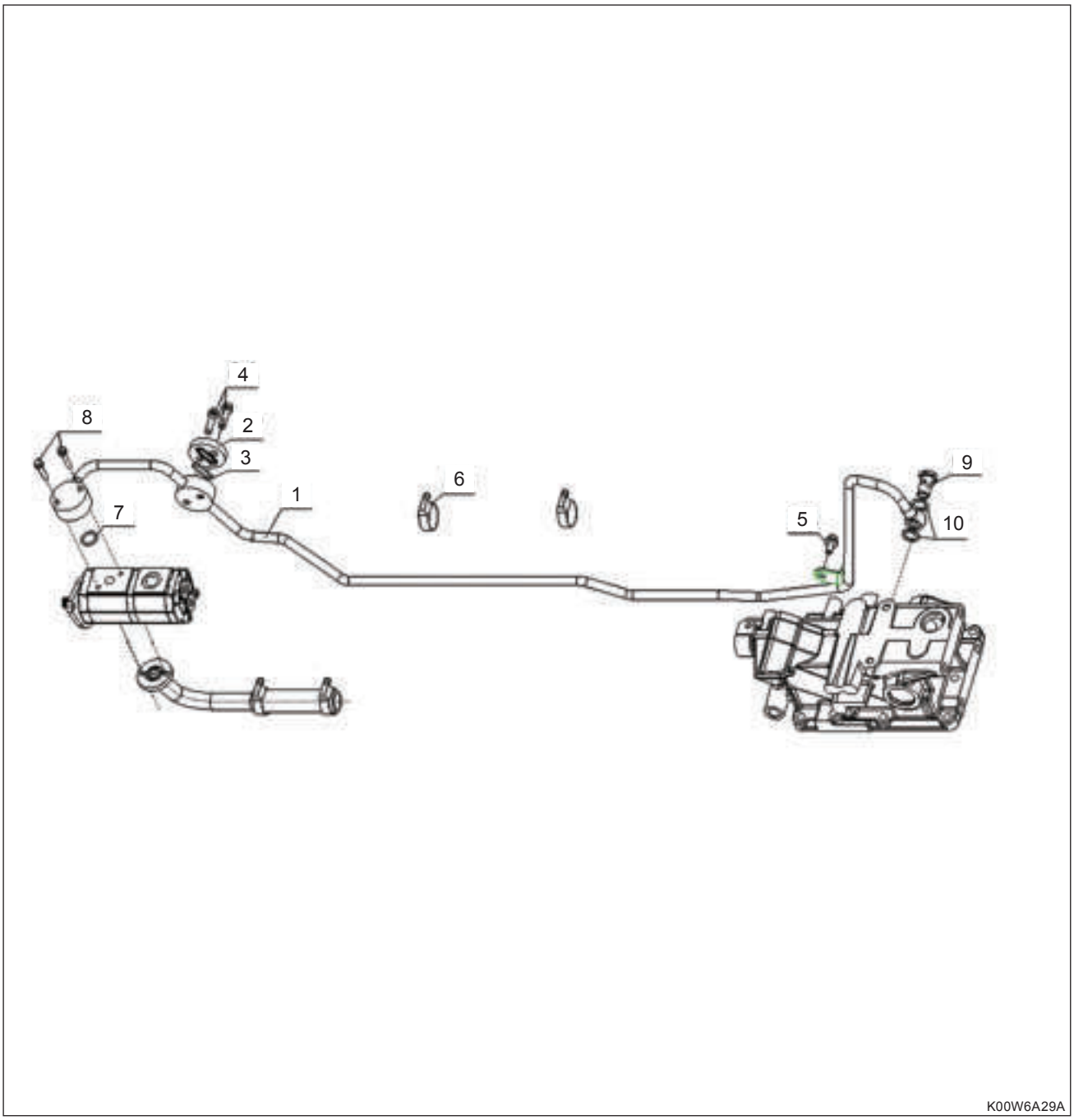
7.8 HYDRAULIC OIL LINE - SUCTION



COMPONENTS

(1) Pipe, suction
(2) Pipe, suction
(3) O-ring
(4) Bolt
(5) Filter, oil
(6) Hose, inlet
(7) Bolt
(8) Joint, screw
(9) Clamp
(10) O-ring

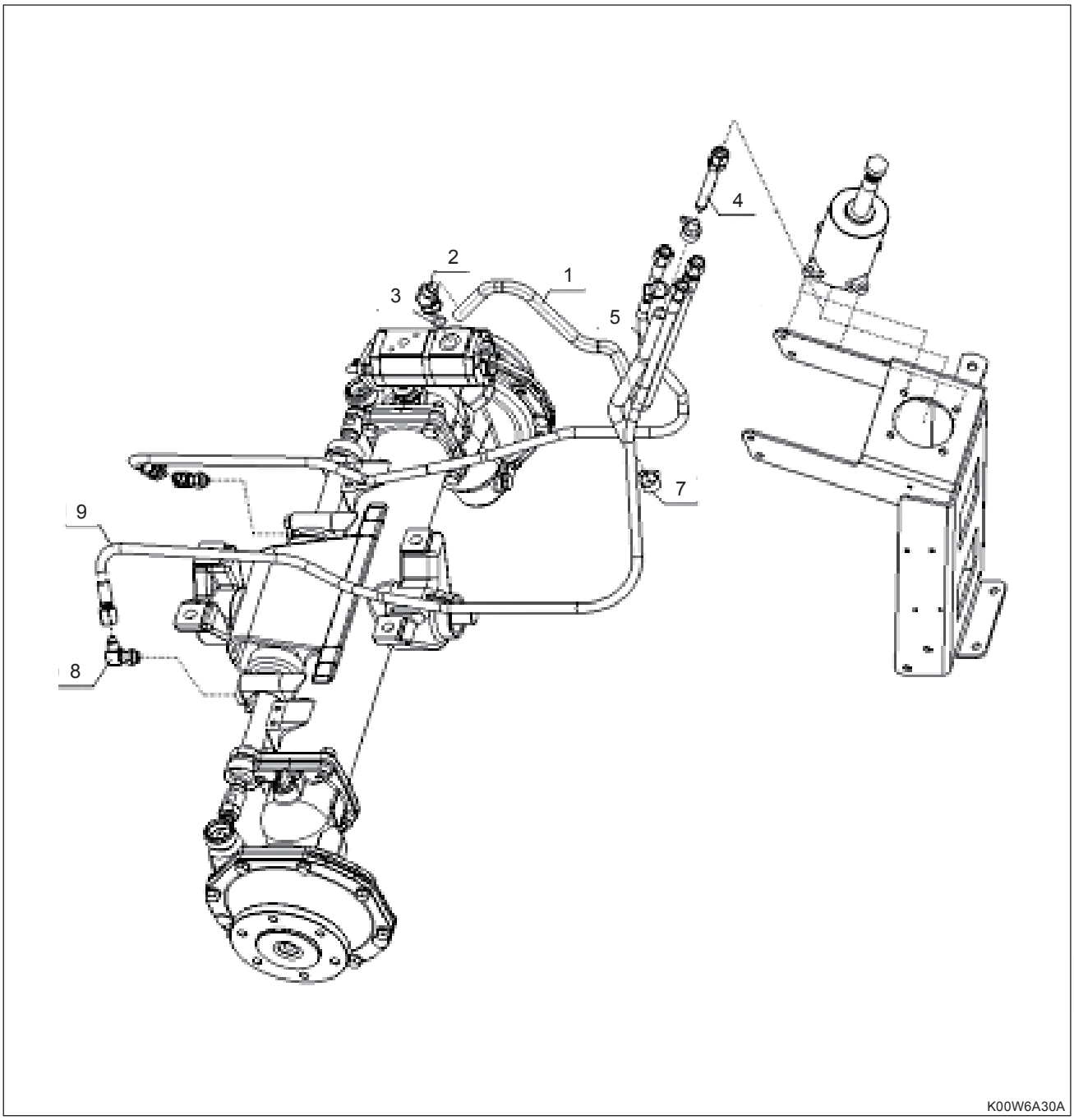
7.9 HYDRAULIC OIL LINE - DELIVERY



COMPONENTS

(1) Pipe, delivery P
(2) Cap
(3) O-ring
(4) Bolt
(5) Bolt
(6) Clamp
(7) O-ring
(8) Bolt
(9) Bolt, joint
(10) Packing

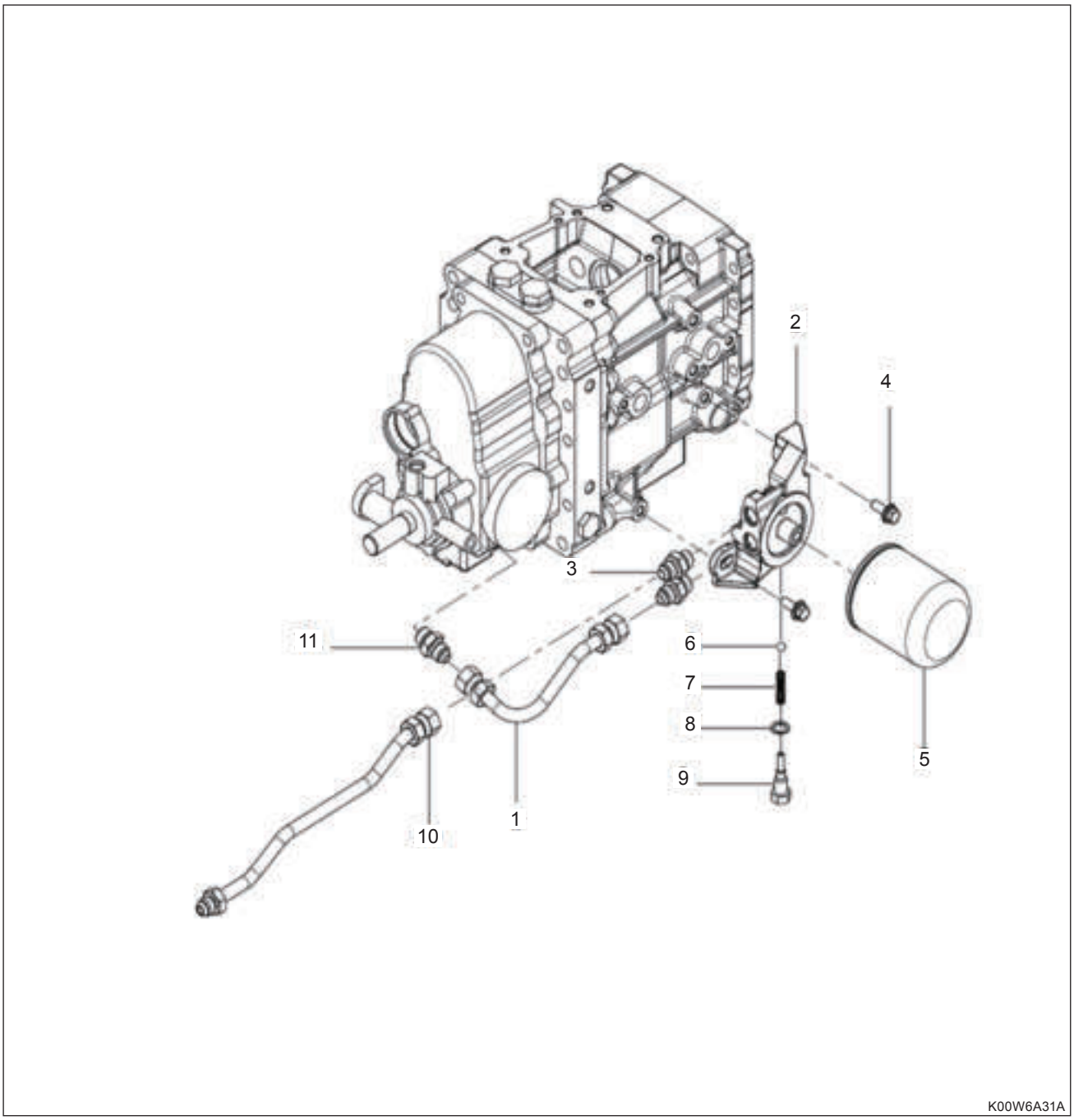
7.10 HYDRAULIC OIL LINE - STEERING



COMPONENTS

(1) Pipe, delivery
(2) Joint, pip
(3) O-ring
(4) Pipe
(5) Hose
(7) Clamp, hose
(8) Joint, pipe
(9) PST hose

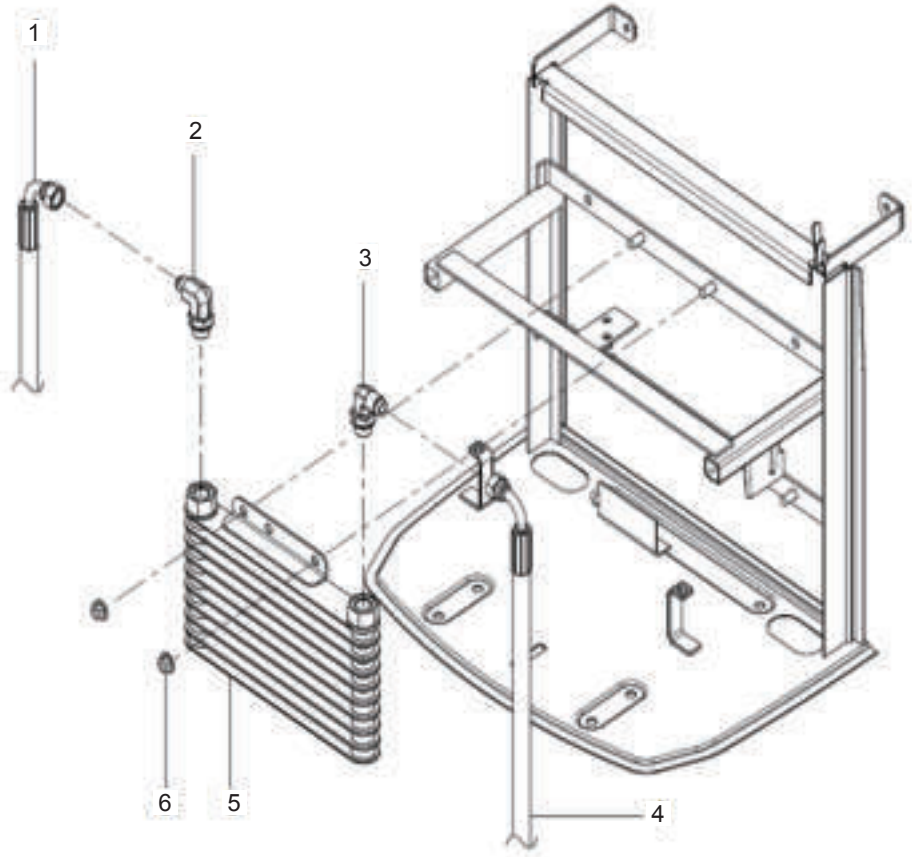
7.11 HYDRAULIC OIL LINE - HST (1)



COMPONENTS

(1) Pipe
(2) Cover, filter
(3) Connector
(4) Bolt
(5) Cartridge, oil filter
(6) Ball
(7) Spring
(8) Packing
(9) Bolt
(10) Pipe
(10) Pipe
(11) Adapter

7.12 HYDRAULIC OIL LINE - HST (2)



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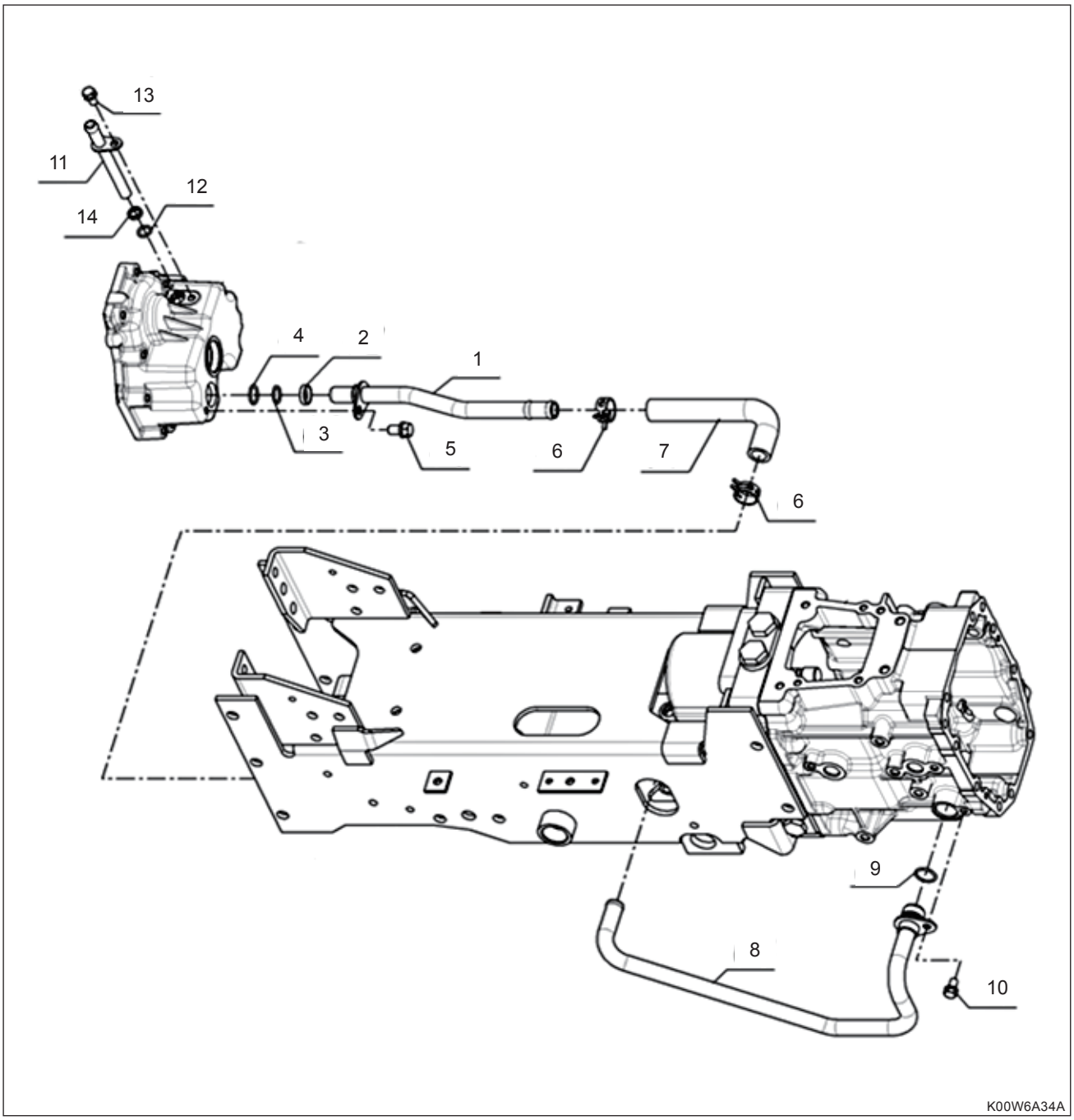
COMPONENTS

(1) Hose
(2) Joint, pipe
(3) Elbow (3/8)
(4) Hose
(5) Oil, cooler
(6) Bolt

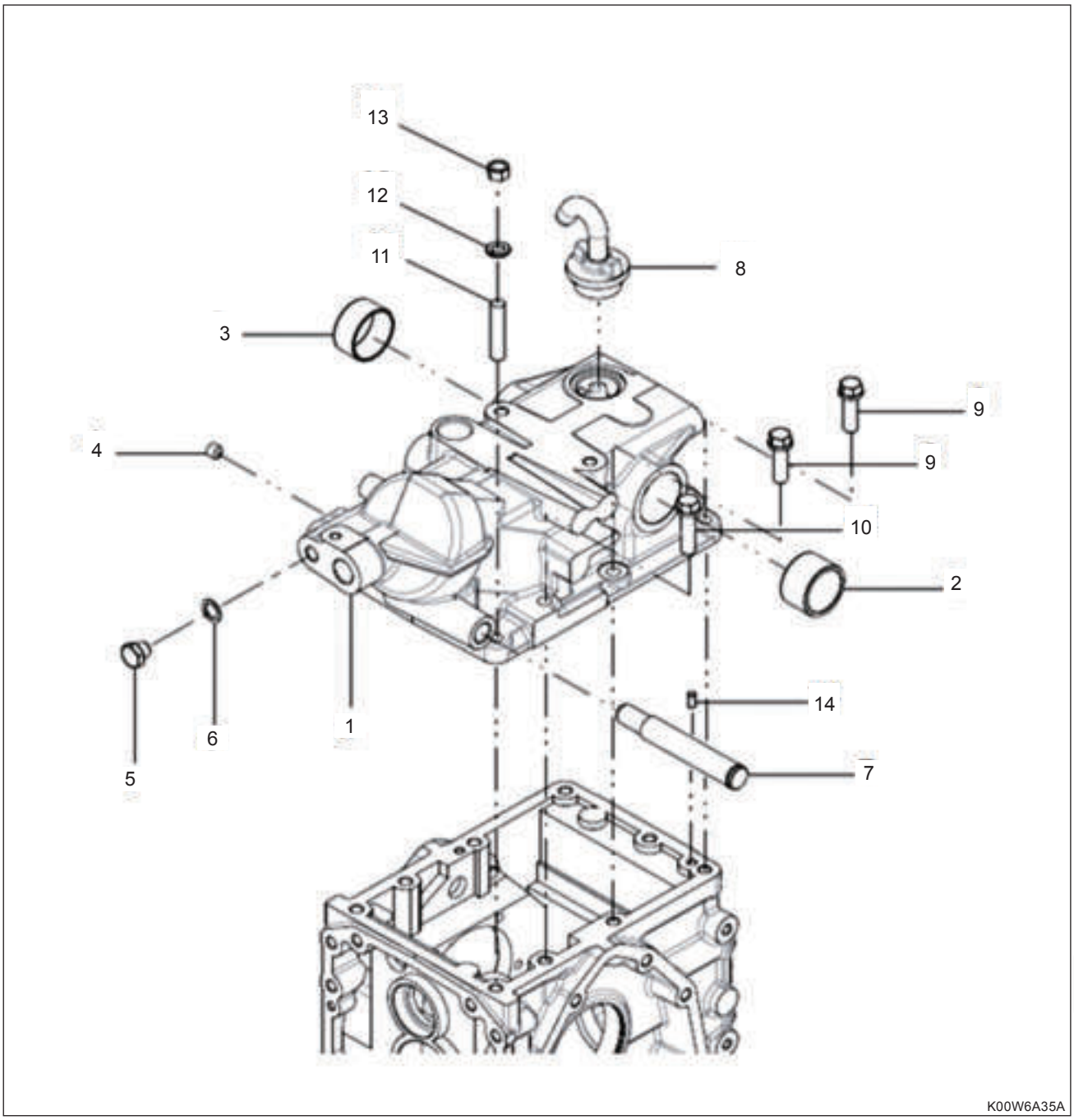
7.13 HYDRAULIC OIL LINE - C/M



COMPONENTS

(1) Pipe
(2) Ring
(3) O-ring
(4) O-ring
(5) Bolt
(6) Clamp
(7) Hose, hydraulic
(8) Pipe
(9) O-ring
(10) Bolt
(11) Pipe,air breather
(12) O-ring
(13) Bolt
(14) Collar

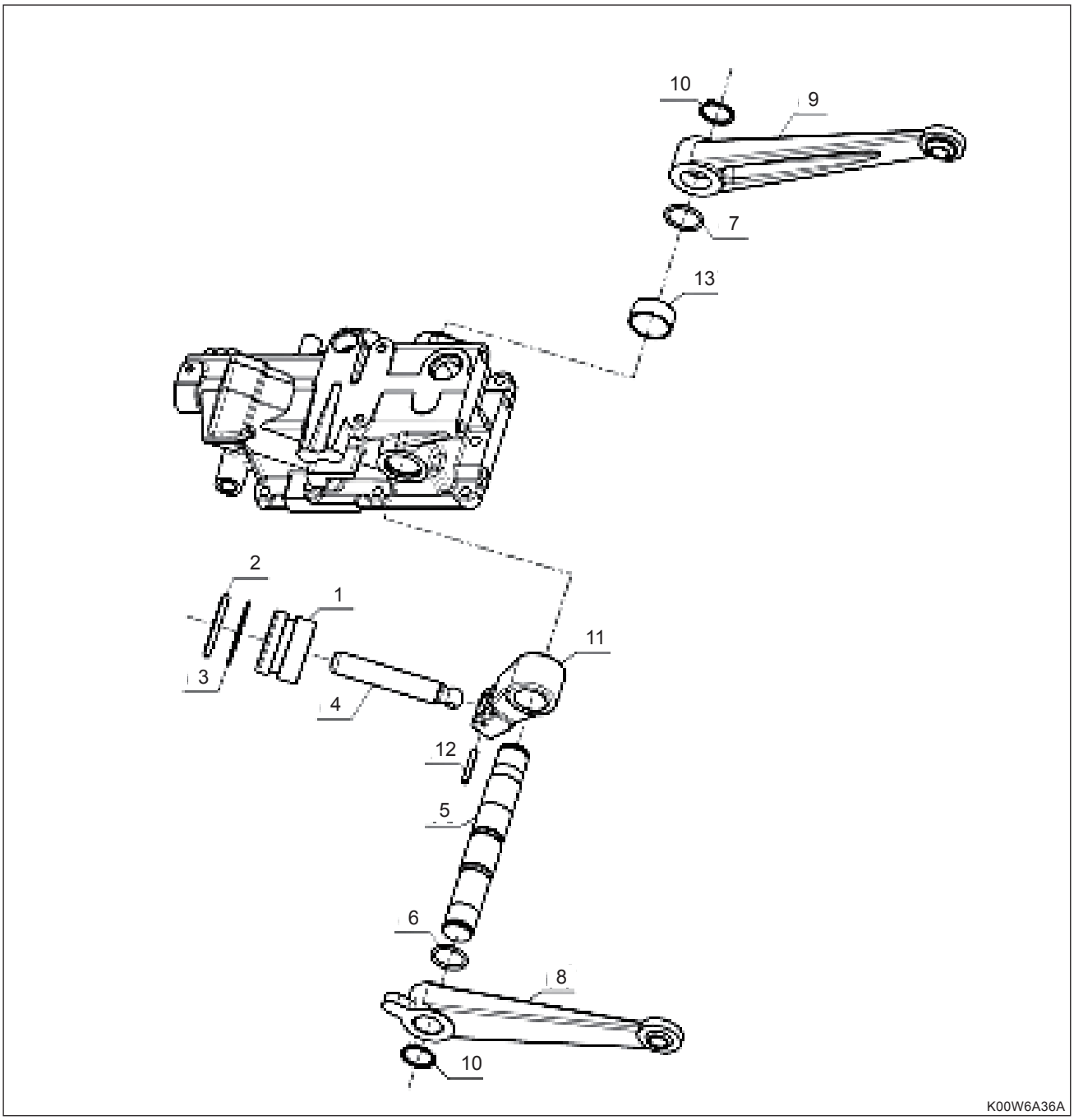
7.14 HYDRAULIC CYLINDER



COMPONENTS

(1) Assy case, cylinder
(2) Bush
(3) Bush
(4) Plug
(5) Plug
(6) Packing
(7) Shaft
(8) Cap, oil intake
(9) Bolt
(10) Bolt
(11) Stud
(12) Washer, spring
(13) Nut
(14) Pin, straight

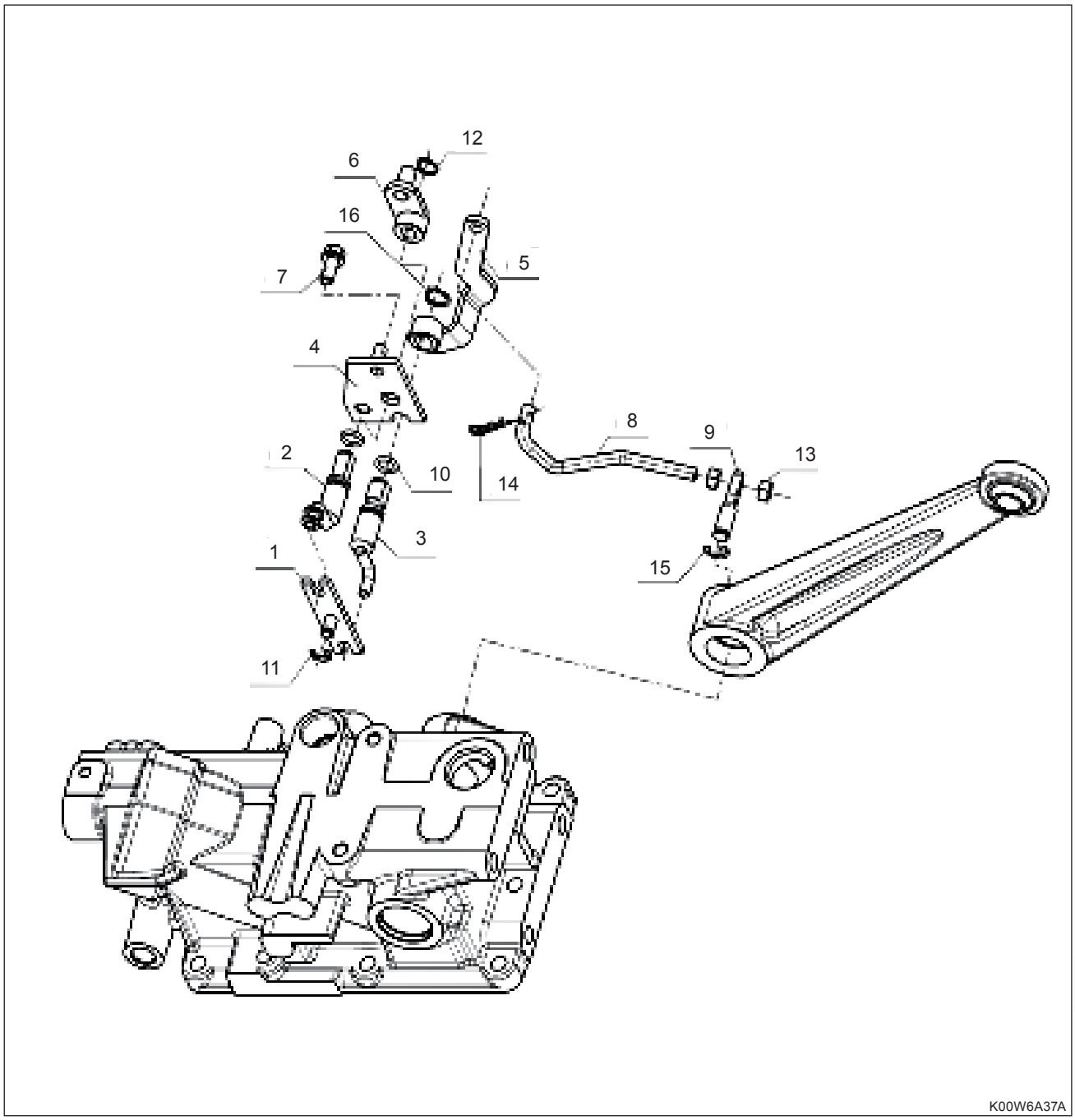
7.15 HYDRAULIC PISTON / LIFT ARM



COMPONENTS

(1) Piston, hyd.
(2) O-ring
(3) Ring, back up
(4) Rod, hyd. Piston
(5) Shaft, hyd. Arm
(6) O-ring
(7) O-ring
(8) Arm, lift LH
(9) Arm, lift RH
(10) Cir clip, external
(11) Arm, hydraulic
(12) Pin, spring
(13) Collar

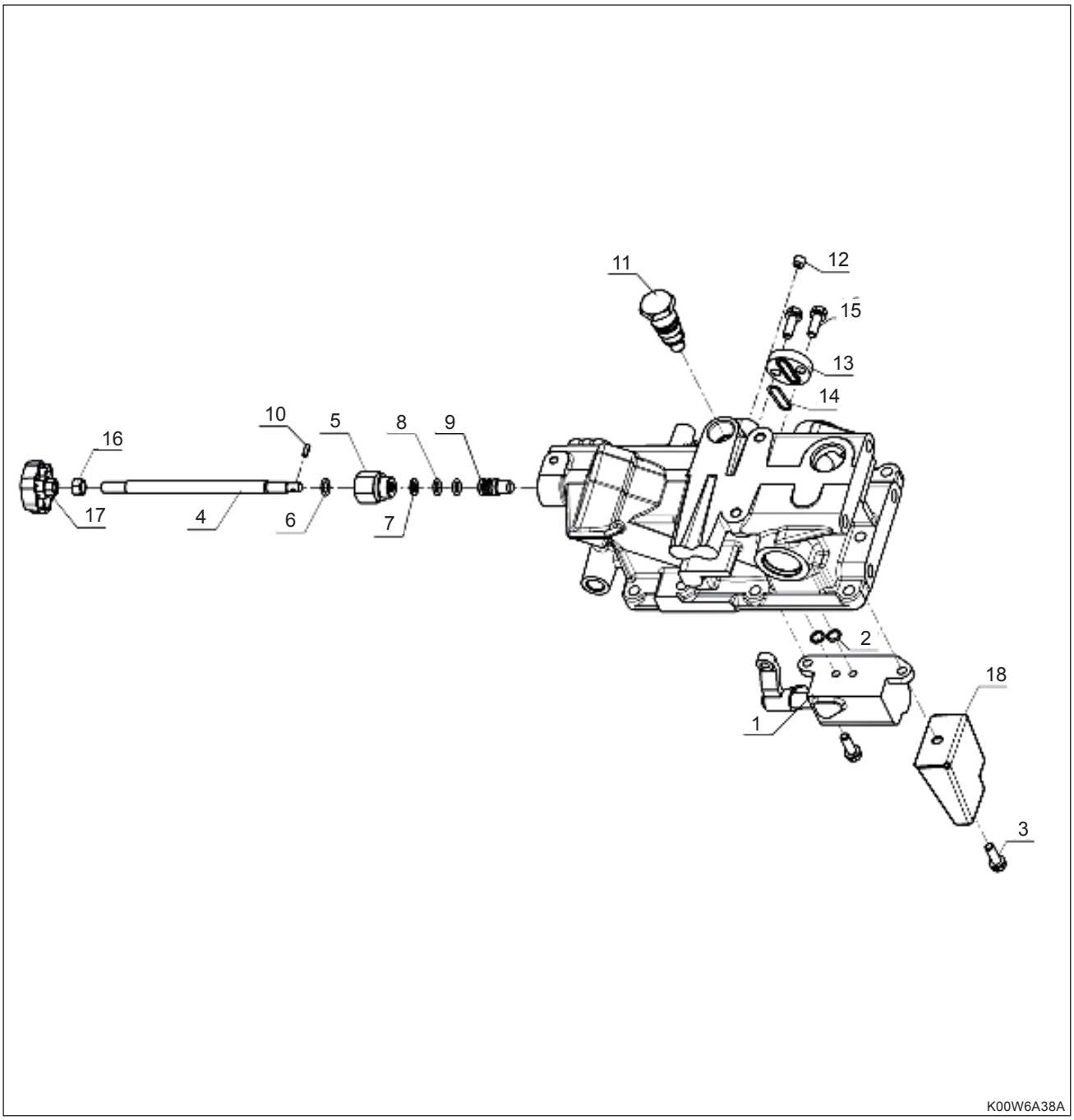
7.16 FEED BACK LEVER - POSITION



COMPONENTS

(1) Link
(2) Control lever
(3) Shaft, feed back
(4) Bracket ass'y
(5) Arm, feed back
(6) Ass'y, control arm
(7) Bolt
(8) Rod, feed back
(9) Pin, feed back
(10) O-ring
(11) Snap ring
(12) Cir clip,external
(13) Nut
(14) Pin, snap
(15) Snap ring
(16) Cir clip,external

7.17 POSITION VALVE



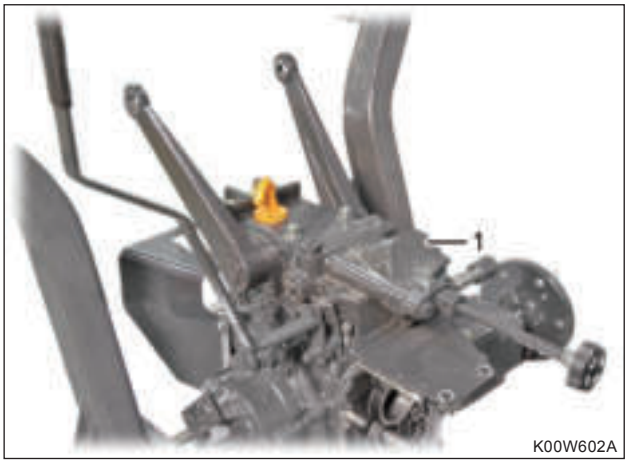
COMPONENTS

(1) Assy valve, position
(2) O-ring
(3) Bolt
(4) Shaft, hyd. Adjust
(5) Holder
(6) O-ring
(7) Washer
(8) O-ring
(9) Valve, stop
(10) Pin, spring
(11) Valve, safety
(12) Plug
(13) Cap
(14) O-ring
(15) Bolt
(16) Nut
(17) Grip
(18) Oil guide

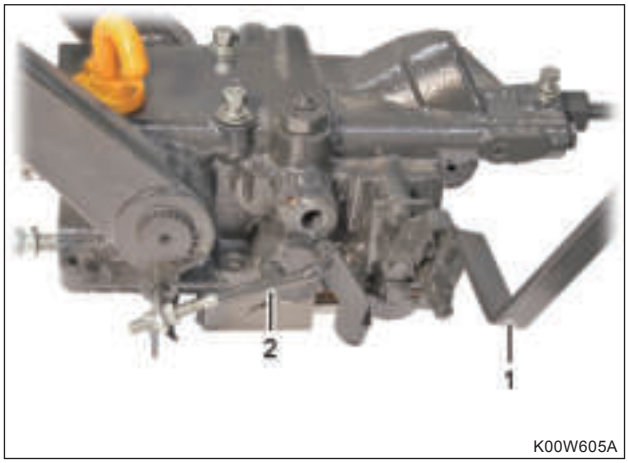
8. DISASSEMBLY AND SERVICE

8.1 HYDRAULIC CYLINDER CASE DISASSEMBLY AND ASSEMBLY

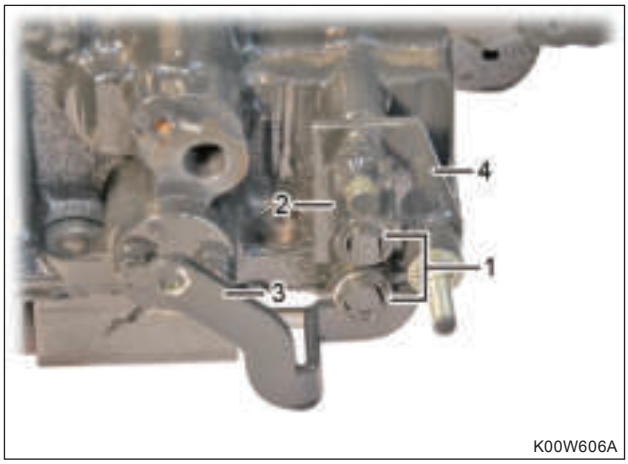
1. Remove the seat (1), fender (LH) (2) and (RH) (3).



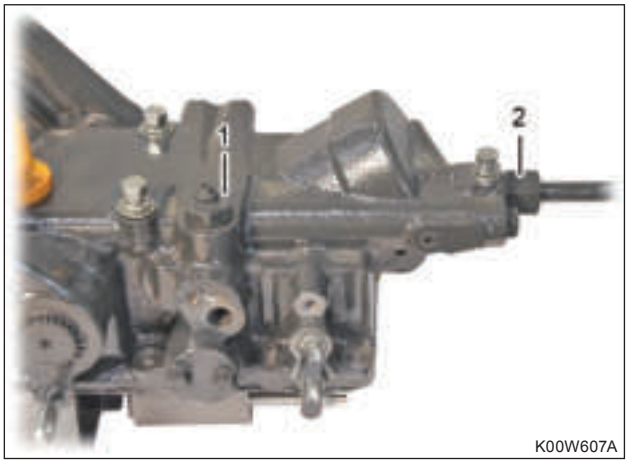
2. Remove the hydraulic cylinder case assembly (1).

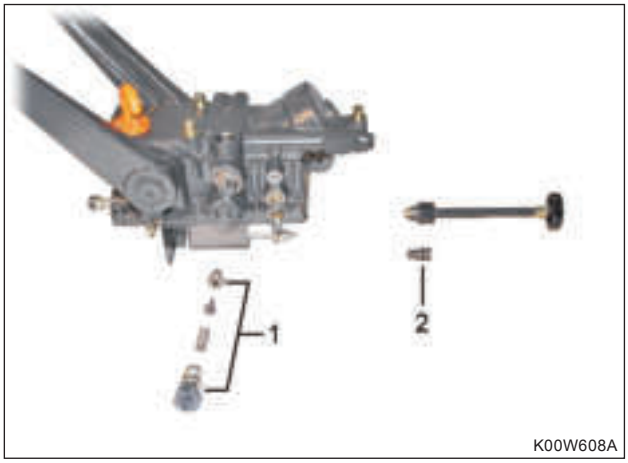


3. Remove the position control lever (1) and feedback rod (2) from the hydraulic cylinder case assembly.

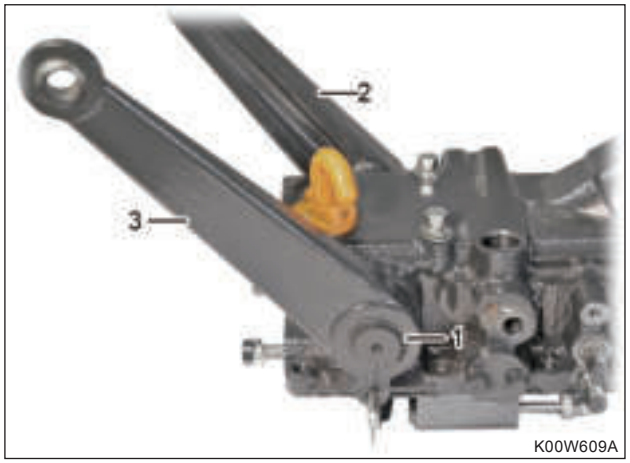


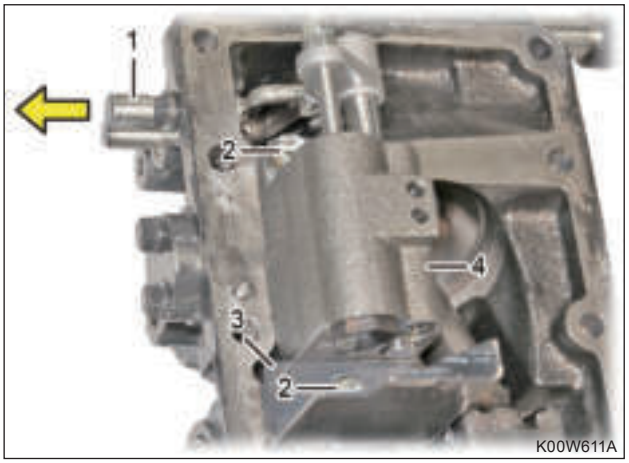
4. Pull out the snap rings (1) from the side of the case to remove the control arm assembly (2), feedback arm (3) and plate assembly (4).

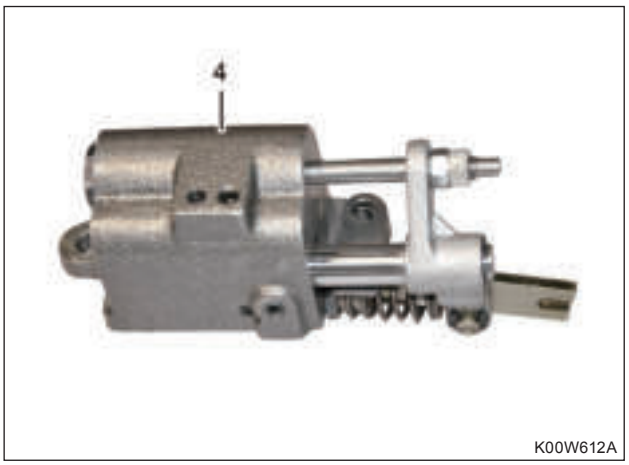




5. Remove the safety valve assembly (1) and stop valve (2).

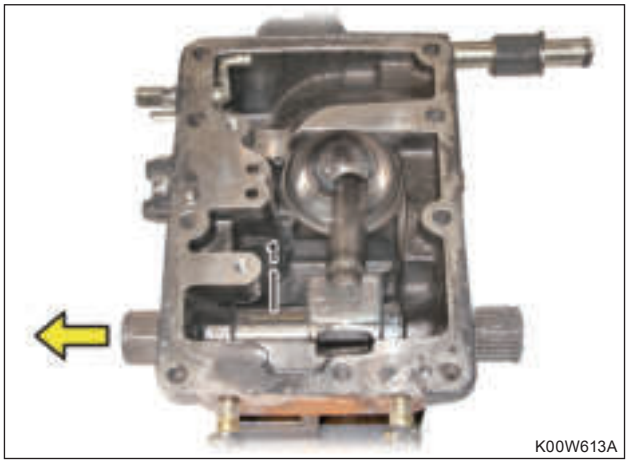


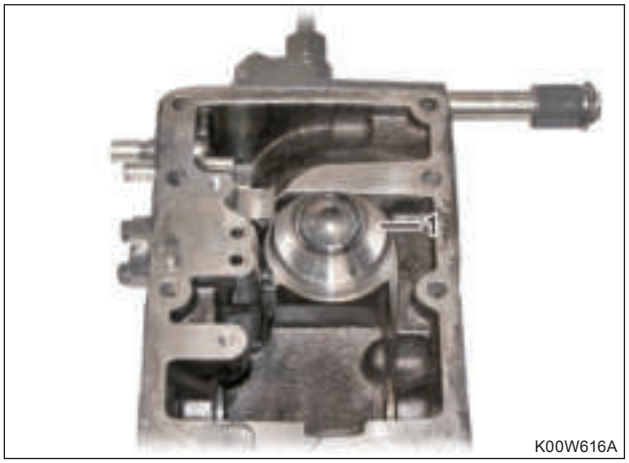


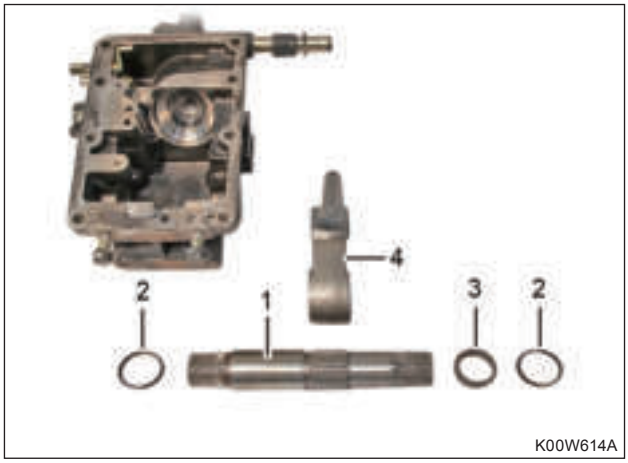


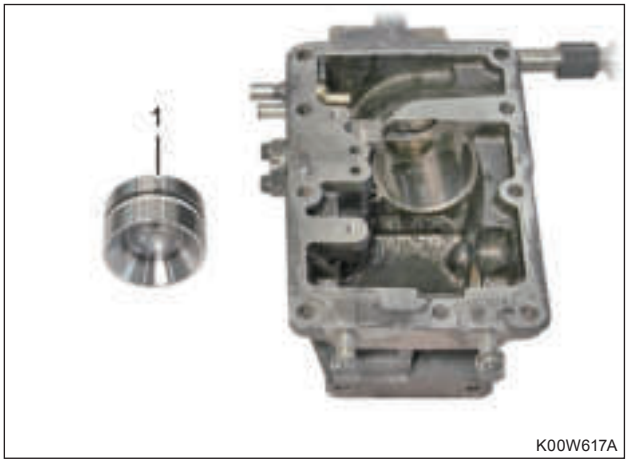
6. Pull out the snap rings (1) from the left and right lift arm to remove the lift arm (LH) (2) and (RH) (3) from the hydraulic arm shaft.

7. Remove the feedback shaft (1) from the link by pulling it forward and unscrew the position control valve mounting bolts (2) to remove the oil guide (3) and position valve (4).



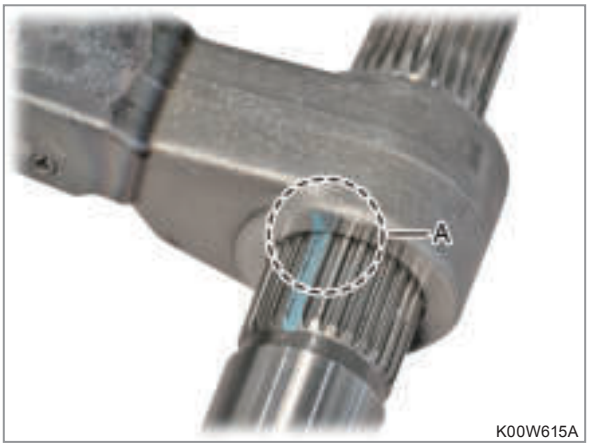






8. While Tapping the hydraulic arm shaft (1) toward the left side, remove the O-ring (2), collar (3) and lift crank (4) in order.

⚠ CAUTION



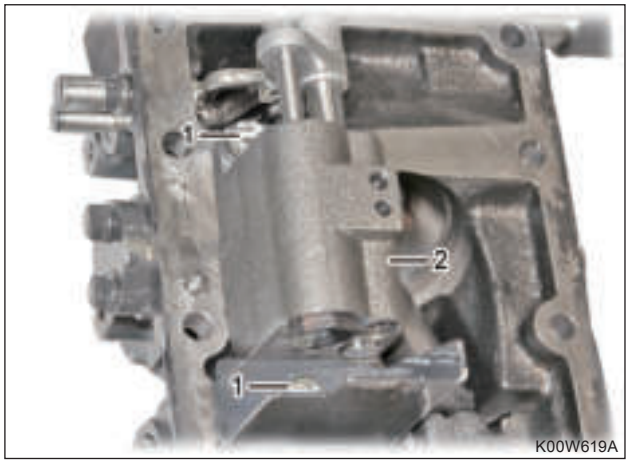
- **When installing the hydraulic arm shaft to the lift crank, make sure to align the aligning marks (A).**

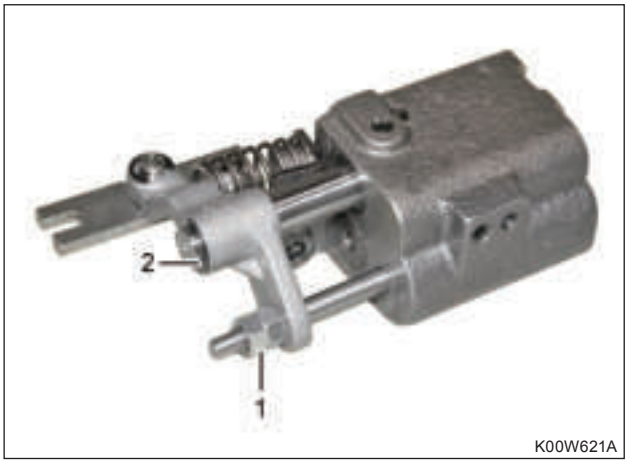
9. Remove the hydraulic piston (1) from the hydraulic cylinder case.

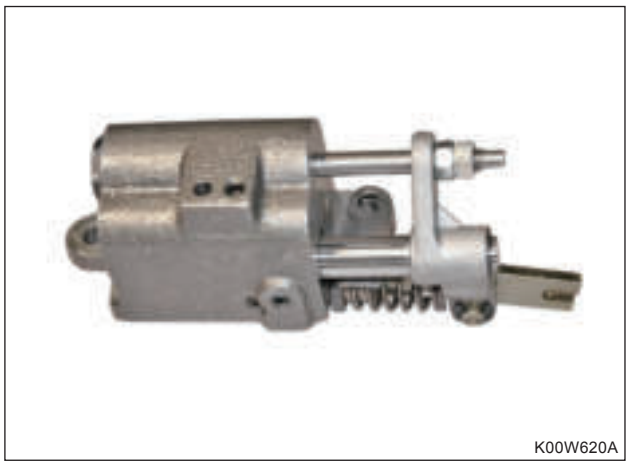
⚠ CAUTION

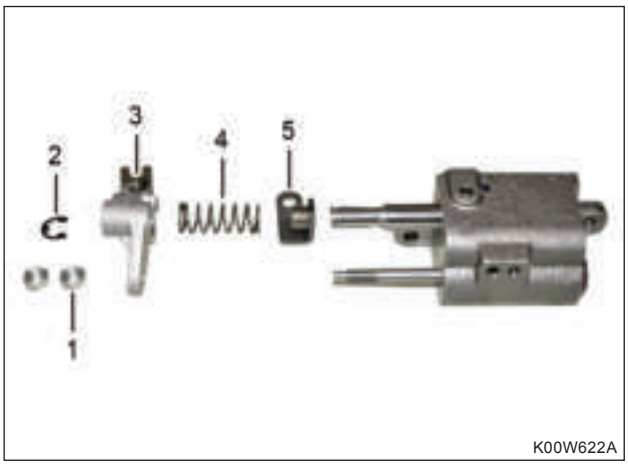
- **Check how much the O-ring (1) and backup ring (2) for the piston are worn, and replace any defective or excessively worn one with a new one.**

8.2 POSITION CONTROL VALVE DISASSEMBLY



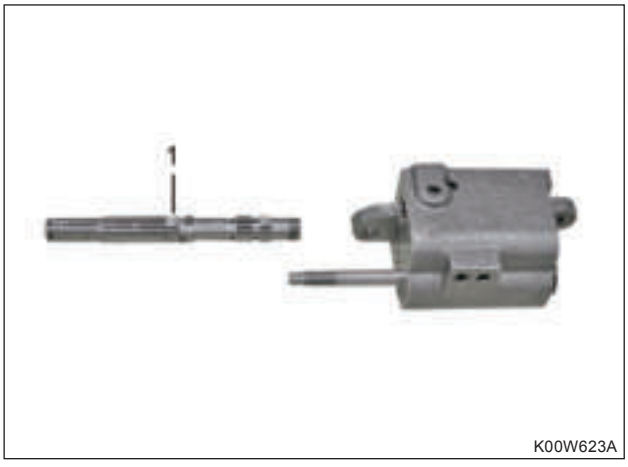




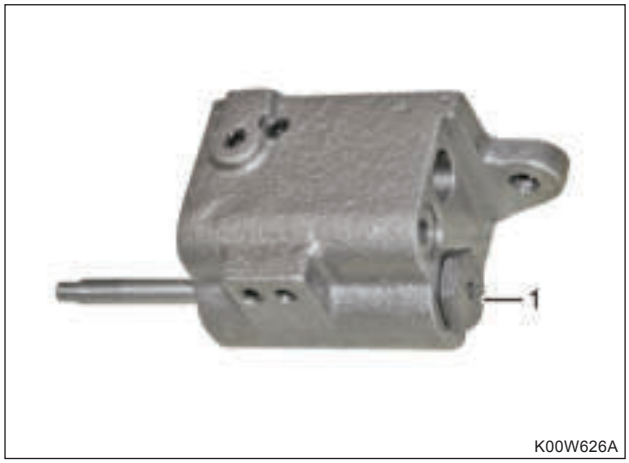


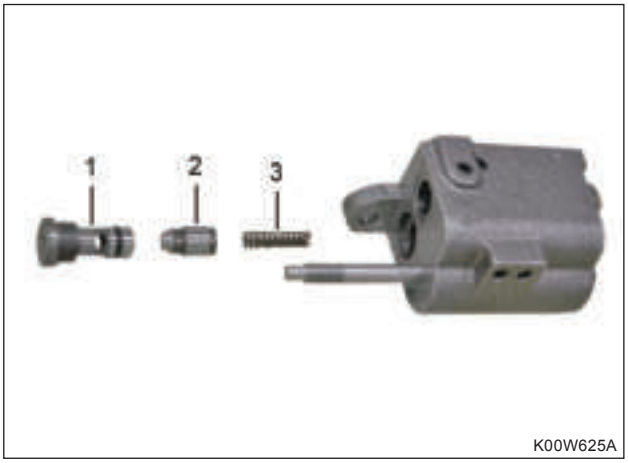
1. Unscrew the position control valve mounting bolts (1) from the hydraulic cylinder case to remove the position control valve (2).

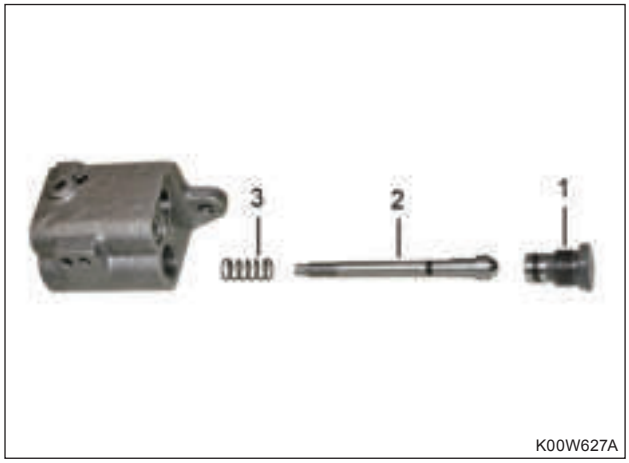
2. Unscrew the hex. nuts (1) and pull out the snap ring (2) from the position control valve to remove the arm (3), spring (4) and seat (5).



3. Remove the main spool (1) from the position control valve.

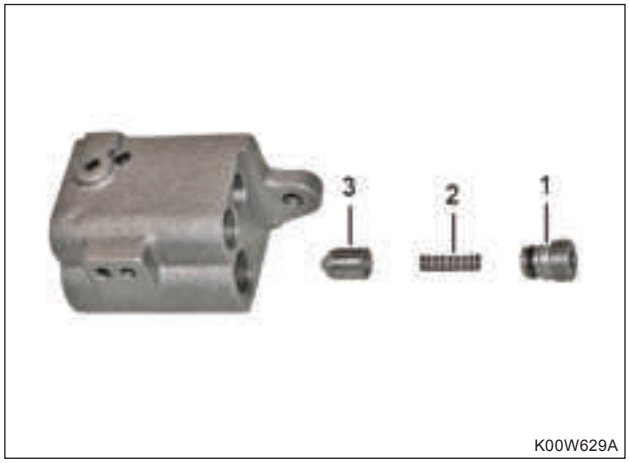




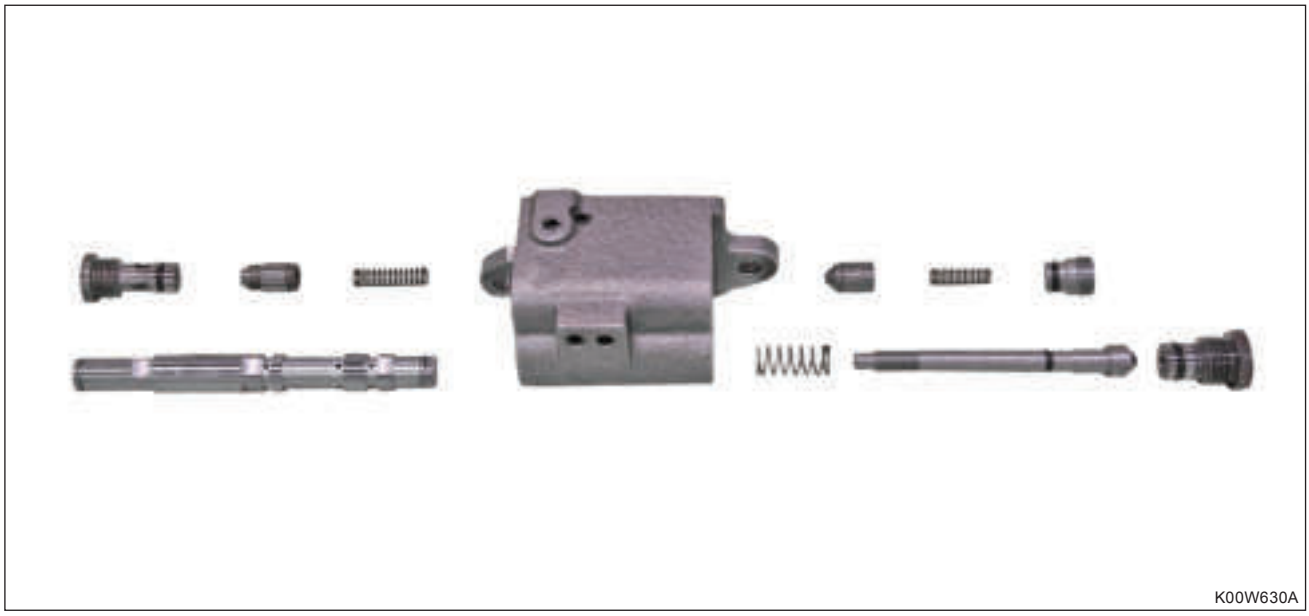


4. Unscrew the plug (1) from the valve body to remove the valve (2) and spring (3).

5. Unscrew the plug (1) to remove the valve (2) and spring (3).



6. Unscrew the plug (1) to remove the spring (2) and valve (3).



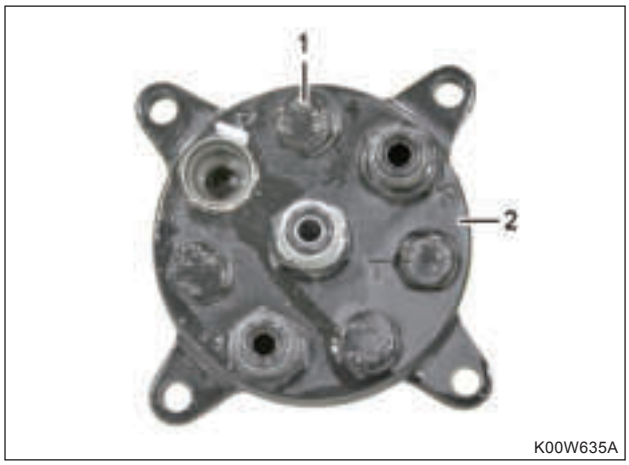
7. Assemble in the reverse order of disassembly.

8.3 PST UNIT DISASSEMBLY

1. Remove the steering wheel (1), upper dashboard (2) and lower dashboard (3).

2. PST unit assembly mounting bolts and nuts (1) to remove the PST unit assembly (2) by lifting it up.

3. Disconnect the PST hydraulic hoses (1) from the PST unit assembly.

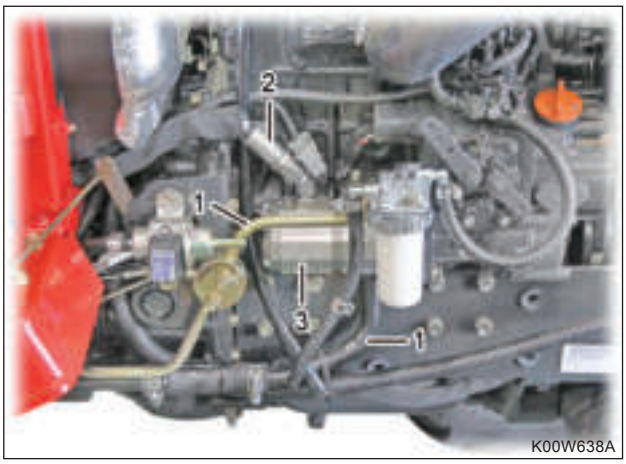


4. Unscrew the mounting bolts (1) from the PST unit end plate to remove the end plate (2).

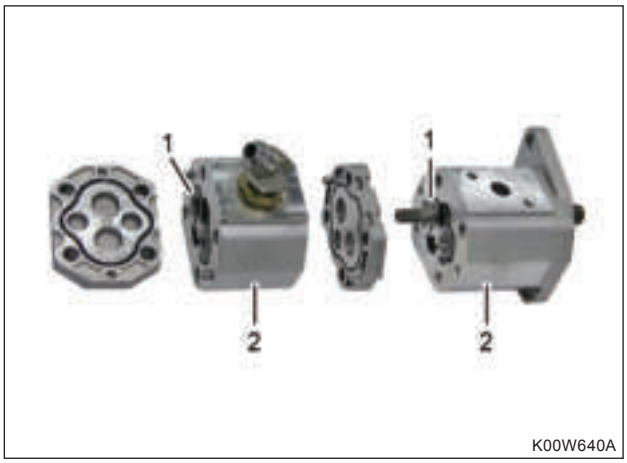
5. Remove the spacer (1), outer rotor (2) and inner rotor (3).

6. Remove the drive (1), plate (2), sleeve assembly (3) in order from the housing (4).

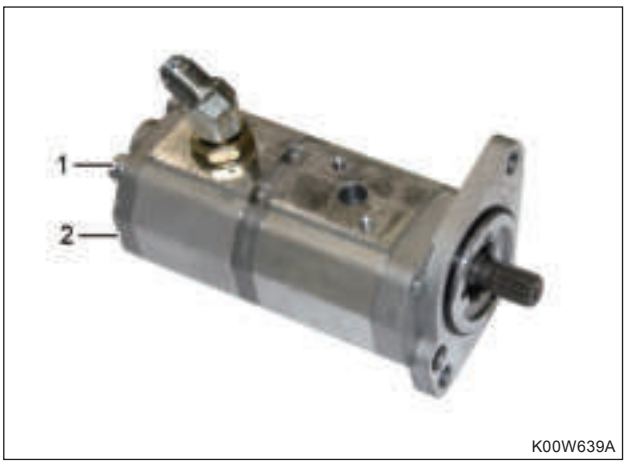
8.4 HYDRAULIC PUMP DISASSEMBLY



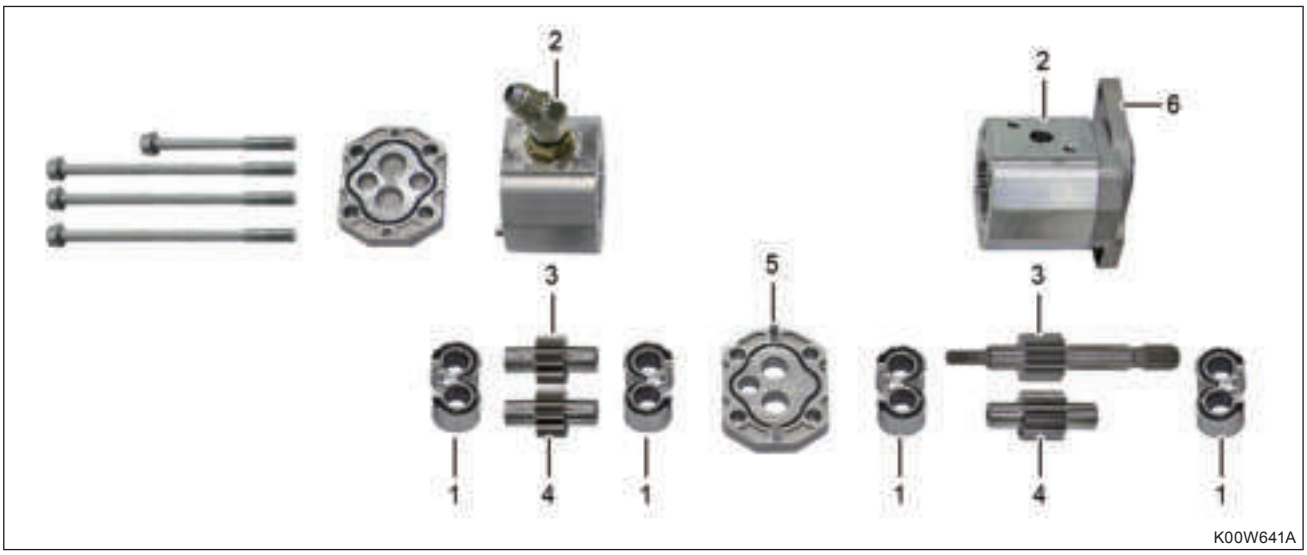
1. Disconnect the hydraulic pipes (1) and hydraulic hose (2) from the engine hydraulic pump and unscrew the mounting bolts to remove the hydraulic pump assembly (3).



3. Remove the shaft holding block (1) and separate the each housing (2).

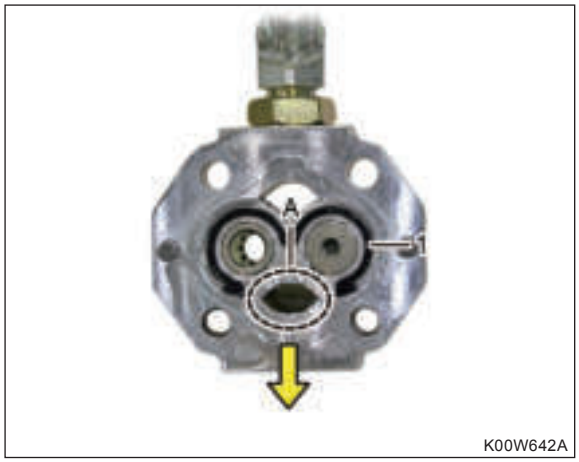


2. Unscrew the housing mounting bolts (1) to remove the rear cover (2).



4. Remove the drive gear (3), driven gear (4), spacer (5) and front cover (6).

IMPORTANT

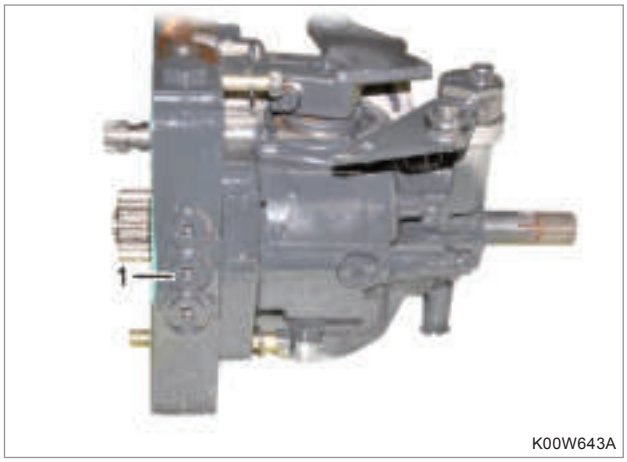


K00W642A

- **The opening section of the seal (1) of the shaft holding block should be installed to the oil suction side (A).**

5. Assemble in the reverse order of disassembly.

8.5 HST DISASSEMBLY

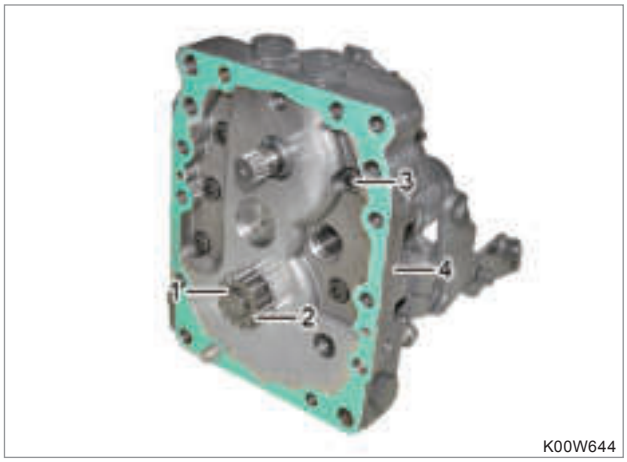


K00W643A

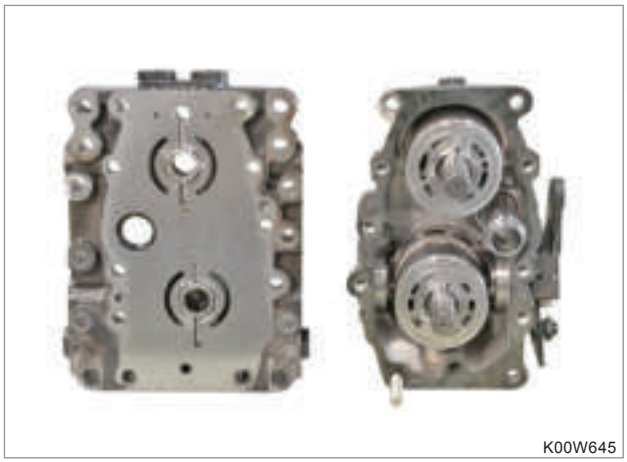
1. Unscrew the drain plug (1) from the bottom of the HST front cover to drain oil.

6-mm L wrench

MOTOR SHAFT DISASSEMBLY



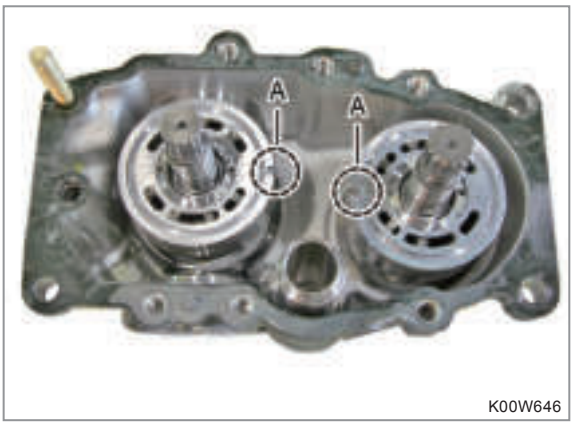
K00W644


K00W645

2. Pull out the snap ring (1) from the front section of the front cover and remove the 14 gear (2). Then, unscrew the HST front cover mounting bolts (3) (6 EA) to remove the front cover (4).

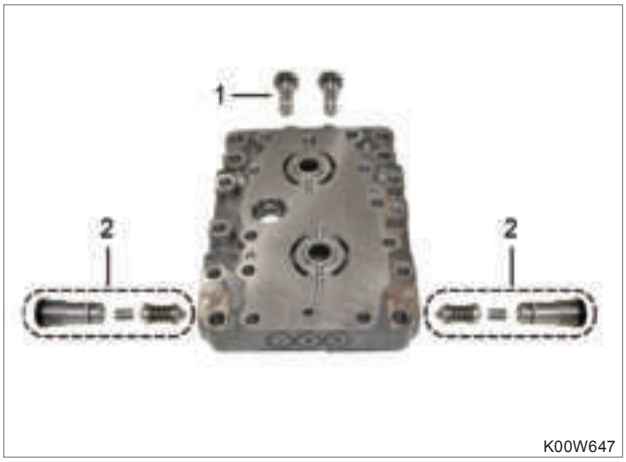
8 mm L wrench

Notes



K00W646

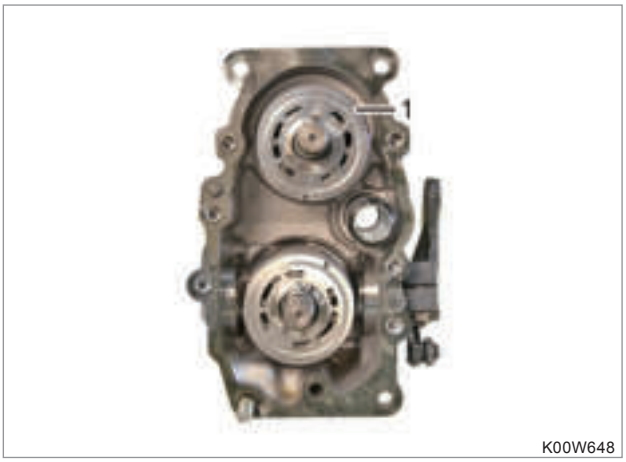
- **Align the valve plate grooves (A) on the center line of the HST pump shaft and the motor shaft when reinstalling.**



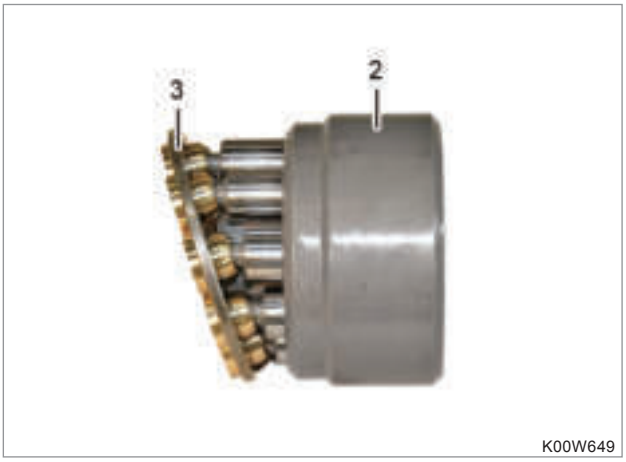
K00W647

3. Remove the neutral valve (1) from the top of the front cover. Then, remove the main relief valve (2).

27 mm socket wrench
24 mm socket wrench



K00W648



K00W649

4. Remove the valve plate (1) on the motor side. Then, remove the cylinder block (2) and piston assembly (3).


K00W650

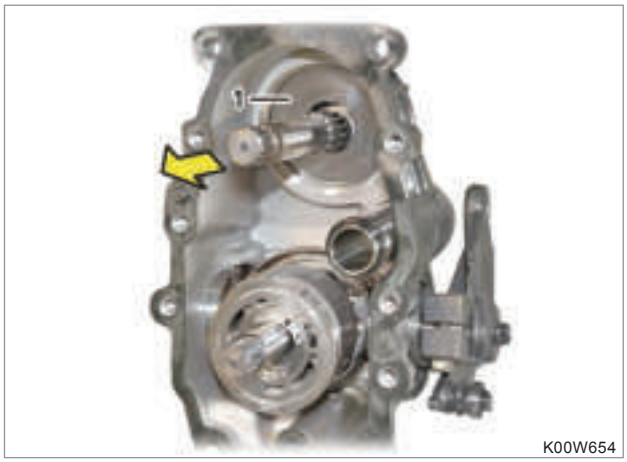
- Valve plate


K00W653

- Piston assembly


K00W651

- Cylinder block



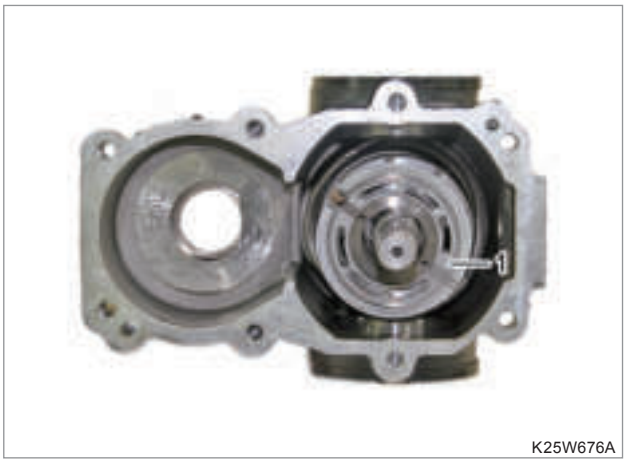
K00W654

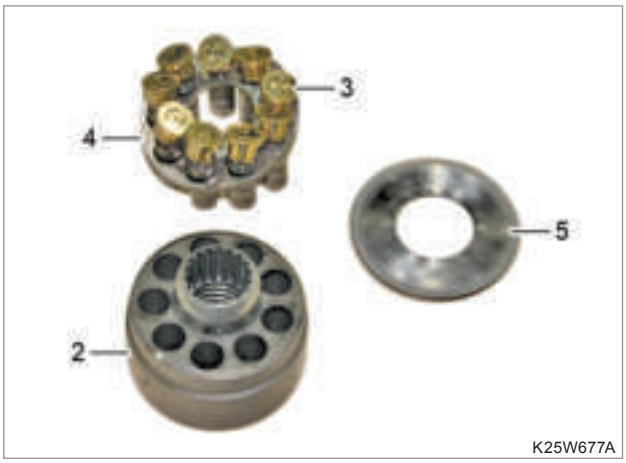

K00W652

K00W655

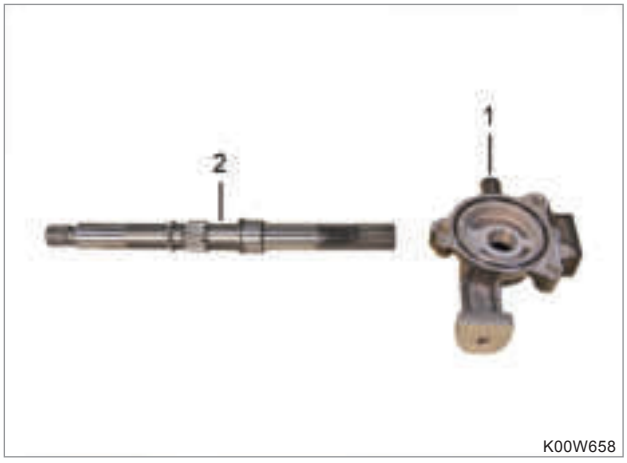
5. Remove the shoe plate (1) and motor shaft (2) by tapping the motor shaft.

PUMP SHAFT DISASSEMBLY



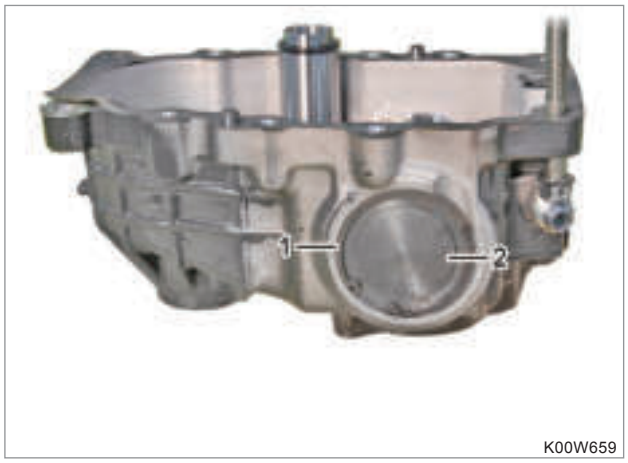


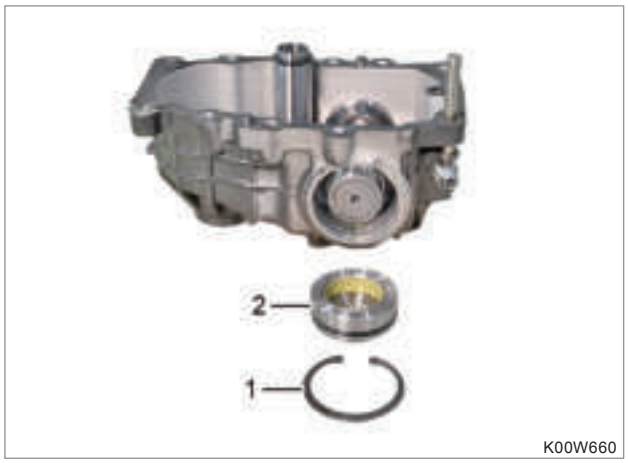
6. Remove the valve plate (1) on the pump side. Then, remove the cylinder block (2), piston assembly (3), set plate (4) and shoe plate (5) after separate the cylinder block and piston assembly.

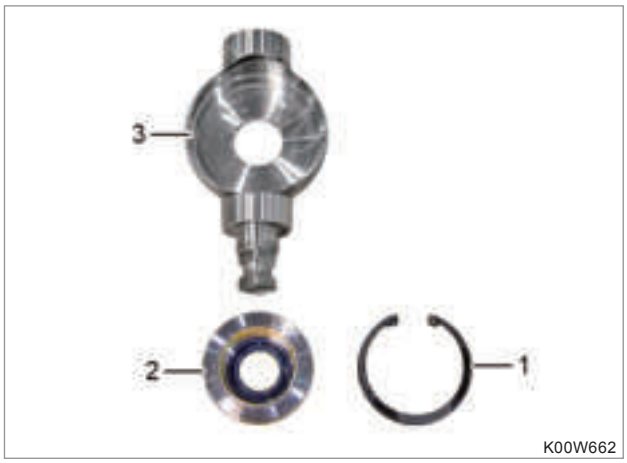


7. Remove the charge pump housing (1) and tap the pump shaft (2) to remove it.

SWASH PLATE DISASSEMBLY







8. Pull out the snap ring (1) from the HST housing to remove the swash boss 1 (2).

9. Pull out the snap ring (1) from the other side to remove the swash boss 2 (2) and swash plate (3).

MEMO

CHAPTER 7 ELECTRIC SYSTEM

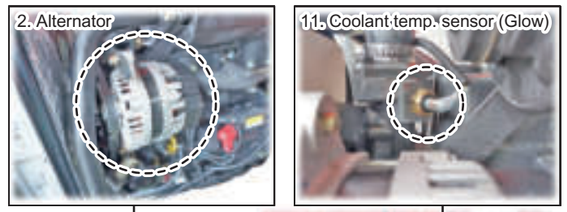
TABLE OF CONTENTS

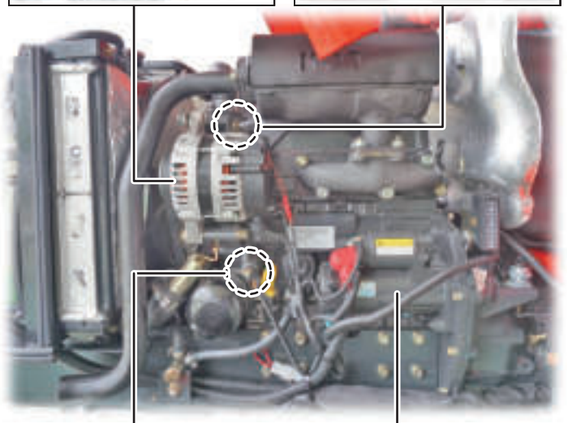
1. MAJOR ELECTRIC SYSTEM SPECIFICATIONS

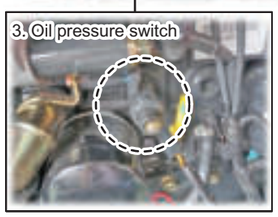
ITEM	STANDARD
Battery	12V 60Ah (20HR)
Alternator	12V 50Ah
Starter	12V 1.4kw
Glow relay	DC 12V, 70A
Safety switch	12V 5A
Control unit	Voltage range: DC 10 - 16V
Flasher unit	Voltage range: DC 10 - 16V
Direct signal lamp	12V 21W / 12V 10W
Tail lamp	12V 15W / 12V 5W
Head lamp	HS1 12V 35W / 35W
Horn	12V , 350 ± 20 Hz, 105 ~ 118 dB
Fusible link	60A
Cruise controller	DC 12V 1A
Safety start neutral switch	DC 12V 5A

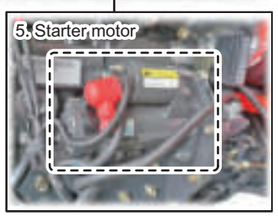
2. MAJOR ELECTRIC COMPONENT LAYOUT DIAGRAM

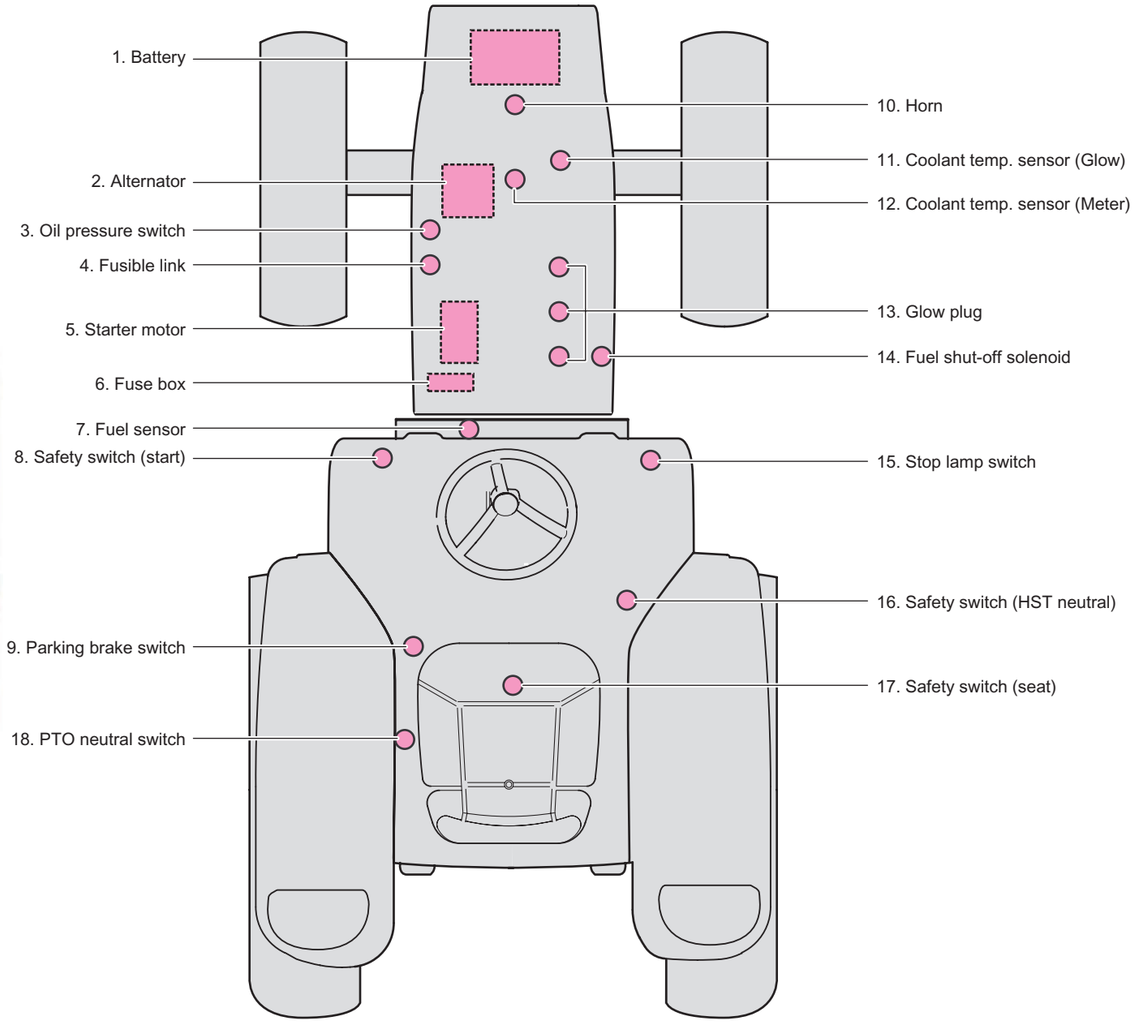
ENGINE (LH)



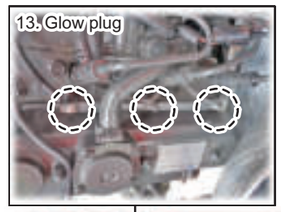


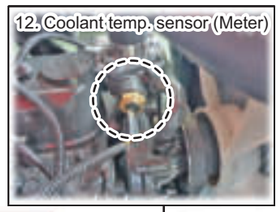


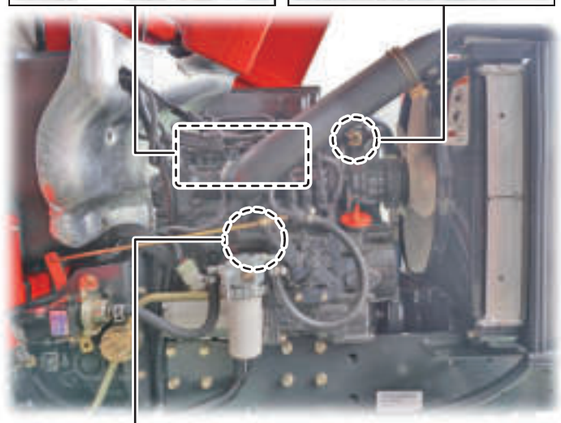


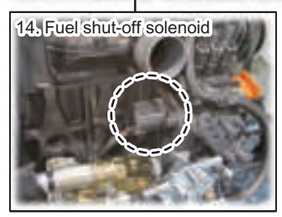


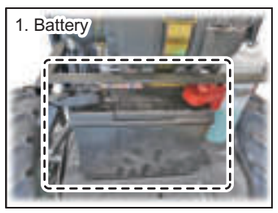
ENGINE (RH)

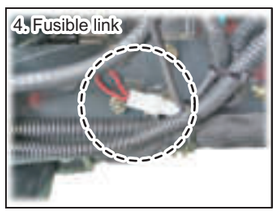


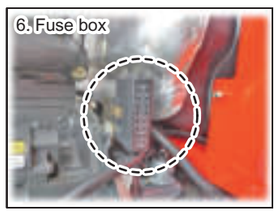


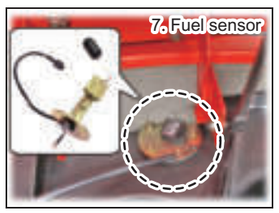


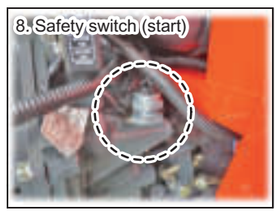


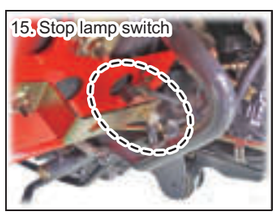


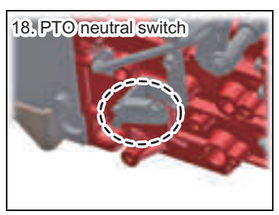




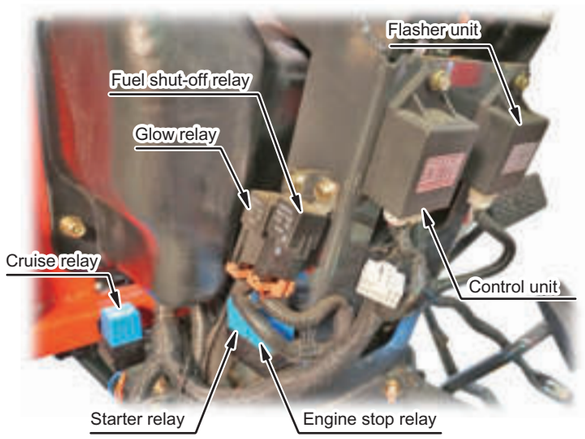








INSIDE OF THE PANEL COVER



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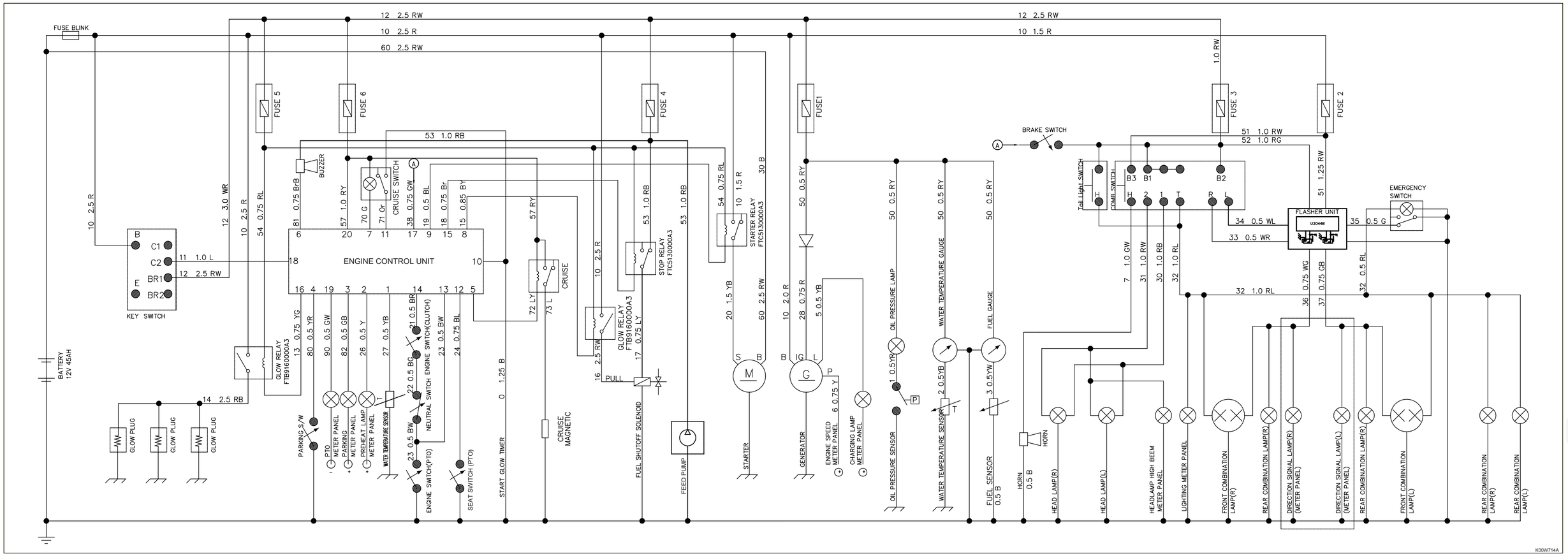
3. ELECTRIC WIRING DIAGRAM



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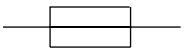
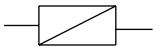
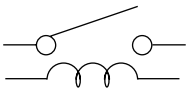
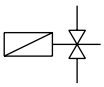
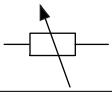
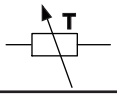
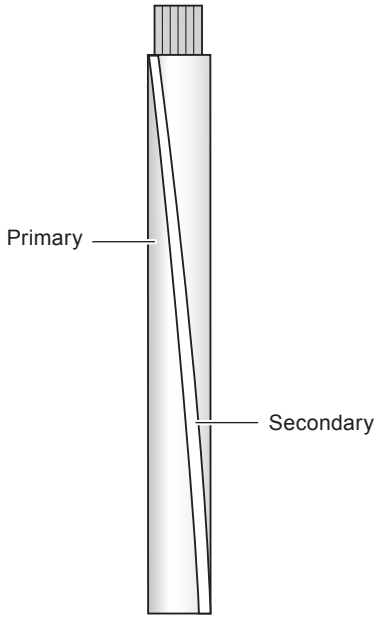
3.1 SYMBOLS AND WIRING COLOR DEFINITION IN ELECTRIC CIRCUIT

3.1.1 SYMBOL

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	Battery		Diode
	Fusible link		Gauge
	Fuse		Lamp
	Relay		Feed pump
	Switch		Fuel shut-off solenoid
	Starter		Horn
	Alternator		Fuel sensor
	Glow plug		Water temp. sensor

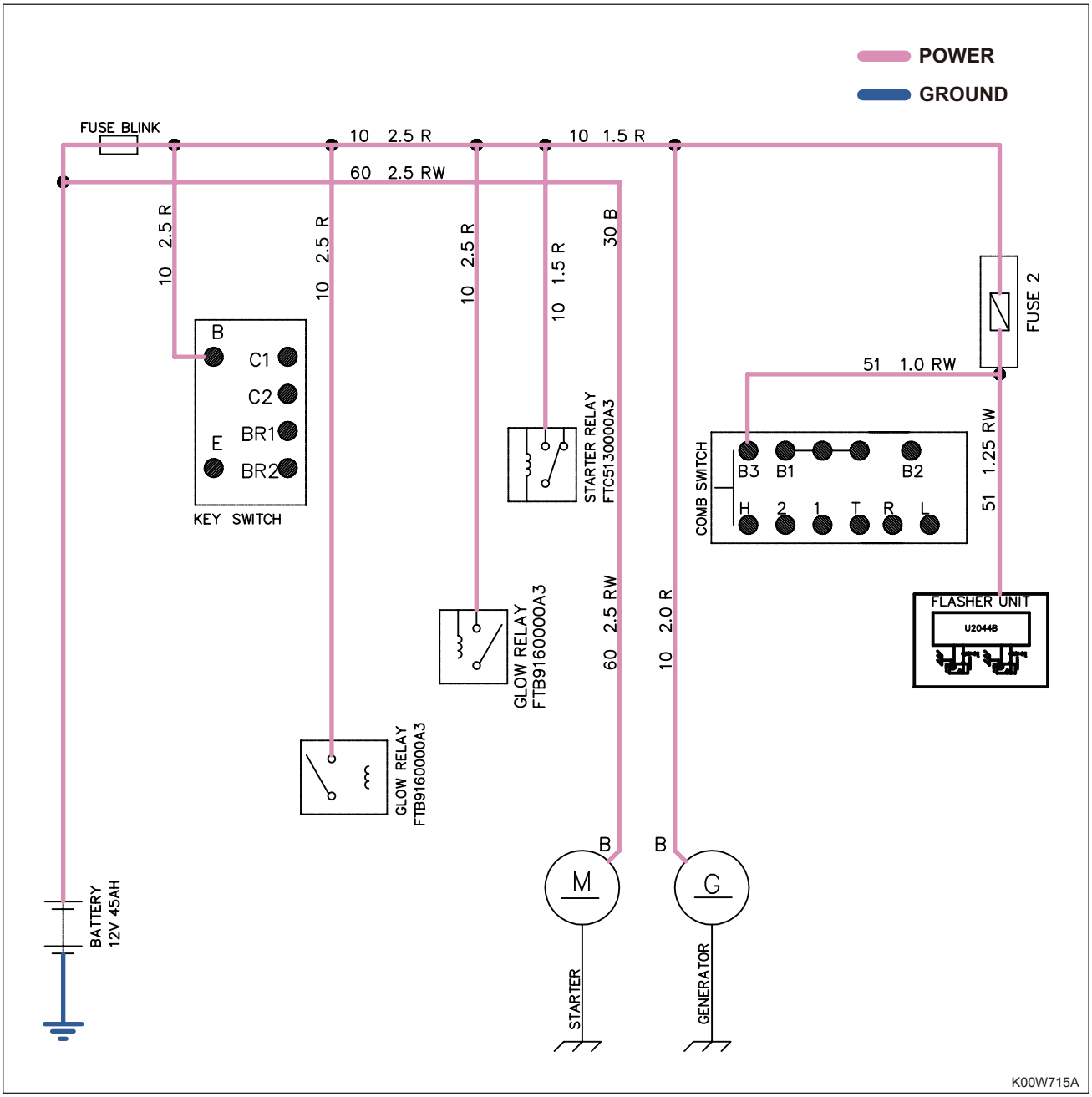
3.1.2 COLOR DEFINITION



SYMBOL	COLOR
B	Black
Y	Yellow
G	Green
W	White
L	Blue
R	Red
Br	Brown
Gr	Gray
Or	Orange
Lg	Light green
BW	Black (primary) + White (secondary)
YG	Yellow (primary) + Green (secondary)

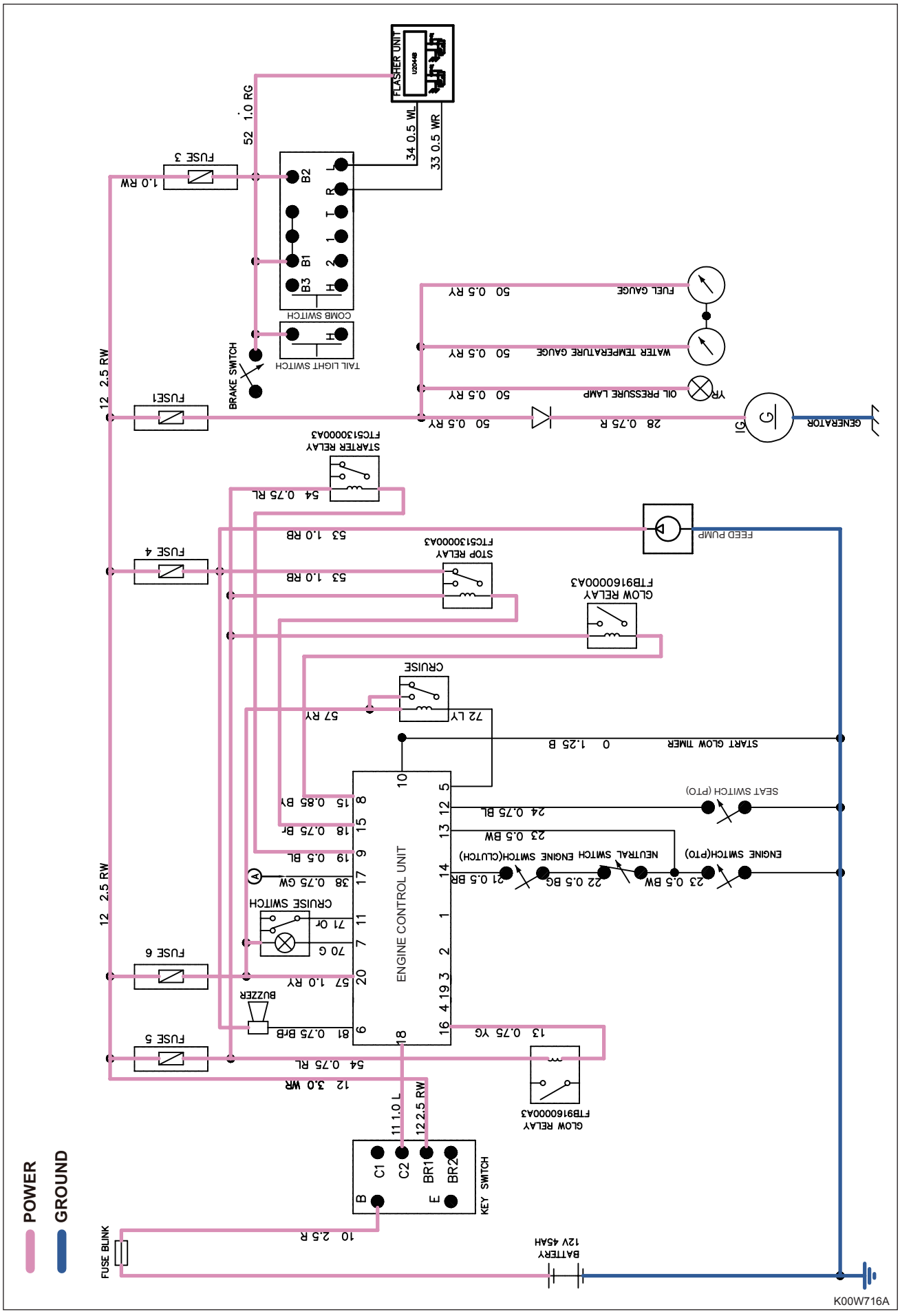
4. CIRCUIT CONFIGURATION BY MAJOR FUNCTION

4.1 BATTERY AND FUSIBLE LINK



There is one fusible link at the end of the wiring 2.5R above the battery in the left section of the circuit diagram. The fusible link on the wiring 2.5R is to supply main power to the glow relay. When the glow relay is energized, power is supplied to the glow plug to operate it. And it is related to all other electric devices except main power for preheating operation. It supplies power to the start relay, generator, flasher unit.

4.2 KEY SWITCH ON



The key switch is located in the middle left section of the circuit diagram. This switch receives battery power through the wiring 2.5R.

1) ON: When the key switch is turned to the first position, the key switch turns on and power is supplied through 2.5 RW wiring from the BR1 terminal. First, the key switch 'ON' signal passes through fuse no.5, then to the preheat relay through 0.75 RL wiring, and finally to the engine control unit through 0.75 YG wiring; the engine control unit begins preheating as soon as it receives this signal.

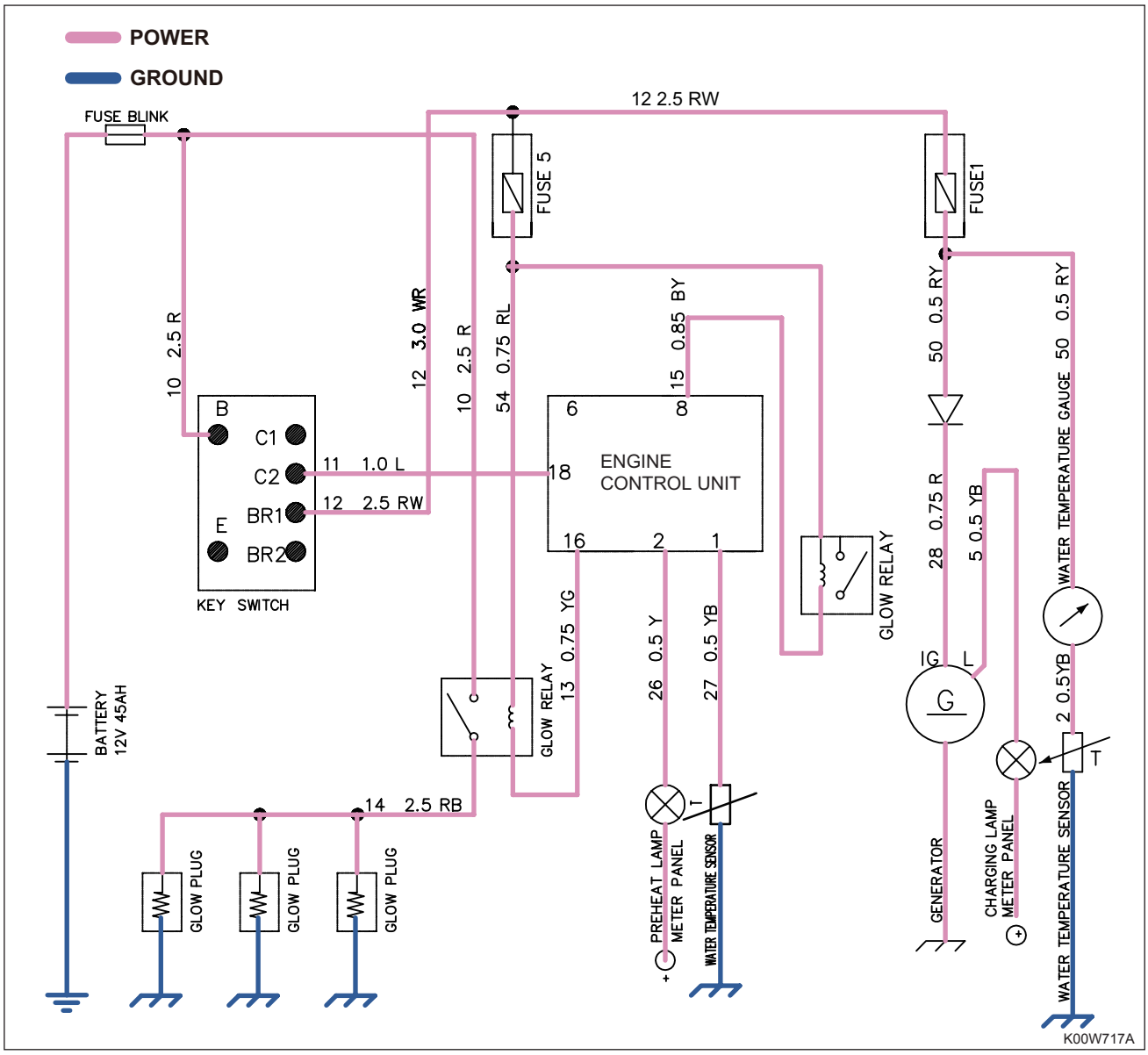
   Power is diverted to another path where it is supplied to the preheat relay, stop relay, and starter relay, as well as being transferred to the engine control unit. Second, the key switch 'ON' signal passes through fuse no.6 and is delivered to the engine control unit, cruise control switch and cruise control. Third, the key switch 'ON' signal passes through fuse no.4 and is transferred to the buzzer, stop relay and feed pump.

   Fourth, the key switch 'ON' signal passes through fuse no.1 and a diode, from which it is supplied to the IG terminal of the alternator through 0.75 R wiring. Here, the signal is diverted once again and delivered to the oil pressure sensor, coolant temperature sensor, and fuel sensor.

   Finally, after traveling to fuse no.3 through 1.0 RW wiring, the key switch 'ON' signal is supplied to the taillight switch, combination switch and flasher unit.

2) START: When the key switch is turned to the 'START' position, the engine start signal is supplied from the C2 terminal to the engine control unit through 1.0 L wiring. When the starting conditions for the PTO switch, neutral switch, clutch switch and seat switch are satisfied in the engine control unit, power from pin no.9 of the engine control unit is applied through 0.5 BL wiring and runs through the starter relay, activating the starter motor and turning on the engine.

4.3 PREHEAT



The circuit related to the preheat operation is located in the left section of the above circuit diagram.

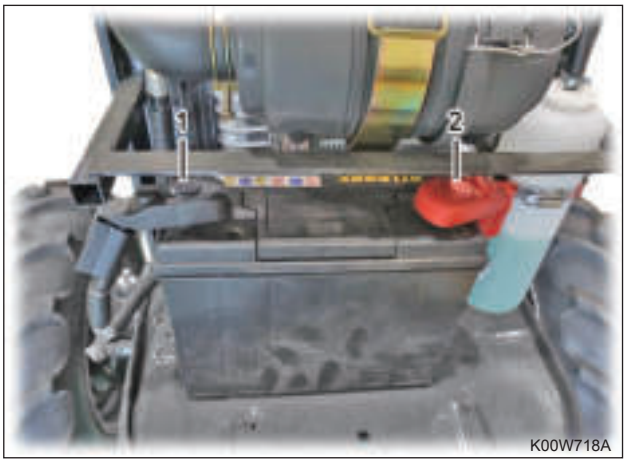
As soon as the key switch is turned to the ON position, preheating operation is started and the preheat indicator on the instrument cluster is turned ON. When the key switch is returned to the ON position from the START position, after-heating operation is started. However, if the engine is not started so the generator is not operated properly, after-heating operation is not performed.

- It receives the manual preheating signal from the key switch through the wiring 1.0L.
- It receives the coolant temperature signal through the wiring 0.5YB.
- It receives the key switch ON signal through the wiring 1.0RY.
- It sends power to the preheat indicator on the instrument cluster through the wiring 0.5Y.
- The wiring 0.75RL is a output wiring for the glow relay coil signal. When the glow relay coil is energized by this signal output, main power is directly supplied from the battery through the fusible link for preheating and wiring 2.5R to the glow plugs installed to each cylinder in the engine.
- The wiring 0.5YB is connected to the terminal L which is a direct current output terminal of the generator. This is to enable after-heating operation only when the generator is normally running.

5. SERVICE TIPS AND COMPONENTS OF ELECTRIC SYSTEM

5.1 SERVICE TIPS

5.1.1 BATTERY



1. Stop the engine and remove the ignition key.
2. Open the hood and disconnect the negative battery cable (1) first and then the positive battery cable (2).
3. Unscrew the bolt from the battery mounting to remove the battery.
4. Replace the battery with a new one if necessary.
5. When re-installing the battery, connect the positive cable first and then the negative cable firmly.

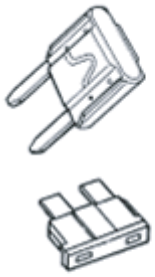
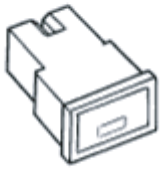
Notes

- **Loose battery terminal can cause a spark or poor charging performance.**
- **If the cable terminal is contaminated, clean it thoroughly and apply grease on it.**

⚠ CAUTION

- **Keep flames or sparks away from the battery. It can explode due to gas production during its operation.**
- **As the battery discharges naturally, charge it every month (for 8 to 10 hours at 7 A).**
- **Make sure to use the battery with the specified capacity.**
- **Be sure to attach the rubber boots to the battery positive terminal and booster terminal.**

5.1.2 FUSE

FUSE	 6015W702A
FUSIBLE LINK	 6015W703A
SLOW-BLOW FUSE	 6015W704A

If any electric part is malfunctioning, check the fuse first.

1. Make sure to use the fuse with the specified capacity.
2. Check if any fusible link is open.

Notes

- **When continuity is detected by touching both terminals with a tester, it is normal. If continuity is not detected, replace the part with a new one.**

3. Check that the slow-blow fuse is bolted into the slow-blow fuse box to the specified torque firmly.

⚠ CAUTION

- **Do not replace the fuse with other metal wires or aluminum foil. It can lead to electric shock and fire.**
- **If the nut of the slow-blow fuse is not tightened firmly, it can cause a fire. Make sure to tighten it firmly.**

5.1.3 ELECTRIC WIRING

1. If any electric part is malfunctioning, check its electric wiring.
2. Check if the electric wiring is in contact with another part, it is peeled off or its contact is loose.

   If it is peeled off, wind insulating tape around it.
3. If water enters the contact area, it can cause malfunction. Wipe out any moisture and dry it sufficiently.
4. Try to disconnect and re-connect any related connectors. Check if a terminal is misaligned or improperly engaged.
5. Inspect it regularly with the engine running after every 50 hours of use or after every season even though there is no apparent sign of damage.

⚠ WARNING

- **Never attempt to modify electric wirings of the machine. It can cause a fire.**

Notes

▶ **INSPECTION ORDER FOR ELECTRIC SYSTEM AND CIRCUIT FAILURE**

- **Battery → Fusible link → Fuse → Ignition relay → Switch → Load**

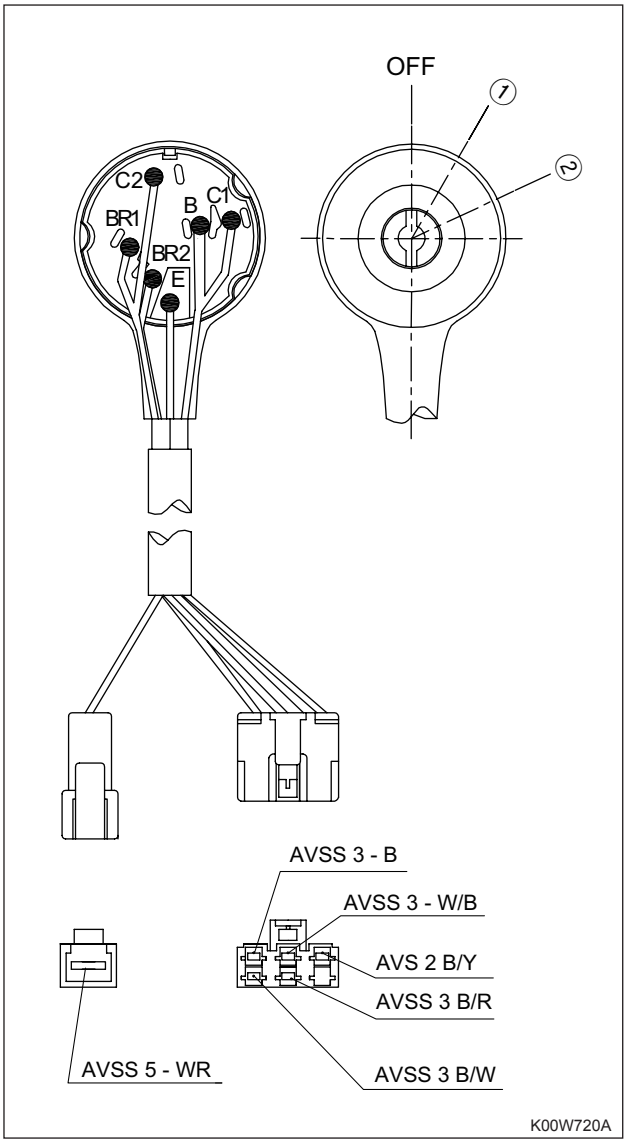
5.2 COMPONENTS

5.2.1 IGNITION SWITCH

The ignition switch is installed on the dashboard from the right side of the steering wheel. When turning the ignition switch clockwise to the first position, "ON" is selected. When turning it to its end, the engine is started.

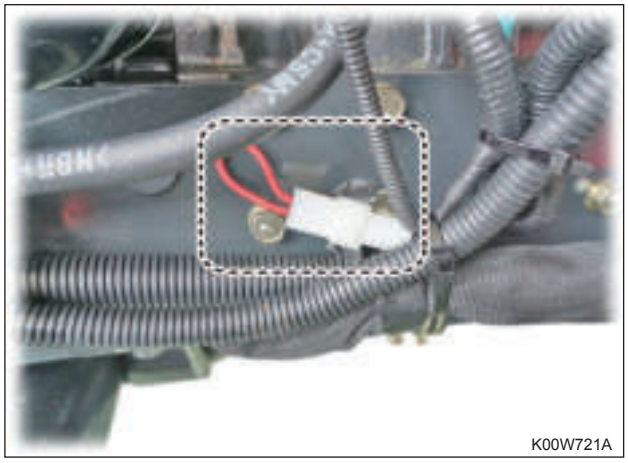
When releasing the switch as soon as the engine is started, the switch is automatically returned to the ON position.

▶ **CONNECTOR AND WIRING DIAGRAM**



ITEM		TERMINAL SYMBOL				
		B	BR1 BR2	C1	C2	E
SWITCHING POSITION	OFF		●			●
	①	●	●			
	②	●	●	●		
		●		●	●	

5.2.2 FUSIBLE LINK


K00W721A

The fusible link is installed on the around of the starter in the left section of the engine compartment. If malfunction occurs in any electric system but the battery is intact, check the condition of the fusible link first.

There is a 60 A fusible link which is for main power.

5.2.3 FUSE BOX

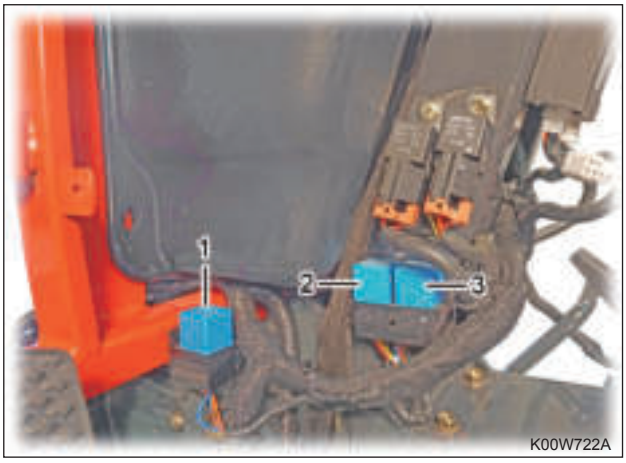

B24W701A

The fuse box is installed on the left lower section of the bonnet hinge assembly.

K00W144A

ITEM	SPECIFICATION	DESCRIPTION
Fuse 1	10 A	Panel
Fuse 2	20 A	Turn lamp
Fuse 3	10 A	Fuel stop
Fuse 4	20 A	Glow
Fuse 5	10 A	Hazard
Fuse 6	10 A	Control unit
Fuse 7	10 A	Spare
Fuse 8	20 A	Spare

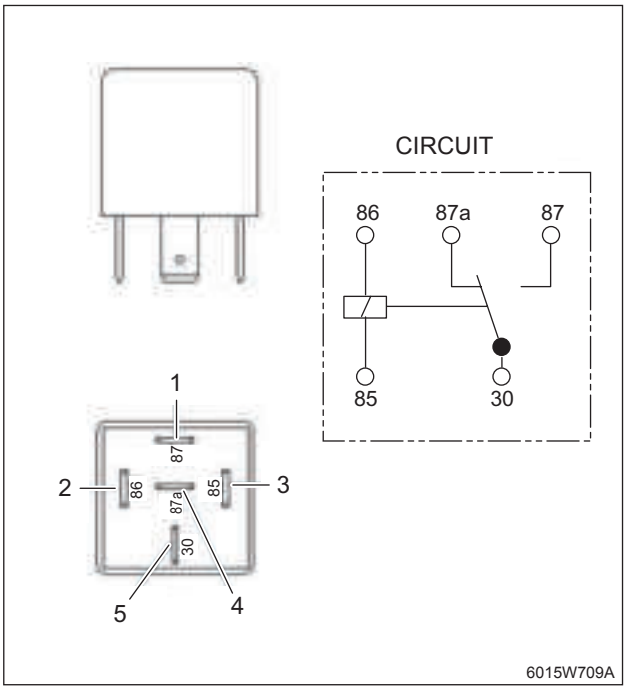
5.2.4 RELAY 5P



(1) Cruise relay
(2) Starter relay
(3) Engine stop relay

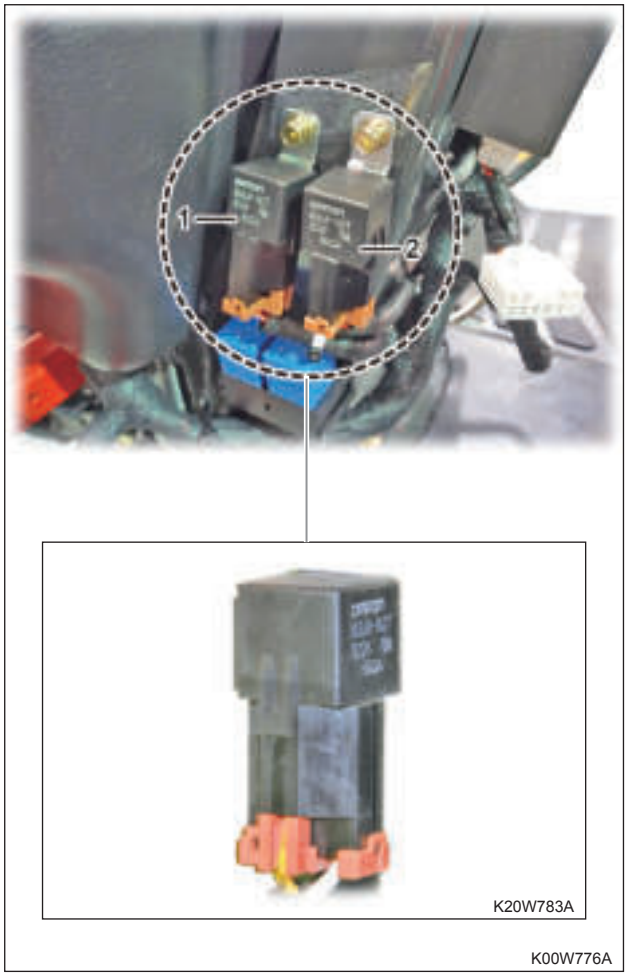
The relay 5P is installed on the lower left section of the steering support assembly to supply power to functions for each operating device.

▶ CONNECTOR AND TEST



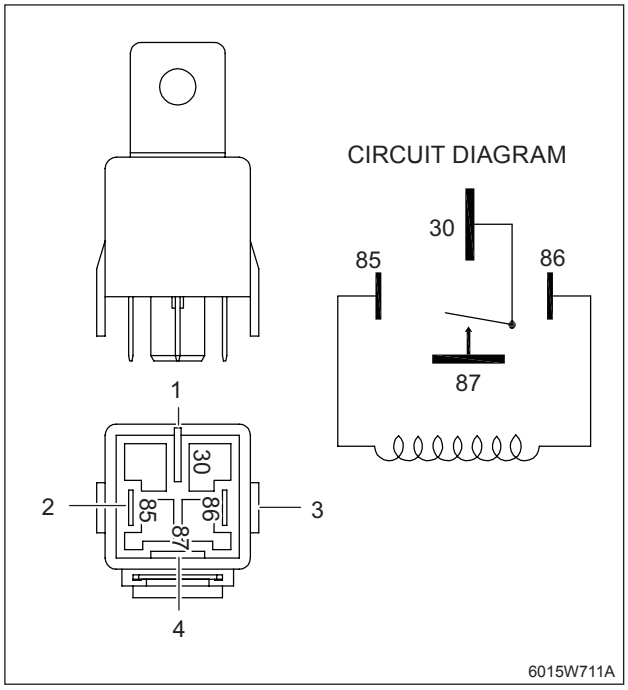
ITEM	TESTING LOCATION		RESULT
	⊕ TERMINAL	⊖ TERMINAL	
Resis-tance	②	③	Approx. 87 Ω
Resis-tance	①	④	0Ω present
Conti-nuity	①	⑤	∞Ω not present

5.2.5 GLOW RELAY / FUEL SHUT-OFF RELAY



The glow relay (1) and fuel shut-off relay (2) are installed on the left middle section of the steering support assembly to supply power to the glow plug and fuel shut off solenoid.

▶ CONNECTOR AND TEST

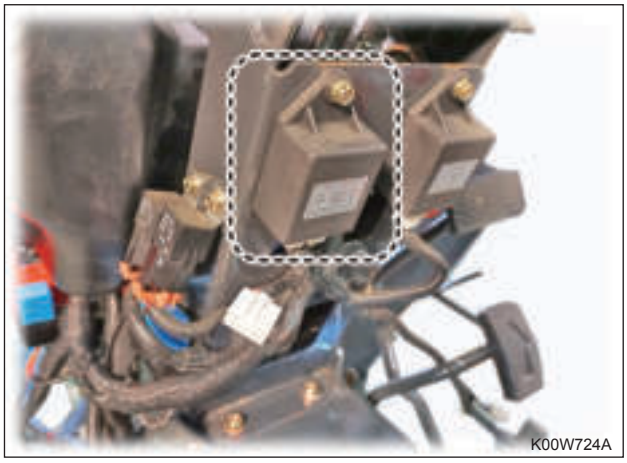


TERMINAL NO.	RESISTANCE (Ω)
① and ②	∞
③ and ④	∞
② and ③	Some Ω (continuity present)

Applying (+) to ③ and (-) to ②

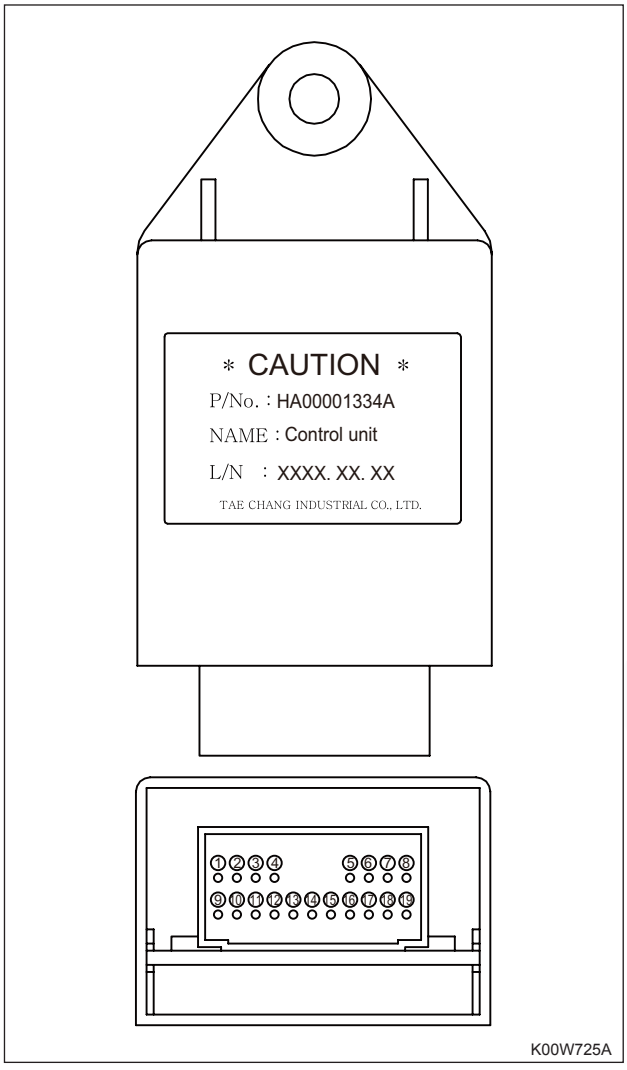
TERMINAL NO.	RESISTANCE (Ω)
① and ④	0

5.2.6 CONTROL UNIT

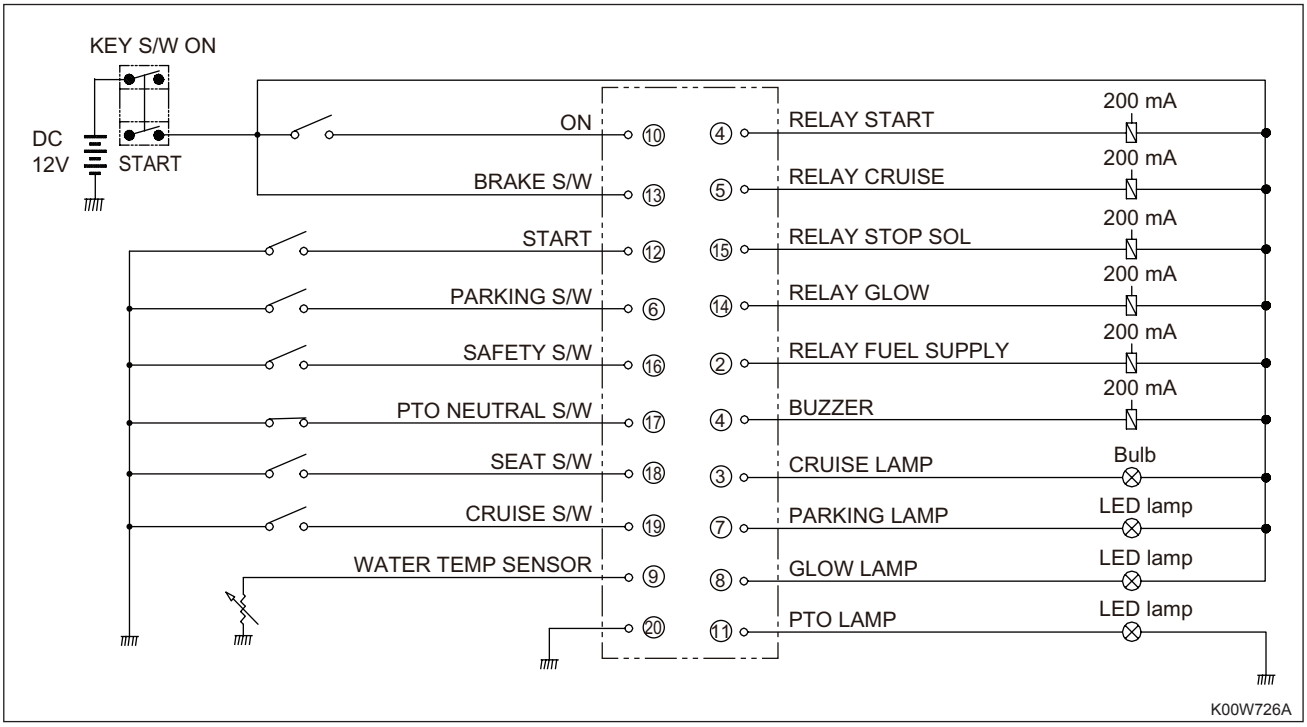


The control unit is installed on the upper front section of the steering support assembly. It receives a signal from the several switches, and then it sends a signal to the several relays for operating and turn on the indicator on the instrument cluster.

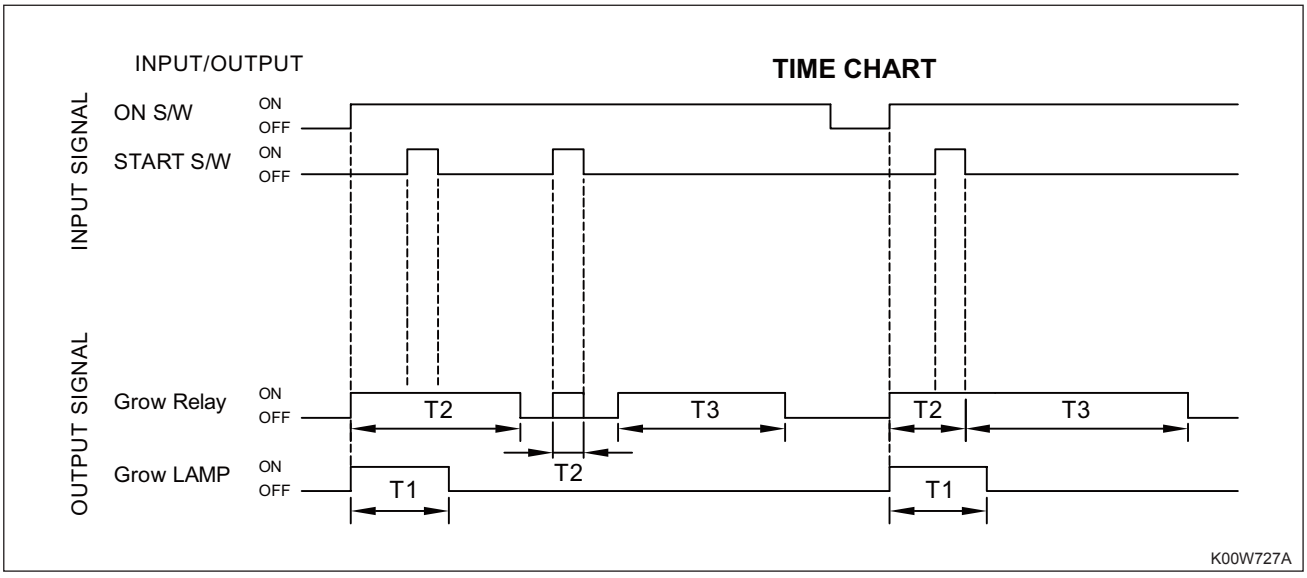
▶ CONNECTOR AND CIRCUIT DIAGRAM



▶ CONTACT DIAGRAM

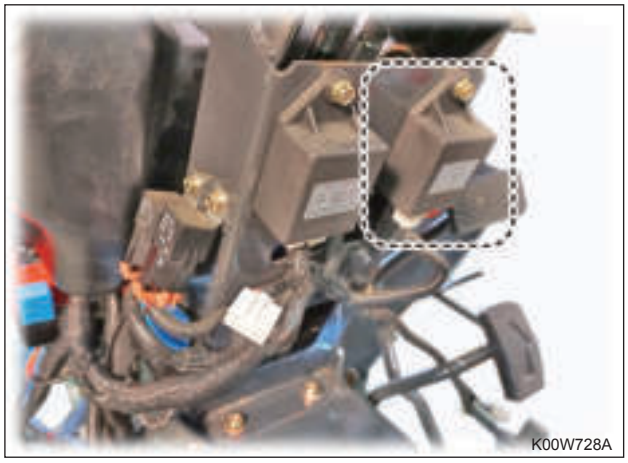


▶ OPERATING SEQUENCE AND CHARACTERISTICS



ITEM	WATER TEMP. SENSOR RESISTANCE (KΩ)	TIME (SEC.)	REMARKS
T1: Lamp time (sec.)	21 (-30℃) or more	14.0 ± 3.5	-
	9.6 (-15℃)	10.0 ± 3.0	
	0.8 (+40℃)	4.0 ± 1.5	
T2: Pre-glow time (sec.)	2.8 (+10℃) or more	30.0 ± 8.0	Relay (37 Ω)
	1.8 (+20℃)	5.0 ± 1.3	
T3: After-glow time (sec.)	0.8 (+40℃)	120 ± 30.0	
	0.4 (+60℃)	5.0 ± 1.3	

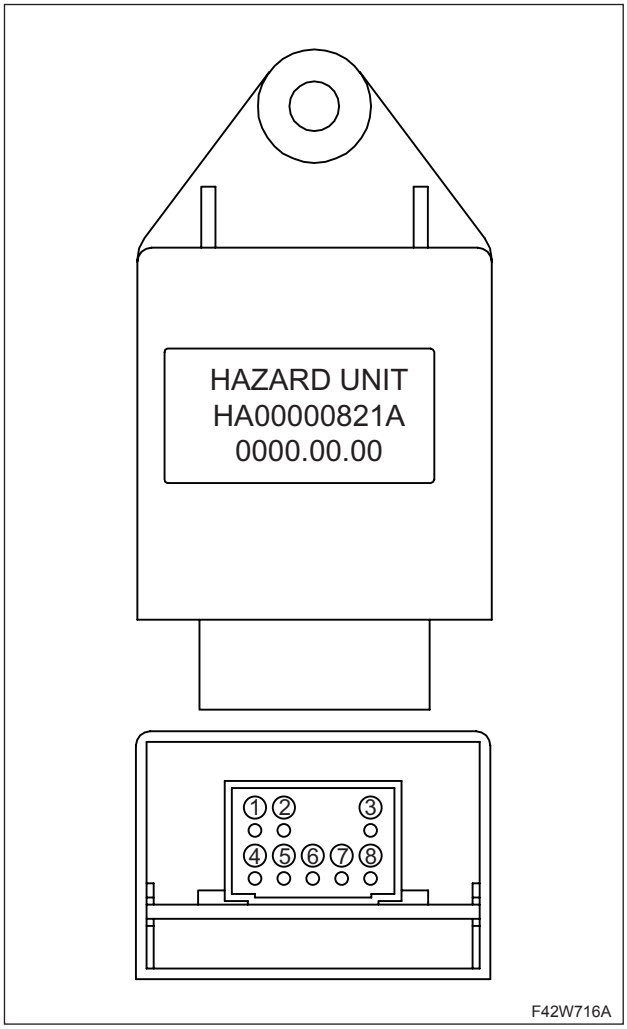
5.2.7 FLASHER UNIT

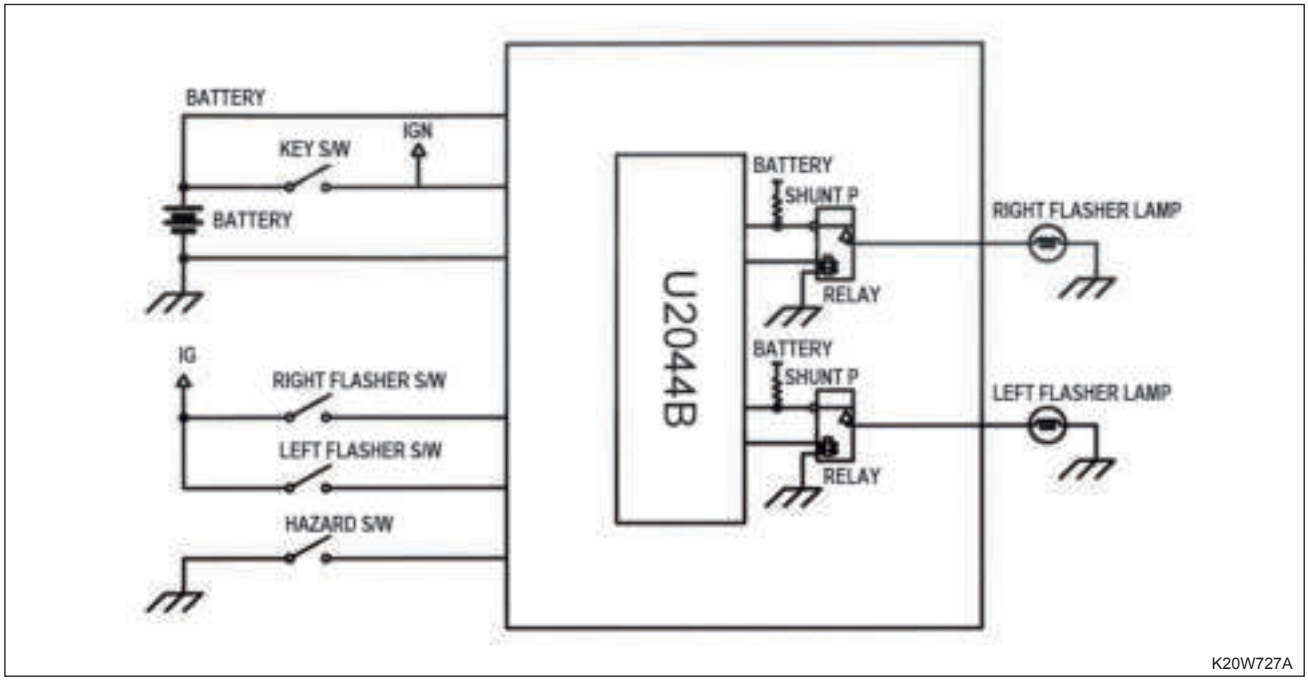


The flasher unit is installed beside of the control unit on the upper front section of the steering support assembly. It makes the turn signal lamps blink when the flasher switch is operated.

NO.	PIN NAME
1	RIGHT FLASHER LAMP
2	LEFT FLASHER S/W
3	RIGHT FLASHER S/W
4	BATTERY
5	LEFT FLASHER LAMP
6	IG (+)
7	HAZARD S/W
8	GND

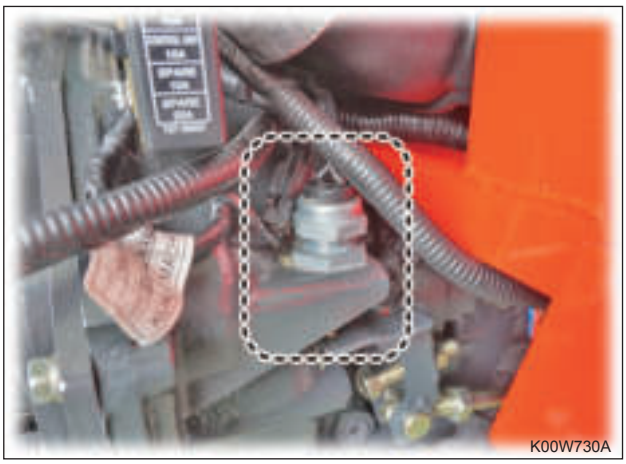
▶ **CONNECTOR AND CIRCUIT DIAGRAM**





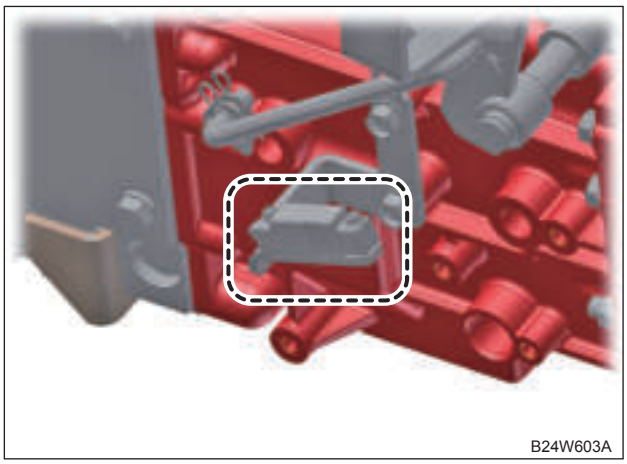
5.2.8 SAFETY SWITCH

START



The safe start switch is installed under the left foot rest. This switch is to prevent the engine from starting when the clutch pedal is not depressed.

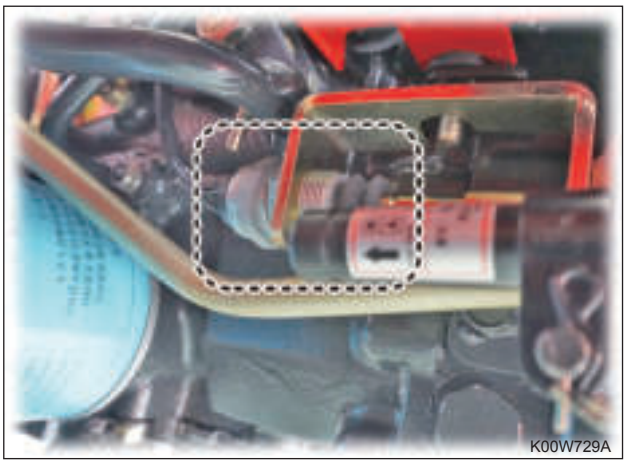
PTO NEUTRAL



The PTO neutral switch is installed on the left side of the transmission case.

This switch is to prevent the engine from starting when the PTO shift lever is engaged.

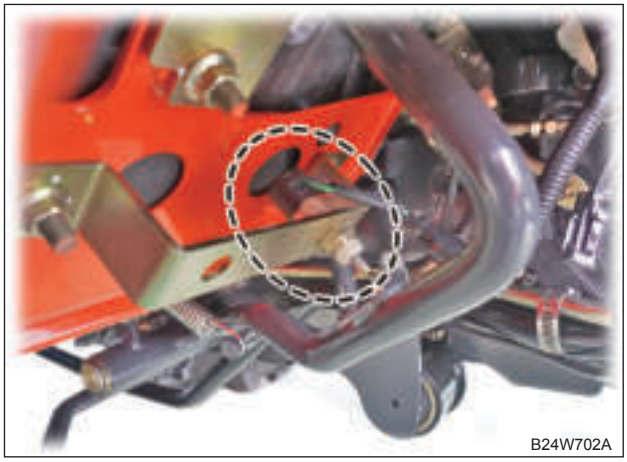
HST NEUTRAL



The HST neutral switch is installed under the right foot rest rear side. This switch is to prevent the engine from starting when the forward pedal or reverse pedal is depressed.

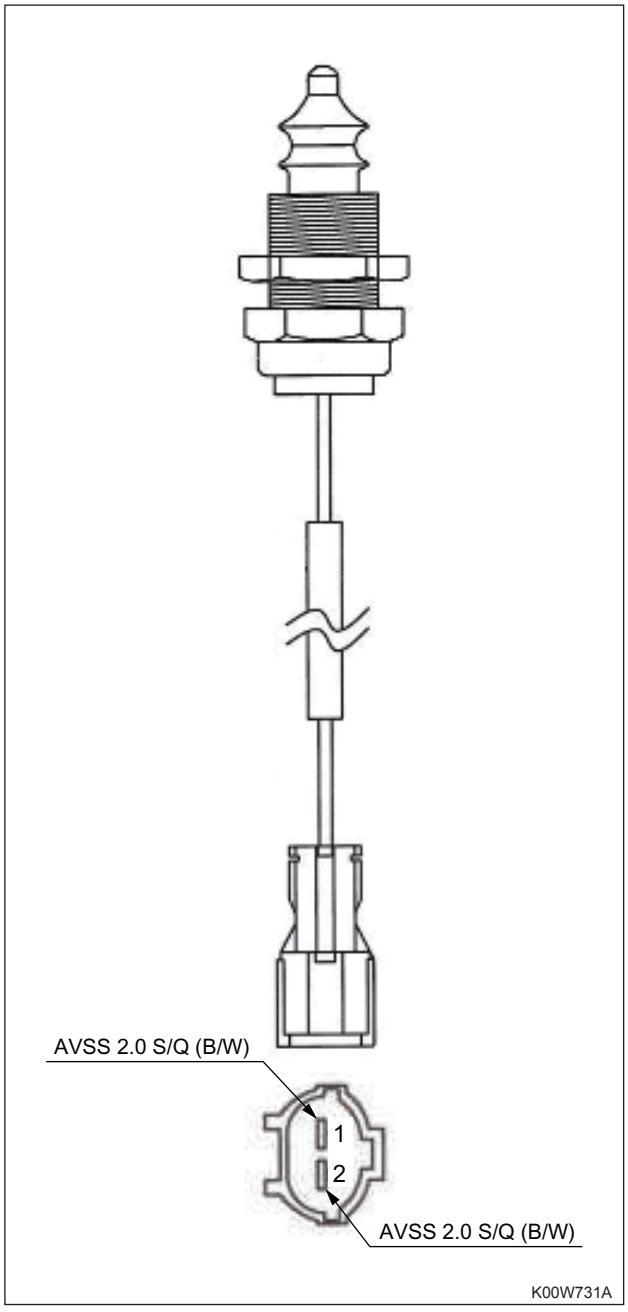
5.2.9 STOP LAMP SWITCH / SAFETY SWITCH

STOP LAMP



The stop lamp switch is installed under the right foot rest front side. According to operation of the brake pedal, the switch contact is connected so the stop lamps of the rear combination lamps are turned on.

▶ **CONNECTOR AND TEST**



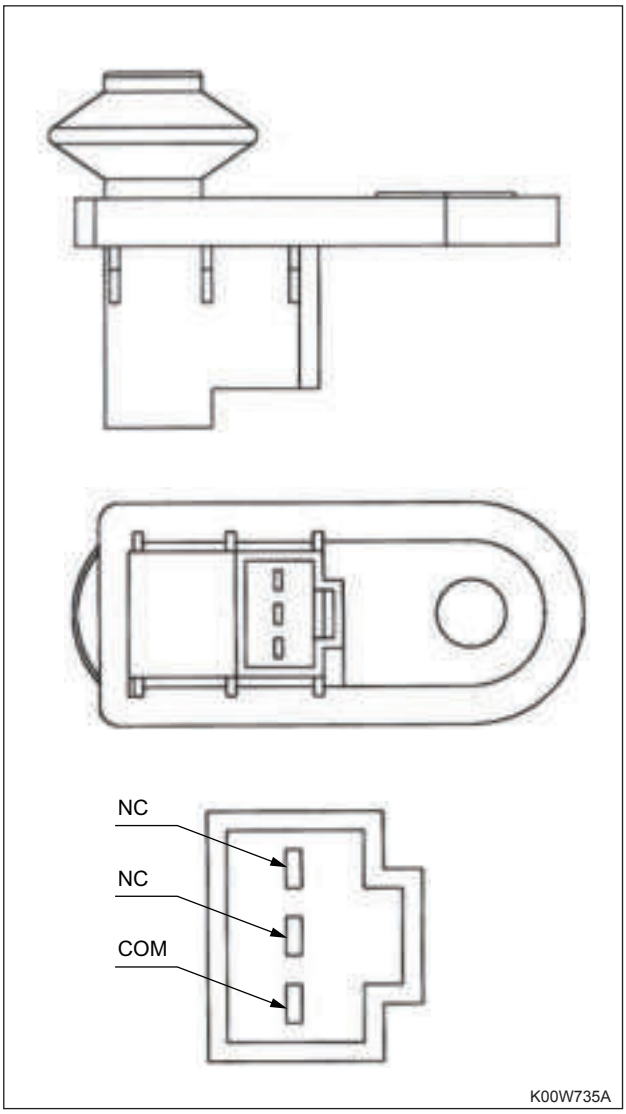
ITEM	CONNECTION		STATUS	RESULT
	+	—		
Resis-tance	1	2	Clutch pedal is depressed	0Ω
			HST pedal is not depressed	

5.2.10 SEAT SAFETY SWITCH

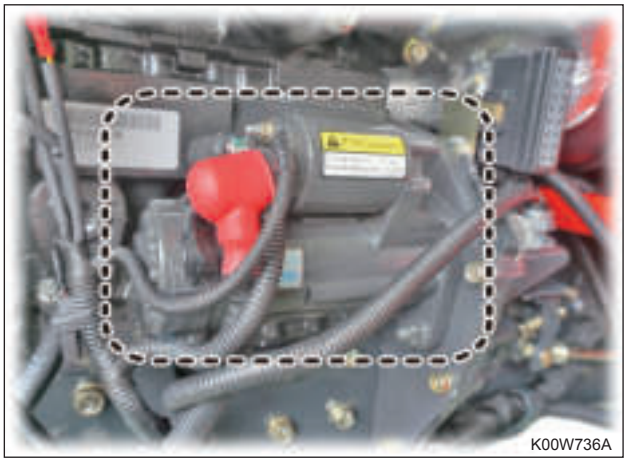
The seat safety switch is installed under the seat.

This safety switch automatically shuts off the engine if the driver leaves the driver's seat while the PTO is activated.

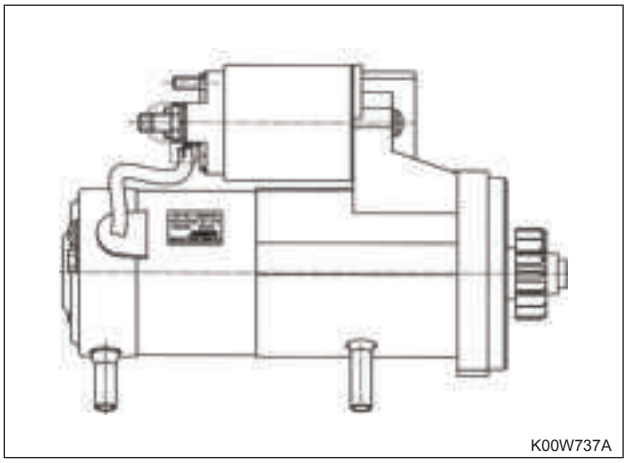
▶ **CONNECTOR**



5.2.11 STARTER



The starter is installed to the rear left section of the engine.

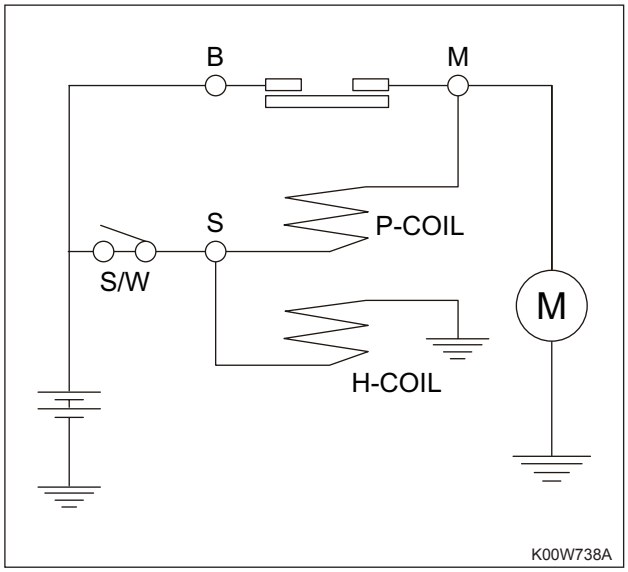


▶ **SPECIFICATION**

NOMINAL POWER	1.4 kW
VOLTAGE	12 V
RATED TIME	30 sec.
ROTATION	Clockwise (View from drive engine)
WEIGHT	Approx. 3.1 kg

5.2.12 ALTERNATOR

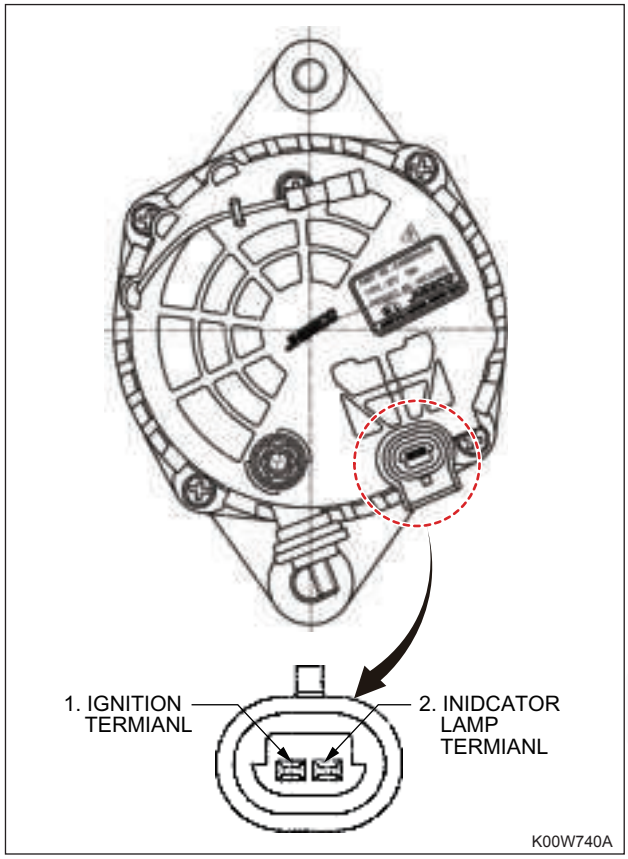
▶ CIRCUIT DIAGRAM



The alternator is installed in the left front section of the engine and it is integrated with the IC regulator.

It supplies power to components with high electric load and charges the battery.

▶ CONNECTOR TEST



ITEM	CONNECTION		STATUS	RESULT
	+	−		
CONNECTOR DC POWER	1	Ground (Chassis)	Ignition switch ON	Approx. 12 V
	2	Ground (Chassis)		

5.2.13 ENGINE OIL PRESSURE SWITCH

The engine oil pressure switch is installed to the cylinder block on the left side of the engine. When pressure is built in the engine, the contact of the oil pressure switch is connected to send a signal to the instrument cluster assembly.

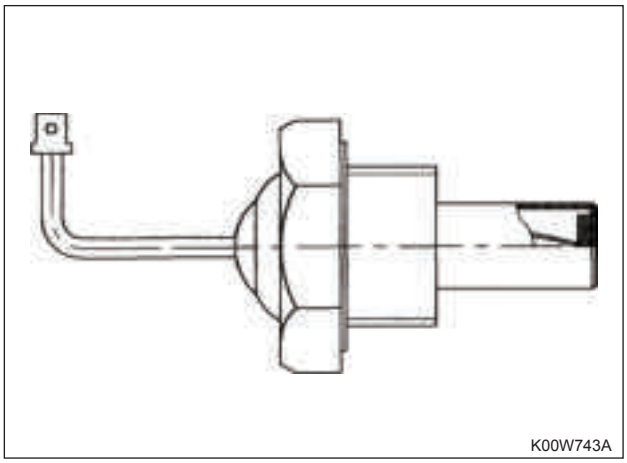
When the pressure in the engine drops below 0.5 ± 0.1 kgf/cm^2 (7.11 ± 1.42 psi),the engine oil pressure warning lamp on the instrument cluster comes on.

▶ CONNECTOR TEST

ITEM	CONNECTION		STATUS	RESULT
	+	—		
Resis-tance	A	Ground (Chassis)	Engine stopped	0 Ω
			Engine running	∞ Ω
DC power	B		Oil pressure warning lamp 「ON」 Ignition switch 「ON」	12 V

5.2.14 COOLANT TEMPERATURE SENSOR (GLOW)

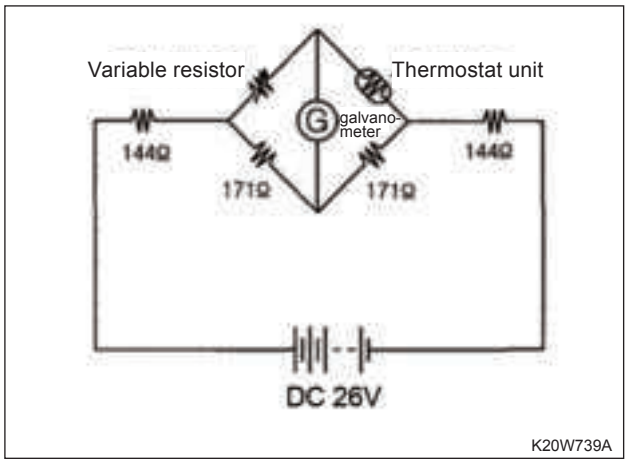
The coolant temperature sensor (GLOW) is installed right side of the coolant flange behind the cooling fan. It supplies information to the control unit in order to determine the preheat indicator ON time and preheat relay connection time.



▶ RESISTANCE BY COOLANT TEMPERATURE

TEMPERATURE (℃)	-30	-15	10	20	40
RESISTANCE DIFFERENCE (Ω)	19.5	9.6	3.4	2.4	1.2

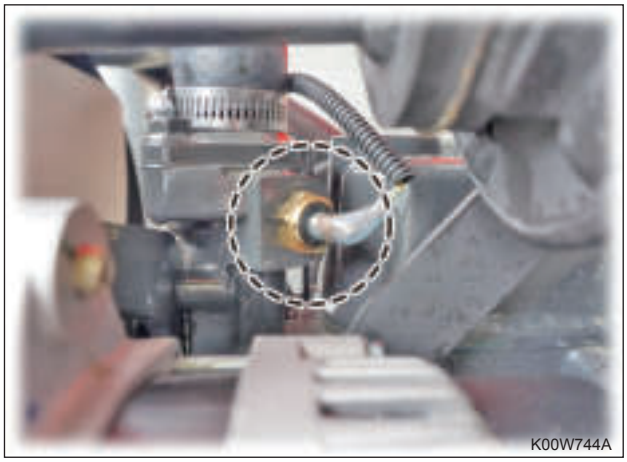
▶ MEASURING CIRCUIT



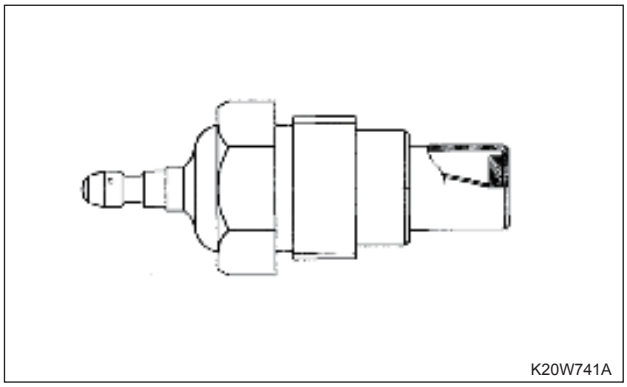
▶ SENSOR TEST

ITEM	CONNECTION		STATUS	RESULT
	+	—		
Resis-tance	1	Ground (Chassis)	–	Resistance changed by coolant temperature
DC power	2	Ground (Chassis)	Ignition switch 「ON」	Approx. 12 V

5.2.15 COOLANT TEMPERATURE SENSOR (METER)



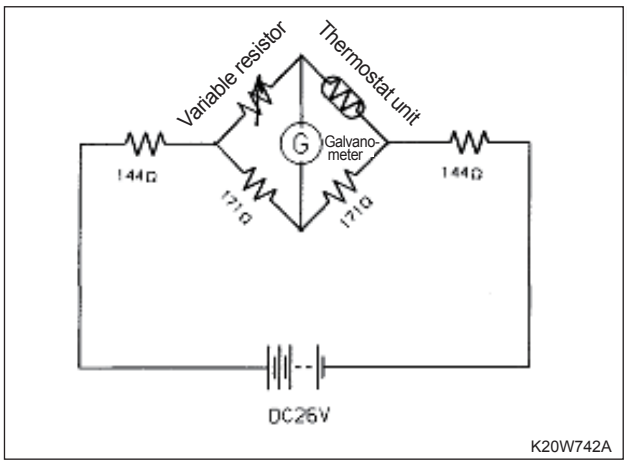
The coolant temperature sensor (meter) is installed left side of the coolant flange. It sends various resistance values according to the coolant temperature to the instrument cluster to display the coolant temperature on the coolant gauge.



▶ RESISTANCE BY COOLANT TEMPERATURE

TEMPERATURE (℃)	(35)	(50)	80	(100)	(105)	115	(120)	(140)
RESISTANCE (KΩ)	(670)	(350)	118±6	(63.5)	(54.5)	42±2.5	(36.2)	(22)

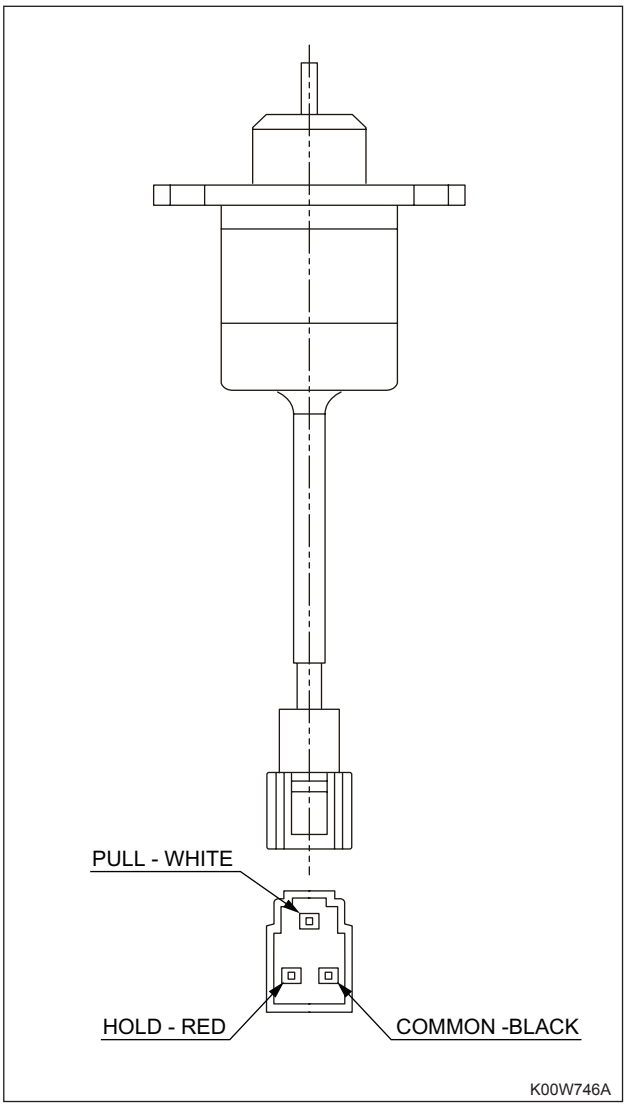
▶ MEASURING CIRCUIT



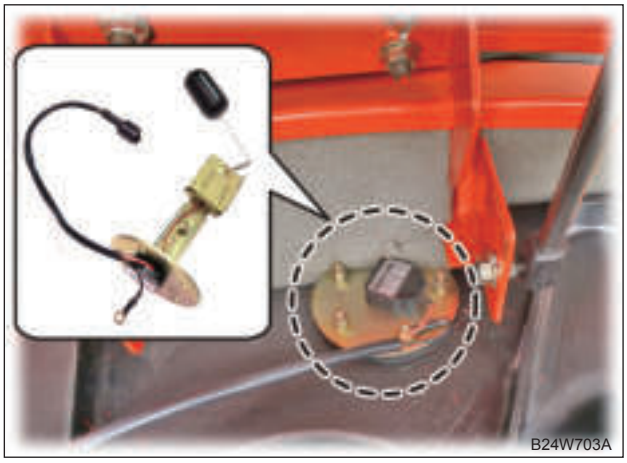
5.2.16 FUEL SHUT-OFF SOLENOID

The fuel shut-off solenoid is installed behind the injection pump in the right section of the engine to allow or block fuel entering the engine depending on the position (ON/OFF) of the key switch.

▶ **CONNECTOR**

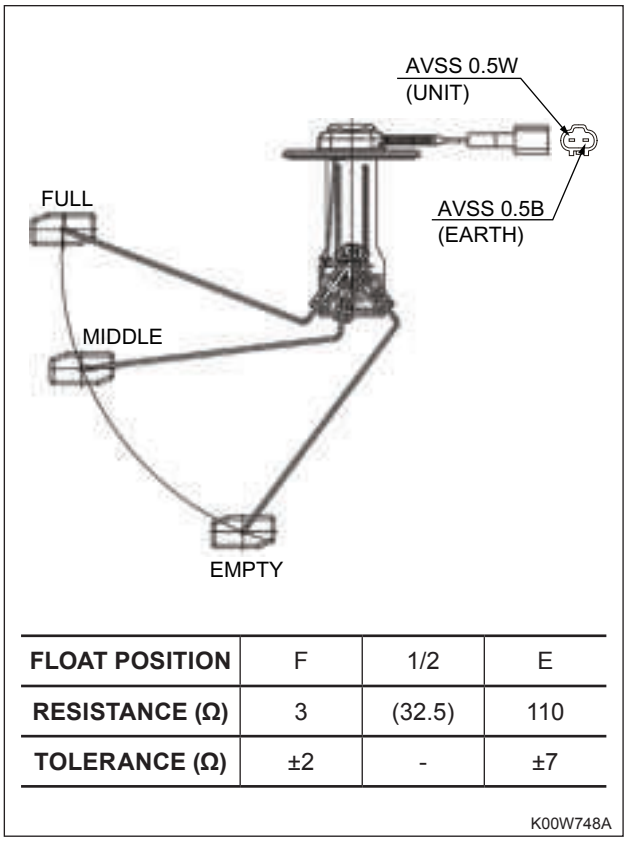


5.2.17 FUEL SENSOR



The fuel sensor is installed to the top of the fuel tank and consists of the float and variable resistor. The float detects the fuel level and the sensor sends the corresponding resistance value to the fuel gauge on the instrument cluster to display the fuel level.

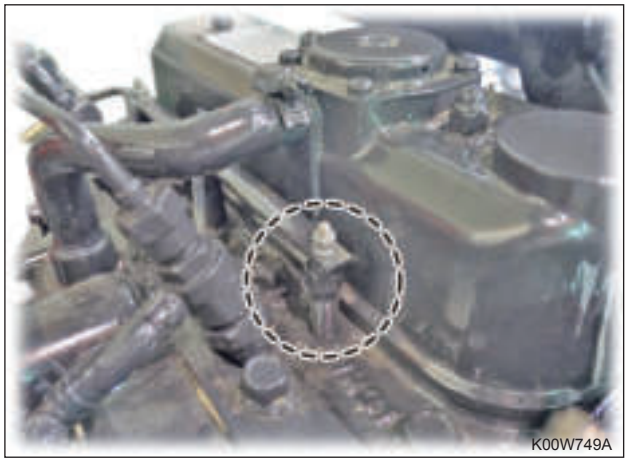
▶ **RESISTANCE BY FLOAT POSITION**



FLOAT POSITION	F	1/2	E
RESISTANCE (Ω)	3	(32.5)	110
TOLERANCE (Ω)	±2	-	±7

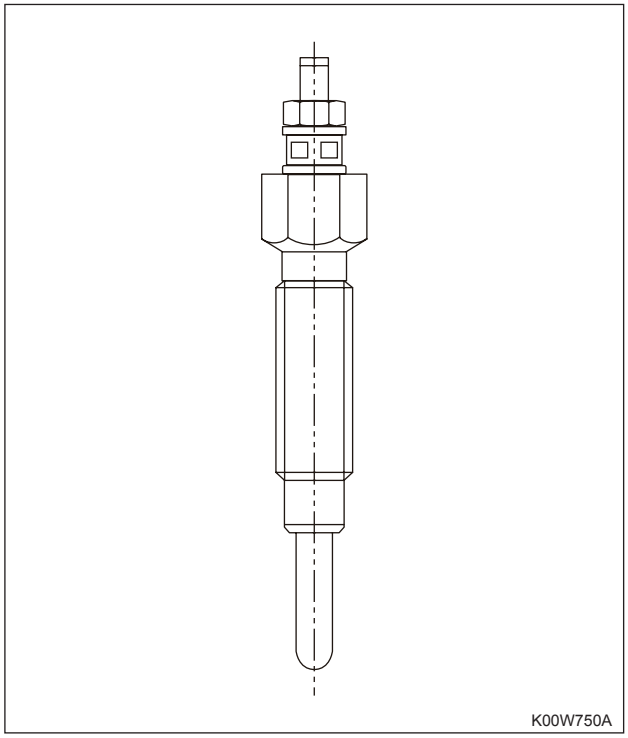
K00W748A

5.2.18 GLOW PLUG



The glow plug is installed to the engine cylinder head to heat the intake air in the pre-combustion chamber in order to facilitate engine starting. The current of the glow plug should be 10 A within 5 seconds after it is applied with DC 11 V and its temperature should rise to 800° in approx. 5 seconds.

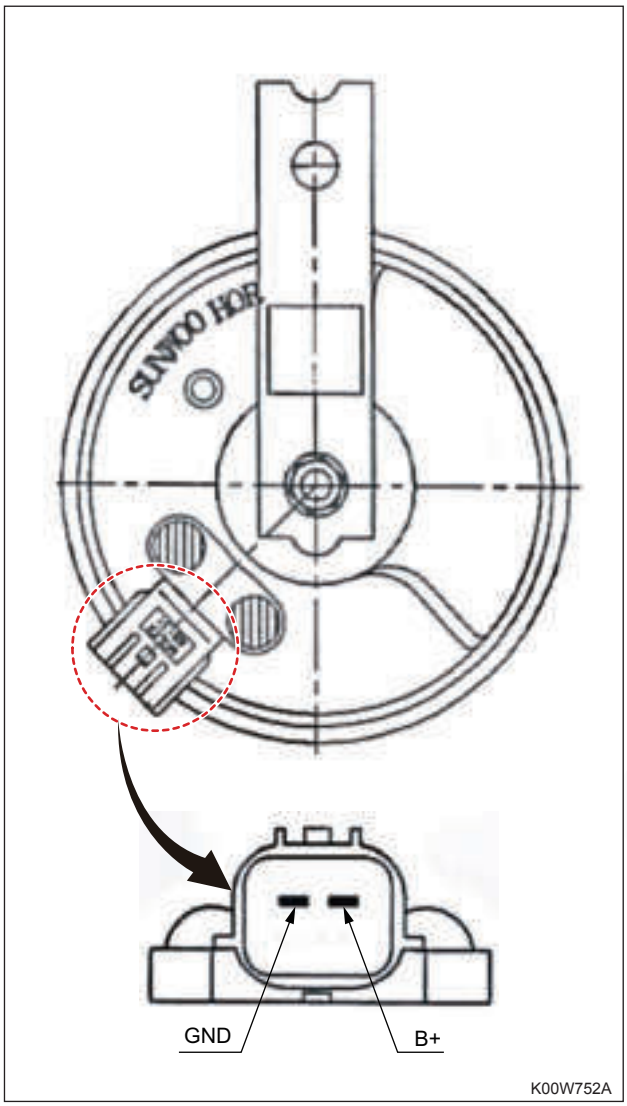
▶ FEATURE



5.2.19 HORN

The horn (1) is installed between the left and right head lamps on the front of the hood.

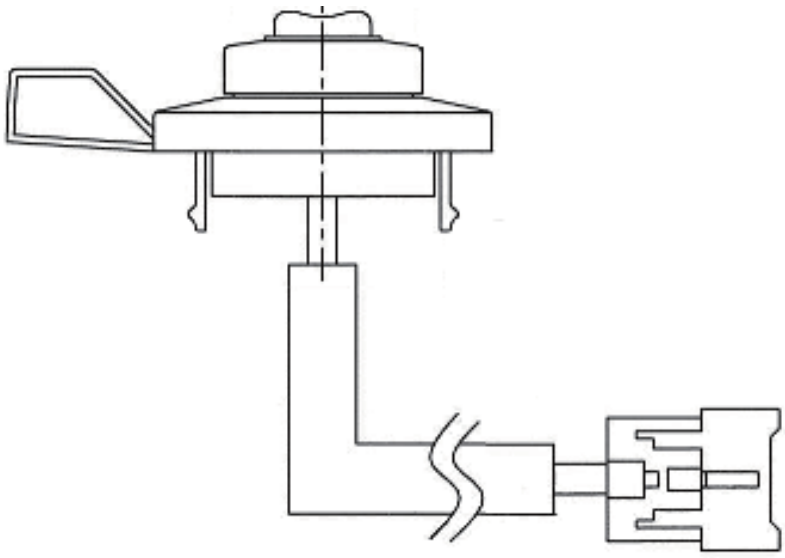
▶ CONNECTOR



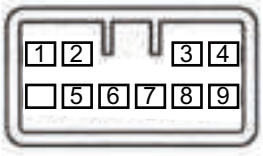
5.2.20 COMBINATION SWITCH

The combination switch is installed to the left side of the dashboard for operation of the head lamp high/low beam, turn signal lamps and horn.

▶ CONNECTOR



PIN NO.	SPEC.
1	AVSS 0.85 S/Q (Or)
2	AVSS 0.85 S/Q (R)
3	AVSS 0.85 S/Q (G/W)
4	AVSS 0.85 S/Q (B)
5	AVSS 0.85 S/Q (R/Y)
6	AVSS 0.85 S/Q (Y)
7	AVSS 0.85 S/Q (R/L)
8	AVSS 0.85 S/Q (G)
9	AVSS 0.85 S/Q (L/W)



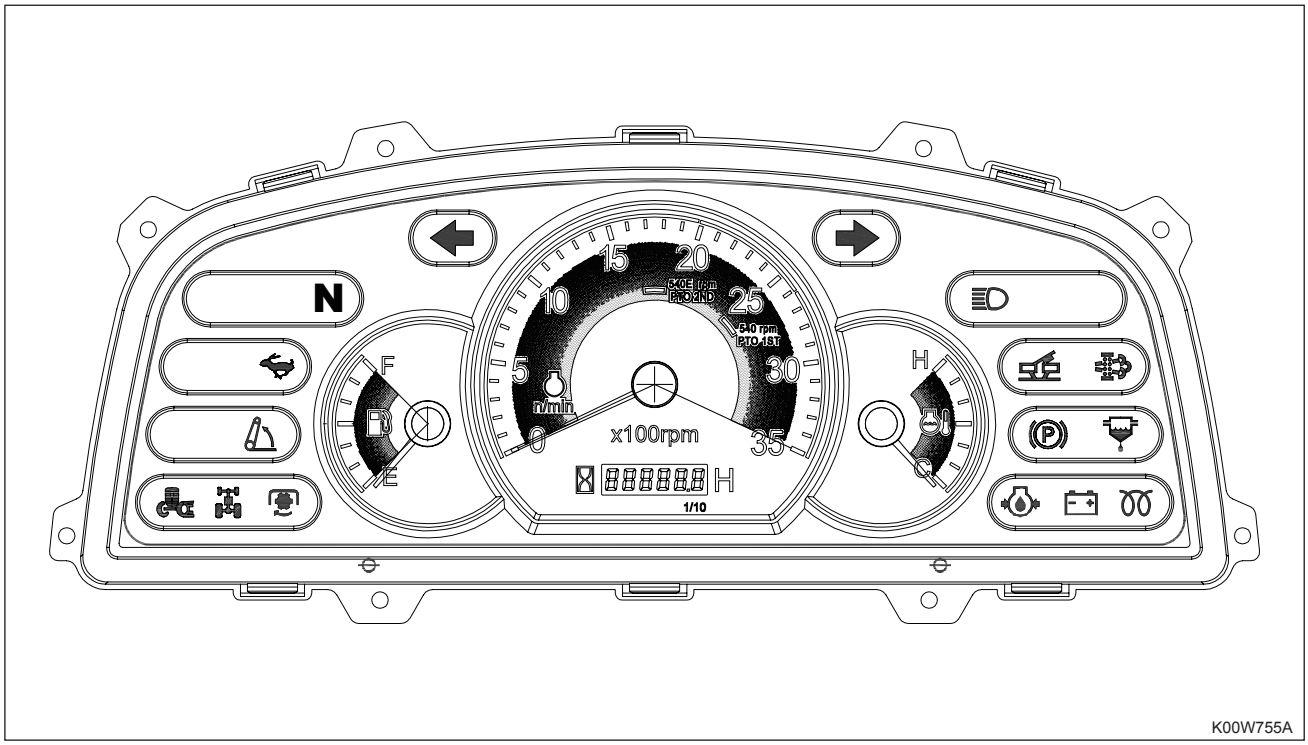
K00W754A

▶ WIRING DIAGRAM

HEAD LAMP					TURN SIGNAL LAMP				HORN		
ITEM	B1	T	1	2	ITEM	B2	R	L	ITEM	B3	H
WIRING COLOR	R	RY	Y	OR	WIRING COLOR	GW	RL	G	WIRING COLOR	8	LW
CIRCUIT NO.	2	5	6	1	CIRCUIT NO.	3	7	8	CIRCUIT NO.	4	9
○					⇨	○—○			FREE		
≡D	○—○	○—○	○		OFF				PUSH	○—○	
≡D	○—○			○	⇦	○	——	○			

5.2.21 INSTRUMENT CLUSTER

▶ CONFIGURATION AND PERFORMANCE SPECIFICATIONS



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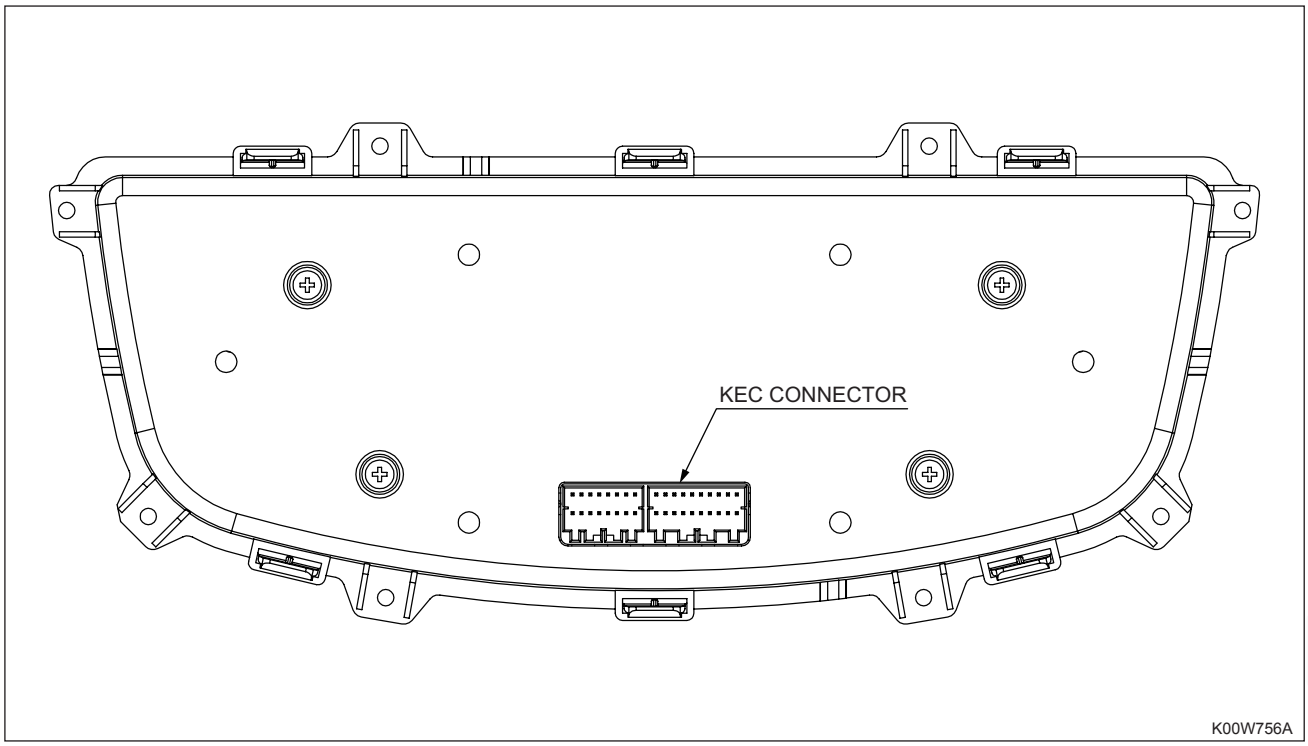
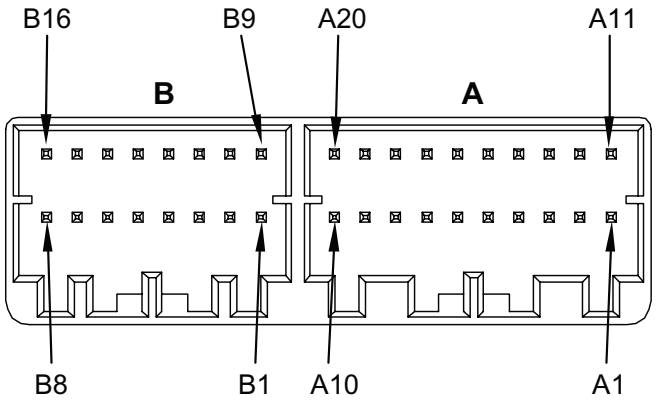


K00W756A

▶ CONNECTOR

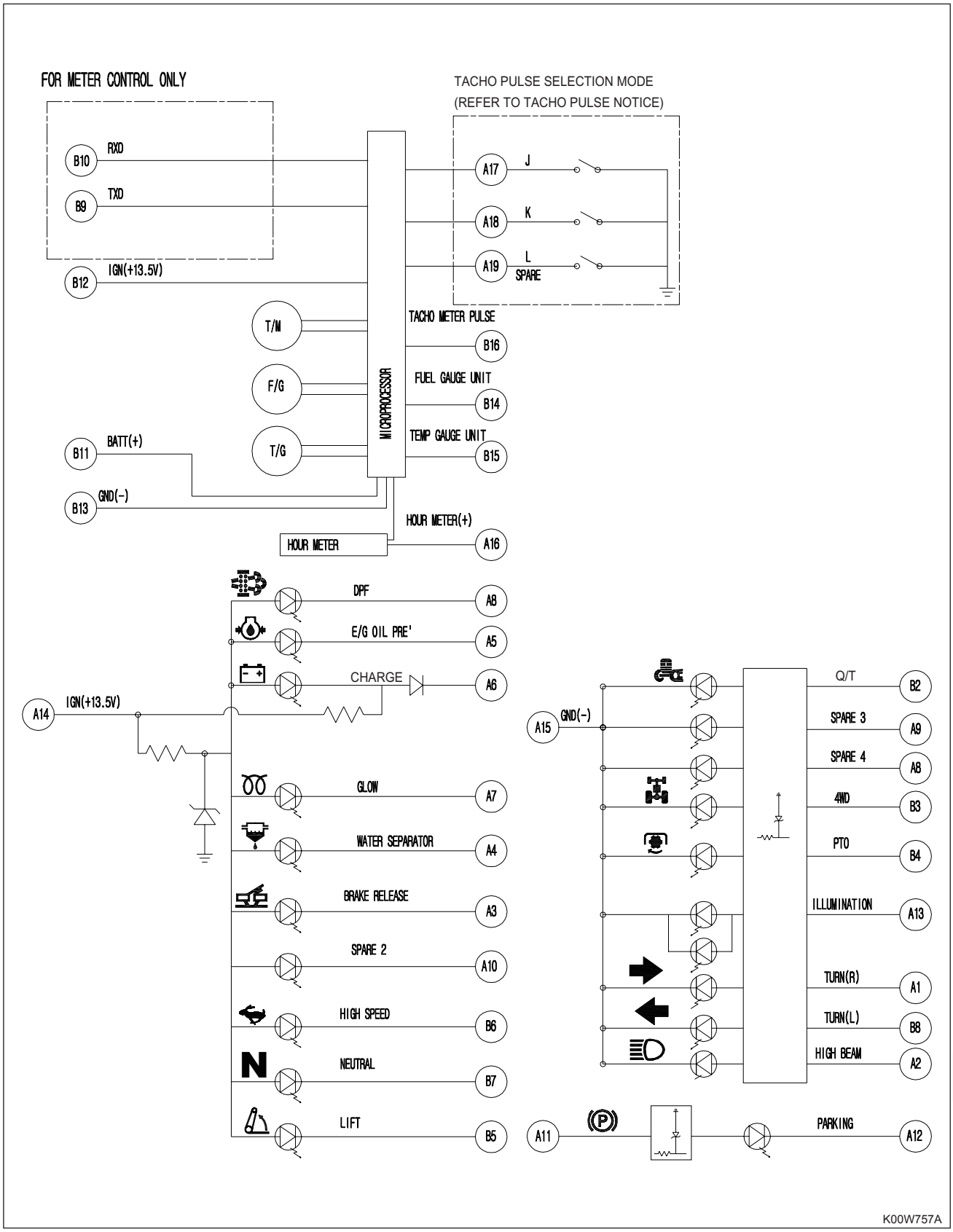


K25W726A

	PIN NO.	NAME	REMARKS
A	A1	TURN (R)	+
	A2	HIGH BEAM	+
	A3	BRAKE RELEASE	-
	A4	WATER SEPARATOR	-
	A5	E/G OIL PRESSURE	-
	A6	CHARGE	-
	A7	GLOW	-
	A8	DPF	
	A9	SPARE 3	-
	A10	SPARE 2	
	A11	PARKING(+)	+
	A12	PARKING(-)	-
	A13	ILLUMINATION	+
	A14	IGN(+13.5V)	+
	A15	GND(-)	-
	A16	HOUR METER(+)	+
	A17	J	-
	A18	K	-
	A19	L(SPARE)	-
	A20		

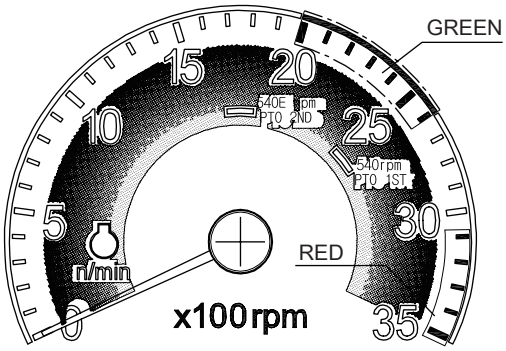
	PIN NO.	NAME	REMARKS
B	B1	SPARE 1	
	B2	Q/T	+
	B3	4WD	+
	B4	PTO	+
	B5	LIFT	-
	B6	HIGH SPEED	-
	B7	NEUTRAL	-
	B8	TURN(L)	+
	B9	TXD	
	B10	RXD	
	B11	BATT(+ REGULAR POWER)	+
	B12	IGN(+13.5V)	+
	B13	GND(-)	-
	B14	FUEL GAUGE UNIT	
	B15	TEMP GAUGE UNIT	
	B16	TACHO METER PULSE	

▶ CIRCUIT

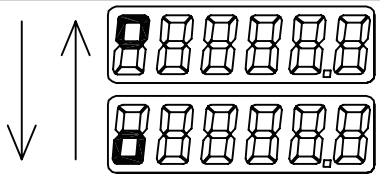

FOR METER CONTROL ONLY
TACHO PULSE SELECTION MODE
(REFER TO TACHO PULSE NOTICE)
B10 RXD
B9 TXD
B12 IGN(+13.5V)
A17 J
A18 K
A19 L
SPARE
T/M
F/G
T/G
MICROPROCESSOR
TACHO METER PULSE
B16
FUEL GAUGE UNIT
B14
TEMP GAUGE UNIT
B15
B11 BATT(+)
B13 GND(-)
HOUR METER(+)
HOUR METER
A16
DPF
A8
E/G OIL PRE'
A5
CHARGE
A6
A14 IGN(+13.5V)
GLOW
A7
WATER SEPARATOR
A4
BRAKE RELEASE
A3
SPARE 2
A10
HIGH SPEED
B6
N
NEUTRAL
B7
LIFT
B5
A15 GND(-)
Q/T
B2
SPARE 3
A9
SPARE 4
A8
4WD
B3
PTO
B4
ILLUMINATION
A13
TURN(R)
A1
TURN(L)
B8
HIGH BEAM
A2
A11
PARKING
A12
K00W757A

▶ PERFORMANCE SPECIFICATIONS

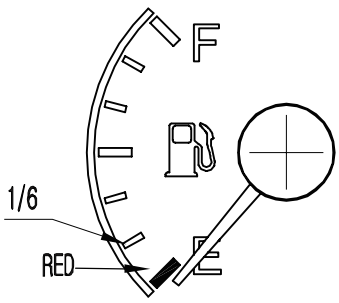
1. Tachometer

PTO RPM		PTO 540 rpm → 2,600 rpm			
Operating range		0 - 3,500 rpm			
Indicator characteristics	Position (rpm)	1,000	2,000	2,500	3,000
	Tolerance (rpm)	± 50	(± 100)	(± 100)	+0 -100
A - Frequency (Hz)		163.4	326.8	408.5	490.2
B - Frequency (Hz)		184.6	369.2	461.5	553.8
Zone					

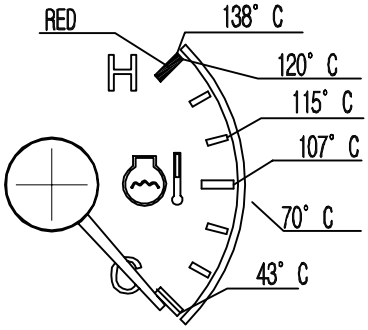
2. Hourmeter

Type	LCD type
Rated voltage	DC 12V)
Max. displaying time	9999.9 hours
Time accuracy	± 5 sec./24 hr.(for continuous operation)
Display	

3. Fuel gauge

Type		STOP MOTOR		
Operational voltage		DC 12 V		
Indicator characteristics	Position	E	1/2	F
	Resistance (Ω)	95	(32.5)	7
	Tolerance (°)	± 3.5	-	± 3.5
Zone				

4. Temp. gauge

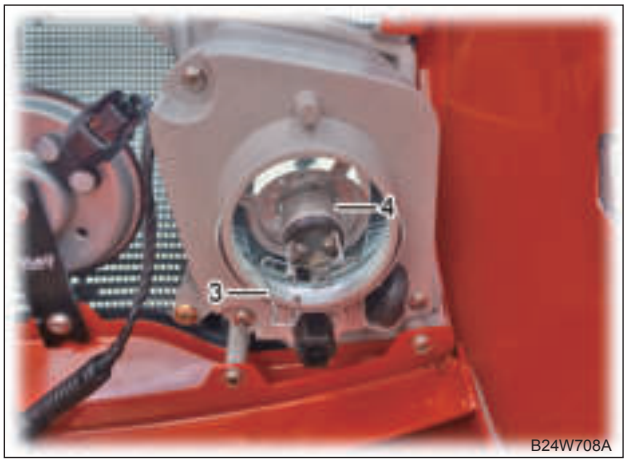
Type		STOP MOTOR					
Operational voltage		DC 12 V					
Indicator characteristics	Position	43	70	107	115	120	138
	Resistance (Ω)	240.5	103.2	38	34.1	30.5	21.2
	Tolerance (°)	(± 3.5)	(± 3.5)	± 3.5	(± 3.5)	± 3.5	(± 3.5)
Zone							

5. Indicator

SYMBOL									SPARE 2
NAME	Turn(L)	Turn(R)	Upper beam	E/G oil	Parking	Charge	Water separator	DPF	BLACK
COLOR	Green	Green	Blue	Red	Red	Red	Red	Yellow	
SYMBOL								N	SPARE 3
NAME	Preheat	Lift	PTO	Brake release	4WD	Q/T	High speed	Neutral	BLACK
COLOR	Red	Yellow	Yellow	Red	Green	Red	Green	Green	
LAMP	LED								

5.3 LAMP BULB REPLACEMENT

5.3.1 HEAD LAMP



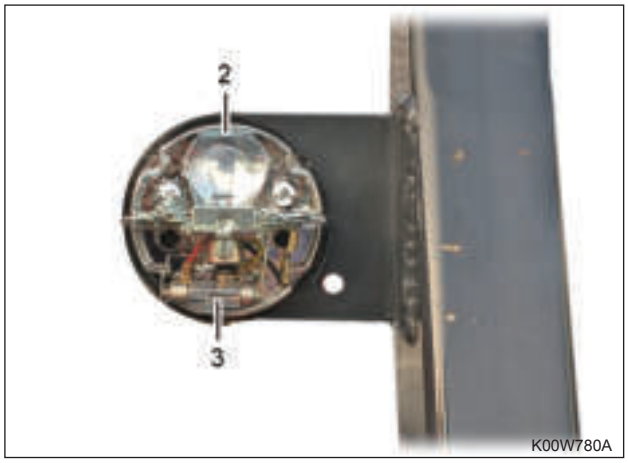
1. Pull the dust cover (1) and connector (2) out to disconnect it.

2. Release the socket spring (3) and remove the bulb (4).

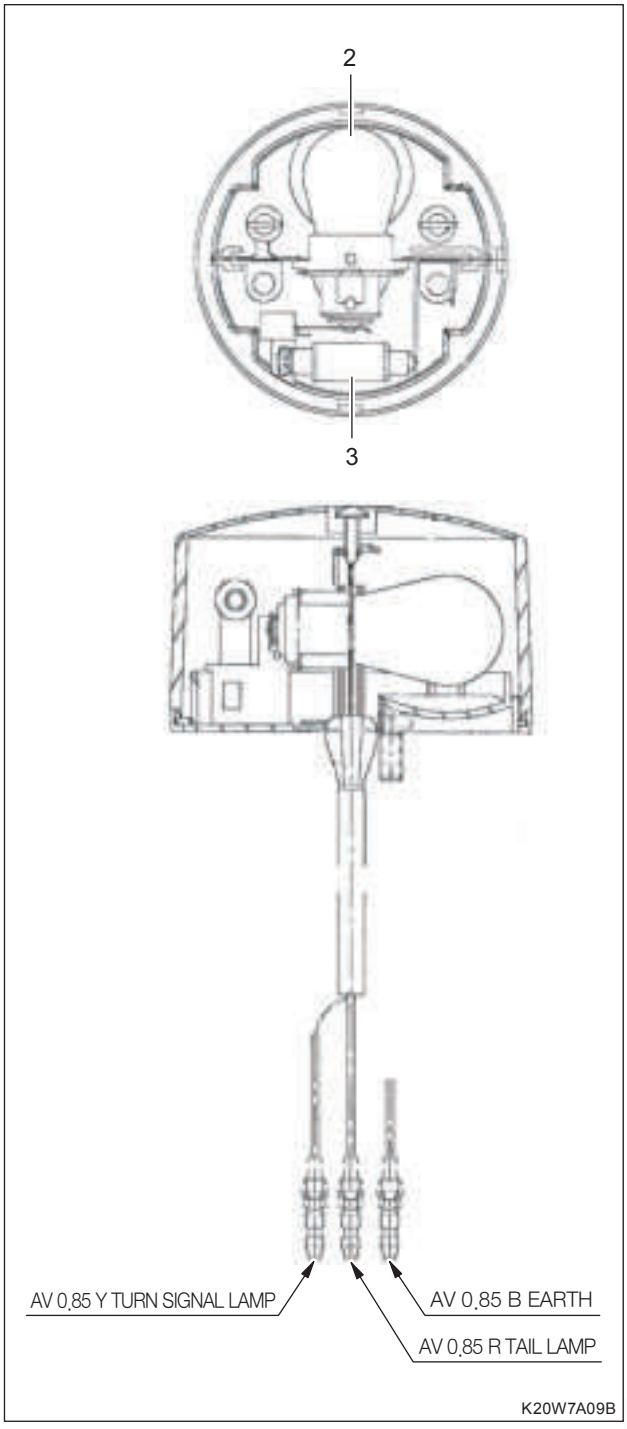
3. Bulb specification: HS1 12 V 35 W/35 W

5.3.2 TURN SIGNAL LAMP

1. Unscrew the front lens mounting screw (1).



2. Remove the bulb (2) by pressing and turning it clockwise.
3. Remove the bulb (3).



- Bulb specification: ② 12 V 21 W
  ③ 12 V 10 W

5.3.3 REAR COMBINATION LAMP

▶ **REAR TURN SIGNAL LAMP**

1. Unscrew the lens mounting screw (1) and pull the lens (2) to remove it.

3. Replace the bulb with a new one.

   Bulb specification: 12 V 15 W

2. Remove the bulb (3) by pressing and turning it.

▶ TURN OR STOP LAMP & BRAKE LAMP

1. Unscrew the lens mounting screw (1) and pull the lens (2) to remove it.

2. Remove the bulb (3) for the brake lamp by pressing and turning it. And remove the bulb (4) for tail lamp.

3. Replace the bulb with a new one.

   Brake lamp bulb: 12 V 15 W

   Tail lamp bulb: 12 V 10 W

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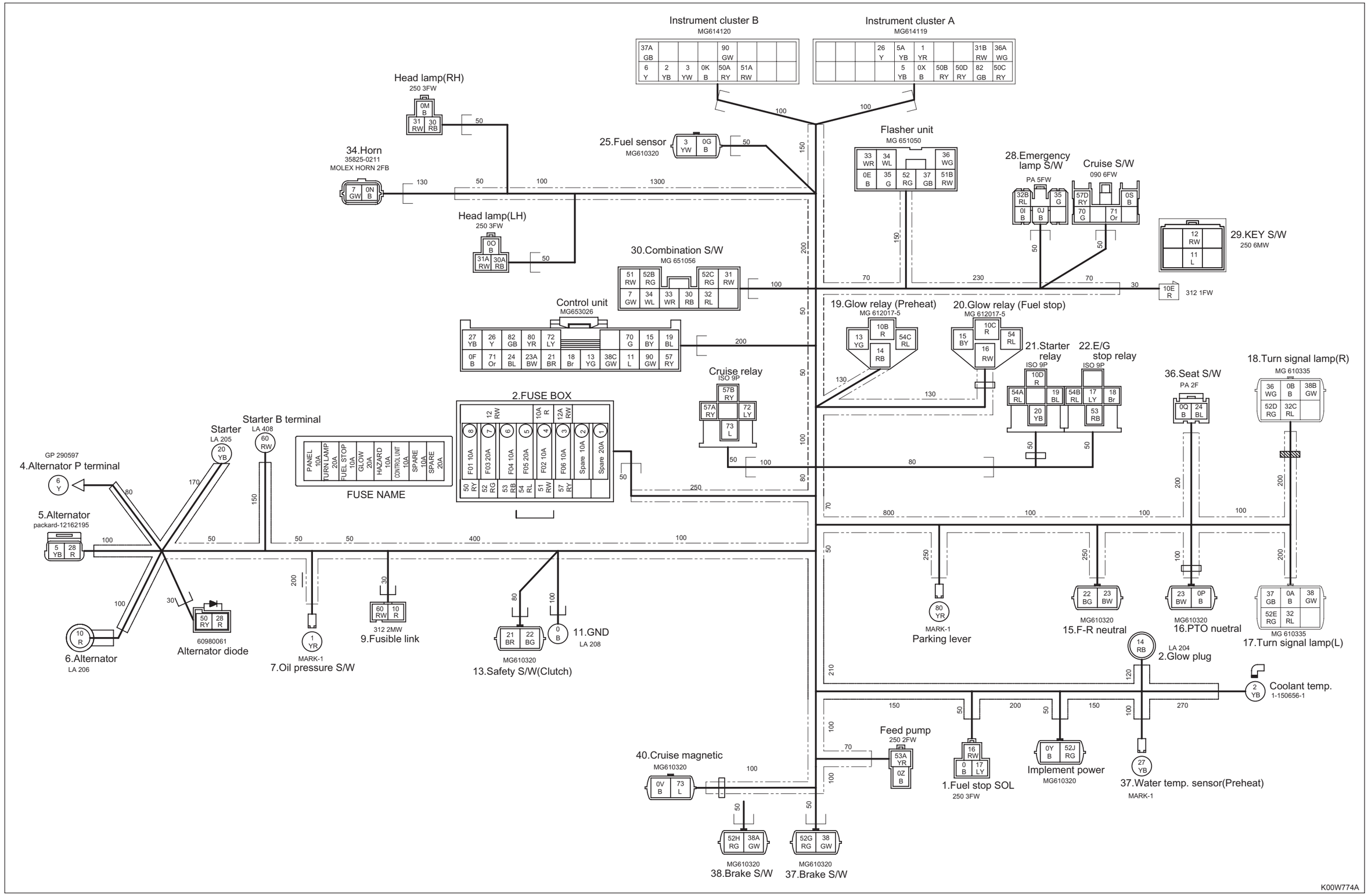
5.4 WIRING DIAGRAM



No.	WIRE	SIZE	COLOR	DESCRIPTION
1	FLRY-B	0.5	YR	Oil pressure S/W
2	FLRY-B	0.5	YB	Coolant temp.
3	FLRY-B	0.5	YW	Fuel sensor
4	FLRY-B	0.5	YB	Charge lamp
5	FLRY-B	0.5	YB	Charge lamp
6	FLRY-B	0.75	Y	Engine speed
7	FLRY-B	1	GW	Horn
8	FLRY-B	2.5	R	Power
9	FLRY-B	1.5	R	Power
10	FLRY-B	2.5	R	Preheat
11	FLRY-B	2.5	R	Fuel stop
12	FLRY-B	1.5	R	Starter
13	FLRY-B	2.5	R	Power
14	FLRY-B	1	L	START
15	FLRY-B	2.5	RW	ON
16	FLRY-B	1	RW	Power
17	FLRY-B	0.75	YG	Preheat
18	FLRY-B	2.5	RB	Glow plug
19	FLRY-B	0.75	BY	Fuel stop
20	FLRY-B	2.5	RW	PULL COIL
21	FLRY-B	0.75	LY	HOLD COIL
22	FLRY-B	0.5	Br	Engine stop signal
23	FLRY-B	0.5	BL	Starter signal
24	FLRY-B	1.5	YB	Starter S terminal
25	FLRY-B	0.5	BR	Clutch safety
26	FLRY-B	0.5	BG	Lever
27	FLRY-B	0.5	BW	PTO neutral
28	FLRY-B	0.5	BW	Emergency stop
29	FLRY-B	0.75	BL	Seat

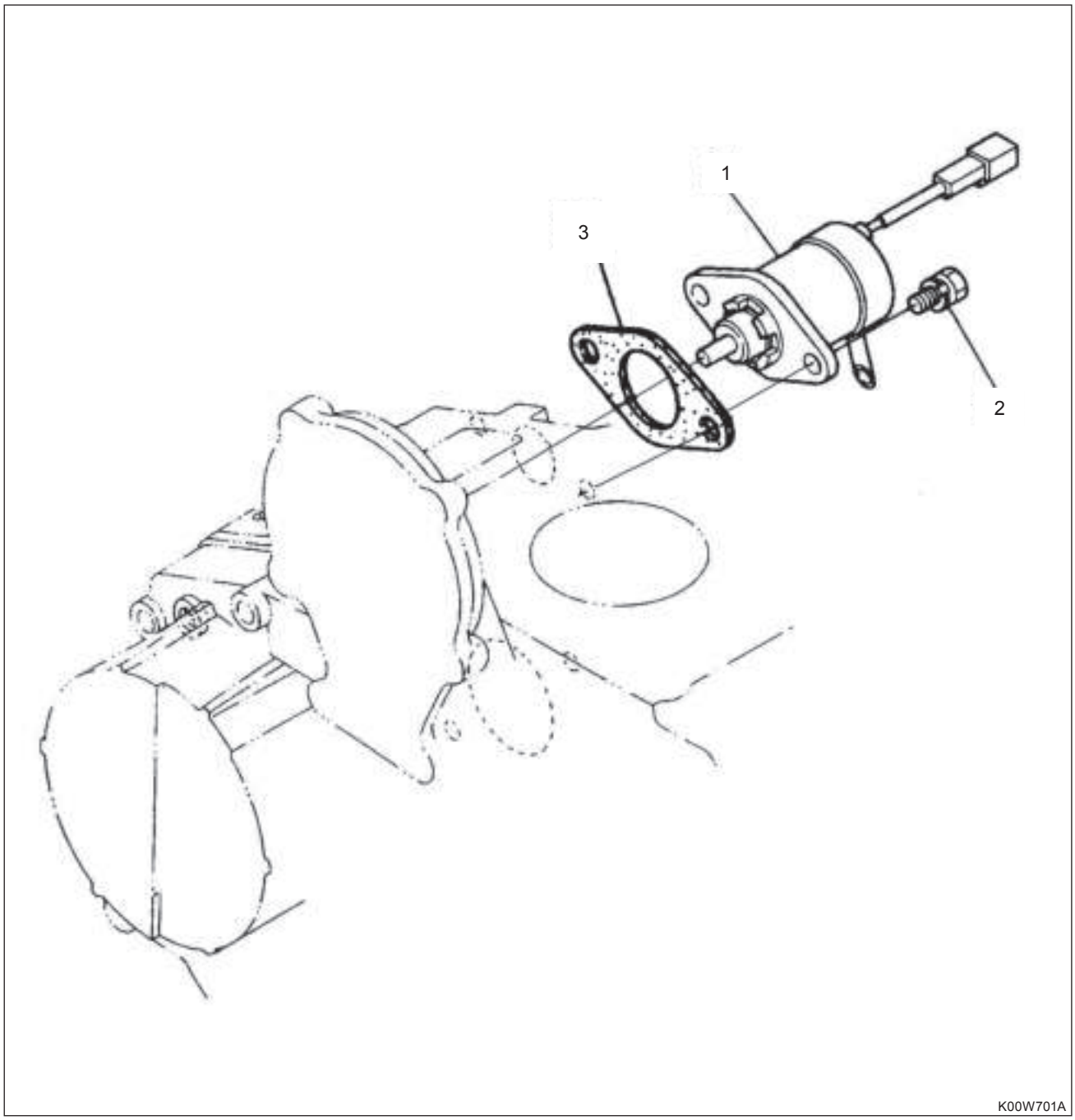
No.	WIRE	SIZE	COLOR	DESCRIPTION
30	FLRY-B	0.5	Y	Preheat lamp
31	FLRY-B	0.5	YB	Water temp. sensor
32	FLRY-B	0.75	R	Alternator
33	FLRY-B	1	RB	Head lamp (L)
34	FLRY-B	1	RB	Head lamp (L)
35	FLRY-B	1	RW	Head lamp (H)
36	FLRY-B	1	RW	Head lamp (H)
37	FLRY-B	0.5	RW	Head lamp (H)
38	FLRY-B	1	RL	Tail lamp
39	FLRY-B	0.5	RL	Tail lamp
40	FLRY-B	1	RL	Tail lamp
41	FLRY-B	0.5	WR	Turn signal lamp (R)signal
42	FLRY-B	0.5	WL	Turn signal lamp (L)signal
43	FLRY-B	0.5	G	Emergency lamp S/W
44	FLRY-B	0.75	WG	Turn signal lamp (R)
45	FLRY-B	0.5	WG	Turn signal lamp (R)
46	FLRY-B	0.75	GB	Turn signal lamp (L)
47	FLRY-B	0.5	GB	Turn signal lamp (L)
48	FLRY-B	0.75	GW	Power
49	FLRY-B	0.75	GW	Power
50	FLRY-B	0.75	GW	Power
51	FLRY-B	0.75	GW	Brake signal
52	FLRY-B	0.5	RY	Power
53	FLRY-B	0.5	RY	Power
54	FLRY-B	0.5	RY	Power
55	FLRY-B	0.5	RY	Power
56	FLRY-B	0.5	RY	Power
57	FLRY-B	1	RW	Power
58	FLRY-B	0.5	RW	Power

No.	WIRE	SIZE	COLOR	DESCRIPTION
59	FLRY-B	0.5	RW	Power
60	FLRY-B	1	RG	Power
61	FLRY-B	1	RG	Power
62	FLRY-B	1	RG	Power
63	FLRY-B	0.75	RG	Power
64	FLRY-B	0.75	RG	Power
65	FLRY-B	0.75	RG	Power
66	FLRY-B	0.75	RG	Power
67	FLRY-B	1	RG	Power
68	FLRY-B	1	RB	Power
69	FLRY-B	1	RB	Power
70	FLRY-B	0.75	RL	Power
71	FLRY-B	0.5	RL	Power
72	FLRY-B	0.5	RL	Power
73	FLRY-B	0.75	RL	Power
74	FLRY-B	2.5	RW	Power
75	FLRY-B	1	RY	Power
76	FLRY-B	0.5	RY	Power
77	FLRY-B	1	RY	Power
78	FLRY-B	0.5	RY	-
79	FLRY-B	0.5	G	-
80	FLRY-B	0.5	Or	-
81	FLRY-B	0.5	LY	-
82	FLRY-B	1	L	Cruise magnetic
83	FLRY-B	0.5	YR	-
84	FLRY-B	0.5	GB	-
85	FLRY-B	0.5	GW	-

K00W775A

6. SECTIONAL VIEW FOR MAJOR COMPONENTS

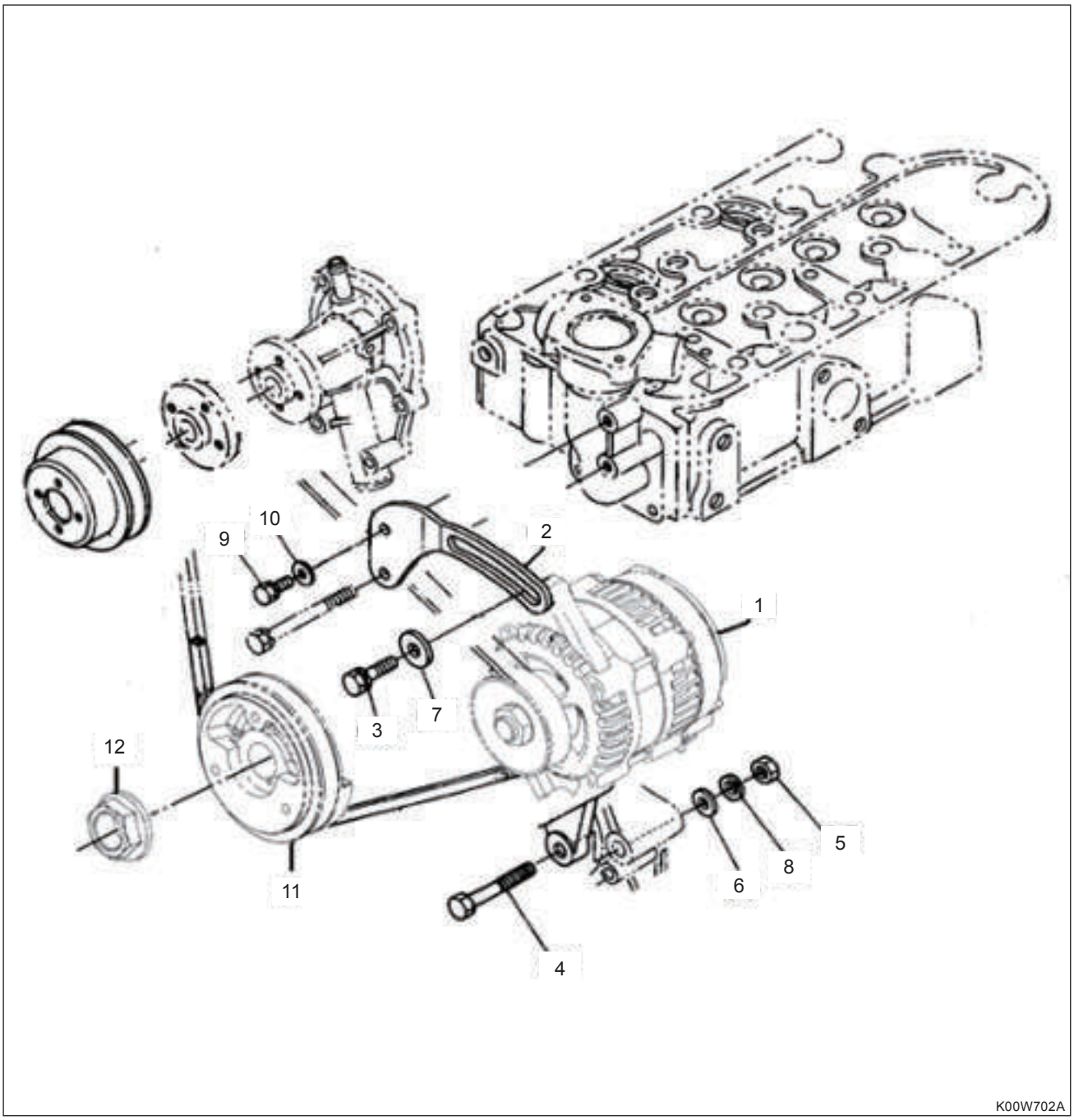
6.1 STOP SOLENOID



COMPONENTS

(1) Ass'y solenoid (2) Screw (3) Gasket, ass'y solenoid

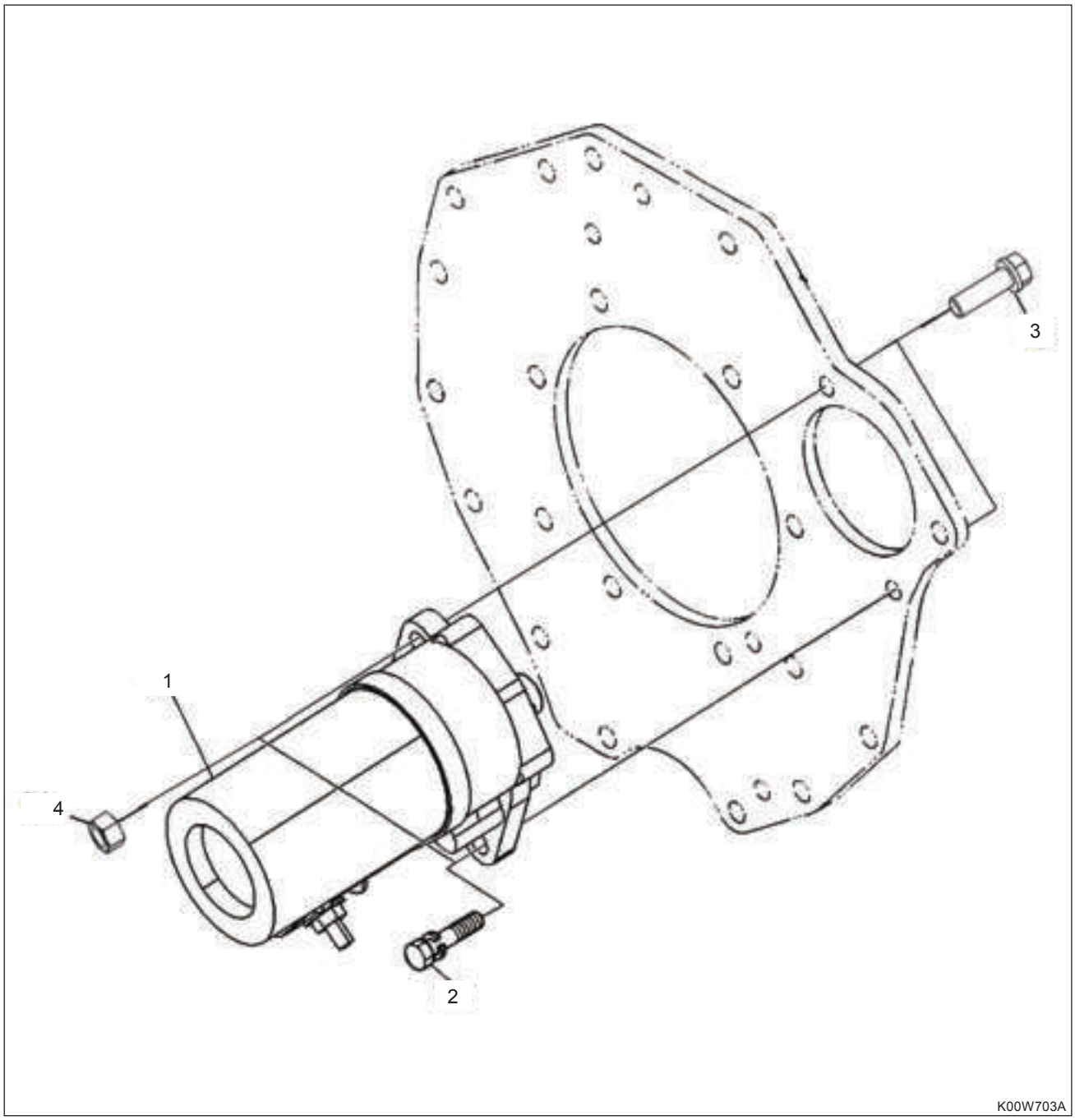
6.2 ALTERNATOR & PULLY



COMPONENTS

(1) Ass'y alternator
(2) Bracket, alternator
(3) Washer
(4) Screw
(5) Nut, regular hexagon
(06) Washer, plain
(07) Bolt
(08) Washer, spring
(09) Bolt
(10) Washer, plain
(11) Pulley, fan drive
(12) Nut, V-pulley

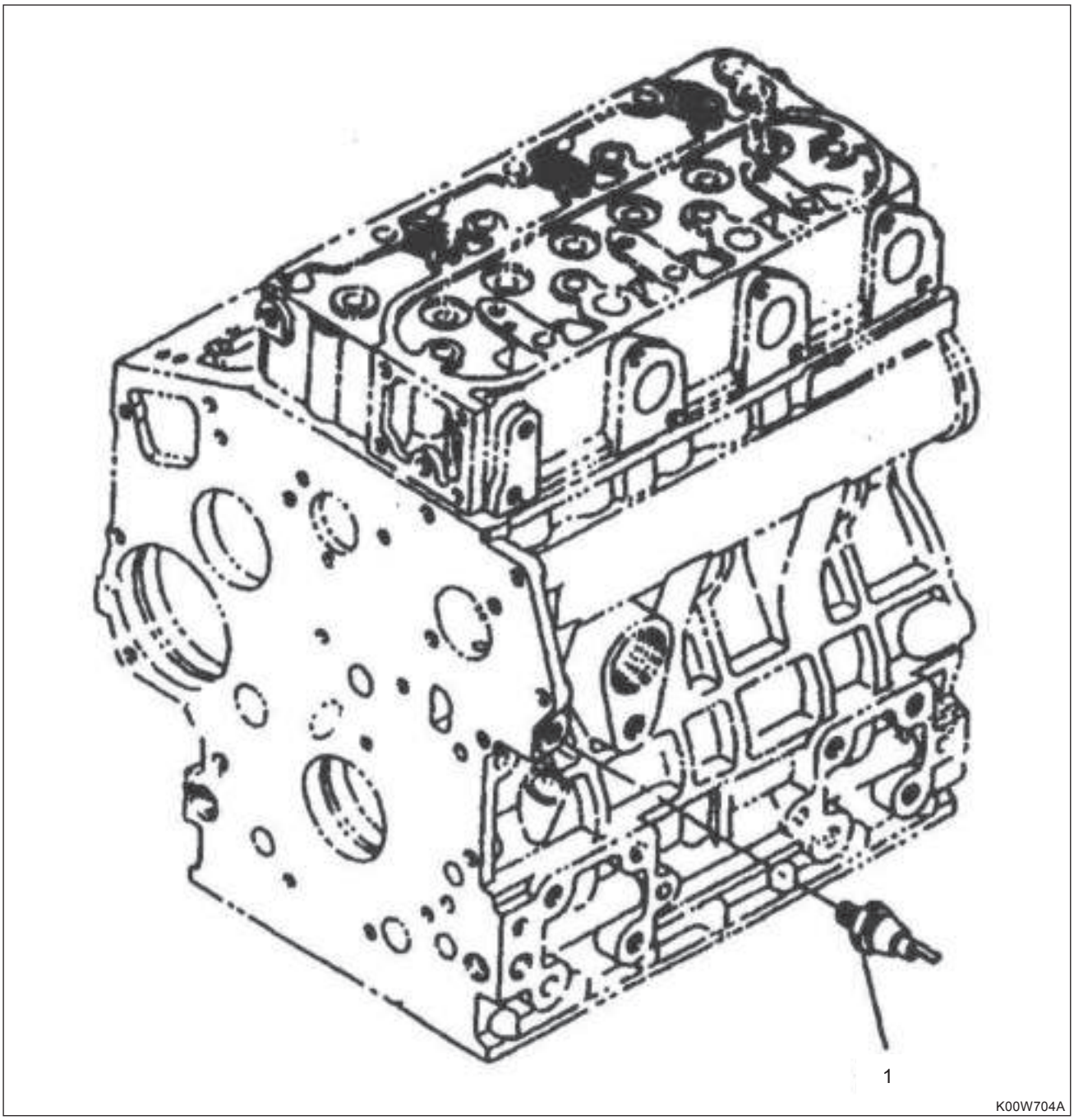
6.3 STARTING MOTOR



COMPONENTS

(1) Motor, starting
(2) Bolt
(3) Bolt
(4) Nut

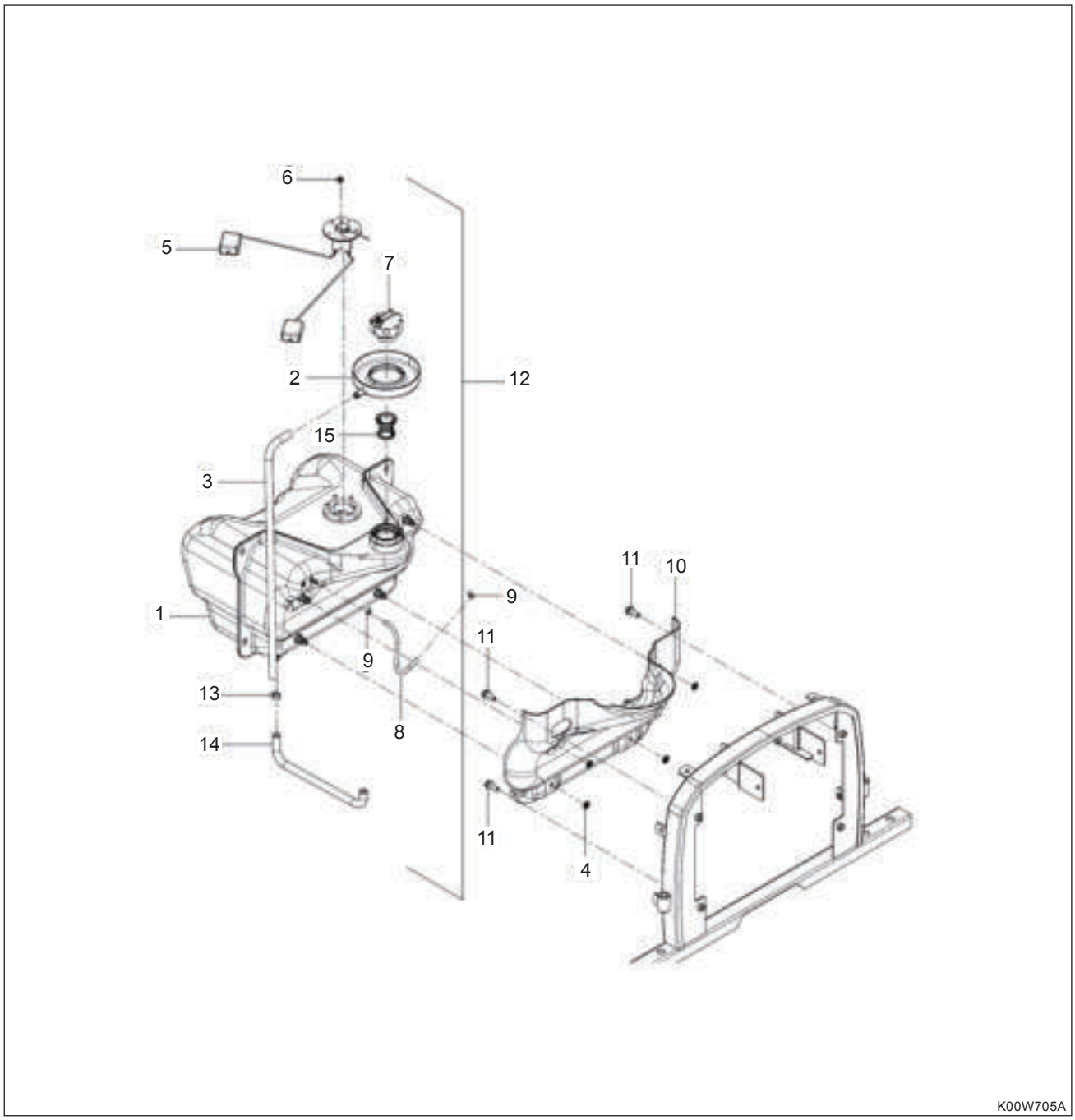
6.4 OIL PRESSURE SWITCH



COMPONENTS

(1) Switch, oil pressure

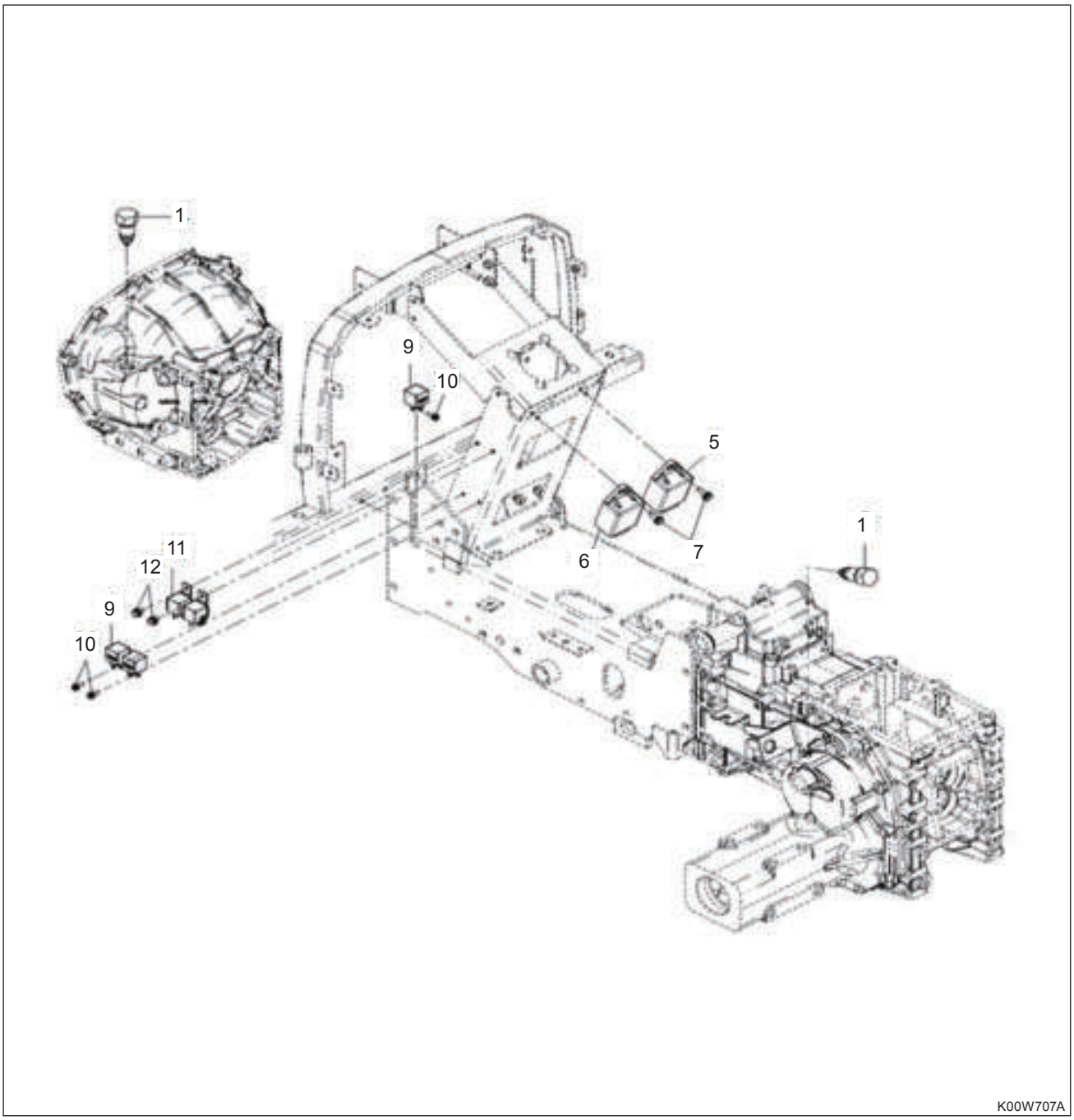
6.5 FUEL TANK



COMPONENTS

(1) Ass'y tank, fuel
(2) Tray, fuel
(3) Hose
(4) Nut
(5) Gauge, fuel
(6) Nut
(7) Ass'y cap, fuel
(8) Tube, fuel
(9) Clip, pipe
(10) Cover, heat
(11) Bolt
(12) Ass'y, fuel tank
(13) Clip, pipe
(14) Hose
(15) Fuel filter

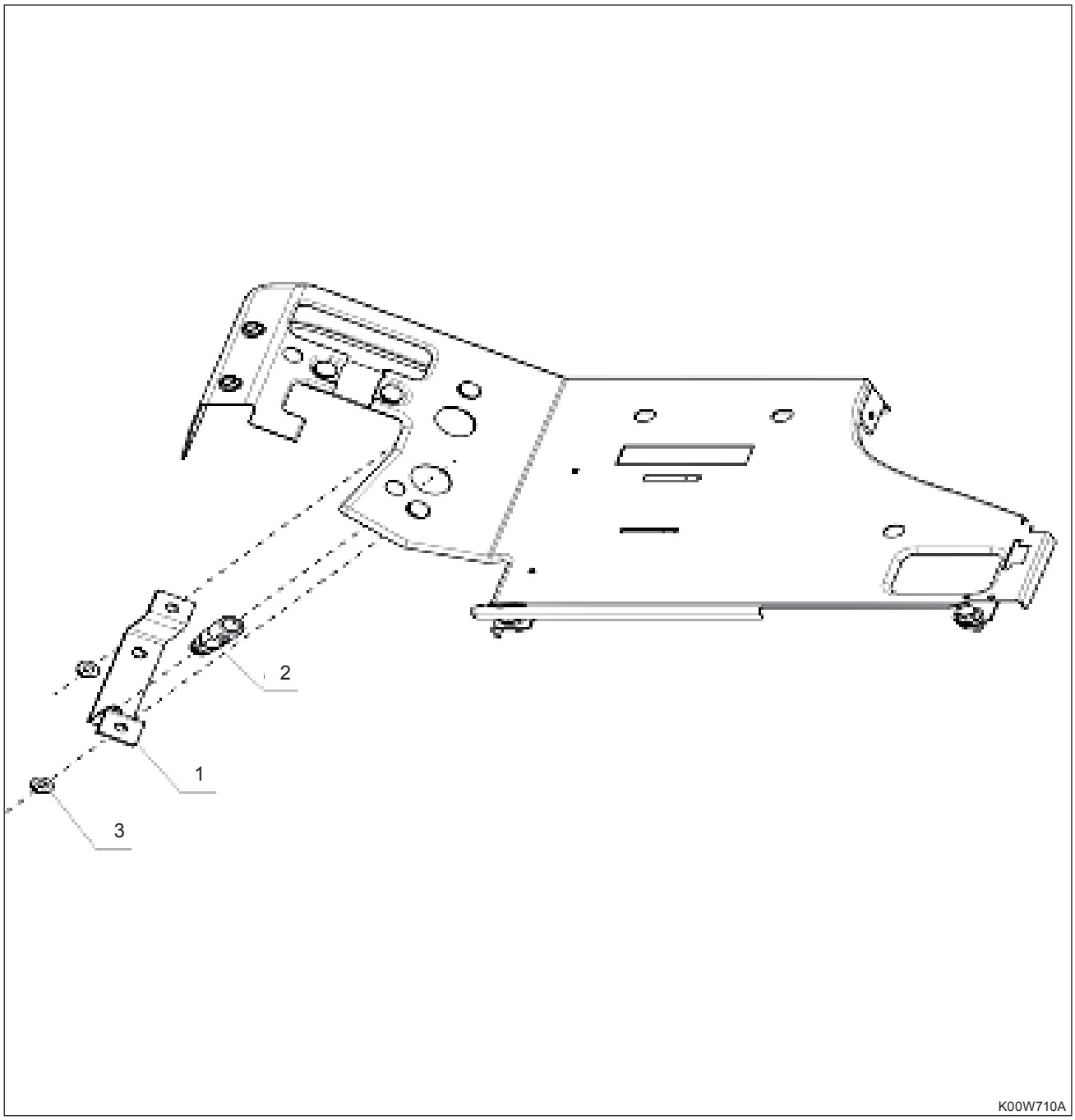
6.6 SWITCH



COMPONENTS

(1) Switch, safety
(5) Unit, flasher
(6) Unit, control
(7) Bolt
(9) Relay
(10) Bolt
(11) Relay
(12) Bolt
(13) Controller (OPC)

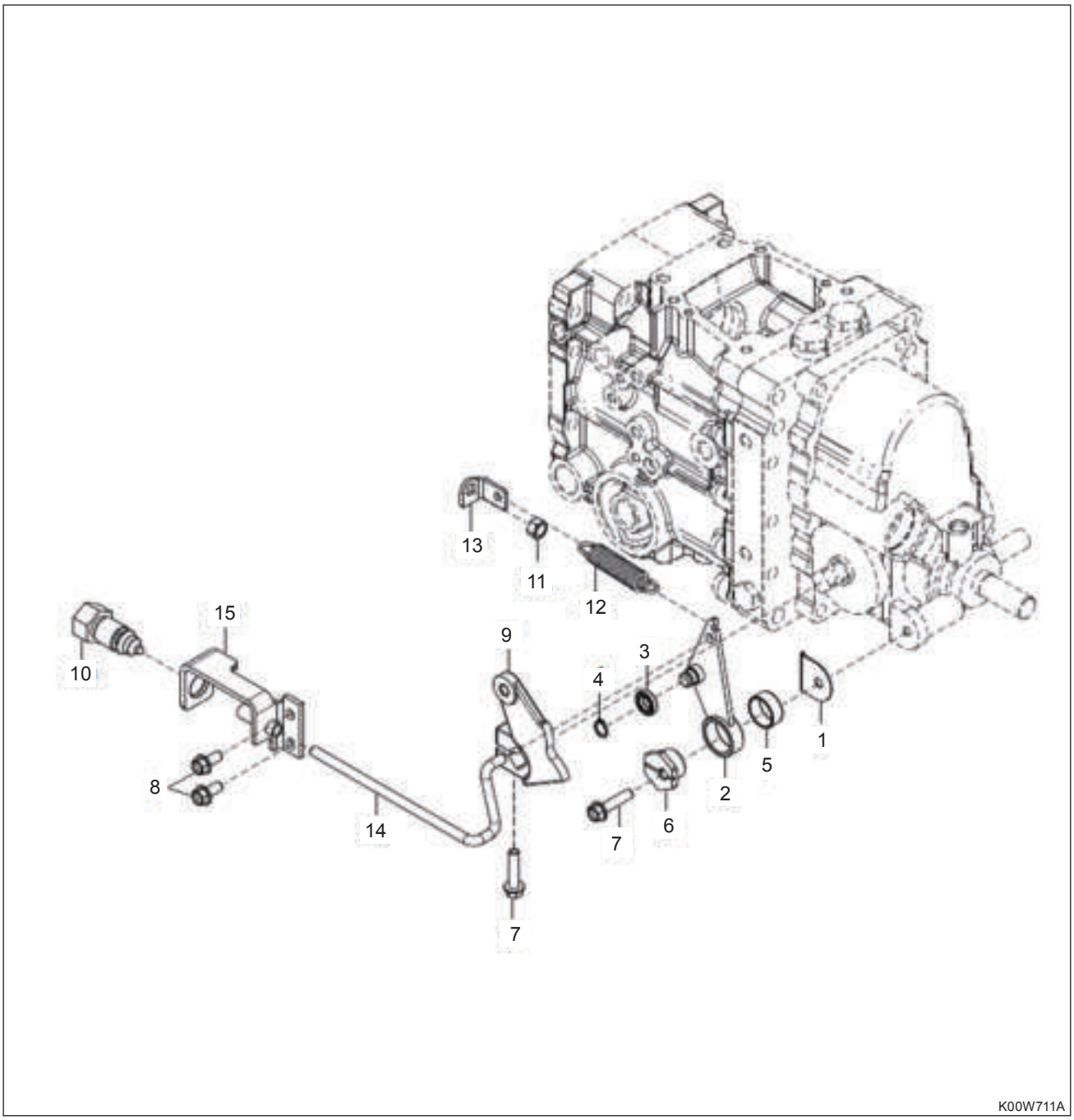
6.7 BRAKE SWITCH



COMPONENTS

(1) Bracket switch (2) Switch (3) Nut

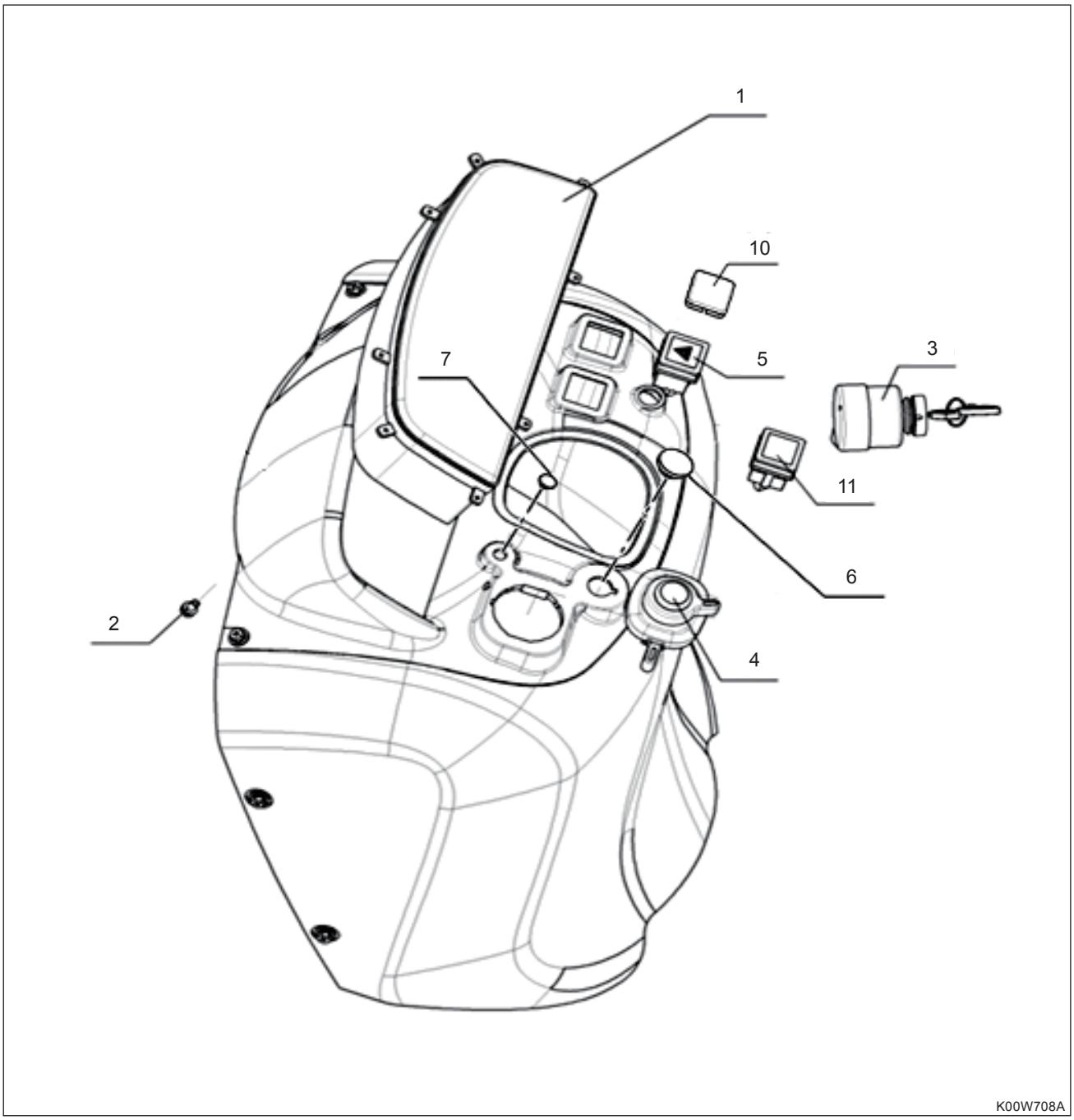
6.8 NEUTRAL HOLDER LINK



COMPONENTS

(1) Spacer
(2) Assy arm, neutral
(3) Bearing, ball
(4) Cir clip, external
(5) Bush
(6) Shaft, holder
(7) Bolt
(8) Bolt
(9) Holder, neutral
(10) Switch, safety
(11) Nut
(12) Spring
(13) Bracket
(14) Rod, HST neutral
(15) Stay, neutral switch

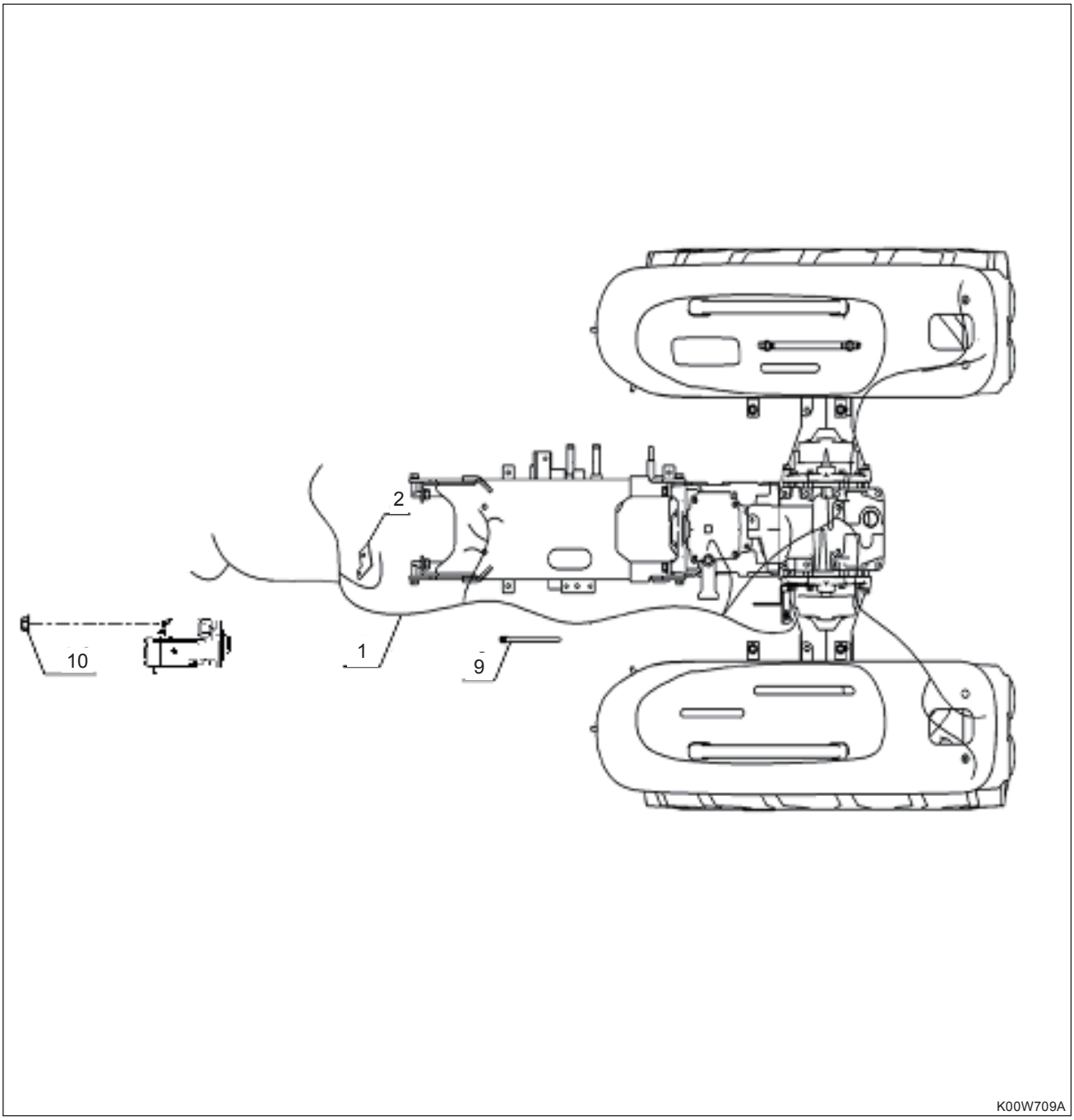
6.9 PANEL BOARD



COMPONENTS

(1) Ass'y meter
(2) Screw, tapping
(3) Switch, starter
(4) Switch, combinaiton
(5) Switch, hazard
(6) Rubber
(7) Rubber
(10) Switch rubber
(11) Switch cruise

6.10 ELECTRICAL WIRING



COMPONENTS

(1) Ass'y wire harness
(2) Bracket
(9) Band, cord
(10) Nut

7. TROUBLESHOOTING

INSPECTION ITEM / SYMPTOM	Safety switch	Safe start relay	Ignition switch	Starter motor	Battery	Fuse and fusible link	Fuel shut-off solenoid	Control unit	Glow relay	Coolant temperature sensor (Glow)	Alternator	Instrument panel	Light bulb	Fuse	Flasher unit
The engine cannot be started (start motor operated)				●	●		●								
The engine cannot be started (start motor not operated)	●	●	●	●	●	●									
The engine can be started without depressing the clutch pedal.									●						
The engine cannot be stopped.							●								
The preheat indicator does not come on.						●		●	●	●		●			
The preheat indicator does not go off.								●	●						
The charge warning lamp does not come on.						●					●	●			
The charge warning lamp does not go off.											●				
The head lamp does not come on.													●	●	
The turn signal lamp does not come on.													●	●	●
The horn does not sound.														●	

MEMO

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