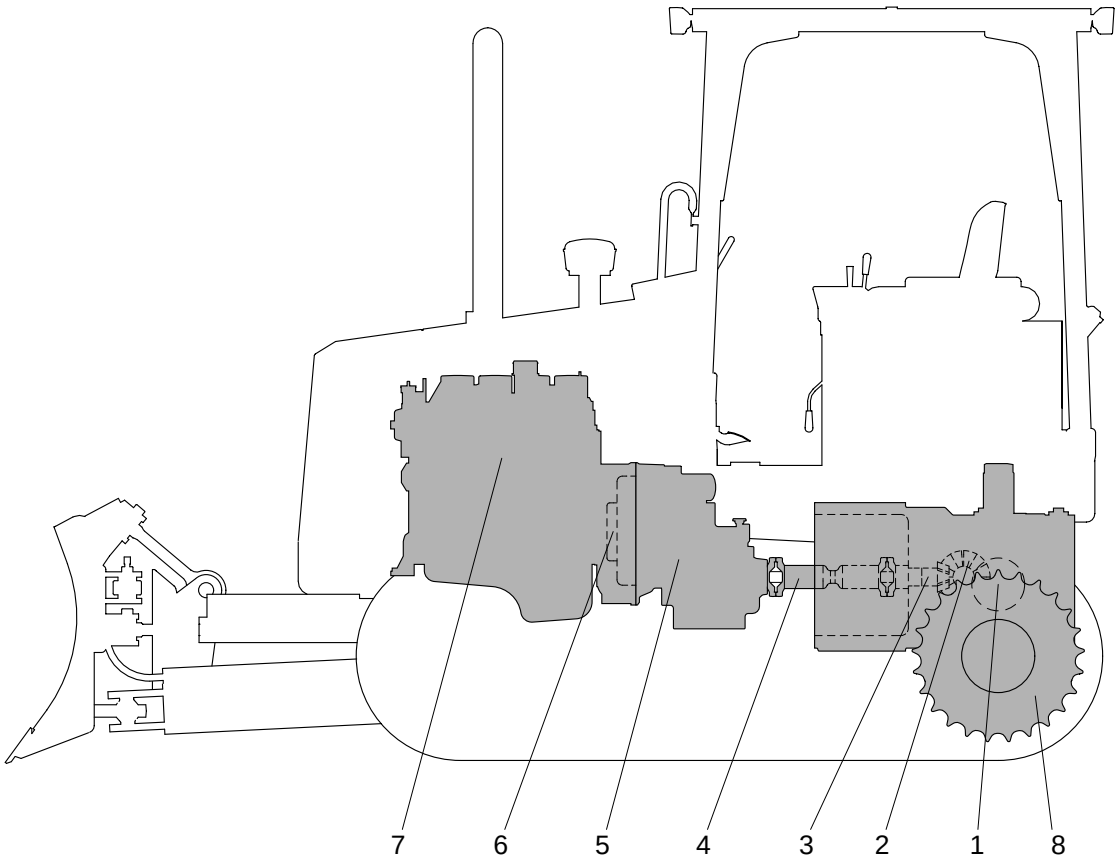
SECTION 3 POWER TRAIN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. POWER TRAIN COMPONENT OVERVIEW

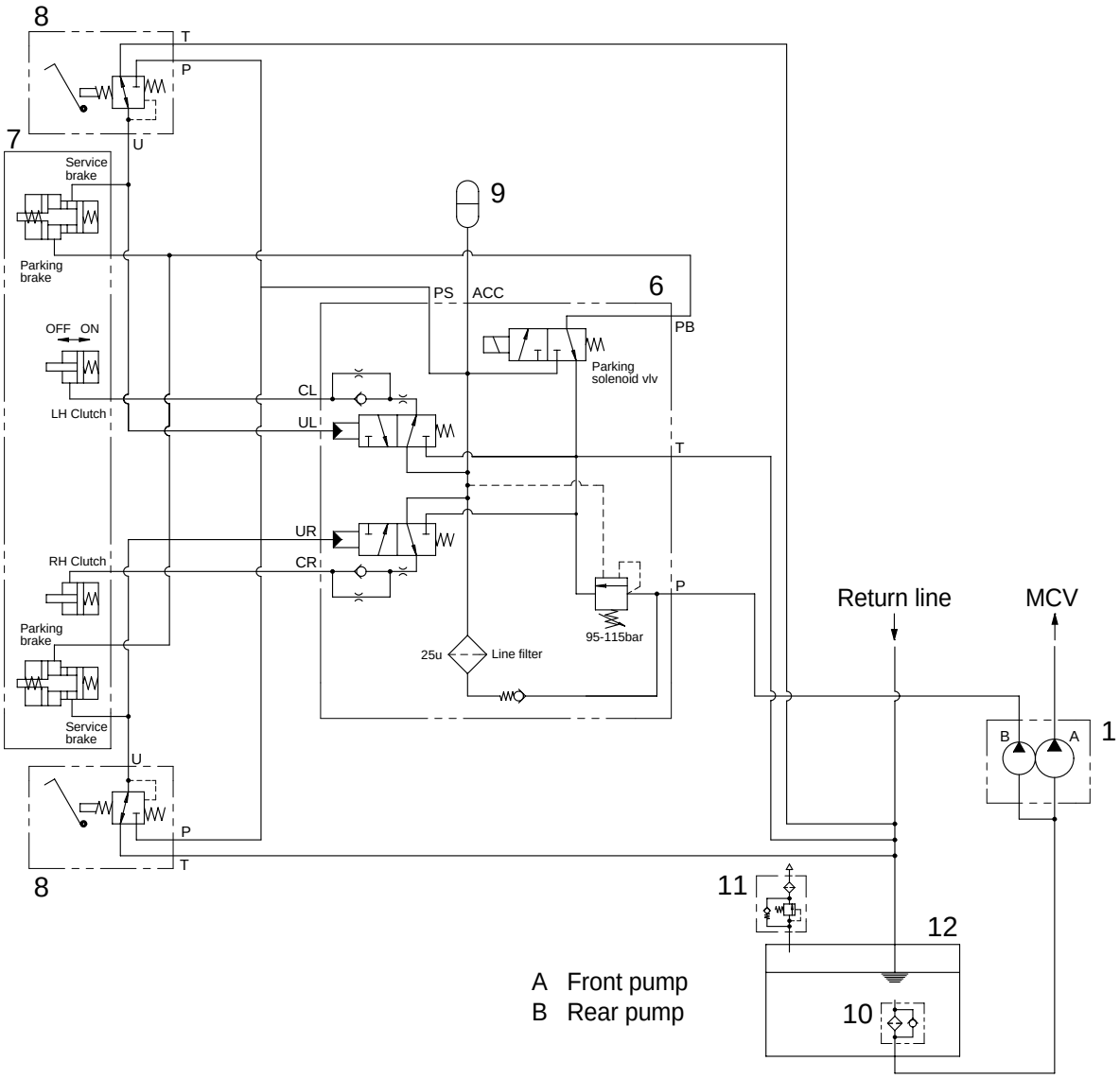


Power from diesel engine(7) is sent from the engine to torque converter(6). The output shaft of the torque converter sends the power to transmission(5). Transmission(5) has five hydraulically activated clutches that give three speeds FORWARD and three speeds REVERSE. Speed and direction are both manually selected.

Power from the transmission flows through drive shaft(4) then to bevel pinion(3). The bevel pinion sends the power to bevel gear(2). The power then flows through steering clutches(1), final drives, and sprockets(8) to the tracks.

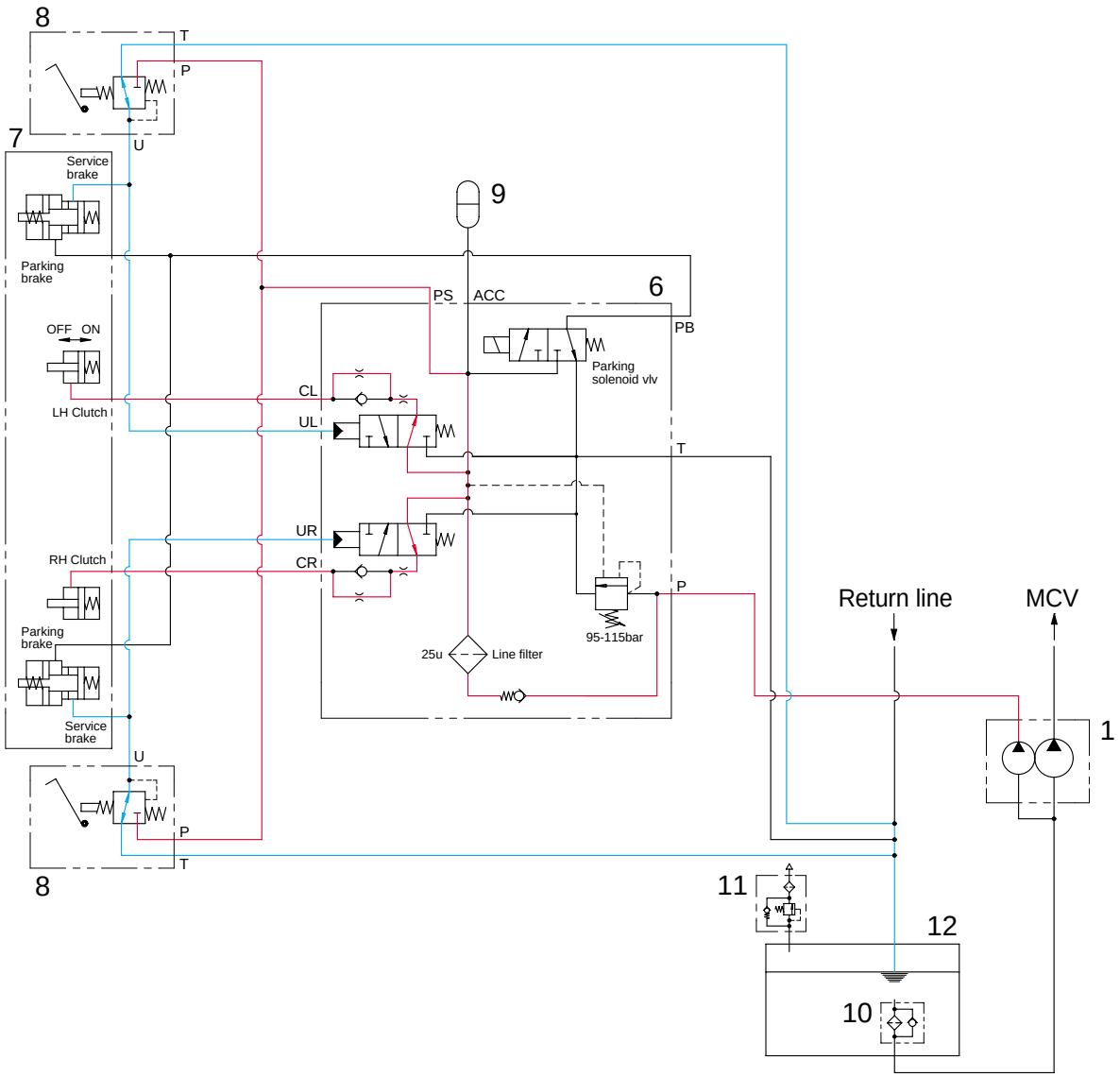
The bevel gear, bevel pinion and steering clutches are in the steering clutch and bevel gear case. The steering clutches are hydraulically controlled. The service brakes are hydraulically controlled by the operator. The steering clutches are used to turn the machine. The service brakes are used to stop the machine and give assistance to the steering clutches to turn the machine.

2. HYDRAULIC CIRCUIT



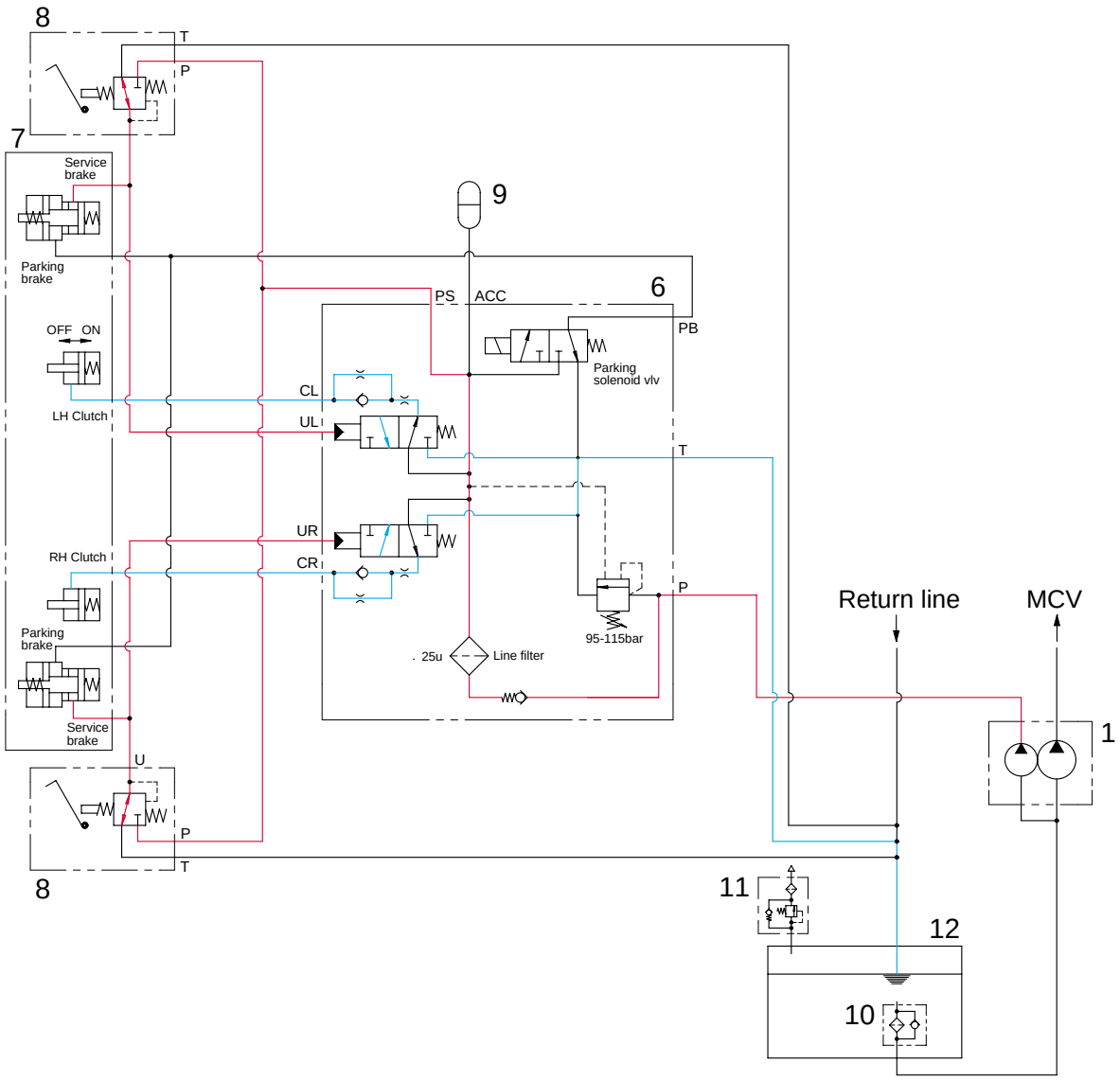
1	Hydraulic pump	8	Foot valve assy	11	Air breather
6	Clutch/brake control assy	9	Accumulator	12	Hydraulic tank
7	Axle unit	10	Hydraulic oil filter		

1) FOOT VALVE PEDAL RELEASED



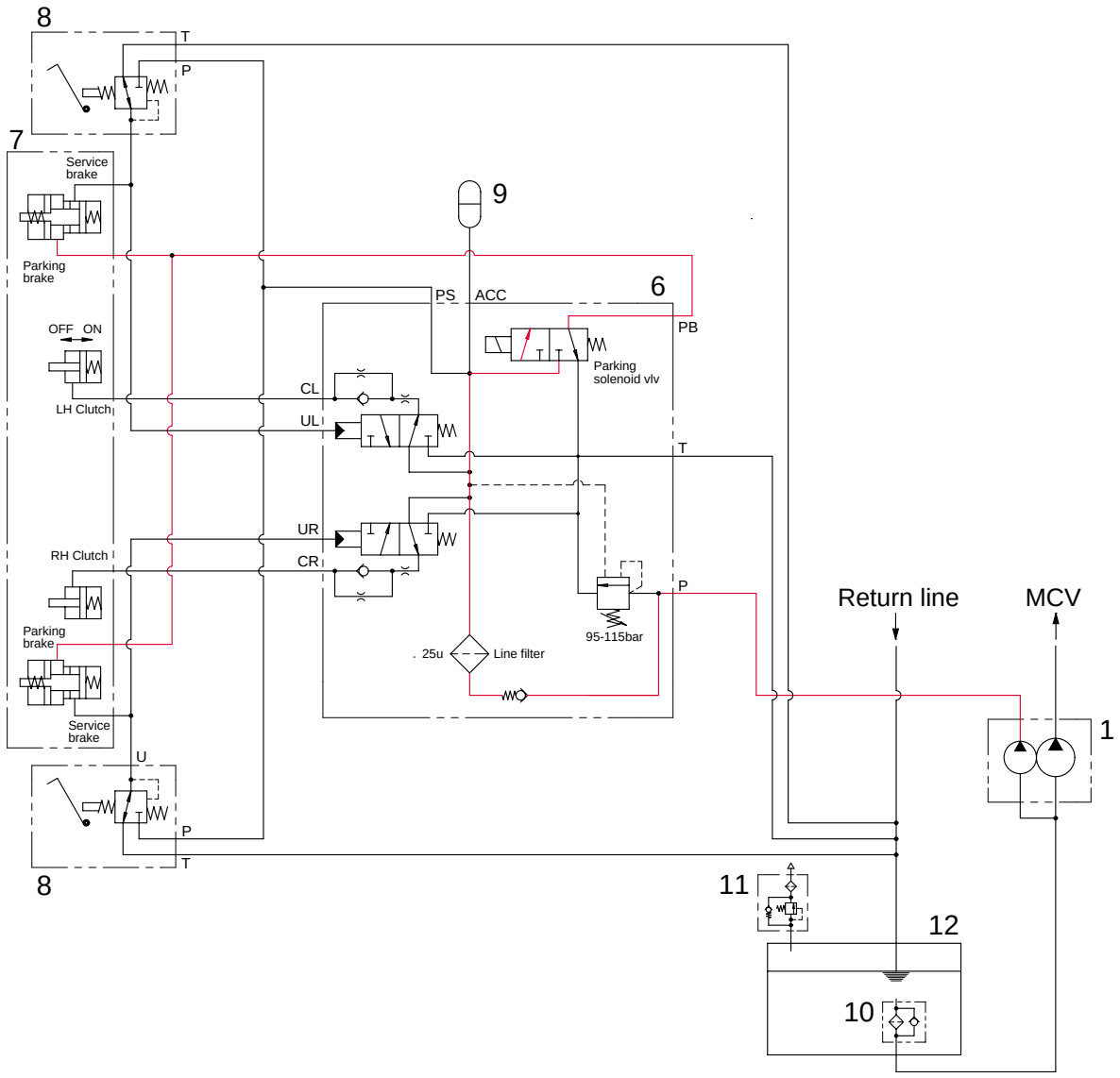
- When the pedal of foot valve(8) is released, the operating force is eliminated by the force of the spring, and the spool is returned.
  When the spool removes up, the service brake port in the axle unit(7) is opened and the hydraulic oil in the service brake chambers unit(7) of axle return to the tank(12) through the foot valve(8).
- Therefore, the service brake kept released.
- At the same time, the oil from hydraulic pump(1) flows into clutch and brake control valve(6) and goes to the chamber of clutch operation assy ; Then the clutch is engaged.

2) FOOT VALVE PEDAL APPLIED



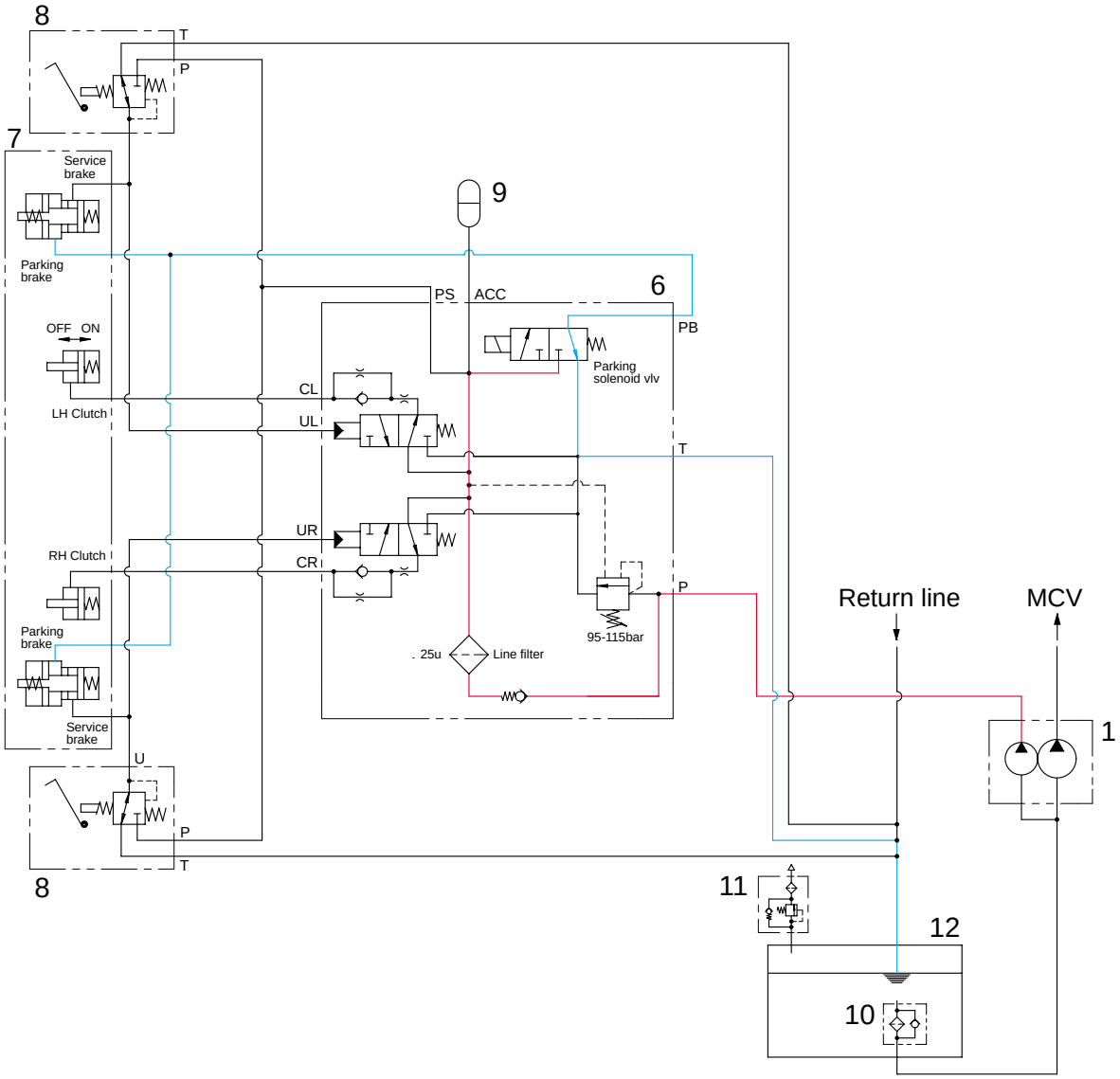
- When the pedal of foot valve(8) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the service brake port in the axle unit(7) is opened, and the hydraulic oil enters the service brake chambers of axle unit(7) through the foot valve(8). Therefore, the service brake is applied.
- At the same time, the oil from hydraulic pump(1) flows into clutch control valve(6) through foot valve(8) ; Then the clutch control spool is shift and the hydraulic oil in chamber of clutch operation assy return to hydraulic oil tank(12). Therefore, the clutch is disengaged.

3) PARKING BRAKE RELEASED



- When the parking brake switch is OFF, the parking brake solenoid valve is energized.
- The oil from hydraulic pump(1) flows into clutch and brake control valve(6) and then goes to the large chamber of brake operation assy through the parking brake solenoid valve. It overcomes the force of the spring and pushes the pull rod. This releases the parking brake.
- Therefore, the parking brake is kept released.

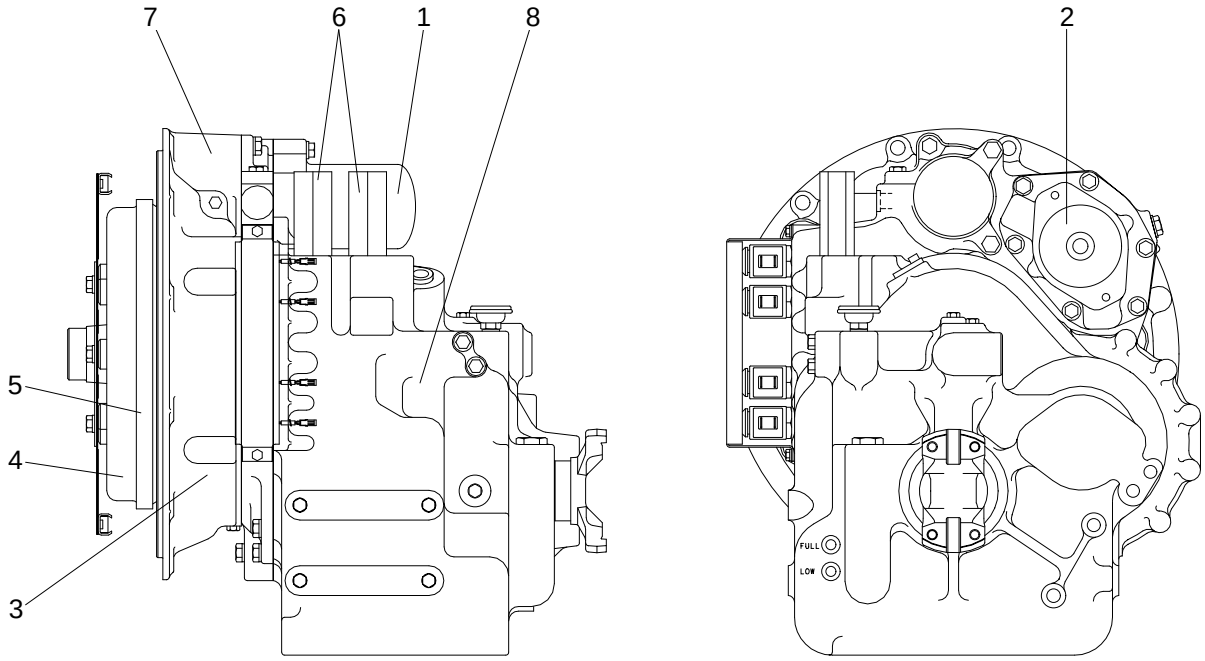
4) PARKING BRAKE OPERATED



- When the parking brake switch is ON, the parking brake solenoid valve is deenergized and the large chamber of brake operation assy open to the hydraulic oil tank port. Then the hydraulic oil in the large chamber of brake operation assy return to the tank through the parking solenoid valve.
- Therefore the parking brake is kept applied.

3. TRANSMISSION

1) STRUCTURE

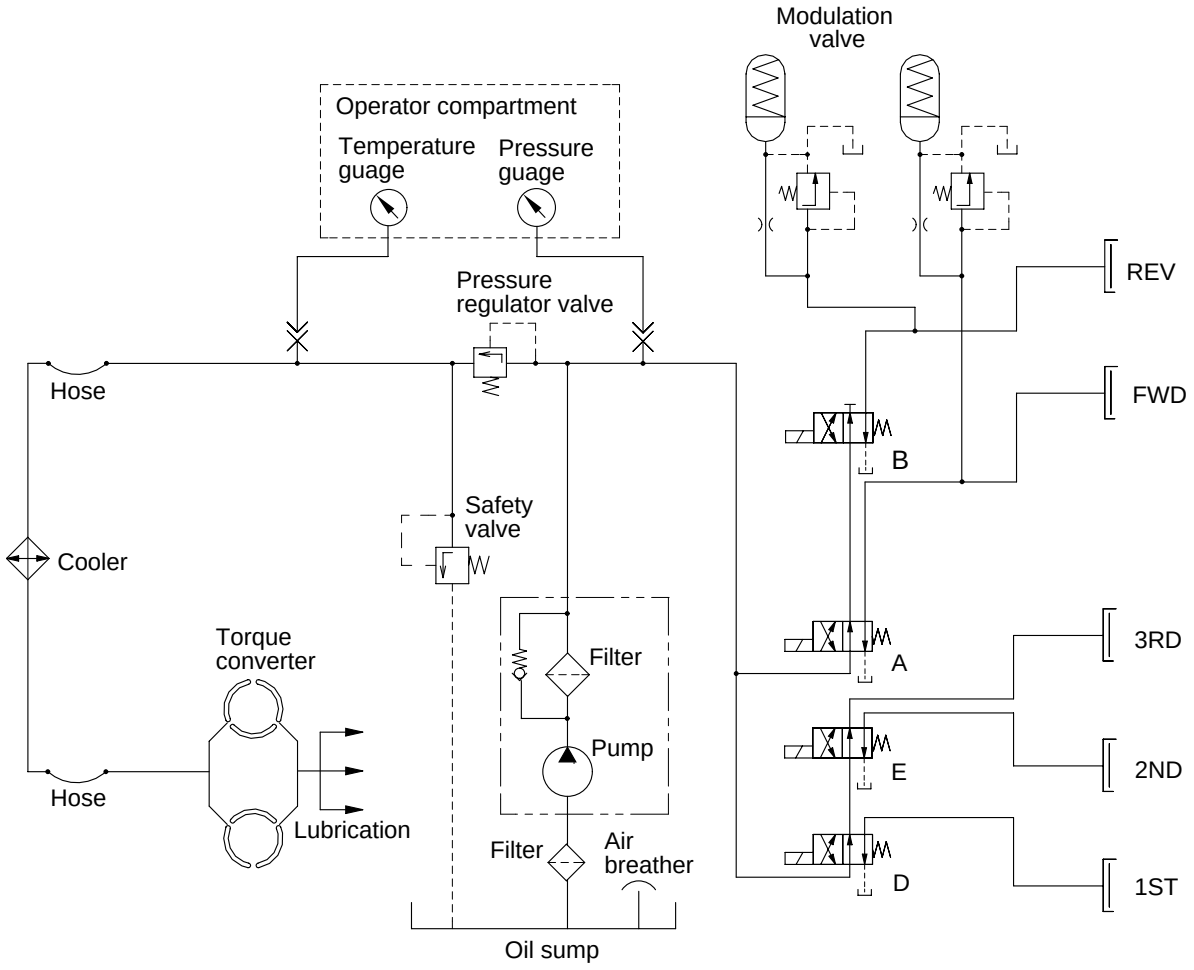


1	Filter	4	Turbine	7	Converter housing
2	Charging pump	5	Stator(Reaction member)	8	Transmission case
3	Impeller	6	Modulator valve		

The transmission is a short-drop torque converter and transmission assembly connected to the engine by means of a drive shaft.

The speed and direction clutch assemblies are mounted inside the transmission case(8) and are connected to the output shaft of the converter either by direct gearing or drive shaft. The purpose of the speed or directional clutches is to direct the power flow through the gear train to provide the desired speed range and direction.

2) HYDRAULIC CIRCUIT



Speed	Forward			Reverse			Neutral
	1	2	3	1	2	3	
B				X	X	X	
A	X	X	X				
E	X	X		X	X		X
D	X			X			

X : Solenoid activated

3) OPERATION

With the engine running, the transmission charging pump(2) draws oil from the transmission sump through the oil suction tube and screen and directs it through the pressure regulating valve and oil filter(1).

The pressure regulating valve maintains pressure to the transmission solenoid valves for actuating the direction and speed clutches. This regulator valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is spring loaded to hold the valve in the closed position. When a specific pressure is achieved, the valve spool works against the spring until an exhaust port is exposed along the side of the bore. This sequence of events provides the proper system pressure. This requires a small portion of the total volume of oil used in the system.

The remaining volume of oil is directed out through an external oil cooler and into the lube inlet port. From the lube inlet port oil goes through the forward-reverse shaft, lubricating the forward and reverse clutches, with the remainder going to the torque converter. After entering the converter, the oil is directed through the converter blade cavity and exits in the passage between the turbine shaft and impeller hub. The oil then lubes the impeller hub bearing with the remainder going to the 3rd clutch shaft and 1st~2nd clutch shaft to lubricate those clutches and shaft bearings. The oil then gravity drains to the transmission sump.

The hydraulic torque converter consists basically of three elements and their related parts to multiply engine torque. The engine power is transmitted from the engine flywheel to the impeller element through the impeller cover. This element is the pump portion of the hydraulic torque converter and is the primary component which starts the oil flowing to the other components which results in torque multiplication. This element can be compared to a centrifugal pump in that it picks up fluid at its center and discharges at its outer diameter.

The torque converter turbine is mounted opposite the impeller and is connected to the output shaft of the torque converter. This element receives fluid at its outer diameter and discharges at its center. Fluid directed by the impeller out into the particular design of blading in the turbine and reaction member is the means by which the hydraulic torque converter multiplies torque.

The reaction member of the torque converter is located between and at the center of the inner diameters of the impeller and turbine elements. Its function is to take the fluid which is exhausting from the inner portion of the turbine and change its direction to allow correct entry for recirculation into the impeller element.

The torque converter will multiply engine torque to its designed maximum multiplication ratio when the output shaft is at zero rpm. Therefore, we can say that as the output shaft is decreasing in speed the torque multiplication is increasing.

With the engine running and the transmission control lever in neutral position, oil pressure from the regulating valve is blocked at the solenoid control valves, and the transmission is in neutral. Movement of the control lever will energize the forward or reverse solenoid valves and selected range(Gear) solenoid, directing oil under pressure to the selected direction and range(Gear) clutches.

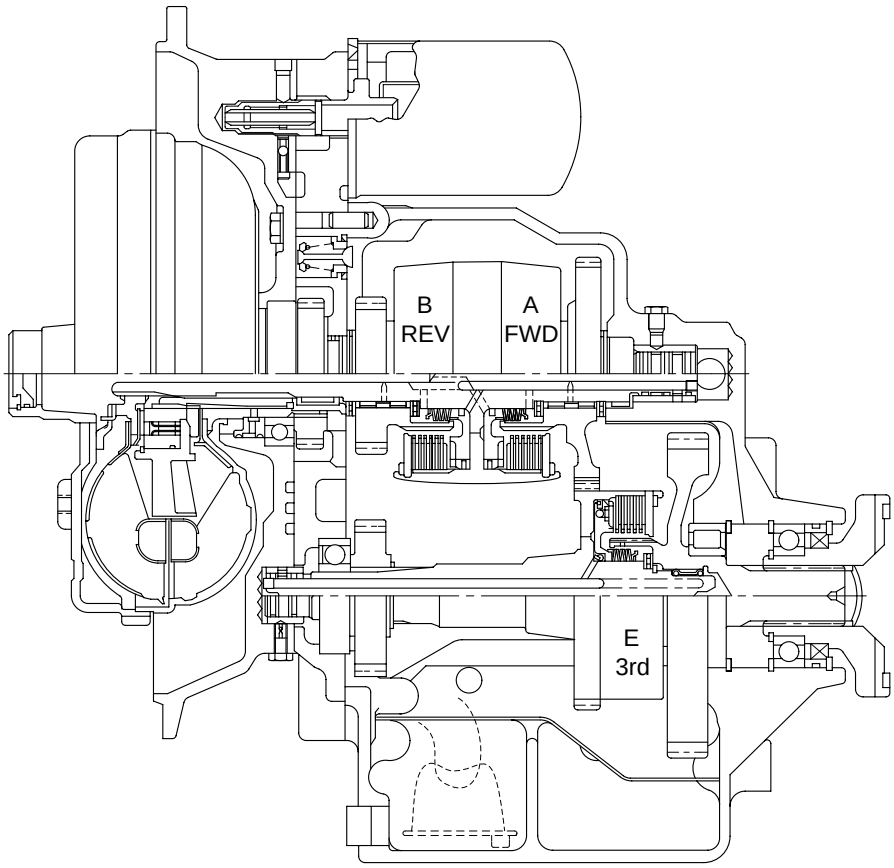
When either directional clutch is selected the opposite clutch is relieved of pressure and vents back through the direction selector solenoid to the oil sump. The same procedure is used in the speed selector.

The direction or speed clutch assembly consists of a drum with slots and a bore to receive a hydraulically actuated piston. The piston is **oil tight** by the use of sealing rings. A steel disc with external tangs is inserted into the drum and rests against the piston. Next, a friction disc with splines at the inner diameter is inserted. Discs are alternated until the required total is achieved. A heavy back-up plate is then inserted and secured with a snap ring. A hub with outer diameter splines is inserted into the splines of discs with teeth on the inner diameter. The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.

To engage the clutch, the transmission control lever is placed in the desired position. This energizes the selected direction and range(Gear) solenoids allowing the oil under pressure to flow through tubes and passages to the selected clutch shafts. Oil sealing rings are located on the clutch shaft. These rings direct oil under pressure through a drilled passageway in the shaft to a desired clutch. Pressure of the oil forces the piston and discs against the heavy back-up plate. The discs with tangs on the outer diameter clamping against discs with teeth on the inner diameter enables the hub and clutch shaft to be locked together and allows them to drive as a unit.

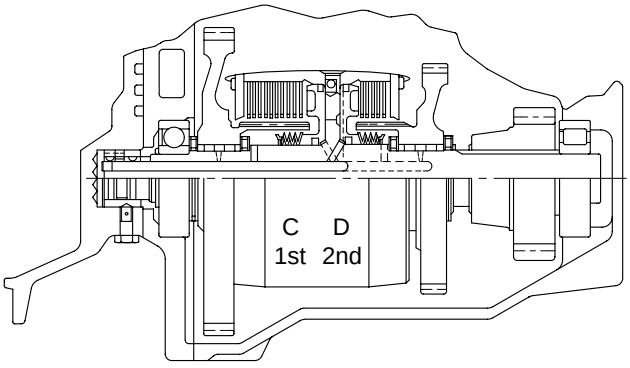
There are bleed balls in the clutch piston or clutch drum which allow quick escape for oil when the pressure to the piston is released.

4) TYPICAL CROSS SECTION



Forward

Shift speed	Direction clutch	Speed clutch
1st	A	C
2nd	A	D
3rd	A	E



Reverse

Shift speed	Direction clutch	Speed clutch
1st	B	C
2nd	B	D
3rd	B	E

The transmission has five hydraulically activated clutches that give three speeds FORWARD and three speeds REVERSE.
Speed and direction are both manually selected.

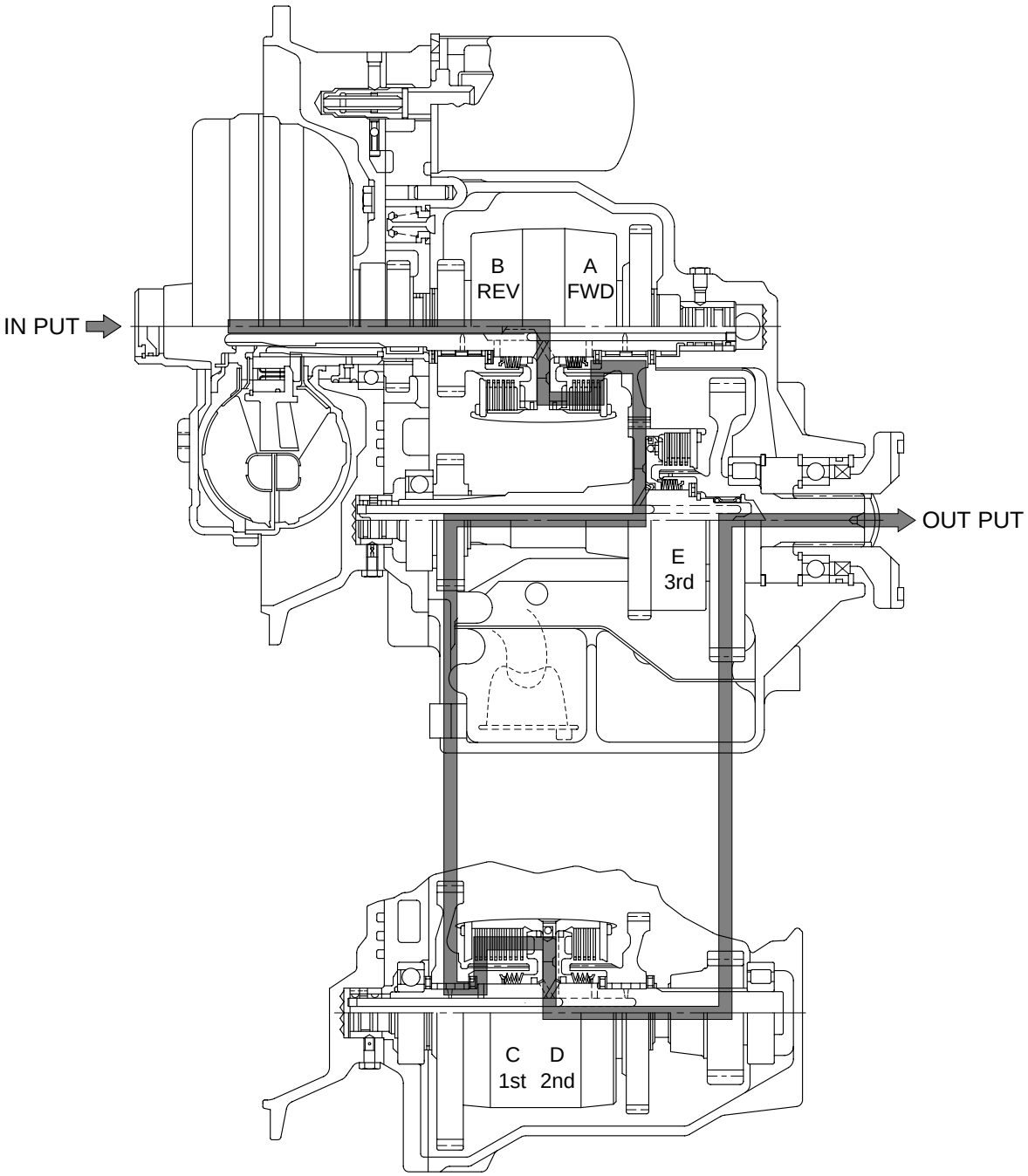
5) OPERATION OF TRANSMISSION

(1) Forward

① Forward 1st

In 1st forward, forward clutch and 1st clutch are engaged.

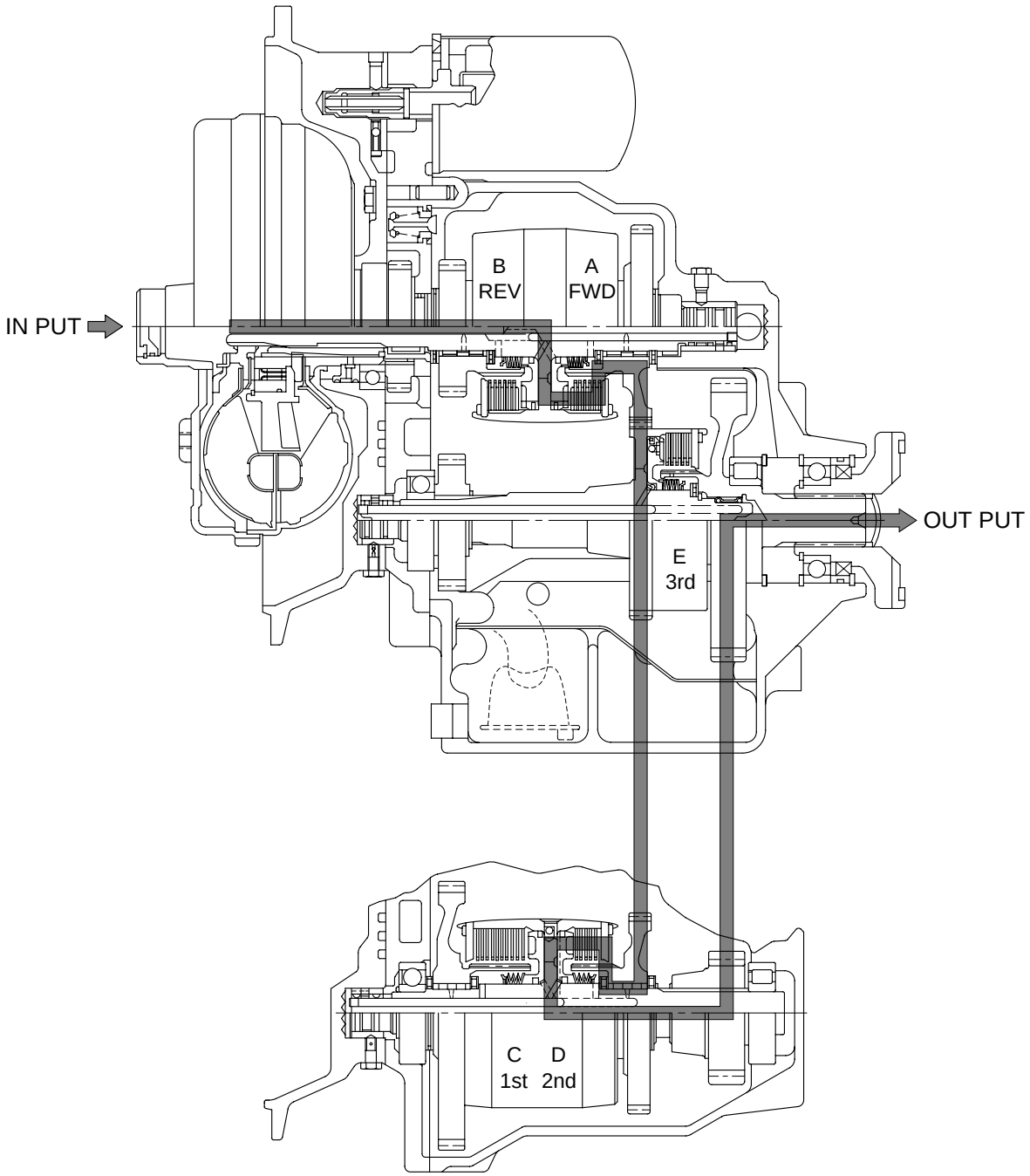
Forward clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.



② **Forward 2nd**

In 2nd forward, forward clutch and 2nd clutch are engaged.

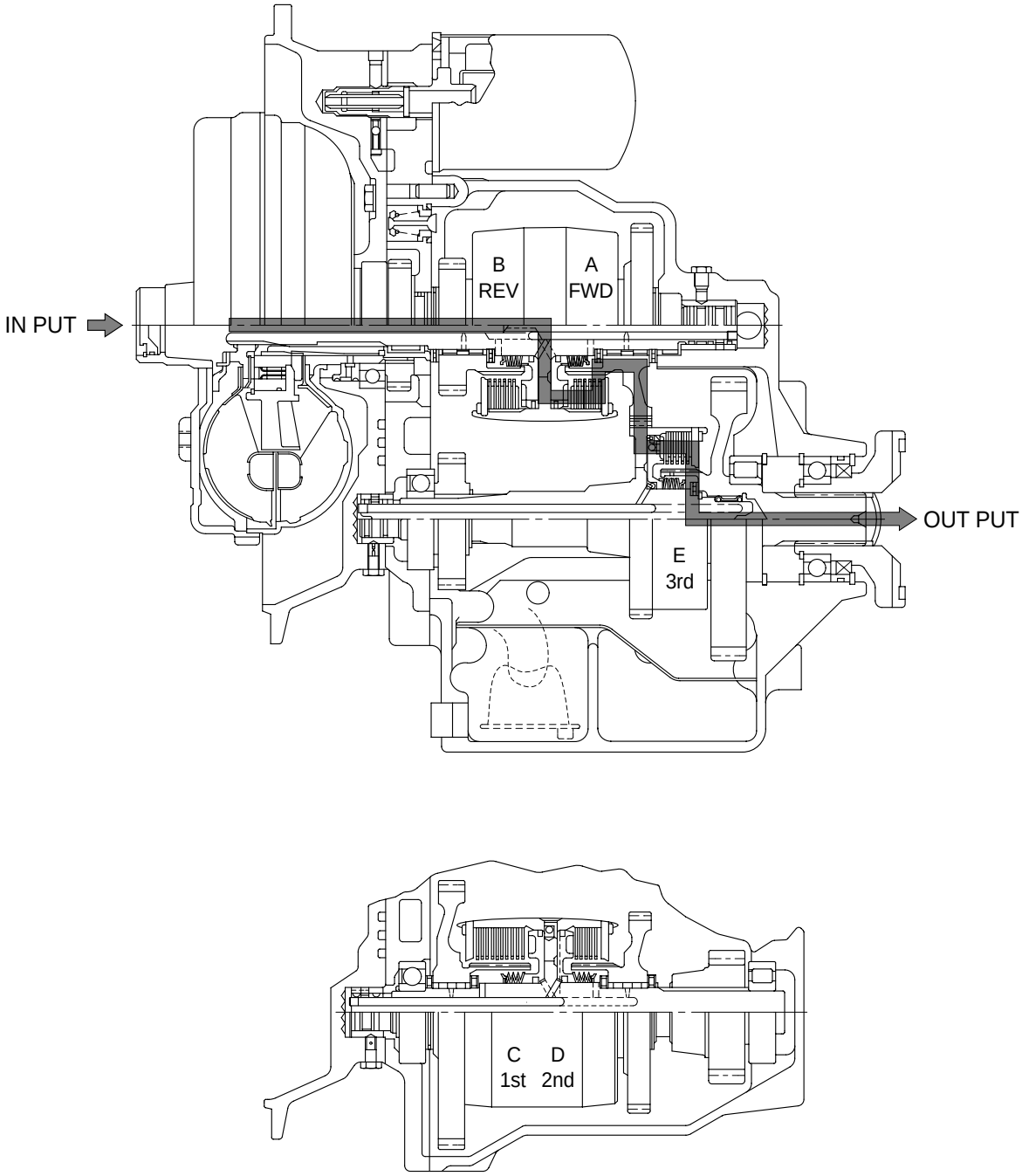
Forward clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.



③ **Forward 3rd**

In 3rd forward, forward clutch and 3rd clutch are engaged.

Forward clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.

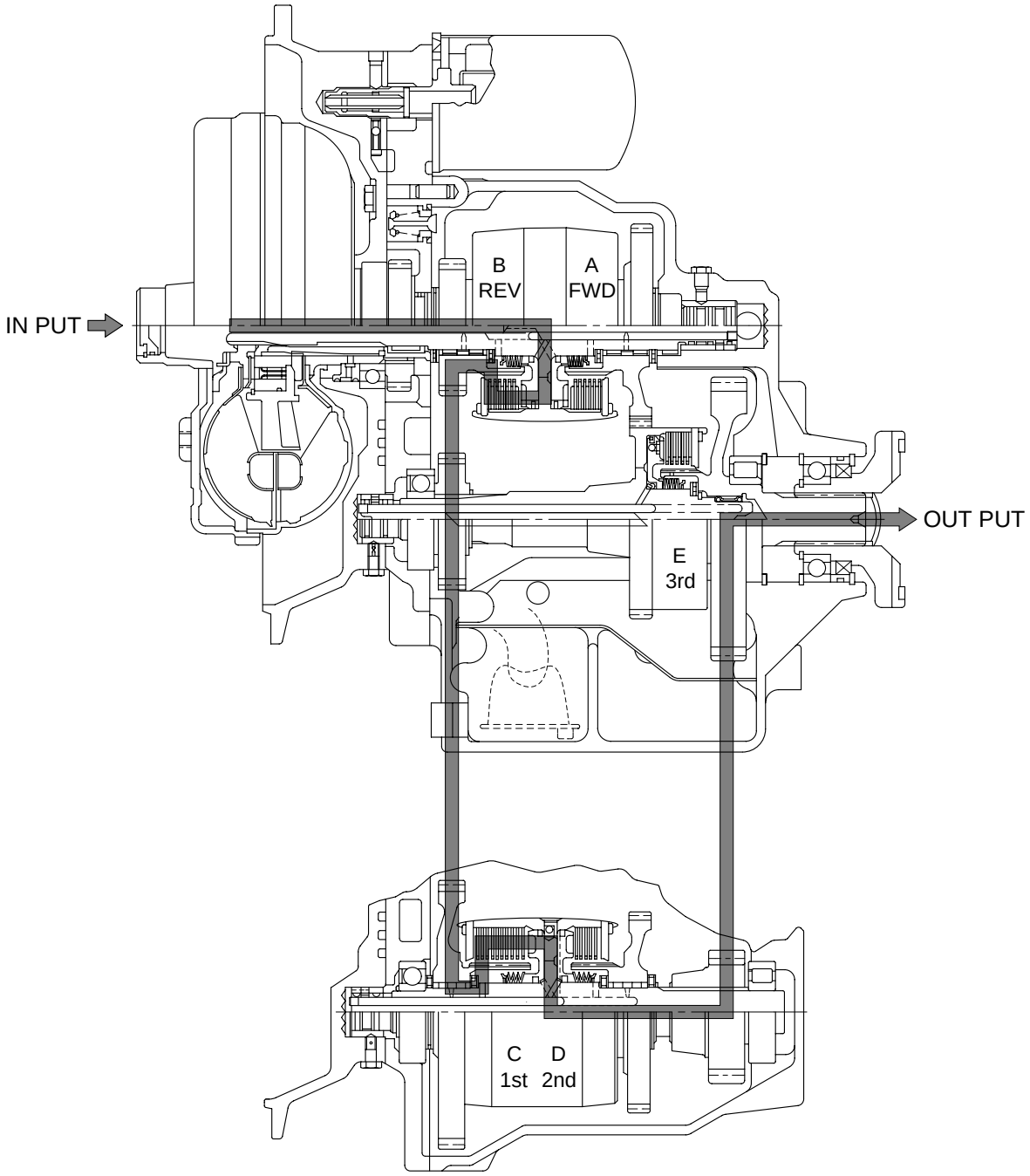


(2) Reverse

① Reverse 1st

In 1st reverse, reverse clutch and 1st clutch are engaged.

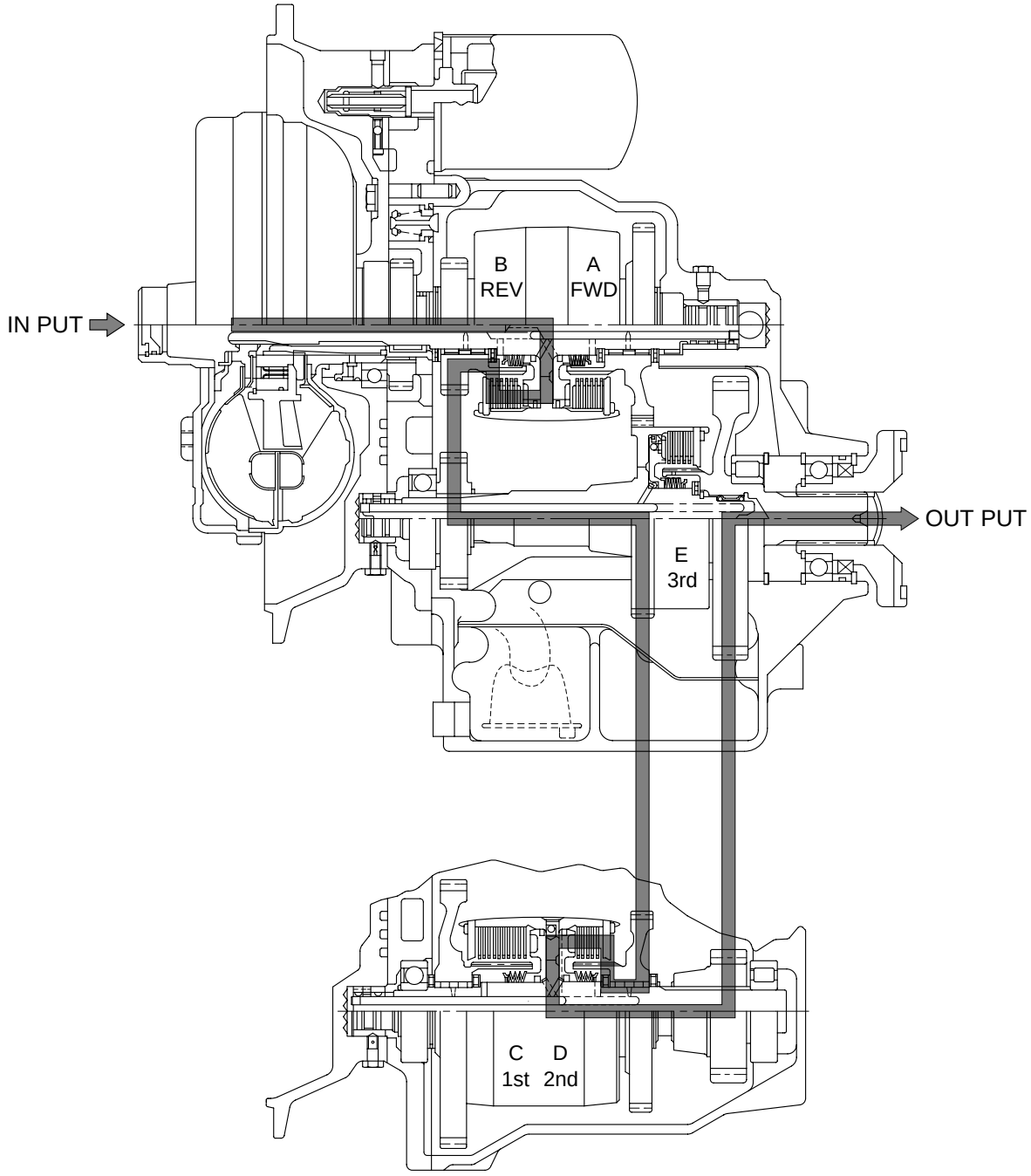
Reverse clutch and 1st clutch are actuated by the hydraulic pressure applied to the clutch piston.



② **Reverse 2nd**

In 2nd reverse, reverse clutch and 2nd clutch are engaged.

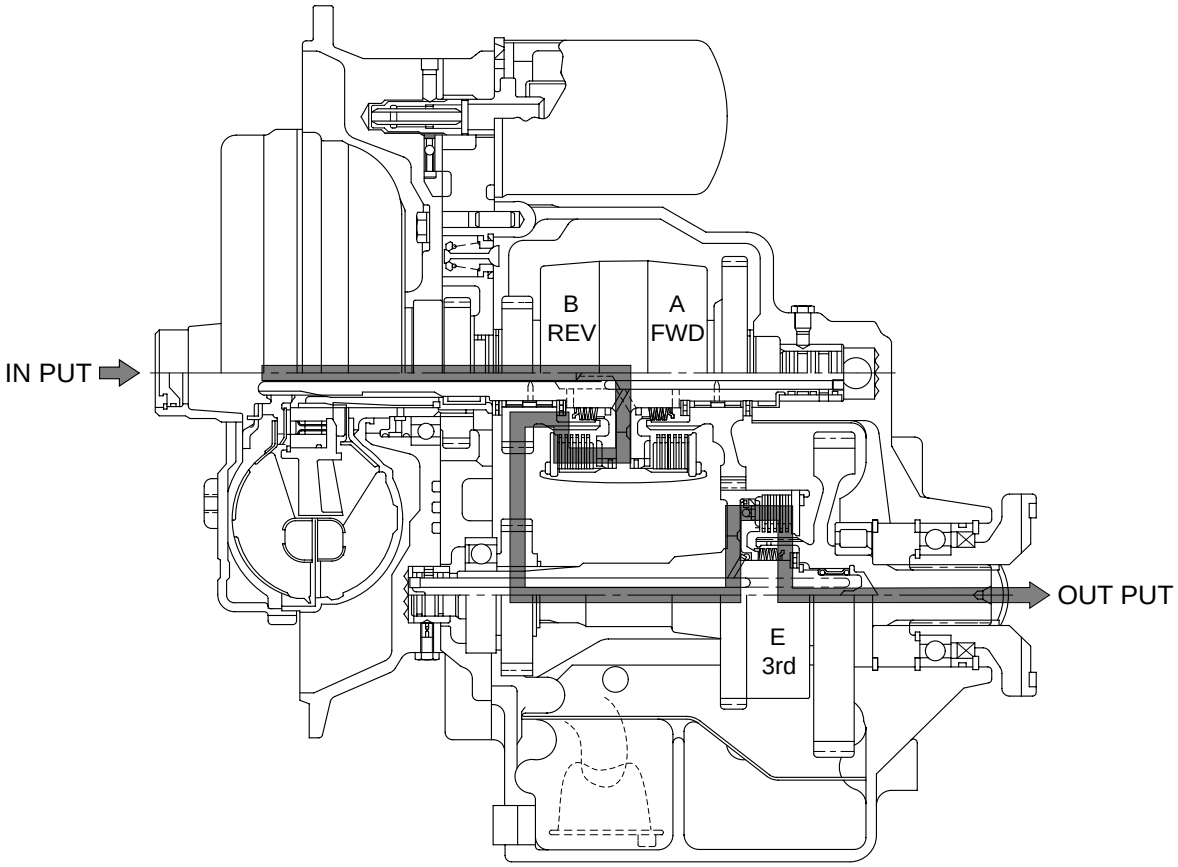
Reverse clutch and 2nd clutch are actuated by the hydraulic pressure applied to the clutch piston.

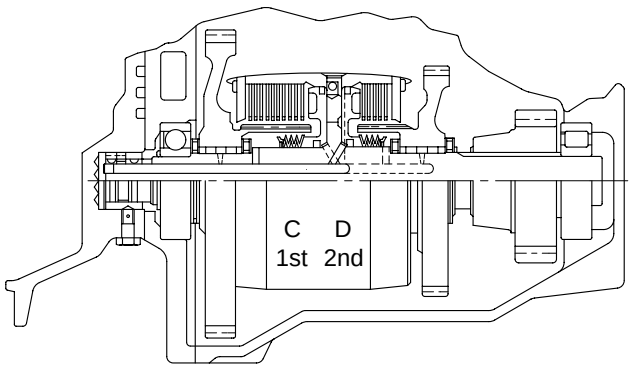


③ Reverse 3rd

In 3rd reverse, reverse clutch and 3rd clutch are engaged.

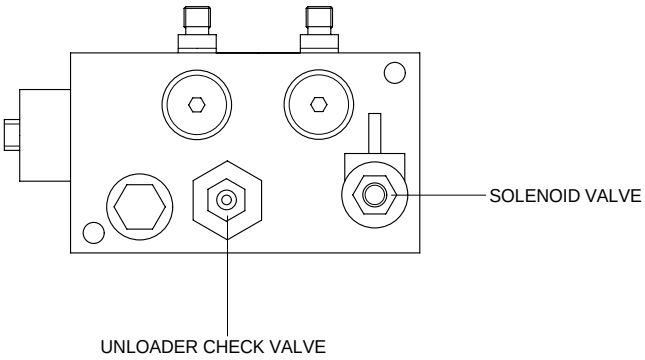
Reverse clutch and 3rd clutch are actuated by the hydraulic pressure applied to the clutch piston.

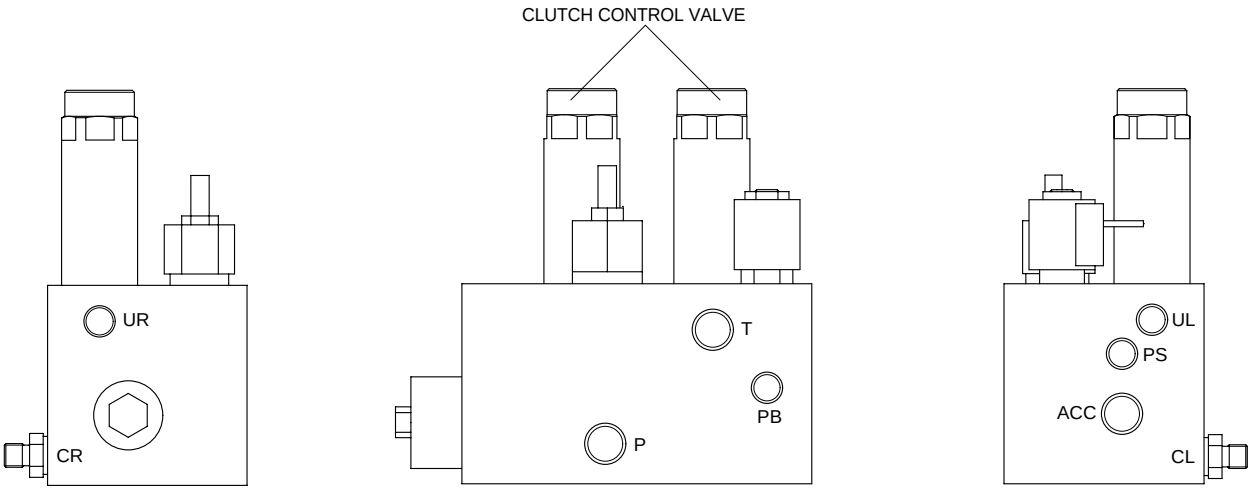


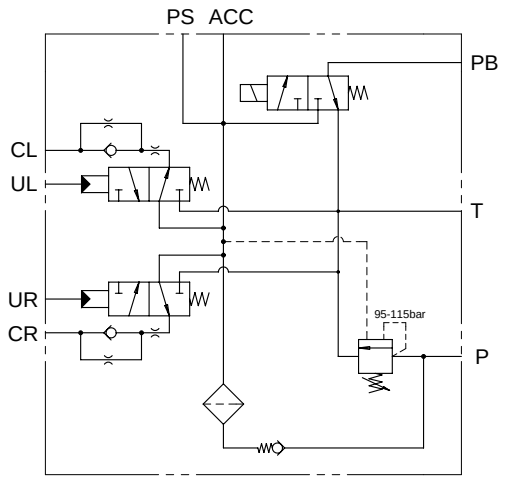


4. CLUTCH AND BRAKE CONTROL VALVE

1) STRUCTURE



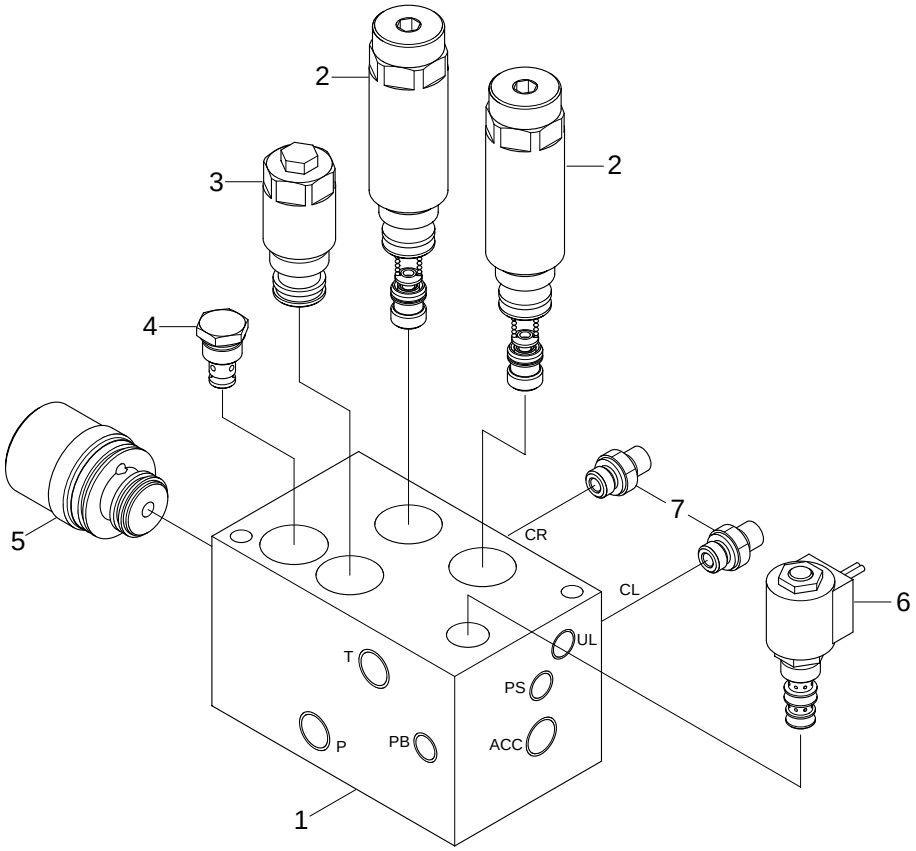




Hydraulic circuit

Port	Port name	Port size
Acc	Accumulator port	3/4 UNF
CL	Left hand clutch conn	PF 1/4
CR	Right hand clutch conn	PF 1/4
P	Supply port	3/4 UNF
PB	Parking brake port	9/16 UNF
PS	Pedal supply port	9/16 UNF
T	Drain port	3/4 UNF
UL	Left hand brake port	9/16 UNF
UR	Right hand brake port	9/16 UNF

2) COMPONENTS

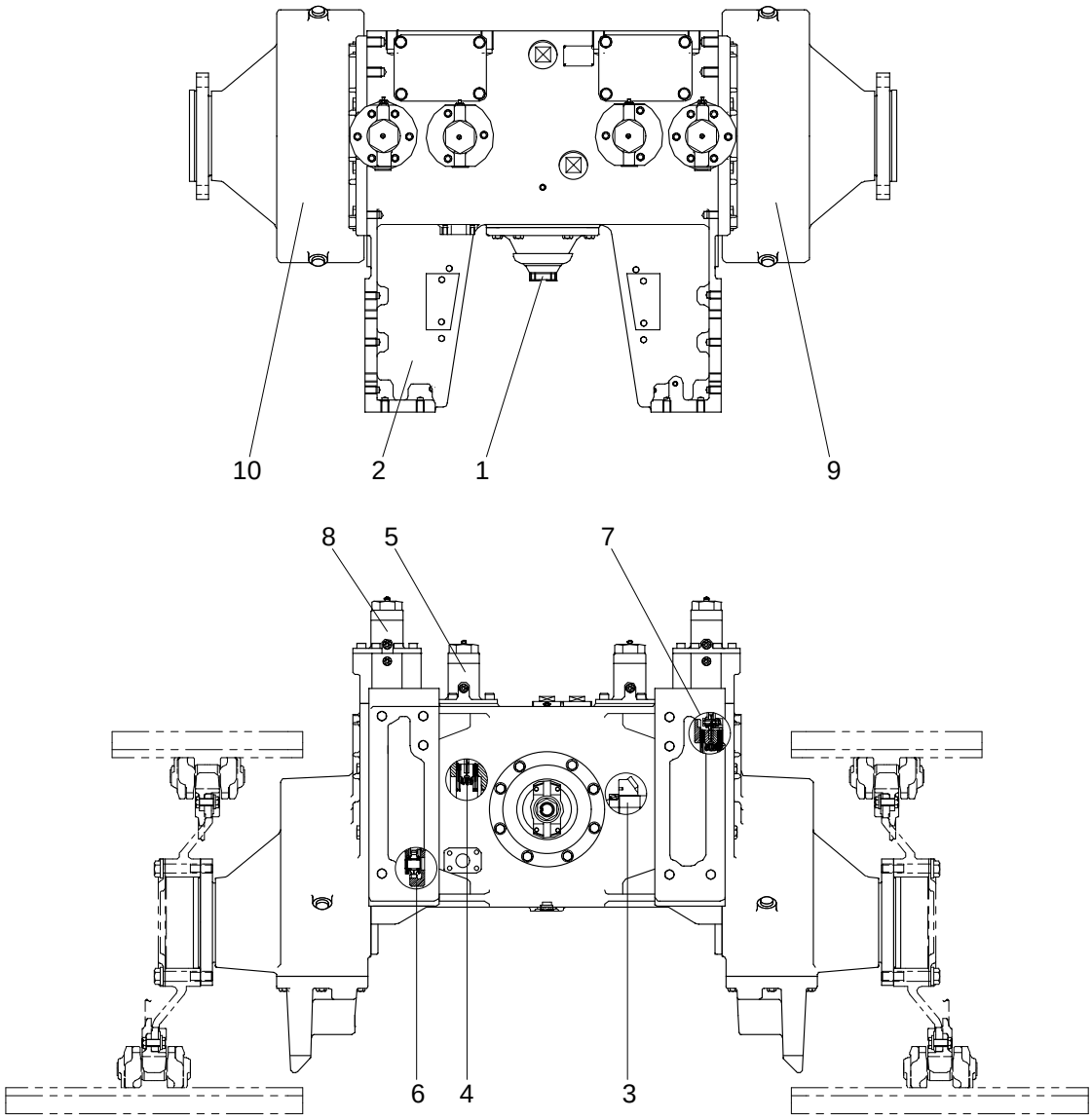


1	Block	4	Check valve	7	Adapter
2	Clutch control valve	5	Line filter		
3	Unload check valve	6	Solenoid valve		

5. AXLE UNIT

1) STRUCTURE

The axle unit is a triple reduction skid steer drive axle with spiral bevel gear input, oil immersed multi-plate disc clutches, oil immersed multi-plate disc failsafe brakes, epicyclic intermediate reduction and a profile ground spur gear final reduction.



1	Input bevel pinion assy	5	Clutch operation assy	9	LH output assy
2	Main case assy	6	Steering epicyclic assy	10	RH output assy
3	Cross shaft assy	7	Brake clutch assy		
4	Steering clutch assy	8	Brake operation assy		

2) GENERAL DESCRIPTION

(1) Axle casings

The main casing and the final drive casings are manufactured from separate casings dowelled and bolted together. Each casing has it's own oil supply which is isolated from the neighboring casing.

(2) Bevel wheel and pinion assemblies

High capacity taper roller bearings support both the spiral bevel wheel and pinion. Drive is transmitted from the spiral bevel gears to the sprockets via the cross shaft, epicylcic intermediate reduction and final drive.

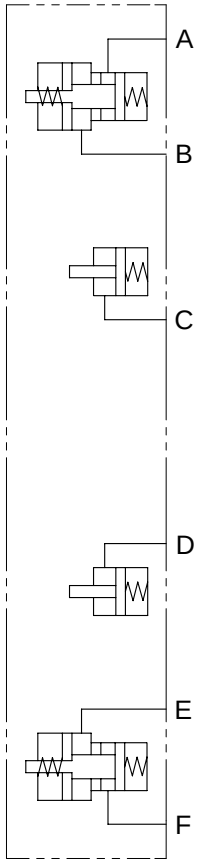
(3) Clutches

The axle is fitted with oil immersed multi-plate clutches inboard of the planetary gear system. The clutch operating mechanism is situated external to the case for easy adjustment.

(4) Brakes

The axle is fitted with oil immersed multi-plate disc brakes located within the axle center casing. The center casing is designed to provide adequate oil capacity for heat dissipation without the need for additional cooling. The brake operating mechanism is situated external to the case for easy adjustment.

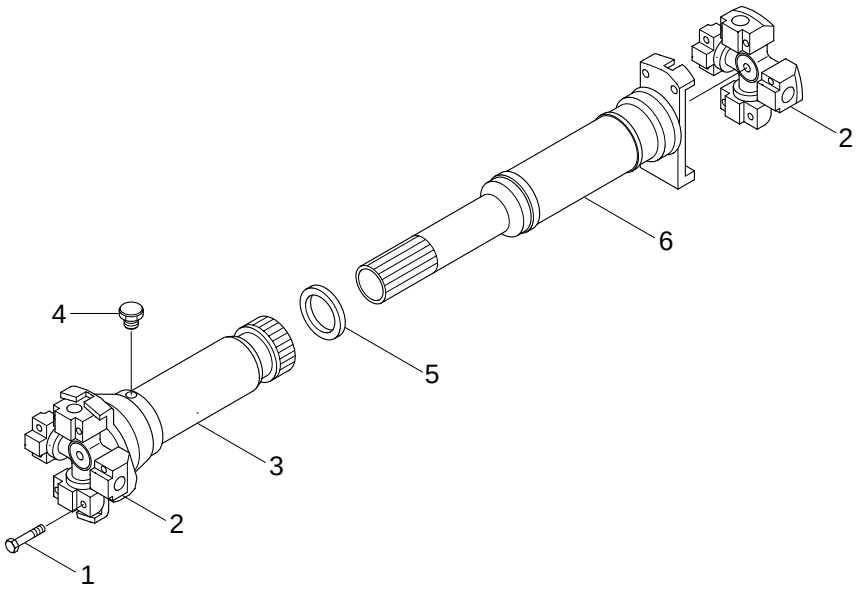
3) HYDRAULIC CIRCUIT



Hydraulic circuit

Port	Port name	Port size
A	LH service brake port	9/16 UNF
B	LH parking brake port	9/16 UNF
C	LH clutch port	PF 1/4
D	RH clutch port	PF 1/4
E	RH parking brake port	9/16 UNF
F	RH service brake port	9/16 UNF

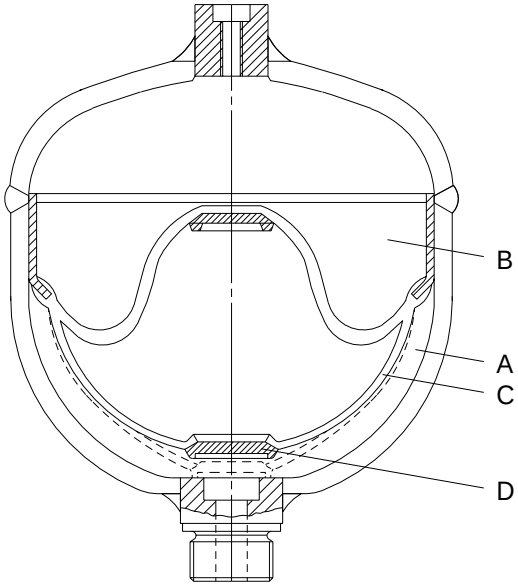
6. DRIVE SHAFT



1	Bolt	4	Plug screw	7	Tube
2	Bearing assembly	5	Seal	8	Tube yoke
3	Slip yoke assembly	6	Spline shaft and yoke		

7. BRAKE ACCUMULATOR

1) STRUCTURE



Item	35D1-11030 (Item 9)
Diameter	105mm
Mounting height	134mm
Nominal volume	0.5 (0.1 U.S. gal)
Priming pressure	51kgf/cm²(725psi)
Operating medium	Oil
Operating pressure	Max 214kgf/cm²(3044psi)
Thread	M30
Operating temperature range	-10 ~ 80℃
Priming gas	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion(A) and a gas portion(B) with a diaphragm(C) as a gas-tight dividing element. The fluid portion(A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk(D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible.

Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30%(Please refer to **Performance testing and checking of the accumulator).**

(5) Disposal of the accumulator

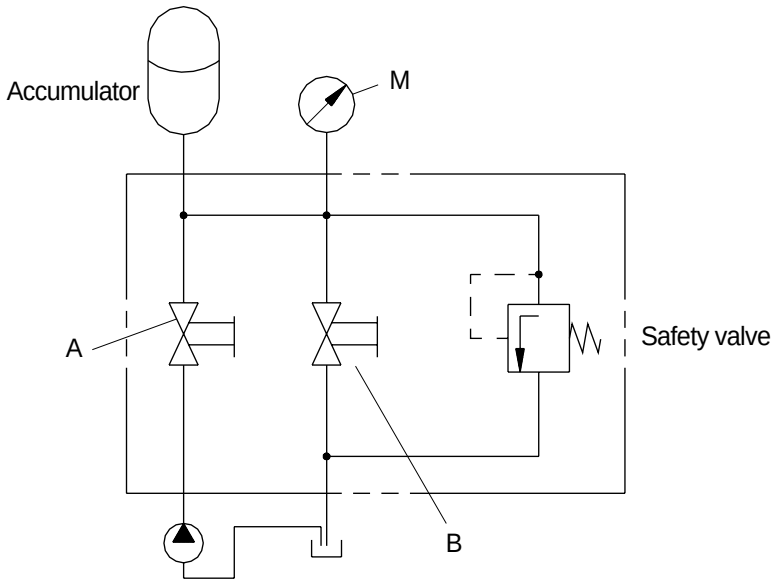
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

Wear safety goggles when doing this job.

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge **M**. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under **Disposal of the accumulator.**

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for **at least one** of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under **Disposal of the accumulator.**



(7) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.**

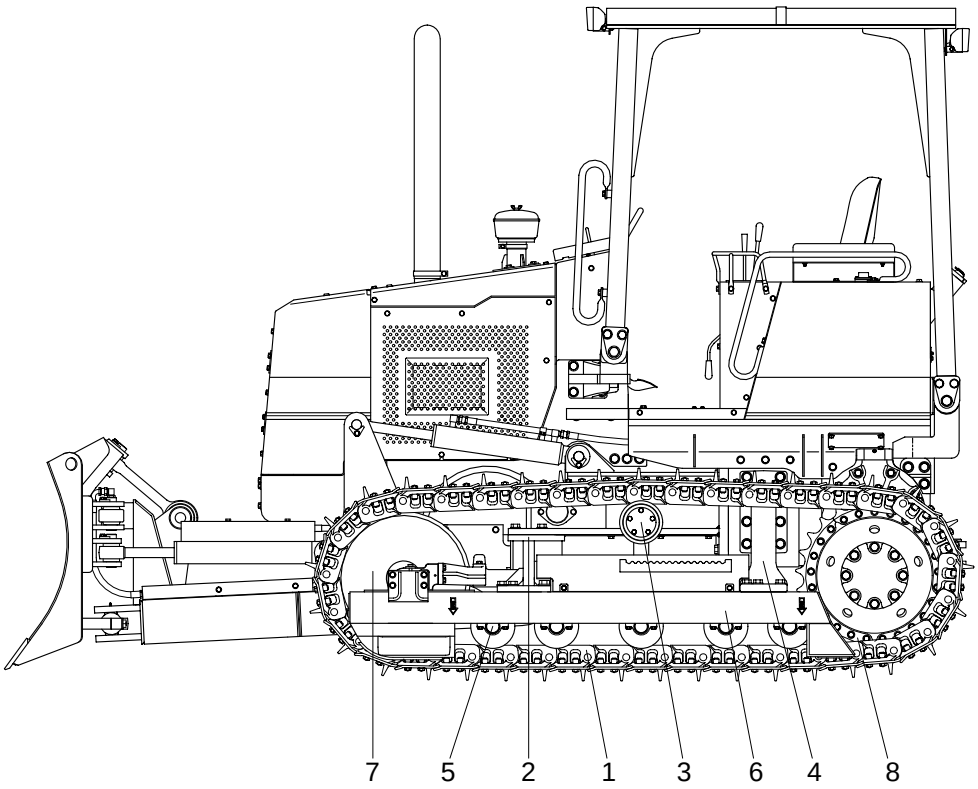
When doing repair work, make sure your environment is very clean.

Immediately close all open ports on the components and on pipes using plugs.

△ **For safety reasons the accumulators need to be replaced as a whole if damaged.**

8. UNDERCARRIAGE

1) STRUCTURE

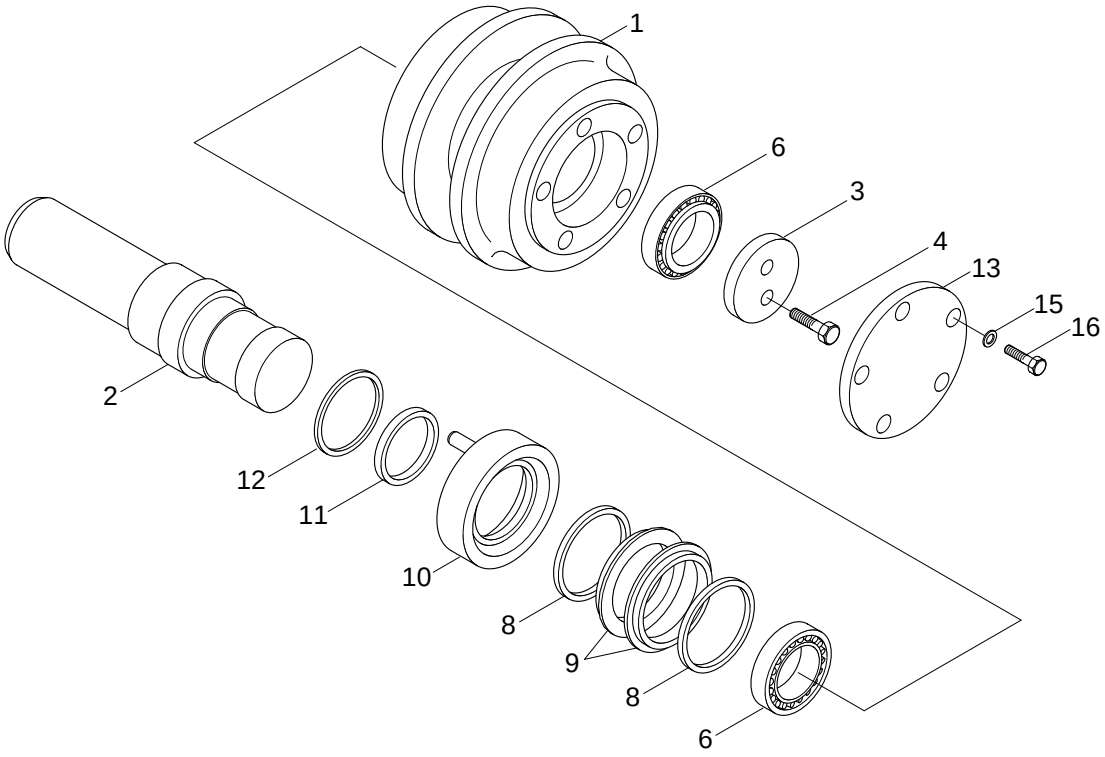


1	Track chain	4	Rear support	7	Front idler
2	Front support	5	Track roller	8	Sprocket
3	Carrier roller	6	Track frame		

The undercarriage connects the frame and axle unit case.
It gives support for the machine weight and is the component that moves the machine along the ground. The two track assemblies are kept in parallel alignment by the rigid connection to the axle unit case and to the frame. Each track frame assembly is in a rigid condition and can not move up and down.

The front idlers, track rollers and track carrier rollers use Duo-Cone seals to prevent the loss of lubricant and to keep out foreign material.

2) CARRIER ROLLER

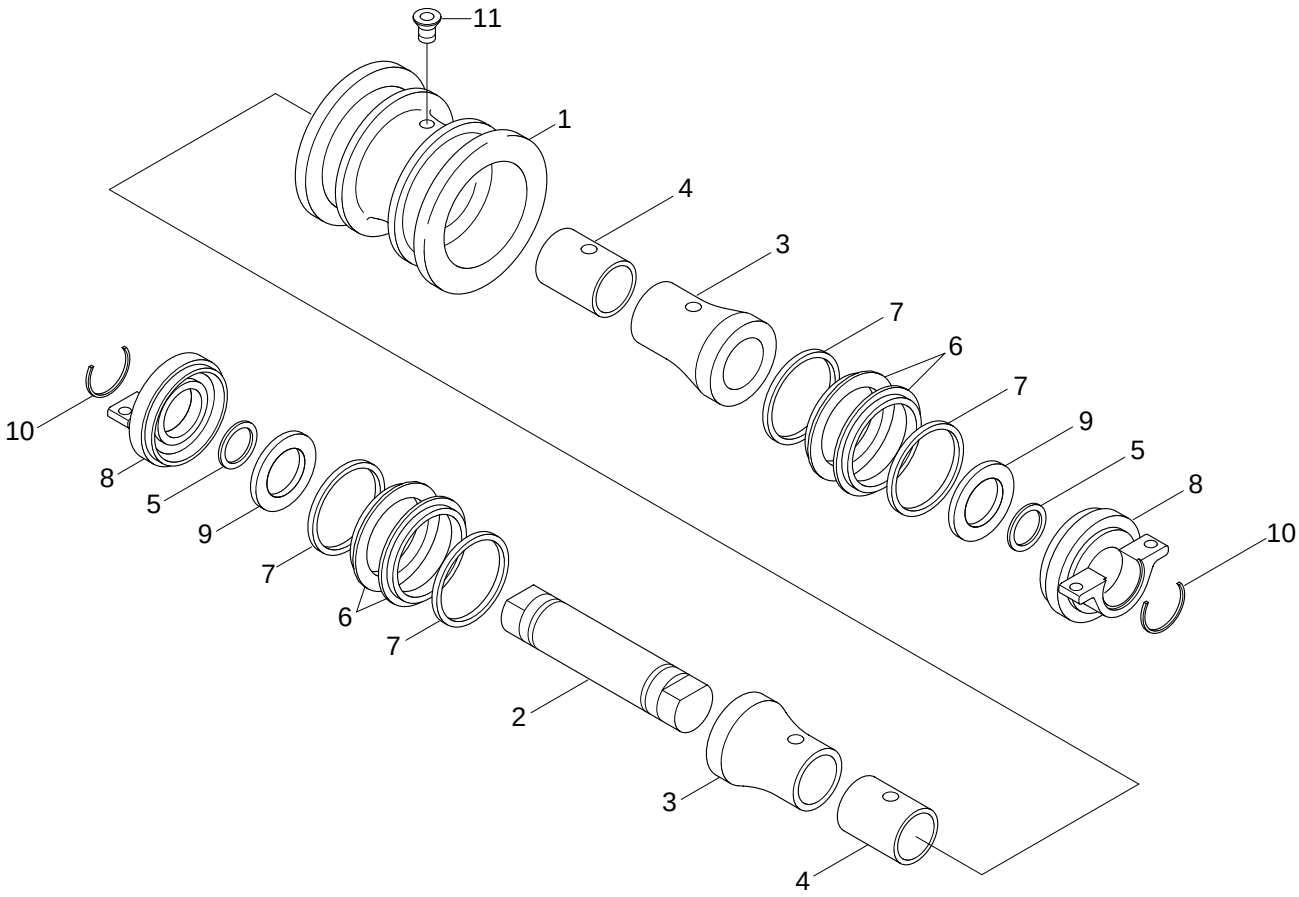


1	Carrier shell	8	Rubber seal	13	Cap
2	Shaft	9	Seal	14	Lock washer
3	Washer seal	10	Retainer seal	16	Bolt
4	Bolt	11	Gasket		
6	Taper roller bearing	12	Snap ring		

The carrier rollers are used to support the track between the sprocket and the front idler. The carrier roller shaft(2) is held in the roller support bracket by a clamp. The support bracket is fastened to the track frame.

Alignment of the carrier rollers with the sprocket and idler can be accomplished by movement of the roller shaft inside the support bracket. Carrier rollers turn on two taper roller bearings(6).

3) TRACK ROLLER



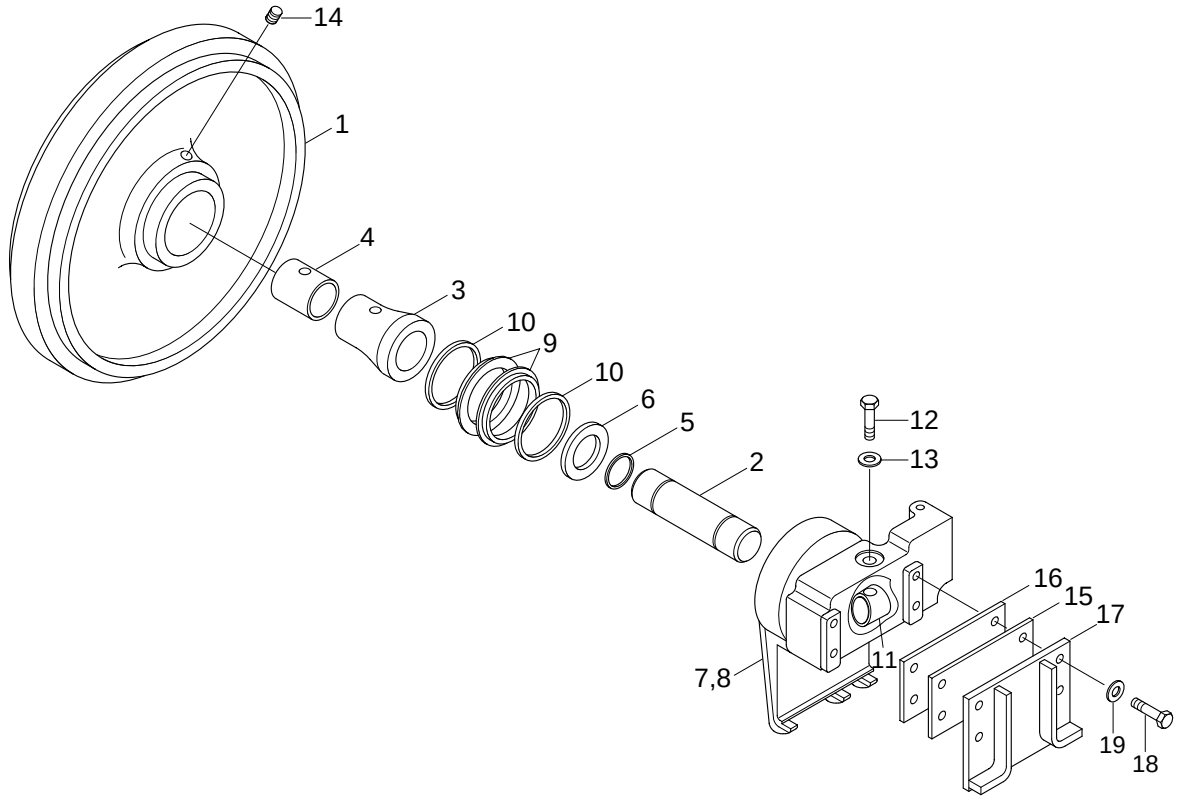
1	Roller shell	5	Gasket	9	Thrust washer
2	Shaft	6	Seal	10	Plate
3	Bushing case	7	Rubber seal	11	Plug
4	Bushing	8	Collar		

The track rollers are fastened to the track frames. The track rollers are in contact with the inside surfaces of the track links. Flanges on the track rollers prevent the movement of the track from side to side. The inside surfaces of the track links cause an even distribution of the weight of the machine along the track.

The track rollers have Duo-Cone seals(6) at both ends to seal the lubricant in and the dirt and debris out. The center of shaft(2) is an oil reservoir. The oil is used for lubrication of the bearing surfaces.

Thrust washers(9) on each end of the roller shaft take the side thrust of the roller. Side movement or end clearance of the shaft can not be adjusted.

4) FRONT IDLER



1	Front idler shell	8	Support(LH)	15	Shim
2	Shaft	9	Seal	16	Shim
3	Bushing case	10	Seals group	17	Outer plate
4	Bushing	11	Pin	18	Hex bolt
5	Gasket	12	Bolt	19	Hardened washer
6	Thrust washer	13	Lock washer		
7	Support(RH)	14	Plug		

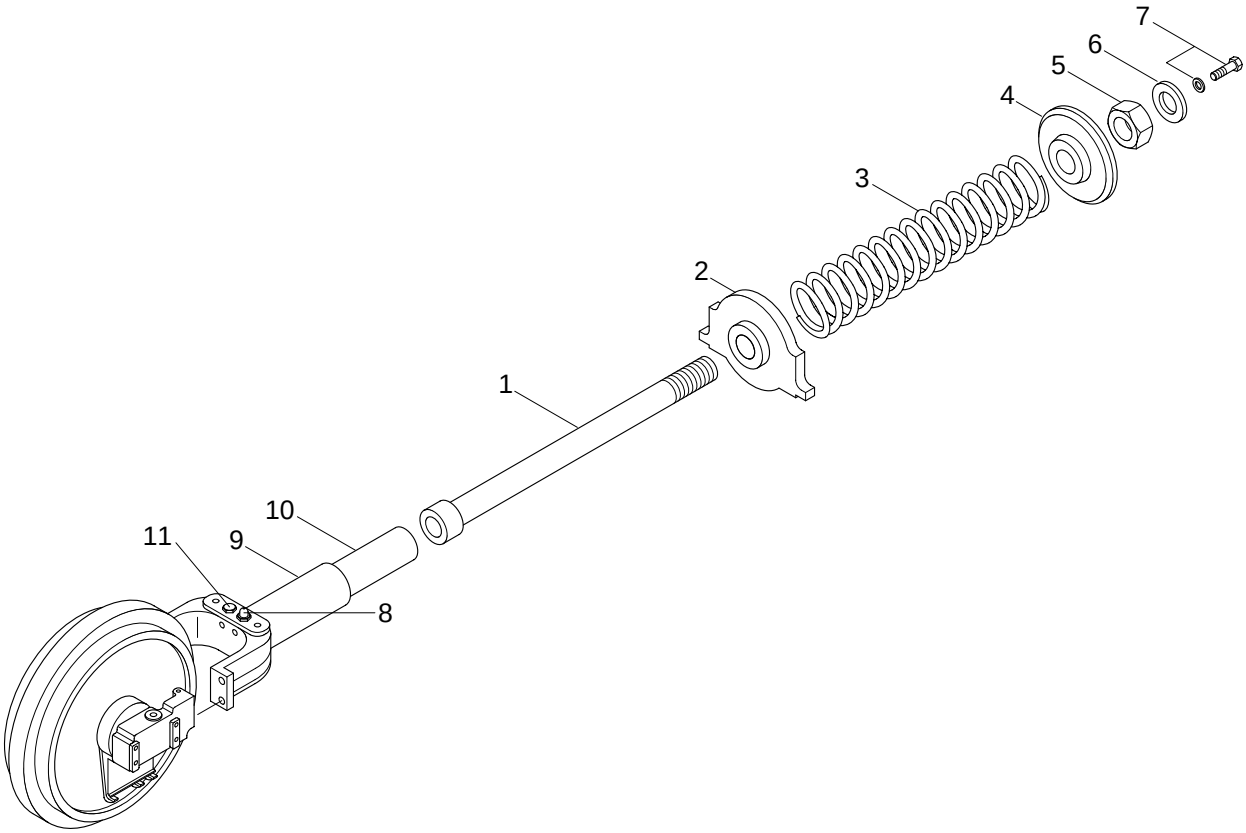
The front idlers put the tracks in position in front of the track rollers. They also keep the tracks in alignment with the sprockets.

The adjustment of the tracks is done by the movement of the front idlers. The track adjusters move the front idlers and hold them in position.

Adjustment of the front idler with the track rollers is done with shims(15, 16) between the supports(7, 8) and outer plate(17). Each idler turns on hardened shaft(2). Side movement or end clearance of the shaft can not be adjusted. The ends of the idler shafts are fastened in the bushing case.

The idler has Duo-Cone seals(9) at both ends to seal the lubricant in and the dirt and debris out. The center of shaft(2) is an oil reservoir. The oil is used for lubrication of the bushing surfaces.

5) TENSION DEVICE



1	Shaft	5	Hex nut	9	Idler yoke
2	Retainer	6	Washer	10	Adjust rod
3	Tension spring	7	Bolt	11	Grease plug
4	Retainer	8	Grease valve		

The tension device is normally in compression and held between a bracket and stopper on the track frame and does not put pressure against the track.

If foreign material gets between the track and its components(Rollers, idler, sprocket), the front idler moves idler yoke(9) to the rear. Since the grease in idler yoke(9) can not be compressed, the idler yoke pushes on tension spring(3). The movement puts tension spring(3) in compression. This prevents too much tension on the track.

Tension spring nut(5) is used to hold spring compression when the spring assembly is to be removed. Nut(5) has no other purpose.

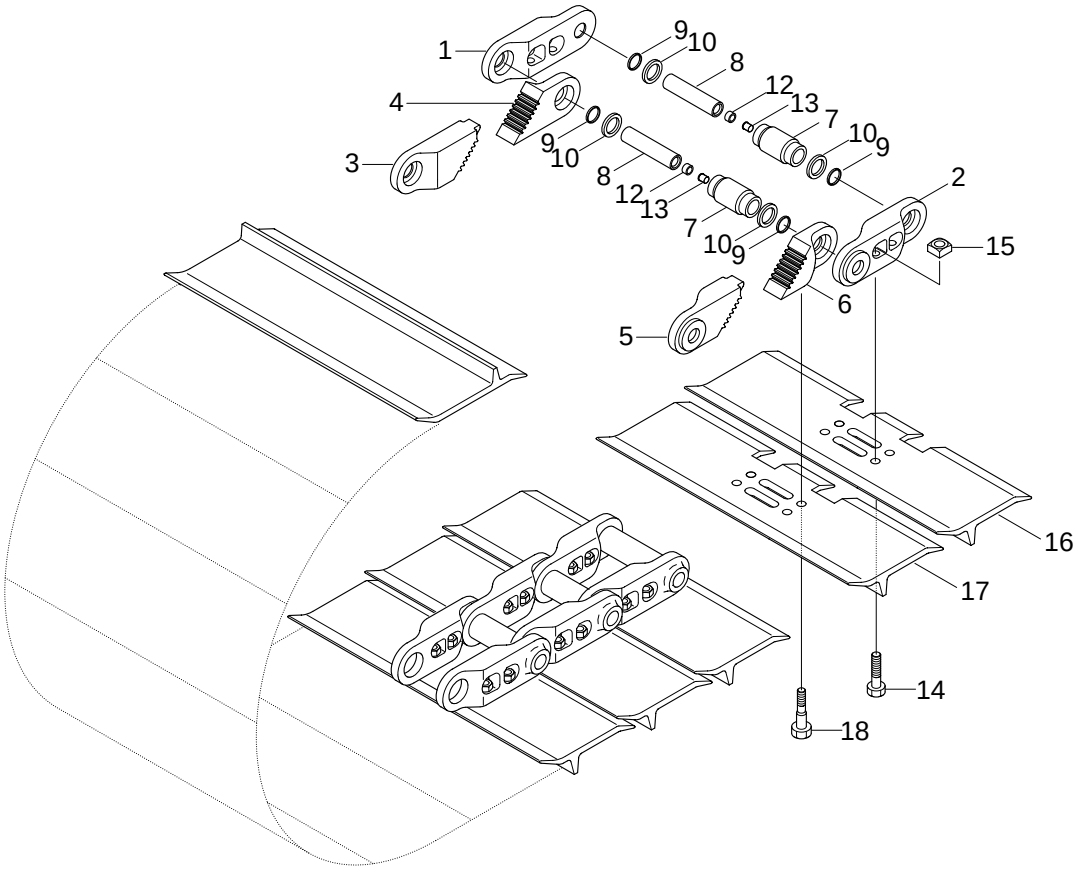
For correct machine operation, the tension spring nut must be installed and held in position of the rear face of the tension spring bolt. The tension spring nut is then held in position by installation of the bolt in the end of the tension spring bolt.

Track adjustment

Track adjustment is made by the hydraulic mechanism for track adjustment. Pressure grease is pumped into grease(8). This moves idler yoke(9) and front idler forward. The movement of the front idler tightens the track. The tension on the track is released by a grease plug.

⚠ **Never visually inspect the vent holes or valves to see if grease or oil is coming out of them. Make sure the vent holes are clean before the tension is released on the track. Watch the idler yoke to see that it moves.**

6) TRACK CHAIN ASSY



1	RH link	7	Bushing	14	Track shoe bolt
2	LH link	8	Pin	15	Track shoe nut
3	RH half link	9	Thrust ring	16	Track shoe
4	RH half link	10	Seal	17	Master track shoe
5	LH half link	12	Rubber stopper	18	Master link bolt
6	LH half link	13	Plastic plug		

Each track assembly has links, pins, bushings, thrust rings, plastic seal assemblies, rubber stoppers and plastic plugs.

Each of track links(1) and (2) makes a fit over the track links in front of them. Link(1) makes a fit over link(4). Link(2) makes a fit over link(6). The connection of the track links makes the track assembly.

Each link has a counterbore in the end which makes a fit with the link in front of it. Seal assemblies(10) are installed in the counterbores of the links. Each seal assembly has a load ring and a seal ring. The load ring pushes the seal ring against the end of bushing(7) and the link counterbore. The seal ring gives a positive seal between the bushing and the link counterbore. The edge of the seal ring is against the end of the bushing. Thrust rings(9) are installed on pin(8). The thrust rings give a specific amount of compression to the seal assemblies and control the end play(Free movement) of the joint. The arrangement of the seal assemblies and thrust rings keep foreign material out of the joint and oil in the joint.

Pin(8) has a hole almost the full length of the pin. Hole is drilled radially in the pin near the center of the pin. Radial hole lets oil flow to the surface between pin(8) and bushing(7) and to the lip of the seal rings. The oil gives lubrication to the pin and bushing and also makes the lip of the seal ring wet. The lip of the seal ring must be kept wet to prevent wear on the lip of the seal ring. Oil is kept in the pin by stopper(12) and plug(13). The oil is installed in the pin through a hole in the center of stopper(12). When the chambers in the pin are filled, plug(13) is installed in stopper(12).

Each pin and bushing assembly is sealed and has its own lubrication ; The result is no internal wear on the joint. The interval for the turning of the track pins and bushings is much longer because the only wear is on the outside of the bushings and the links.

Two piece links(3, 4, 5, 6) and master shoe(17) are held together with master link bolts(18).