TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of KUBOTA T1600H. It is divided into two parts, "Mechanism" and "Disassembling and Servicing".

■ **Mechanism**

Information on the construction and function are included in this section. This part should be understood before proceeding with troubleshooting, disassembling and servicing.

■ **Disassembling and Servicing**

The heading "General" includes general precautions, troubleshooting, servicing specification lists, check and maintenance and special tools. For each section, there are checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information, illustrations and specifications contained in this manual are based on the latest production information available at the time of publication.

KUBOTA reserves the right to make changes in information at any time without notice.

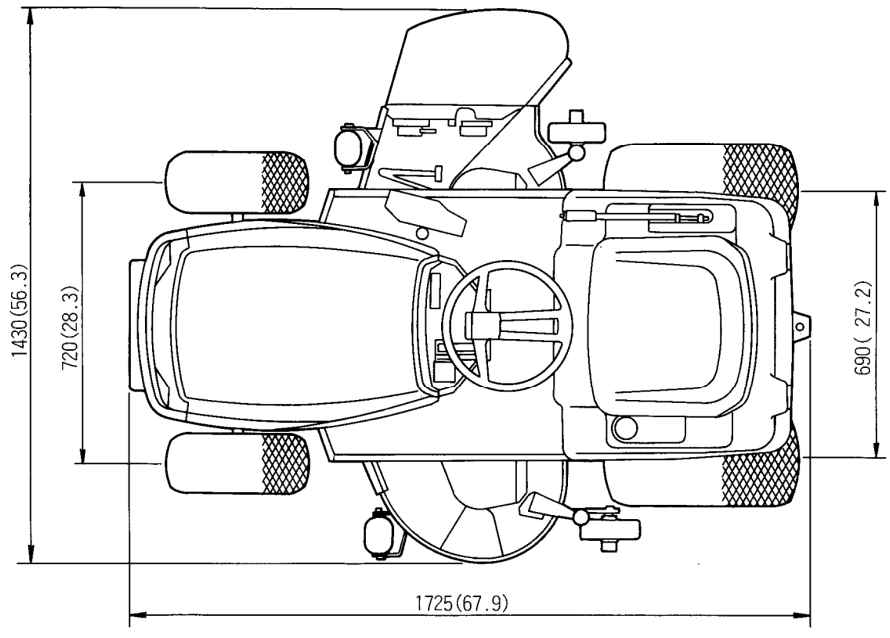
Mar. '89

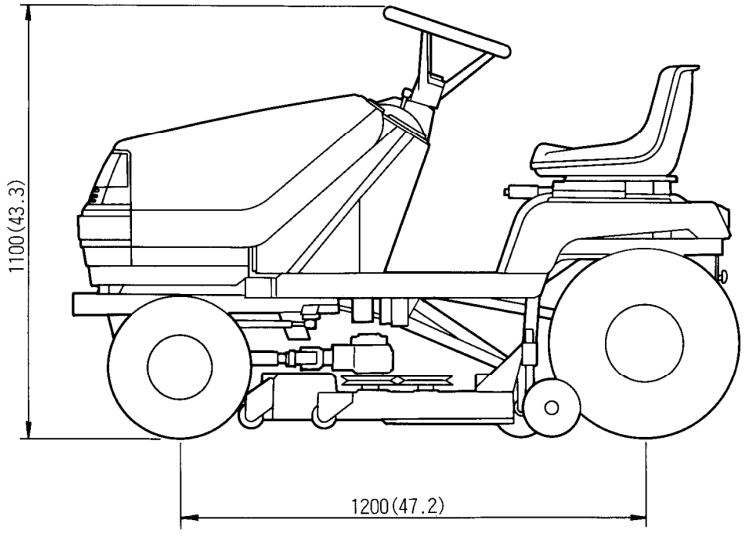
CONTENTS

SPECIFICATIONS

Model			T1600H
Engine	Model		Z482
	Type		Vertical, liquid cooled, 4-cycle, diesel engine
	Number of Cylinders		2
	Bore x Stroke		67 x 68 mm (2.64 x 2.68 in.)
	Total Displacement		479 cm^3 (29.3 cu.in.)
	Brake Horsepower (SAE Gross)		10.0 kW (13.5 HP)
	Rated Engine Speed		3200 rpm
	Combustion Chamber		N-TVCS (Serial No. : up to 488290), E-TVCS (Serial No. : 488291 and above)
	Fuel Injection Pump		Bosch MD mini pump
	Governor		Centrifugal ball mechanical governor
	Injection Nozzle		Throttle type (DN4PD62)
	Injection Timing		19 to 21° (0.33 to 0.37 rad.) before TDC
	Injection Pressure		13.73 MPa (140 kgf/cm^2, 1991 psi)
	Direction of Rotation		Counter-clockwise (viewed from flywheel)
	Compression Ratio		23 to 1
	Lubricating System		Forced lubrication by trochoid pump
	Cooling System		Pressurized radiator, Forced circulation with water pump
	Starting System		Electric starter (12 V, 0.8 kW)
	Charging System		AC dynamo (12 V, 150 W)
	Battery		12 V, 28 AH
	Engine Stop		Key stop
	Fuel		Diesel fuel No.2 [above –10°C (14°F)], No.1 [below –10°C (14°F)]
	Lubricating Oil		API service CC or CD
	Weight (Dry)		62.5 kg (includes radiator, air cleaner and muffler)
Dimensions	Overall Length		1725 mm (67.9 in.)
	Overall Width		1430 mm (56.3 in.)
	Overall Height		1100 mm (43.3 in.)
	Wheel Base		1200 mm (47.2 in.)
	Tread	Front	720 mm (28.3 in.)
		Rear	690 mm (27.2 in.)
Weight			300 kg (662 lbs.)
Fuel Tank Capacity			10 ℓ (2.6 gals)
Tire Size	Front		15 x 6.00–6
	Rear		20 x 10.00–8
Steering System			Manual
Brake (Parking Brake)			Dry disc (Serial No. : up to 49999), Wet disc (Serial No. : 50001 and above)
Transmission			Hydrostatic transmission
Traveling Speed	Forward		0 to 9 km/h (0 to 5.6 mph)
	Reverse		0 to 5 km/h (0 to 3.1 mph)
PTO	Direction of Revolution		Counter-clockwise viewed from front
	Revolution		2740 rpm (at engine 3200 rpm)
	PTO Clutch		Belt tension
Mower	Mounting Method		Parallel linkage
	Adjustment of Cutting Height		Gauge wheel
	Cutting Height		25.4 to 102 mm (1.0 to 4.0 in.)
	Cutting Width		1118 mm (44 in.)
	Number of Blades		3
	Weight		55 kg (121 lbs.)
	Dimensions	Total Length	825 mm (32.5 in.)
		Total Width	1430 mm (56.3 in.)
		Total Height	282 mm (11.1 in.)
	Discharge		Right side

DIMENSIONS





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Unit: mm (in.)

M.MECHANISM

F FEATURE

■ **New 13.5 HP KUBOTA Diesel Engine with "New Three Vortex Combustion System (N-TVCS)"**

This new engine featuring the new three vortex combustion system (N-TVCS) has been developed on the basic of Kubota's advanced technologies.

This compact engine provides high output and torque as well as low noise, low fuel consumption ratio and excellent start ability.

It promises the maximum operation efficiency with high reliability and durability.

- Since January 1994, E-TVCS has been used for the combustion chamber of our products instead of traditional N-TVCS.
  E-TVCS was developed with an eye toward clean exhaust gas which is more environmentally friendly.
  The combustion chamber models mentioned hereinafter refers to E-TVCS.
  Model of combustion chamber :
  N-TVCS (Engine Serial Number ; up to 488290)
  E-TVCS (Engine Serial Number ; 488291 and above)

■ **Hydrostatic Transaxle**

The hydrostatic transmission, reduction gear and rear axle are housed in a compact package. Easy operation by the speed control pedal without clutch operation realizes comfortable operation.

■ **Shaft Drive System for Hydrostatic Transmission, Mid-mount Mower and Grass Catcher (Optional)**

The shaft drive system attains high reliability and durability for easy maintenance.

■ **Full-flat Deck, Spring Suspension Seat**

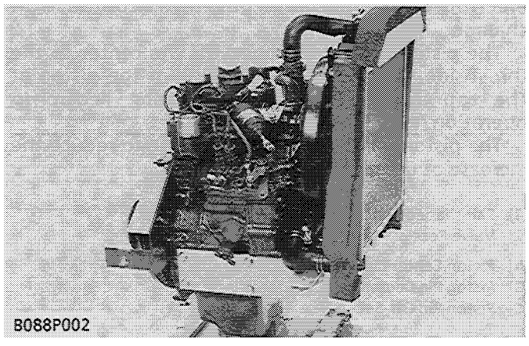
The full-flat deck and spring suspension seat ensure operator's comfort throughout many hours of mowing operation.

■ **Engine Key Stop**

The engine can be stopped easily by key switch operation.

1 ENGINE

[1] FEATURE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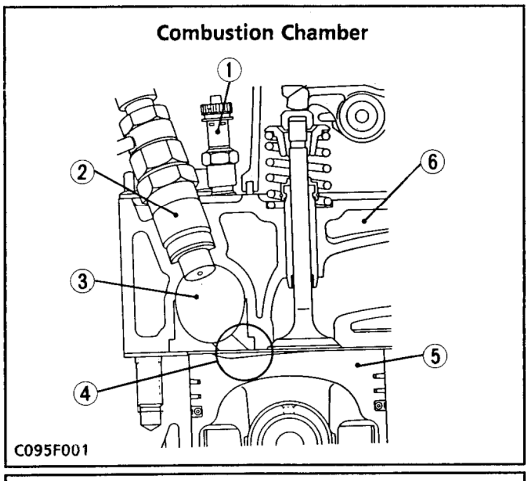
The Z482 is a liquid cooled 4-cycle diesel engine, utilizing Kubota's unique combustion system "NTVCS", special designed engine, the well-known Bosch MD type injection pump, alminum radiator for greater heat radiation, super glow for quick starting and a well-balanced design.

So this engine features greater power, low fuel consumption, reduced vibration and quiet operation.

[2] COMBUSTION SYSTEM



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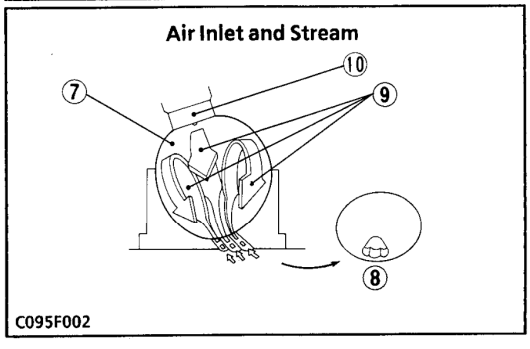

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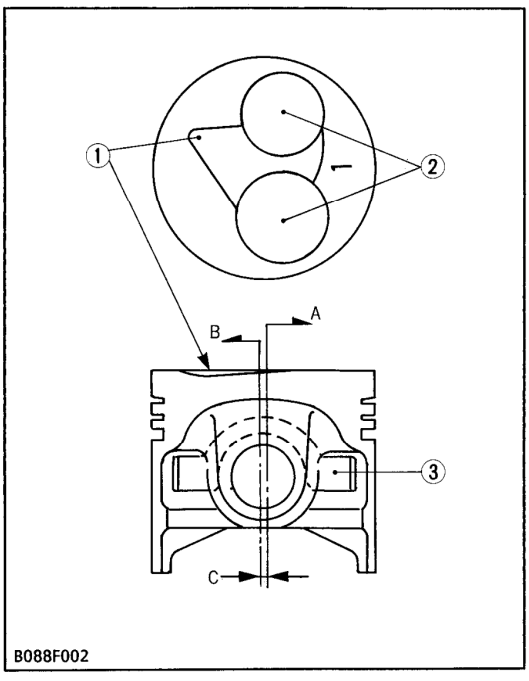
This engine uses the "NTVCS" (New Three Vortex Combustion System) to achieve perfect combustion for maximum power. The NTVCS combustion system provides unique shape of throat in the air inlet (8) for combustion chamber, to produce three streams of air (9) in the chamber (7) when compressing, giving an ideal mixture of air and fuel. In addition, a fan-shaped concave (4) is provided on top of the piston (5) to allow a smooth ejection of the exhaust gas, offering highly efficient combustion.

(1) Glow Plug
(2) Injection Nozzle
(3) Combustion Chamber
(4) Fan-shaped Concave
(5) Piston
(6) Cylinder Head
(7) Combustion Chamber
(8) Air Inlet
(9) Air Stream
(10) Injection Nozzle

[3] PISTON



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This piston is made of an aluminum alloy. Provided on top of the piston are a valve recess (2) and a fan-shaped concave (1) to allow smooth ejection of the exhaust gas from combustion chamber.

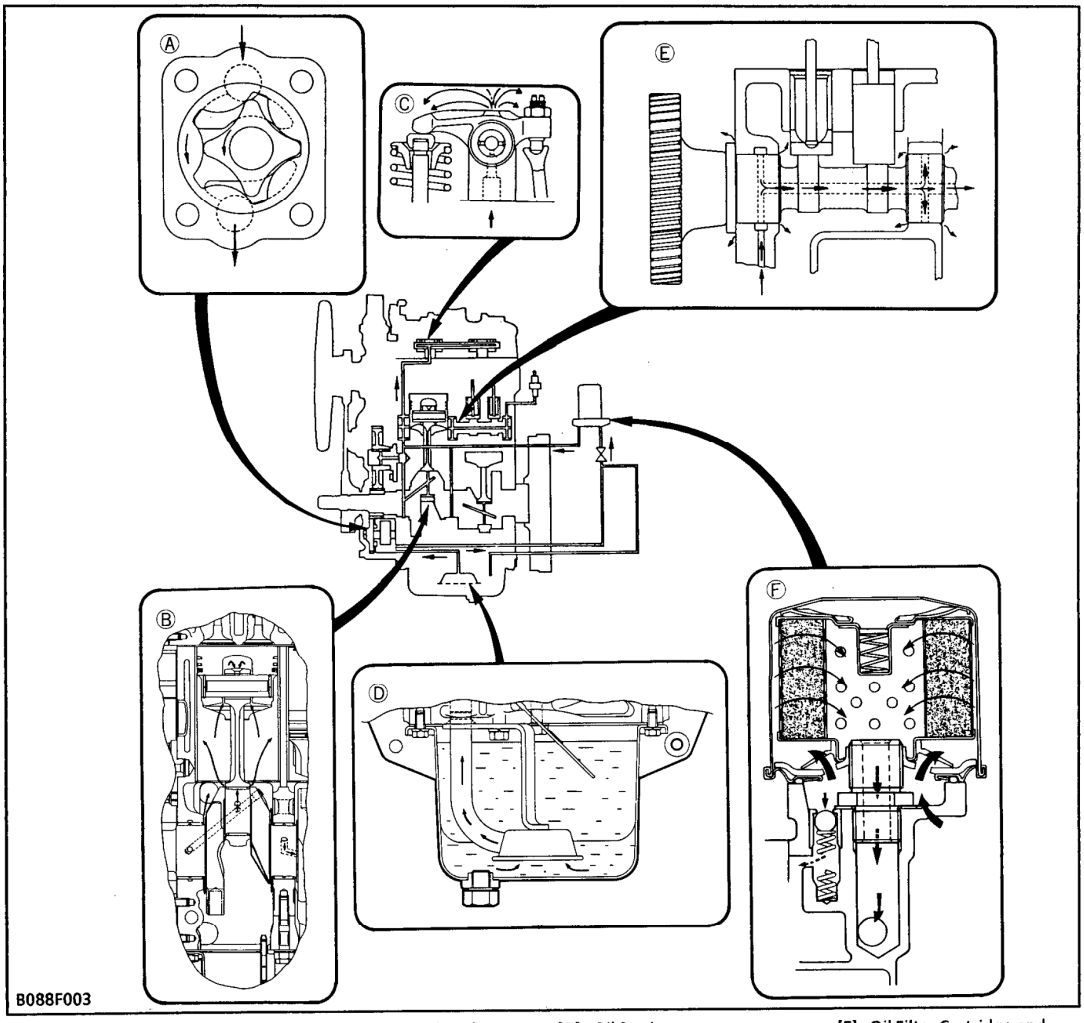
The piston pin is positioned off the center to the thrust side, which prevents a swing of the piston at the top and bottom dead centers, reducing operation noise.

The piston has a steal strut (3) inside to reduce the increase of the piston diameter.

(1) Fan-shaped Concave
(2) Valve Recess
(3) Steel Strut

[A] Piston Center Line
[B] Piston Pin Center Line
[C] Piston Pin Off-Set

[4] LUBRICATING SYSTEM



[A] Oil Pump
[B] Crankshaft and Piston
[C] Rocker Arm and Rocker Arm Shaft
[D] Oil Strainer
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

This engine lubricating system consists of oil strainer, oil pump, relief valve, oil filter cartridge and oil switch.

The oil pump is of rotor type working smoothly and noiselessly, sucks lubricating oil from the oil pan through the oil strainer. Then the oil flows to the oil filter cartridge, where it is further filtered.

Oil filter cartridge has a by-pass valve inside, to prevent the lack of oil in case that the element is clogged. When the pressure difference before filtering and after is more than 98.1 kPa (1 kgf/cm^2, 14.2 psi), the by-pass valve opens.

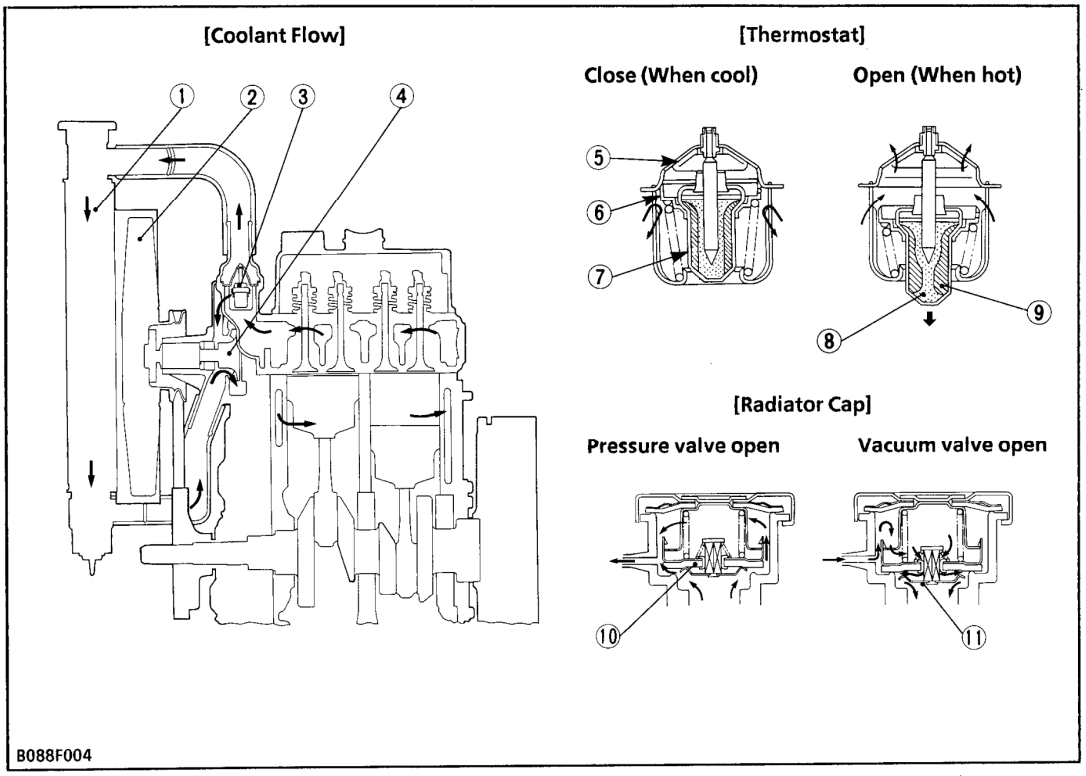
Near the oil filter cartridge is a relief valve, preventing damage to the lubrication system due to high oil pressure. When the oil pressure exceeds 441 kPa (4.5 kgf/cm^2, 64 psi), the valve opens and the oil escapes.

The filtered oil is force-fed to the crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft through the oil passage in the crankcase and the crankshaft to lubricate each part.

Some part of oil, splashed by the crankshaft or thrown off from gaps of each part, lubricate these parts; the pistons, the cylinder walls, the piston pins, the tappets, the push rods and the inlet and exhaust valves.

Oil switch is mounted on the crankcase and is led to the oil passage. When the oil pressure falls below 49.0 kPa (0.5 kgf/cm^2, 7.1 psi), the oil switch closes to turn on the oil pressure warning lamp.

[5] COOLING SYSTEM



(1) Radiator
(2) Cooling Fan
(3) Thermostat
(4) Water Pump
(5) Seat
(6) Valve
(7) Pellet
(8) Rubber
(9) Wax
(10) Pressure Valve
(11) Vacuum Valve

The cooling system consists of a radiator, a centrifugal water pump, a suction fan and a thermostat.

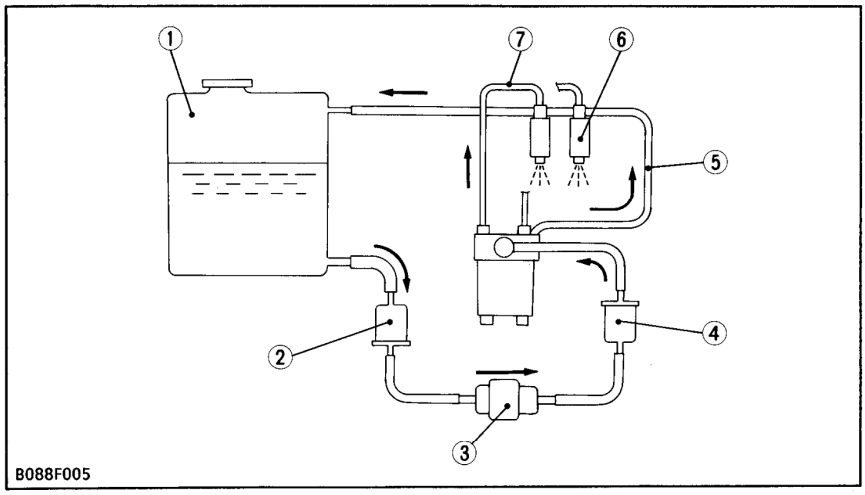
The coolant is cooled through the radiator core, and the fan behind the radiator core pulls the cooling air through the core to improve cooling. The radiator is louverless corrugated fin type made from aluminum offering greater cooling performance.

The water pump sucks the coolant from the radiator or from the crankcase, and forces it to the crankcase.

The thermostat is of the wax pellet type, controlling the flow of the coolant to the radiator to keep the proper temperature. As the coolant temperature rises, the wax in the pellet turns liquid and expands, causing the pellet to lower. The valve opens to send the coolant to the radiator.

The radiator cap is of the pressure type providing pressure valve and vacuum valve. When the pressure in the radiator increases, the pressure valve open to reduce the pressure. When the pressure in the radiator becomes negative, the vacuum valve opens and introduce air into the radiator to prevent distortion of the radiator.

[6] FUEL SYSTEM



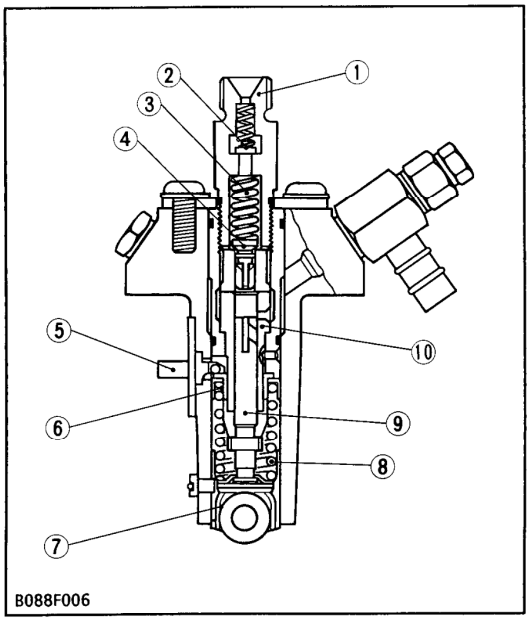
(1) Fuel Tank
(2) Fuel Filter
(3) Fuel Pump
(4) Fuel Filter
(5) Fuel Overflow Pipe
(6) Injection Nozzle
(7) Injection Pipe
(8) Injection Pump

Fuel system consists of a fuel tank (1), fuel filters (2), (4), a fuel pump (3), an injection pump (8) and injection nozzles (6).

When the key switch is turned "**ON**", the fuel pump starts to feed the fuel to the injection nozzle through the filters. The fuel returns to the tank through the overflow pipe (5).

While the engine is running, the injection pump pressure-feeds the fuel to the injection nozzle through the injection pipe, then the fuel is injected to the combustion chamber.

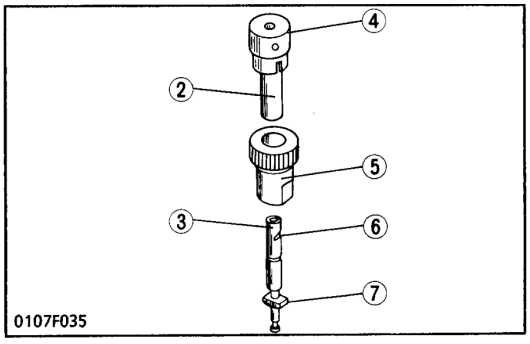
(1) Fuel Injection Pump



The injection pump is a Bosch MD type mini-injection pump, which gives high injection quality even at low engine speed. The plunger (9) is reciprocated by the fuel camshaft through the tappet (7).

The control rack (5) is pushed or pulled by the fork lever of the governor and rotates the control sleeve (6) and the plunger, which has a left-hand lead control groove, to vary the amount of fuel forced into the injection nozzle.

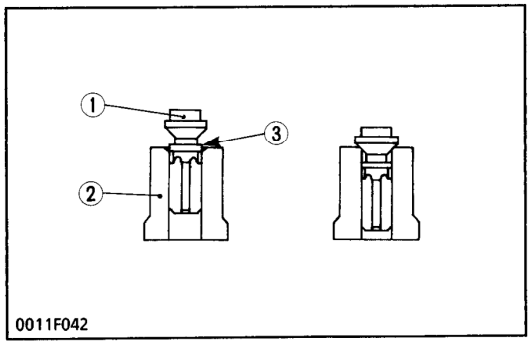
(1) Delivery Valve Holder
(2) Damping Valve
(3) Delivery Valve Spring
(4) Delivery Valve
(5) Control Rack
(6) Control Sleeve
(7) Tappet
(8) Spring
(9) Plunger
(10) Cylinder



■ Pump Element

The pump element is composed of a cylinder (2) and a plunger (3), and their sliding surfaces are precisely finished to generate high pressure even at low speed. The plunger has a slanted groove which is called control groove (6), and a connecting hole called feed hole (4).

(1) Pump Element
(2) Cylinder
(3) Plunger
(4) Feed Hole
(5) Control Sleeve
(6) Control Groove
(7) Driving Face



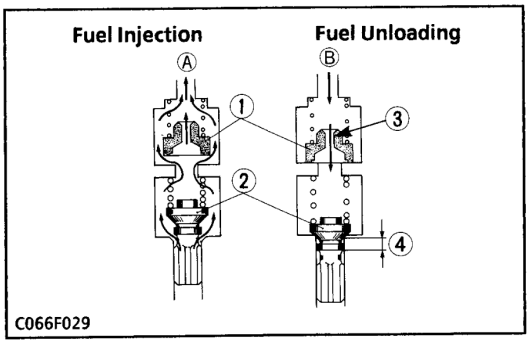
■ Delivery Valve

The delivery valve consists of the valve (1) and the valve seat (2).

The delivery valve prevents the fuel from flowing back into the delivery chamber through the injection pipe. It also prevents the fuel from dribbling at the injection nozzle.

When the delivery stroke ends the relief plunger (3) moves into the bore of the valve seat and seals the delivery line from the delivery chamber. The relief plunger lowers further until the valve seat sucks back the fuel to prevent dribbling at the injection nozzle.

(1) Valve
(2) Valve Seat
(3) Relief Plunger



■ Damping Valve

The damping valve (1) with a ø0.4 mm orifice (3) is provided above the delivery valve (2) to prevent rapid pressure drop at the delivery stroke ends.

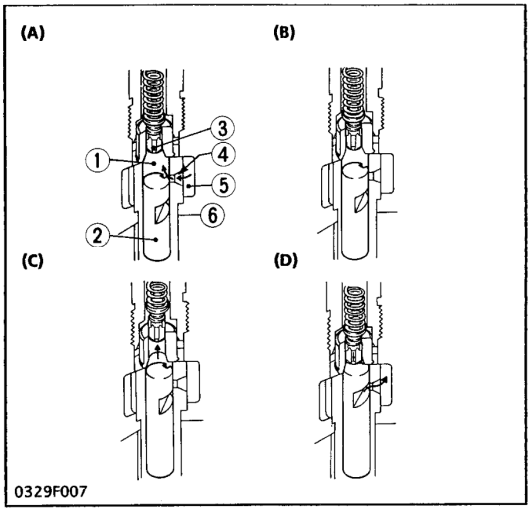
In the fuel injection state, the damping valve rises against the spring force and the fuel is forcibly fed to the nozzle through around the damping valve and its orifice.

When the delivery valve sucks back the fuel after the end of injection, the fuel passes through the orifice only.

Therefore, the pressure drop in the sucks back process is retarded for perfect prevention of secondary injection caused by rapid pressure drop and to improve the nozzle durability.

(1) Damping Valve
(2) Delivery Valve
(3) Orifice
(4) Sucking Back Stroke

[A] To Injection Pipe
[B] From Injection Pipe



■ **Operation of The Pump Element**

(A) Before delivery ------ As the tappet lowers, the plunger (2) lowers and fuel is drawn into the delivery chamber (1) through the feed hole (4) from the fuel chamber (5).

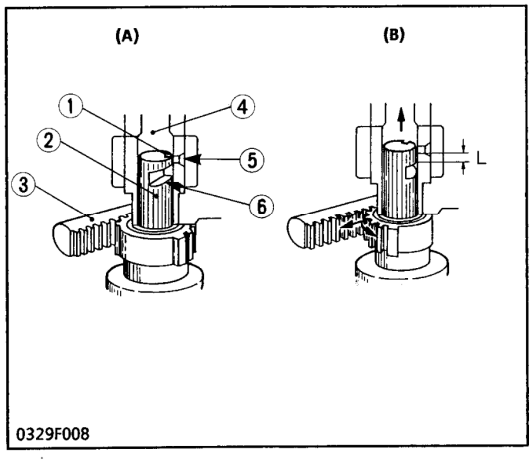
(B) Beginning of delivery ------ When the plunger is pushed up by the cam and the head of the plunger closes the feed hole, the pressure in the delivery chamber rises to push the delivery valve (3) open.

Fuel is then force-fed into the injection pipe.

(C) Delivery ------ While the plunger is rising, delivery of fuel continues.

(D) End of delivery ------ When the plunger rises further and the control groove (6) on its periphery meets the feed hole, the fuel returns to the fuel chamber from the delivery chamber through the control groove and the feed hole.

(1) Delivery Chamber
(2) Plunger
(3) Delivery Valve
(4) Feed Hole
(5) Fuel Chamber
(6) Control Groove



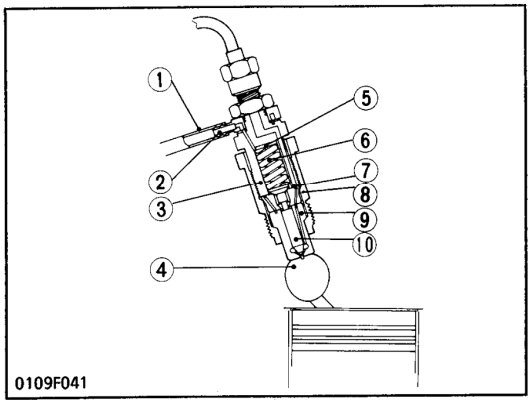
■ **Positions of The Pump Element**

(A) No fuel delivery ----- At the engine stop position of the control rack (3), the lengthwise slot (1) on the plunger (2) aligns with the feed hole (5). The delivery chamber (4) is led to the feed hole during the entire stroke of the plunger, and no fuel is forced to the injection nozzle.

(B) Fuel delivery ----- The plunger is rotated (See figure) by the control rack and the feed hole is not aligned with the lengthwise slot. When the plunger is pushed up, the feed hole is closed by the plunger. The pressure in the delivery chamber builds up and forces the fuel to the injection nozzle until the control groove (6) meets the feed hole. The amount of the fuel to be forced into the nozzle corresponds to the distance "**L**".

(1) Slot
(2) Plunger
(3) Control Rack
(4) Delivery Chamber
(5) Feed Hole
(6) Control Groove

(2) Injection Nozzle



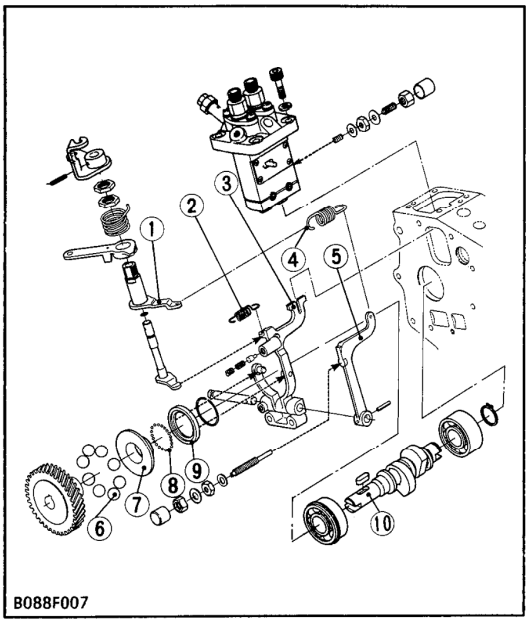
The nozzle is of the throttle type. The needle valve (10) is pushed against the nozzle body (9) by the nozzle spring (6) with the push rod (7).

The fuel forced from the injection pump pushes up the needle valve and is injected into the sub-combustion chamber (4). The excessive fuel which is not injected returns through the center chamber of the nozzle holder and the eye joint (2) to the fuel tank.

The injection pressure can be adjusted with the adjusting washer (5).

(1) Fuel Overflow Pipe
(2) Eye joint
(3) Nozzle Holder Body
(4) Sub-combustion Chamber
(5) Adjusting Washer
(6) Nozzle Spring
(7) Push Rod
(8) Retaining Nut
(9) Nozzle Body
(10) Needle Valve

(3) Governor



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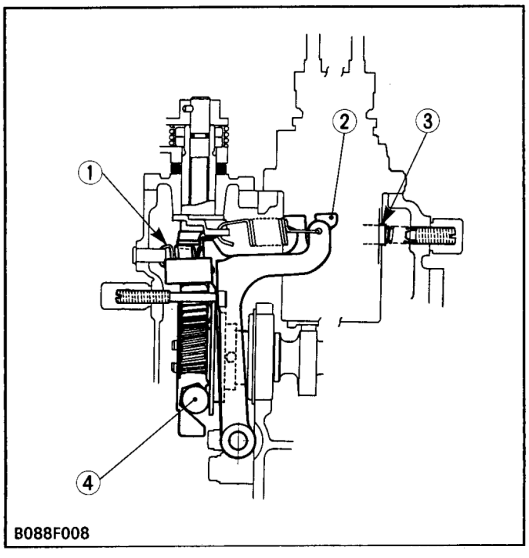
The governor controls the amount of the fuel to be fed in the entire speed range to prevent the engine from changing its speed according to the load.

The fork lever 1 (3) is held where two forces on it are balanced. One is the force that fork lever 2 (5) pushes, which is caused by the tension of the governor spring (4) between the governor lever (1) and fork lever 2 (5). Another is the component of the centrifugal force produced by the steel balls (6) which are rotated by the fuel camshaft (10).

(1) Governor Lever
(2) Start Spring
(3) Fork Lever 1
(4) Governor Spring
(5) Fork Lever 2
(6) Steel Ball
(7) Governor Sleeve
(8) Steel Ball
(9) Governor Ball Case
(10) Fuel Camshaft



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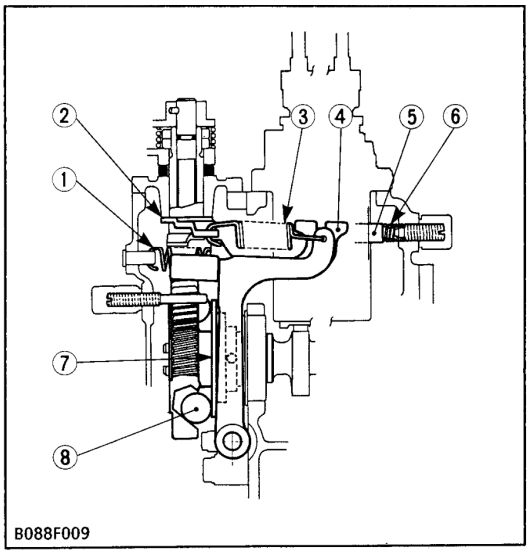
■ At start

The steel ball (4) has no centrifugal force.

Fork lever 1 (2) is pulled by the start spring (1) and the control rack (3) moves to the maximum injection position for easy starting.

(1) Start Spring
(2) Fork Lever 1
(3) Control Rack
(4) Steel Ball



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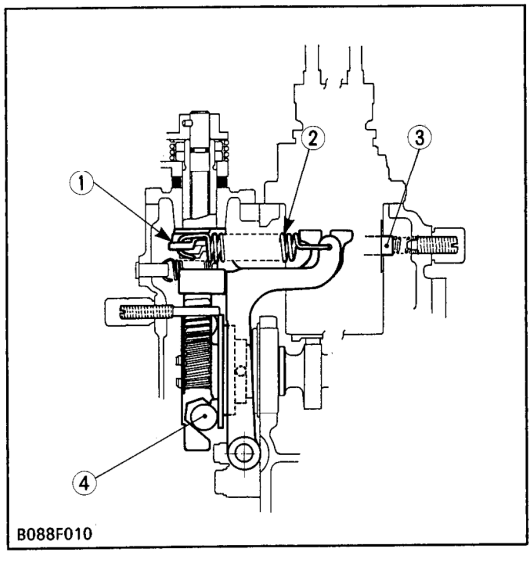
■ **At idling**

When the speed control lever (2) is set at the idling position, the governor spring (3) is pulled slightly.

As the camshaft rotates, the steel balls (8) increase their centrifugal force and push the governor sleeve (7). Fork lever 1 (4) pushed by the governor sleeve, pushes the control rack (5) and the control rack compresses the idling adjust spring (6).

The control rack is kept at a position where the centrifugal force is balanced with the spring tension on the control rack providing stable idling.

(1) Start Spring
(2) Speed Control Lever
(3) Governor Spring
(4) Fork Lever 1
(5) Control Rack
(6) Idling Adjust Spring
(7) Governor Sleeve
(8) Steel Ball



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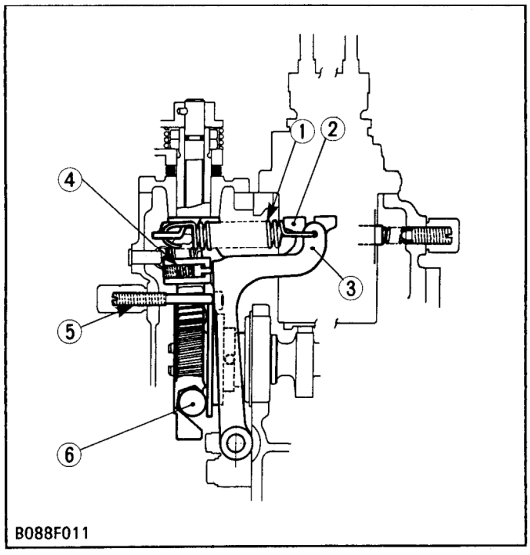
■ **At medium or high speed running**

When the speed control lever (1) is turned further, the governor spring (2) increases the tension and the control rack (3) is pulled to increase the engine speed.

The steel balls (4) increase their centrifugal force and the control rack is pushed, decreasing the engine speed, until the centrifugal force and the spring tension are balanced.

When the engine speed is dropped with the increase of the load, the centrifugal force of the steel ball decreases and the control rack is pulled. The amount of the fuel to the injection nozzle is increased to produce a higher engine torque required for the load.

(1) Speed Control Lever
(2) Governor Spring
(3) Control Rack
(4) Steel Ball



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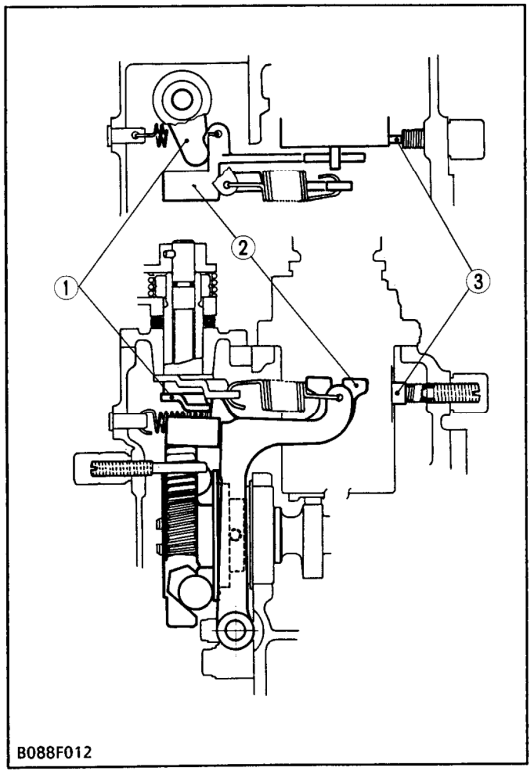
■ **At maximum speed running with an overload**

When the engine is overloaded at the high speeds and the engine speed drops, the centrifugal force of the steel balls (6) decreases and the governor spring (1) pulls fork lever 1 (2) and 2 (3).

When fork lever 2 contacts the adjusting screw (5), the spring (4) which is built in fork lever 2 begins to push the fork lever 1 to pull the control rack.

The fuel to the injection nozzle is increased to run the engine at high speed and torque.

(1) Governor Spring
(2) Fork Lever 1
(3) Fork Lever 2
(4) Spring
(5) Adjusting Screw
(6) Steel Ball



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■ **To stop the engine**

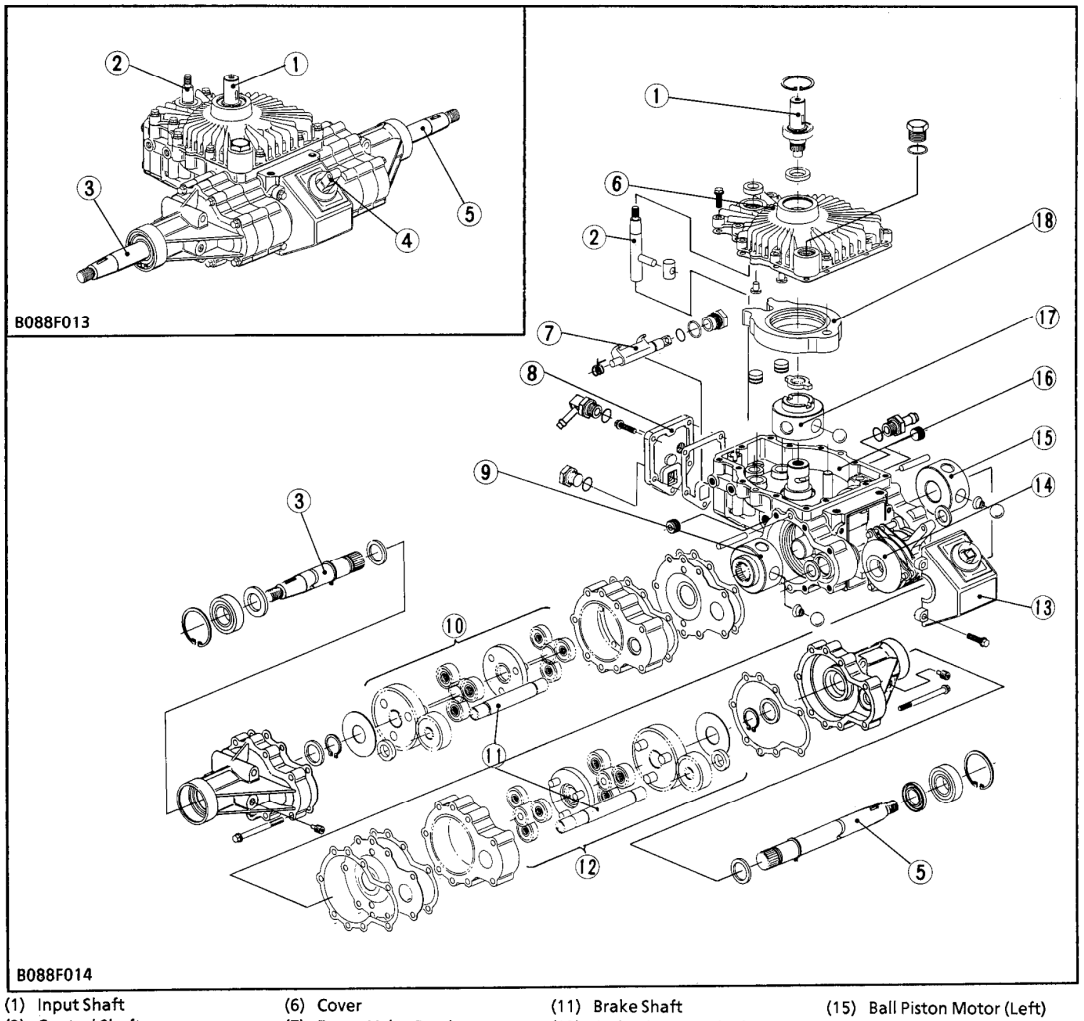
When the stop lever (1) is moved to the stop position, fork lever 1 (2) is pushed and the control rod (3) is moved to stop the fuel injection.

(1) Stop Lever
(2) Fork Lever 1
(3) Control Rod

2 TRANSMISSION

[1] HYDROSTATIC TRANSAXLE

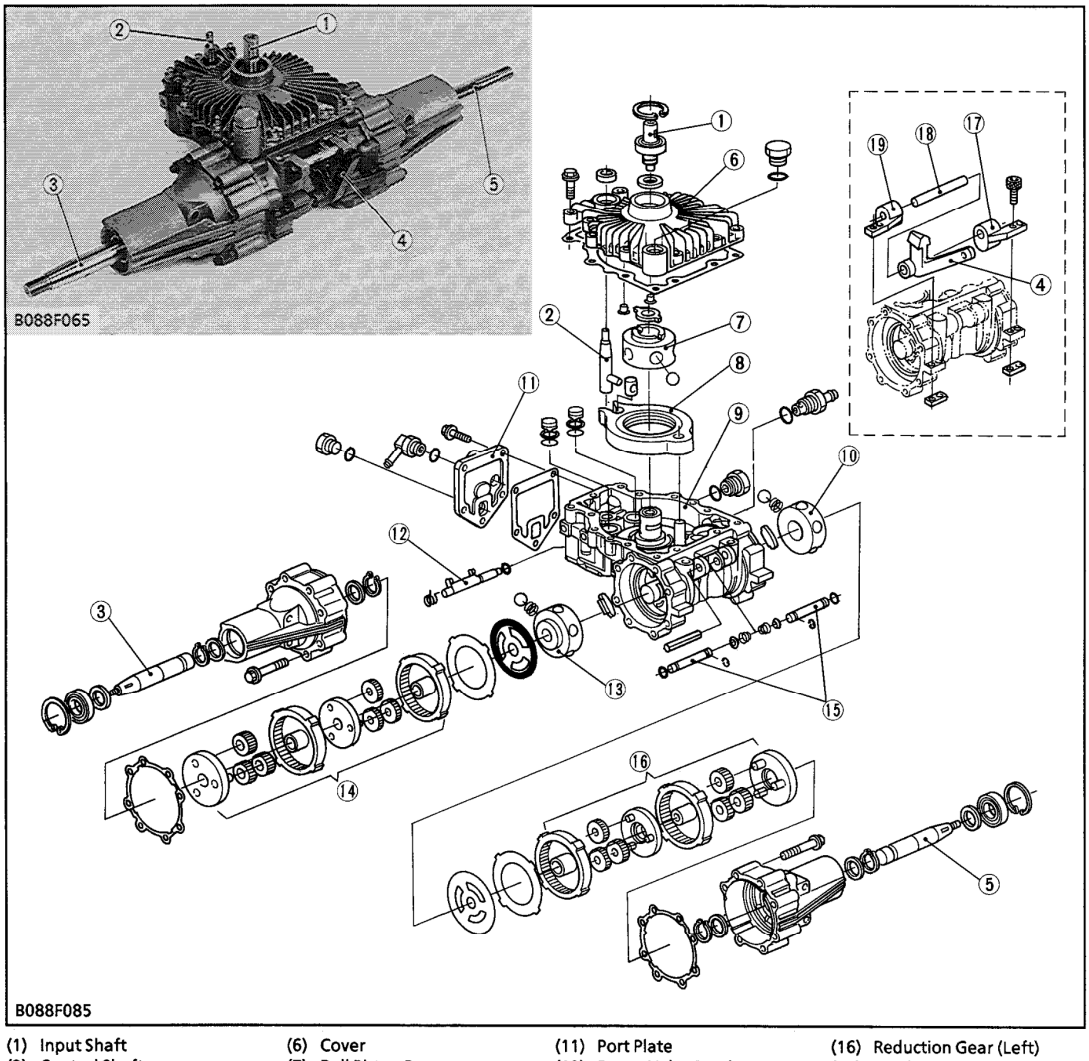
[Vehicle Serial No. : Up to 49999]



(1) Input Shaft
(2) Control Shaft
(3) Rear Axle (Right)
(4) Brake Lever
(5) Rear Axle (Left)
(6) Cover
(7) Dump Valve Bracket
(8) Port Plate
(9) Ball Piston Motor (Right)
(10) Reduction Gear (Right)
(11) Brake Shaft
(12) Reduction Gear (Left)
(13) Brake Cover
(14) Brake Assembly
(15) Ball Piston Motor (Left)
(16) Housing
(17) Ball Piston Pump
(18) Cam Ring

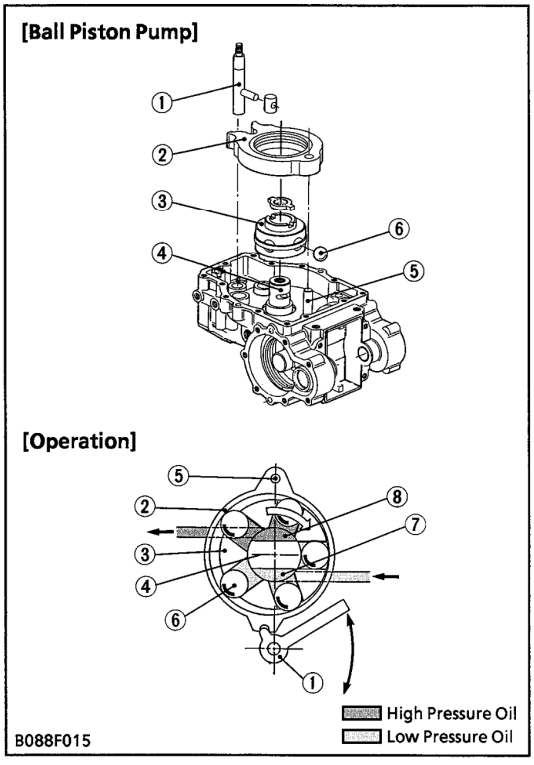
T1600H is installed with Eaton's hydrostatic transaxle for easy changeover between forward and reverse travelings and speed control by one foot pedal. Clutch operation and shift lever operation are unnecessary. The hydrostatic transaxle, in its compact package, has the hydrostatic transmission, rear axle case with reduction gear and parking brake mechanism. The hydrostatic transmission block adopts a simple design consisting of one ball piston pump and two ball piston motors, attaining excellent durability requiring least maintenance.

[Vehicle Serial No. : 50001 and Above]



(1) Input Shaft
(2) Control Shaft
(3) Rear Axle (Right)
(4) Brake Lever
(5) Rear Axle (Left)
(6) Cover
(7) Ball Piston Pump
(8) Cam Ring
(9) Housing
(10) Ball Piston Motor (Left)
(11) Port Plate
(12) Dump Valve Bracket
(13) Ball Piston Motor (Right)
(14) Reduction Gear (Right)
(15) Push Rod
(16) Reduction Gear (Left)
(17) Bracket
(18) Brake Shaft
(19) Bracket

(1) Ball Piston Pump



The ball piston pump driven by the input shaft is of the variable displacement type in which the delivery rate and direction are changed by the cam ring.

The ball piston pump consists of pump shaft (4) having two ports (7), (8), pump rotor (3) having five ball pistons (6) installed on the pump shaft, and cam ring (2) whose position around the pump rotor is changed by the speed control pedal operation.

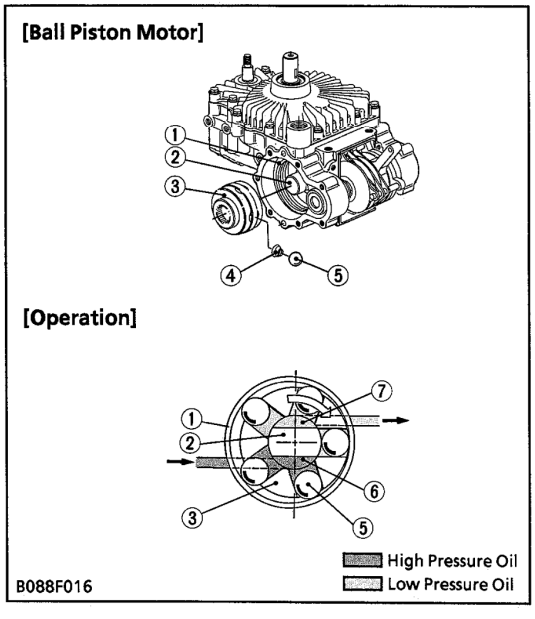
When the input shaft drives the pump rotor, the ball pistons move along the inner circumference of the cam ring because of the centrifugal force.

When the cam ring is in an eccentric position as against the pump rotor, ball pistons also move in the up and down direction as against the cylinder to effect oil suction and discharge through two ports on the pump shaft.

Speed control pedal operation causes control shaft (1) to be rotated via the link mechanism to oscillate the cam ring around fulcrum (5). As a result, the cam ring is placed concentrically or eccentrically with the rotor. As the cam ring eccentricity increases, the oil suction and discharge rates increase.

(1) Control Shaft
(2) Cam Ring
(3) Pump Rotor
(4) Pump Shaft
(5) Fulcrum
(6) Ball Piston
(7) Port
(8) Port

(2) Ball Piston Motor



Two fixed displacement type ball piston motors are provided.

Each motor is driven by the oil fed under pressure from the pump to drive the rear axle LH or RH.

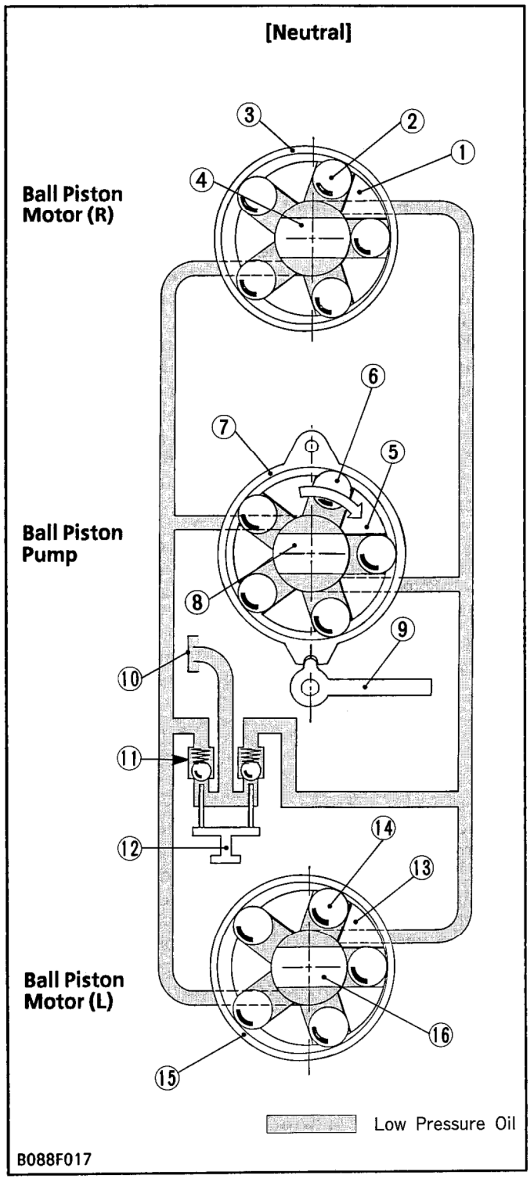
Each ball piston motor consists of motor shaft (2) having two ports (6), (7), motor rotor (3) having five ball pistons (5) and installed on the motor shaft, and motor race (1) installed eccentrically with the motor rotor to limit the ball piston movement.

When the oil fed under pressure from the ball piston pump enters the cylinder through port (6) on the motor shaft, ball pistons are pushed in the direction to increase the cylinder capacity, the motor rotor starts rotation in the direction of the arrow in the illustration.

The motor rotor revolving speed increases as the incoming oil flow rate increases. When the oil inlet port is reversed, the motor rotor revolving direction is reversed.

(1) Motor Race
(2) Motor Shaft
(3) Motor Rotor
(4) Spring
(5) Ball Piston
(6) Port
(7) Port

(3) Oil Flow



Each two ports of the ball piston motor (R) and (L) and the ball piston pump are connected to form a closed oil circuit as illustrated.

■ Neutral

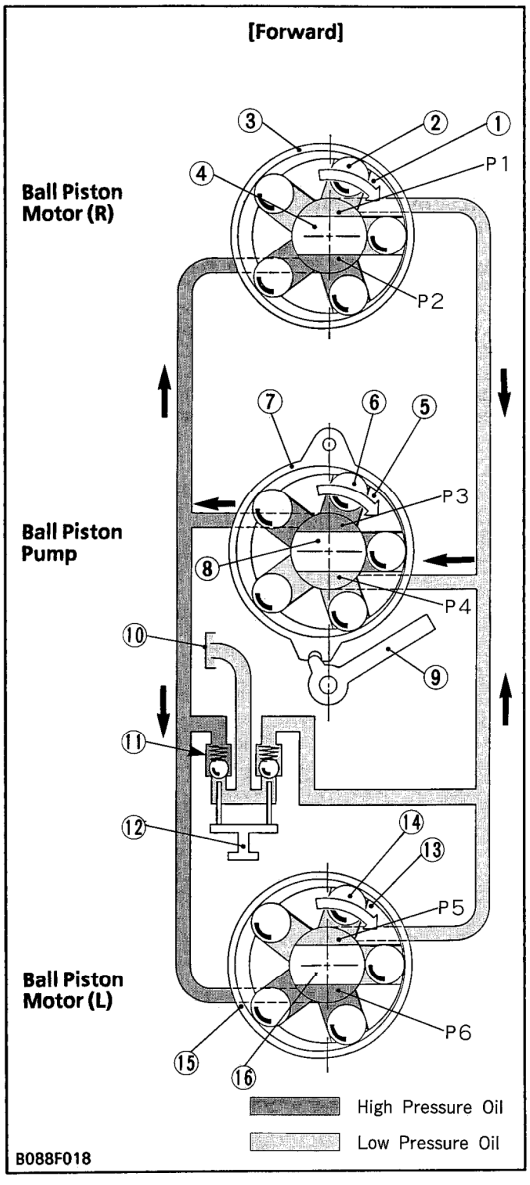
When the speed control pedal is in its neutral position, control shaft (9) sets cam ring (7) concentrically with the pump rotor (5) to effect no oil delivery when the pump rotor rotates. Therefore no oil pressure generates in the oil circuit to keep ball piston motors stopped to cause no traveling.

■ By-pass Lever

When the engine is stopped or in the neutral state, ball piston motors (R), (L) are locked to effect rear wheel braking because of the closed oil circuit.

Operating by-pass lever (12) opens the check valve (11) to free ball piston motors, enabling the vehicle to be moved by manual pushing.

(1) Motor Rotor (R)
(2) Ball Piston
(3) Motor Race (R)
(4) Motor Shaft (R)
(5) Pump Rotor
(6) Ball Piston
(7) Cam Ring
(8) Pump Shaft
(9) Control Shaft
(10) Oil Tank
(11) Check Valve
(12) By-pass Lever
(13) Motor Rotor (L)
(14) Ball Piston
(15) Motor Race (L)
(16) Motor Shaft (L)

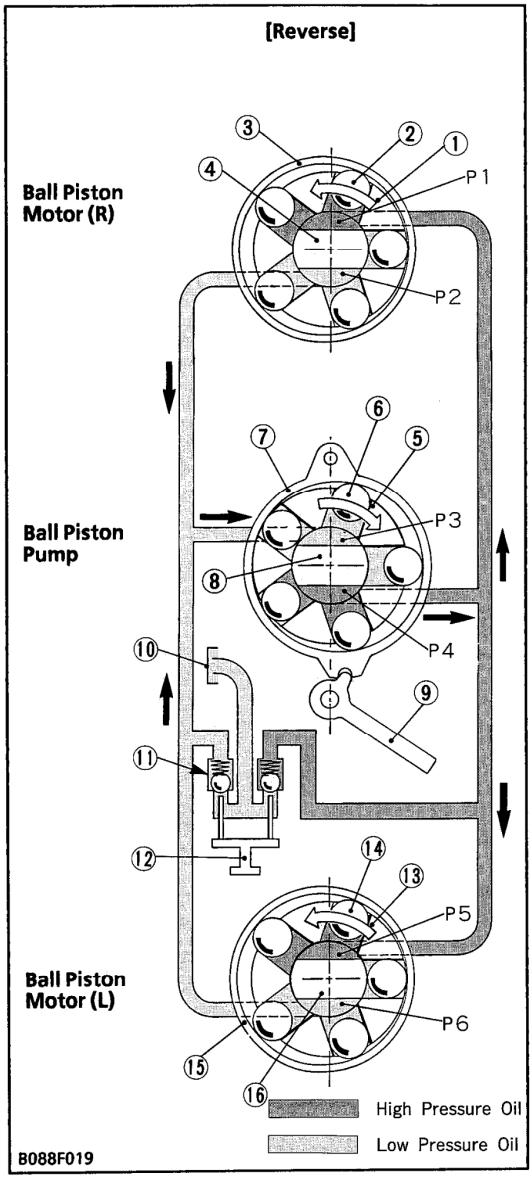


■ **Forward**

When the speed control lever is operated in the forward direction, control shaft (9) sets cam ring (7) eccentrically with pump rotor (5). Pressurized oil fed through the **P3** port flows to ball piston motors (R) and (L) through the **P2** and **P6** ports to drive the motors (R) and (L) for forward traveling of the vehicle.

As the speed control pedal movement increases, the cam ring eccentricity and the resultant pump discharge rate increase to increase the traveling speed.

(1) Motor Rotor (R)
(2) Ball Piston
(3) Motor Race (R)
(4) Motor Shaft (R)
(5) Pump Rotor
(6) Ball Piston
(7) Cam Ring
(8) Pump Shaft
(9) Control Shaft
(10) Oil Tank
(11) Check Valve
(12) By-pass Lever
(13) Motor Rotor (L)
(14) Ball Piston
(15) Motor Race (L)
(16) Motor Shaft (L)



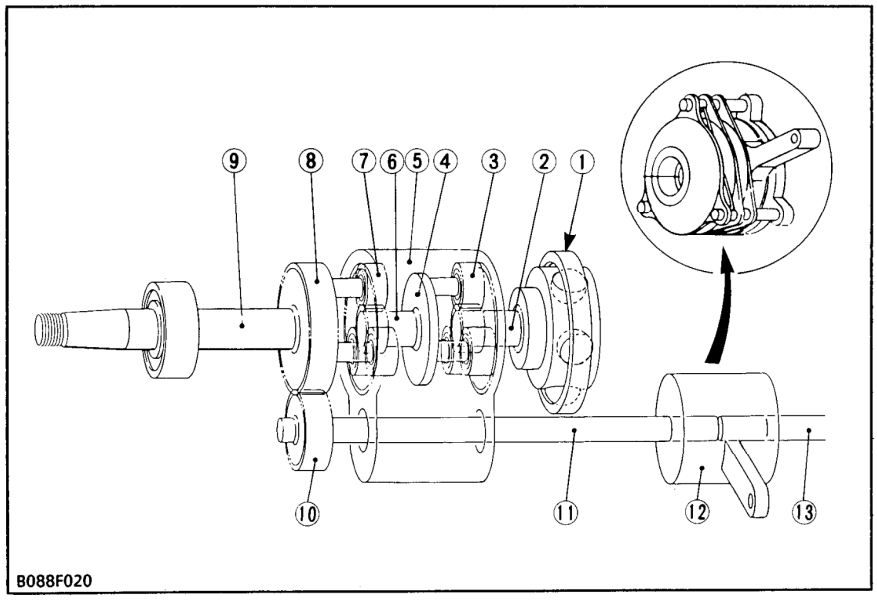
■ **Reverse**

When the speed control pedal is operated in the reverse direction, control shaft (9) sets cam ring (7) eccentrically with pump rotor (5) in the direction opposite to that for forward traveling.

The pressurized oil is fed through the **P4** port and flows through the **P1** and **P5** ports to the ball piston motor (R) and (L). As a result, ball piston motors (R) and (L) rotate in the reverse direction to cause reverse traveling of the vehicle.

(1) Motor Rotor (R)
(2) Ball Piston
(3) Motor Race (R)
(4) Motor Shaft (R)
(5) Pump Rotor
(6) Ball Piston
(7) Cam Ring
(8) Pump Shaft
(9) Control Shaft
(10) Oil Tank
(11) Check Valve
(12) By-pass Lever
(13) Motor Rotor (L)
(14) Ball Piston
(15) Motor Race (L)
(16) Motor Shaft (L)

(4) Reduction Gear and Parking Brake (Vehicle Serial No. : Up to 49999)



(1) Ball P iston Motor (L)
(2) 1st Sun Gear
(3) 1st Planetary Gear
(4) 1st Carrier
(5) Ring Gear
(6) 2nd Sun Gear
(7) 2nd Planetary Gear
(8) 2nd Carrier
(9) Rear Axle (L)
(10) Brake Gear
(11) Brake Shaft (L)
(12) Brake Assembly
(13) Brake Shaft (R)

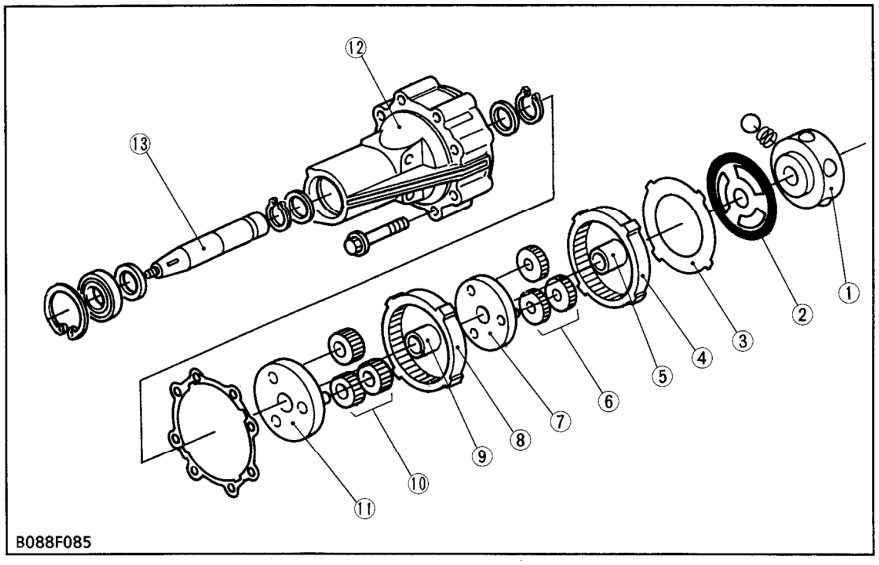
The revolving speed of ball piston motor (1) is reduced by the reduction gear system consisting of two stages of planetary gears and ring gear (5), then transmitted to rear axle (9).

The transmission sequence is as follows:

Ball piston motor (1) → 1st sun gear (2) → 1st planetary gear (3) → 1st carrier (4) → 2nd sun gear (6) → 2nd planetary gear (7) → 2nd carrier (8) → Rear axle (9)

The rotation of the 2nd carrier is also transmitted to brake assembly (12) through brake gear (10) and brake shaft (11). This brake assembly is for parking brake. The brake disc in the brake assembly is locked when the brake pedal is depressed.

(5) Reduction Gear (Vehicle Serial No. : 50001 and Above)

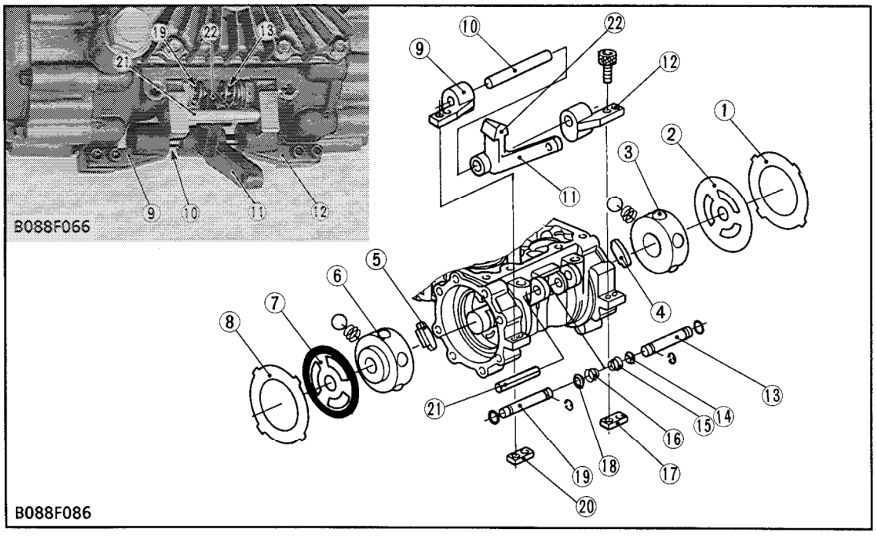


(1) Ball Piston Motor
(2) Reaction Plate
(3) Backup Plate
(4) 1st Ring Gear
(5) 1st Sun Gear
(6) 1st Planetary Gear
(7) 1st Carrier
(8) 2nd Ring Gear
(9) 2nd Sun Gear
(10) 2nd Planetary Gear
(11) 2nd Carrier
(12) Axle Housing
(13) Axle Shaft

The revolving speed of ball piston motor (1) is reduced by the reduction gear system consisting of two stages of planetary gears and ring gears, then transmitted to axle shaft (13).

The transmission sequence is as follows :
Ball piston motor (1) → 1st sun gear (5) → 1st planetary gear (6) → 1st carrier (7) → 2nd sun gear (9) → 2nd planetary gear (10) → 2nd carrier (11) → Axle shaft (13)

(6) Parking Brake (Vehicle Serial No. : 50001 and Above)



(1) Backup Plate (L)
(2) Reaction Plate (L)
(3) Ball Piston Motor (L)
(4) Friction Pad (L)
(5) Friction Pad (R)
(6) Ball Piston Motor (R)
(7) Reaction Plate (R)
(8) Backup Plate (R)
(9) Bracket (R)
(10) Shaft
(11) Brake Lever
(12) Bracket (L)
(13) Push Rod (L)
(14) Spring Base (L)
(15) Spring (L)
(16) Spring (R)
(17) Threaded Plate (L)
(18) Spring Base (R)
(19) Push Rod (R)
(20) Threaded Plate (R)
(21) Spring Pin
(22) Wedge Shaped Portion

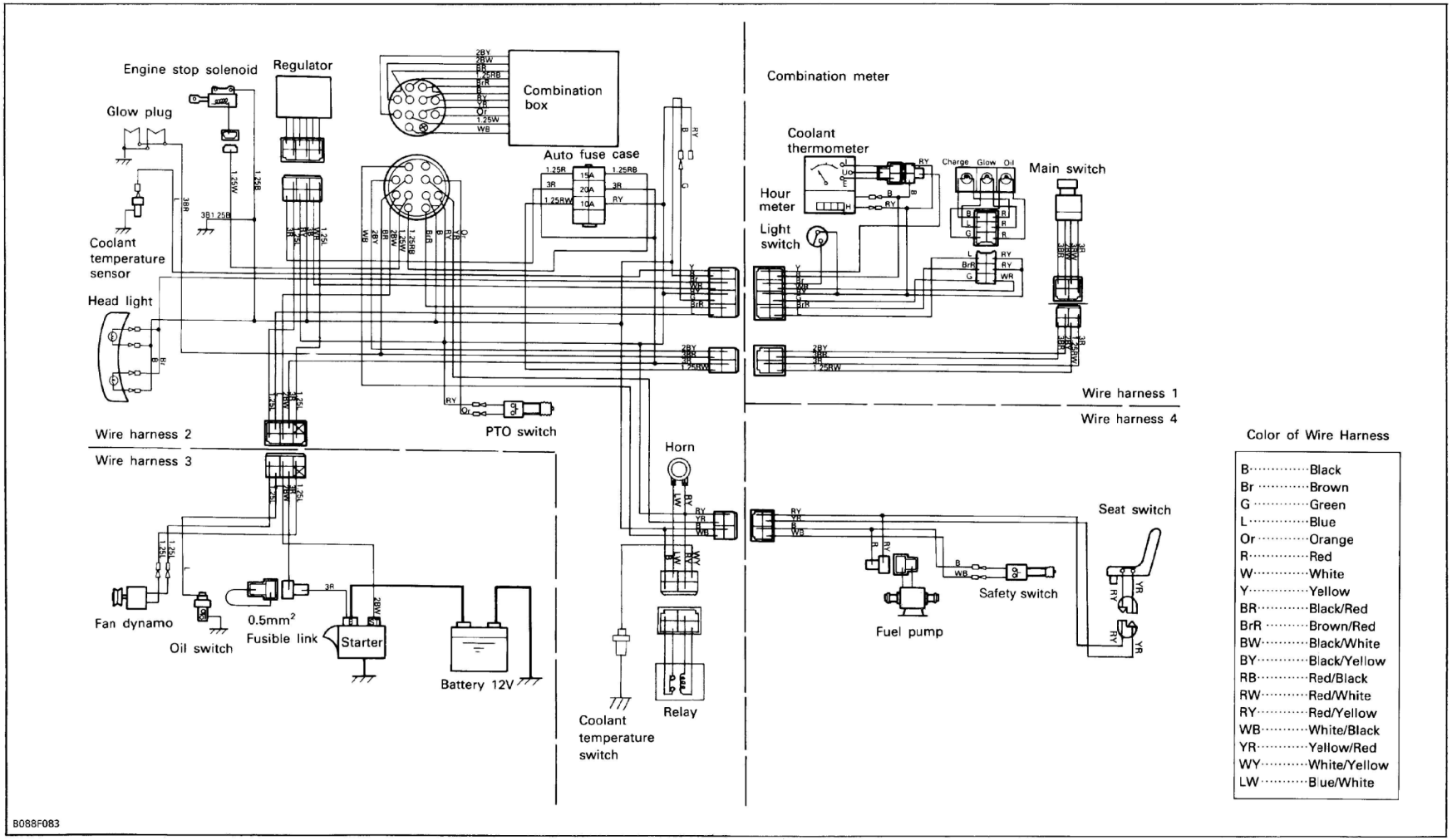
When the brake pedal is depressed, the force is conveyed through the linkage to the brake lever (11), which is rocked around the shaft (10).

Now the wedge shaped portion (22) of the brake lever presses the push rods (13) and (19) against the springs (15) and (16). the push rods are thus forced into the housing.

As a result, the friction pads (4) and (5) in the housing are pressed by the push rods into contact with the ball piston motors (3) and (6) in order to produce the braking force between the backup plates (1), (8) and the reaction plates (2), (7).

3 ELECTRICAL SYSTEM

[1] WIRING DIAGRAM AND ELECTRICAL CIRCUIT



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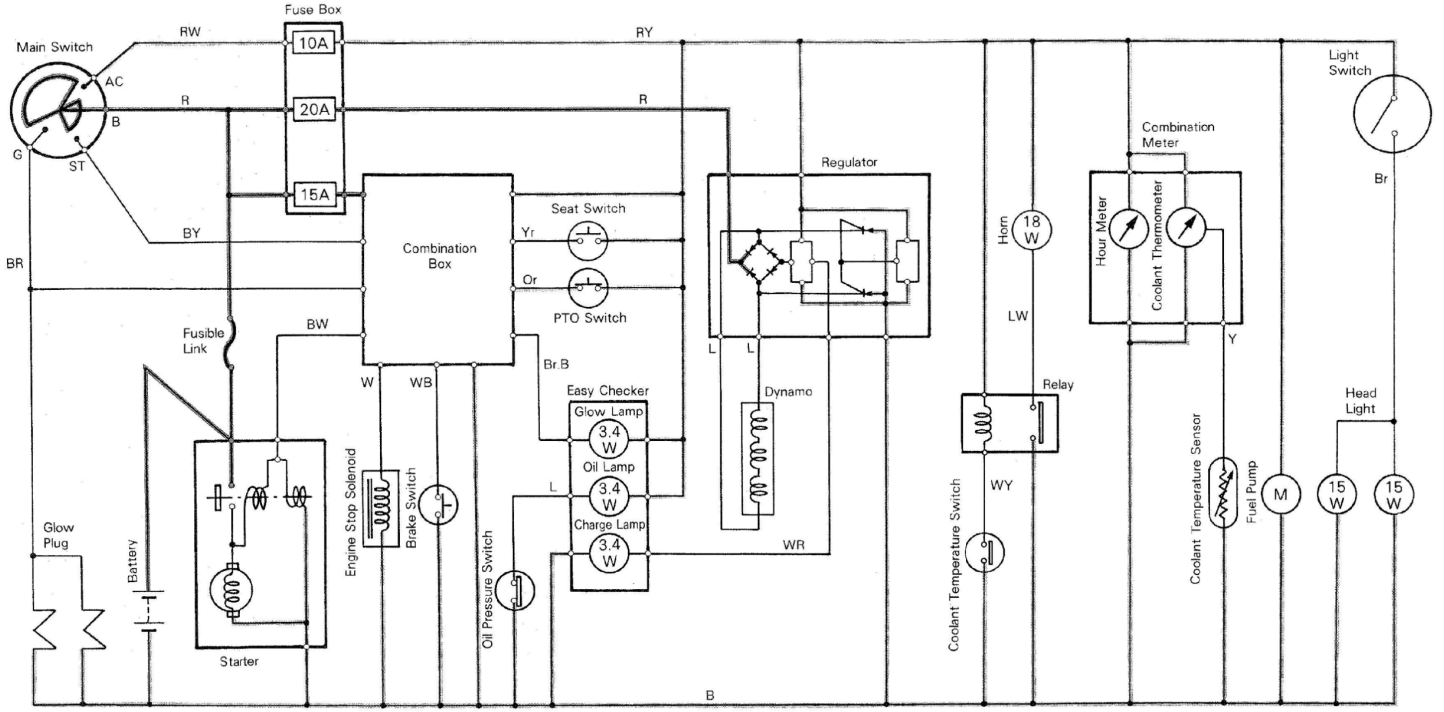
- **Main Switch Table**

Terminal / Key Position	B	AC	G	ST
OFF	●			
ON	●	●		
PREHEAT	●	●	●	
START	●	●	●	●



Denotes battery voltage at any position of main switch
Denotes battery voltage when turning on main switch **"ON"** position
Denotes ground line

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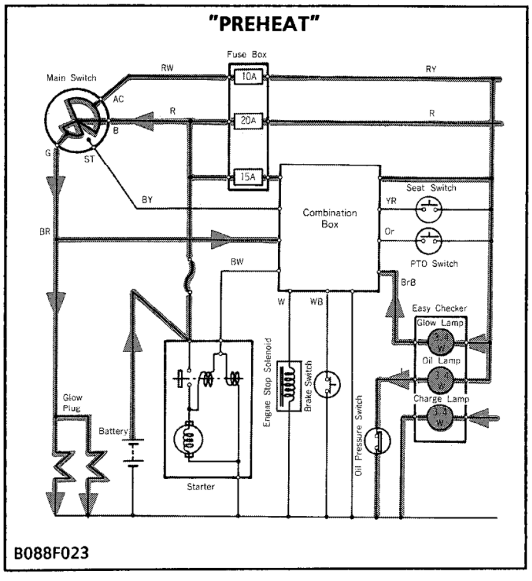
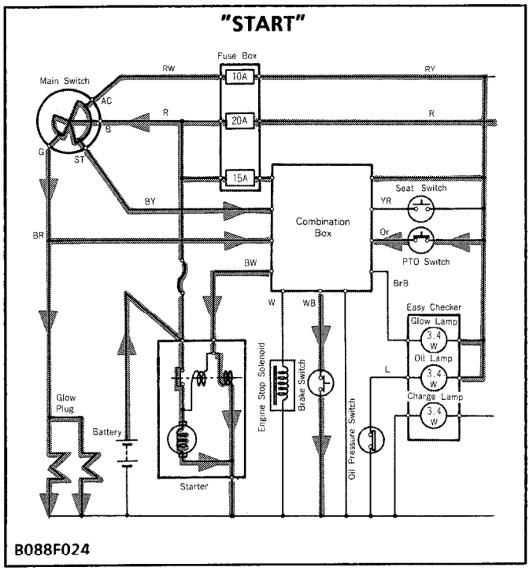
[2] STARTING SYSTEM

(1) Starting Circuit



When the main switch is turned to the **"PREHEAT"** position, terminal **B** is connected to terminal **AC** and **G**. The glow plug becomes hot. Electric current flows to the combination box through the glow lamp, and the glow lamp lights for 5 seconds by the timer relay in the combination box.



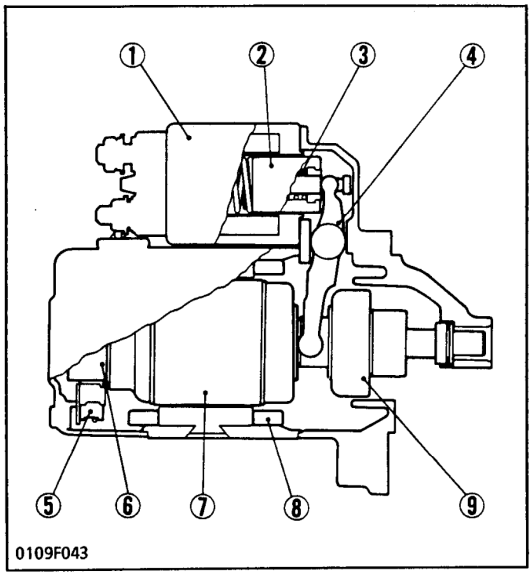
When the main switch is turned to the **"START"** position, terminal **B** is connected to terminal **AC, G** and **ST**. Electric current flows to the combination box from terminal **ST**.

Under the following condition, a start signal flows to the starter and starts the engine.

Starting condition

- Brake switch is **"ON"** (Brake pedal is depressed).
- PTO switch is **"ON"** (PTO lever **"DISENGAGE"**).

(2) Starter

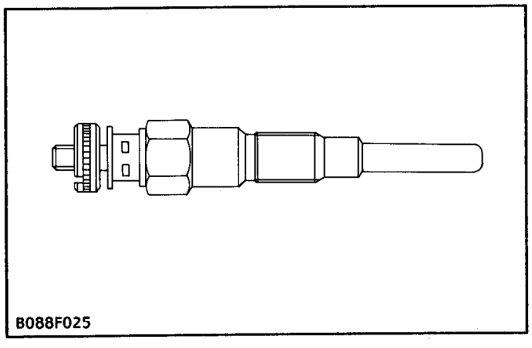


The starter is of the electromagnetic drive type.

Type of motor	DC, Series-wound, Electromagnetic drive
Nominal voltage	12 V
Nominal output	0.7 kW
Time rating	30 seconds (Do not rotate continuously for longer periods.)
Direction of rotation	Clockwise as viewed from pinion side

(1) Solenoid Switch
(2) Plunger
(3) Spring
(4) Shift Lever
(5) Brush
(6) Commutator
(7) Armature
(8) Field Coil
(9) Overrunning Clutch

(3) Glow Plug



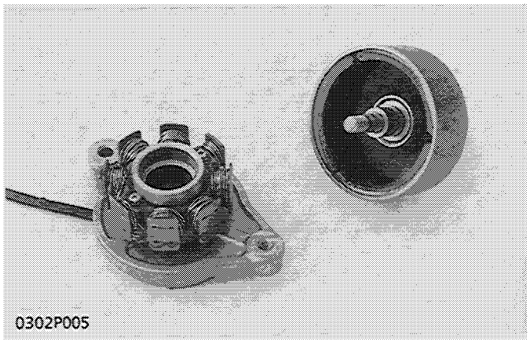
The glow plugs are used for each sub-combustion chamber of the cylinder head.

The glow plugs are of the quick-heating type, which makes starting easier with short preheating time.

- Rated Voltage ------ DC 11 V
- Temperature ------- more than 800°C (1472°F) / 6 sec.

[3] CHARGING SYSTEM

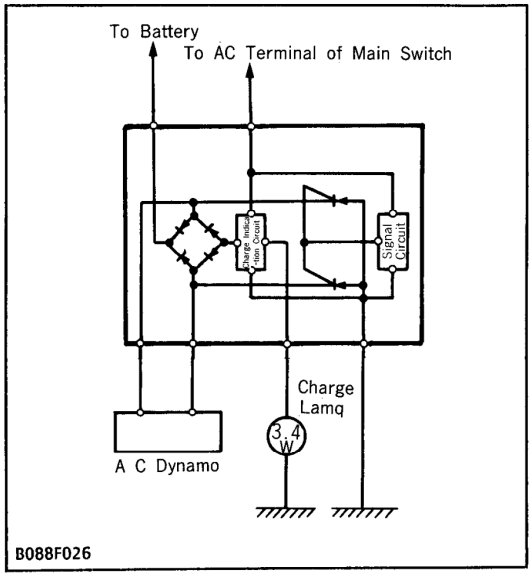
(1) AC Dynamo



This dynamo is an 8-8 pole rotating magnet type generator.

It is simple is construction, consisting of a stator and rotor. The rotor is made up of eight permanent magnet pole pieces assembled on a shaft and rotates on the center of the stator around which eight electro-magnetic coils are provided for. This dynamo produces higher voltage in slow speed rotation, and charges electric current to the battery during engine idling. Accordingly, there is no fear of battery failure.

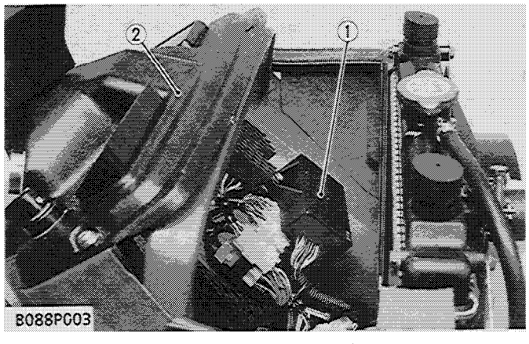
(2) Regulator



This regulator has following functions.

1. When battery voltages low, the signal circuit turns the SCR on to form a charging circuit to the battery.
2. When the battery voltage rises and reaches the specified value, the signal circuit turns the SCR off, cutting the current to the dynamo. As a result, the dynamo does not over-charge the battery.
3. During charging, the charge indication circuit extinguishes the battery charge lamp.

[4] COMBINATION BOX



(1) Combination Box (2) Dashboard

This combination box has relays and timers for starting and stopping the engine.
The combination box has following functions.

1. **Starting Control**
   The combination box sends a starting signal to the starter when the main switch is turned to the **"START"** position, under the condition that the brake switch is **ON** (depressed) and the PTO switch is **ON** (disengaged).
2. **Glow Lamp Control**
   The combination box lights the glow lamp for 5 seconds when the main switch is turned to the **"PREHEAT"** position.
3. **Engine Stop Control**
   The combination box sends an electric signal to the engine stop solenoid for 8 seconds under the following conditions.
   - The main switch is turned to the **"OFF"** position.
   - PTO switch is turned to **OFF** (engaged) while the seat switch is **OFF** (operator is not on the seat).
   - Seat switch is turned to **OFF** (operator leaves the seat) while the PTO switch is **OFF** (engaged).