

# Hydraulic Mobile Cranes

## Product knowledge guidebook

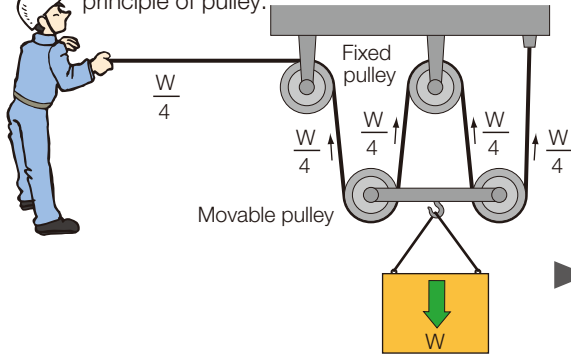


# 1 BASIC PRINCIPLE OF CRANE

A crane is a machine to be operated by combining the principle of pulley, Pascal's law, principle of leverage, and balance of moment of forces.

### [1] Principle of pulley

A crane increases the hoist-up force of the winches in combination of fixed and movable pulleys by applying the principle of pulley.

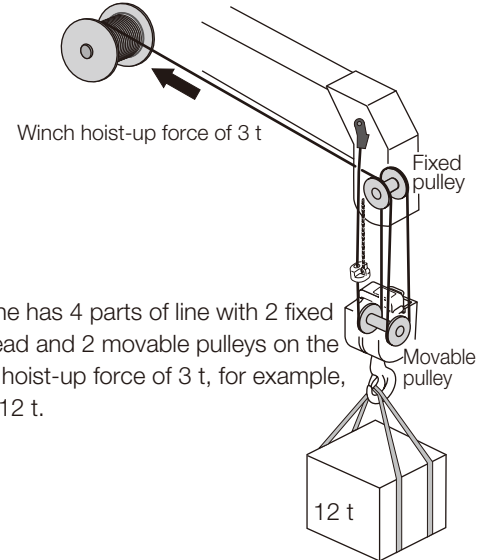


In the case of 4 parts of line in combination of 2 fixed pulleys and 2 movable pulleys, a load of 100 kg can be hoisted up with a force of 25 kg.

Note that the hoist-up speed for the load will be 1/4.

► Applied to crane

Assuming that the crane has 4 parts of line with 2 fixed pulleys at the boom head and 2 movable pulleys on the hook block, the winch hoist-up force of 3 t, for example, can hoist up a load of 12 t.

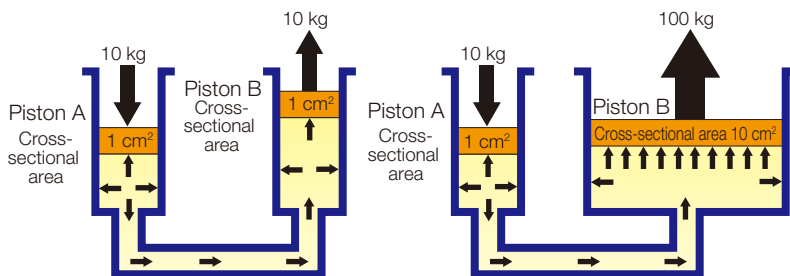


### [2] Pascal's law

A crane works using hydraulic force and obtains a larger force by applying the Pascal's law.

The Pascal's law indicates that a pressure applied to some portion of a static fluid in a sealed container will be transmitted to any portion of the fluid with the same intensity.

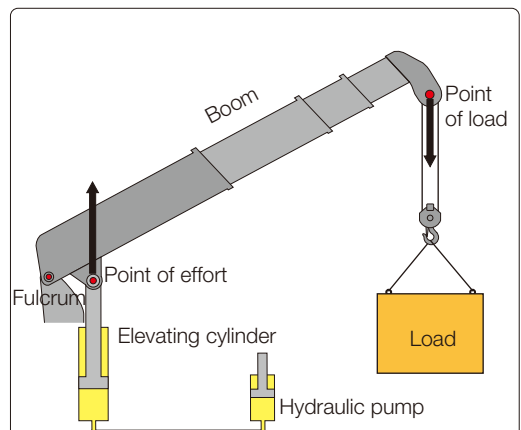
The Pascal's law is a principle discovered by Pascal, a scientist in France. Pascal (Pa), the unit of pressure, is named after his name.



When the piston A is pushed at a force of 10 kg, the piston B which has the same cross-sectional area will be pushed up with a force of 10 kg.

When the piston A is pushed at a force of 10 kg, the piston B which has the 10-time larger cross-sectional area will be pushed up with a force of 100 kg.

► Applied to crane



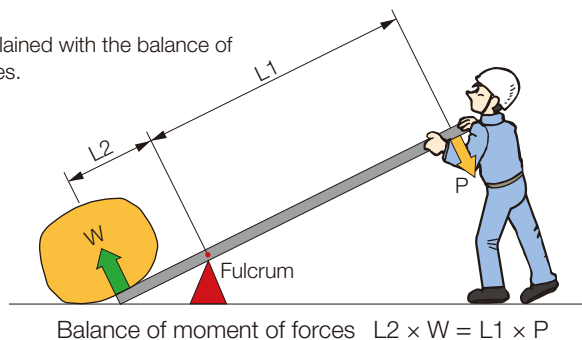
The hydraulic pressure generated in the hydraulic pump is led to the hydraulic cylinder (or hydraulic motor) having a large cross-sectional area and the force is increased there by applying the Pascal's law to move the crane. Further, the load is lifted up by applying the principle of leverage and balance of moment of forces.

► Applied to crane

### [3] Principle of leverage and balance of moment of forces

The principle of leverage means when  $L_1$  is made larger than  $L_2$ , a heavy object  $W$  can be lifted with a smaller force  $P$ .

This can be explained with the balance of moment of forces.



$$\text{Balance of moment of forces } L_2 \times W = L_1 \times P$$

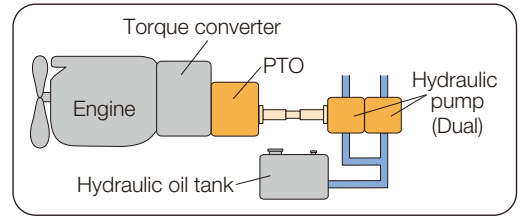
## 2 KNOWLEDGE OF HYDRAULIC PRESSURE

### [1] Basic knowledge of hydraulic pressure

#### (1) Generation of hydraulic pressure

Most of crane operations are made by the force of hydraulic pressure. The engine power is taken out by the PTO and converted to the hydraulic pressure by the hydraulic pump. Then, a larger force is generated by applying the Pascal's law to move the crane.

PTO: A device that transfers power from the engine. Turning to "ON" will drive the hydraulic pump.



#### (2) Advantages of converting engine power to hydraulic pressure - Advantages of hydraulic pressure

- Even with small hydraulic equipment, a large force can be achieved with higher hydraulic pressure.
- By controlling the pressure, the force can be easily and accurately controlled.
- By continuously changing the hydraulic oil flow rate, continuous variable shifting can be achieved easily.
- Because the hydraulic oil is light in weight and the hydraulic equipment is also compact, operations are smooth with less vibration.
- Because the hydraulic oil acts also as lubricating oil, high durability can be ensured with very little wear.
- By connecting multiple units of hydraulic equipment with pipes, an easy remote operation is also possible.
- By connecting with pipes, some units of hydraulic equipment can be added optionally.

Disadvantage of hydraulic pressure: Piping consumes time and labor, there is a risk of (flammable) hydraulic oil leak, and hydraulic oil is affected by a temperature change.

Disadvantage of water pressure: Water corrodes metals, with low viscosity and almost no lubricity. At a temperature below 0°C, water will be solidified, and at a temperature exceeding 100°C, it will be vaporized.

Disadvantage of air pressure: Because the air is highly compressive, the positioning and response are poor, and lubricating measures are required.

#### (3) Pressure and flow rate

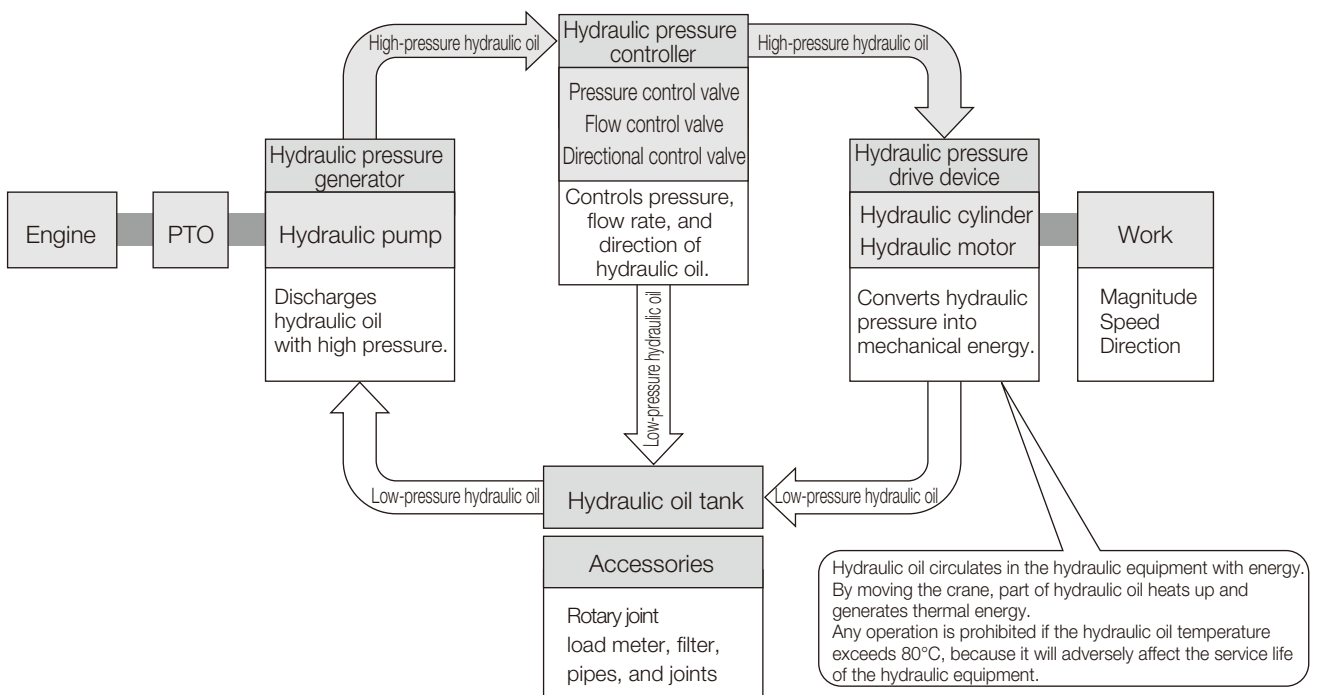
Pressure ... Pressure is a force acting on unit area, and the unit of hydraulic pressure is MPa.

The higher the hydraulic pressure is, the larger the force of the hydraulic cylinder and hydraulic motor will be.

Flow rate ... Flow rate is an amount of hydraulic oil flowing per unit time and generally indicates the fluid amount flowing per minute. The unit is L/min.

The higher the flow rate is, the faster the hydraulic cylinder telescoping speed and hydraulic motor speed will be.

#### (4) Configuration of hydraulic equipment



## 2 KNOWLEDGE OF HYDRAULIC PRESSURE

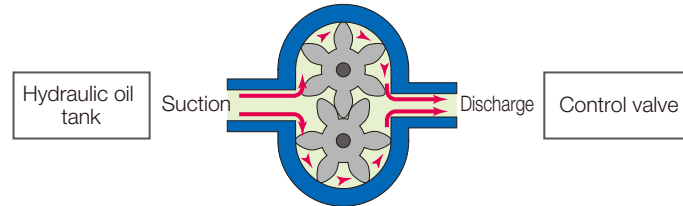
### [2] Hydraulic equipment

#### (1) Hydraulic pressure generator

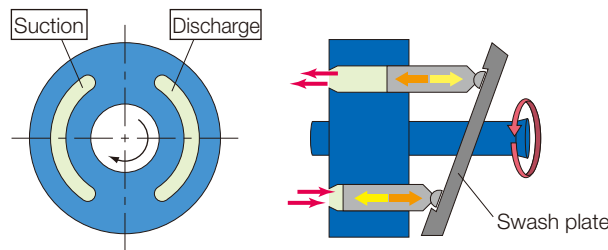
##### Hydraulic pump

The hydraulic pump is a hydraulic oil pressure generator driven by the engine or the like, sucking oil from the hydraulic oil tank, discharging it as pressurized oil, sends it to the hydraulic cylinder, hydraulic motor, etc. via the control valve. Cranes are equipped with gear pumps and piston pumps.

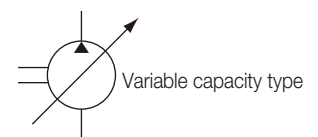
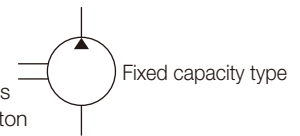
Gear pump: Sucks, discharges, and transfers oil to the discharge port as the engaged gears rotate.



Piston pump: Discharges oil as a result of a reciprocating motion of the piston, which is caused by its end sliding on the swash plate surface. Cranes are equipped with variable capacity piston pumps that can increase/decrease the discharge amount by changing the inclination angle of the swash plate.



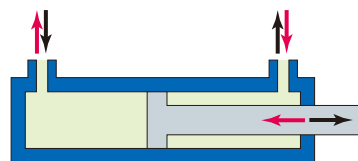
JIS symbols



#### (2) Hydraulic pressure drive device

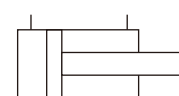
##### ① Hydraulic cylinder

This is a device that can perform a linear motion with hydraulic pressure. Cranes are equipped with reciprocating hydraulic cylinders. Reciprocating hydraulic cylinder has a structure that can supply pressurized oil to the both sides of the piston, and is used as the boom telescoping cylinder, elevating cylinder, outrigger jack cylinder, etc.



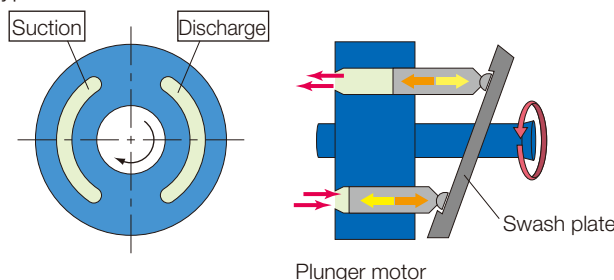
Reciprocating hydraulic cylinder

JIS symbol



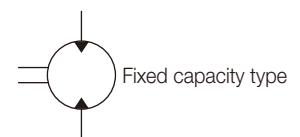
##### ② Hydraulic motor

This is a device that can perform a rotary motion continuously with hydraulic pressure. The hydraulic pump discharges oil as the drive shaft rotates. On the contrary, the hydraulic motor shaft rotates when the oil is pushed in. The winches and slewing device are equipped with an hydraulic motor called a plunger motor, which has the fixed capacity type and variable capacity type.



Plunger motor

JIS symbols





## 2 KNOWLEDGE OF HYDRAULIC PRESSURE

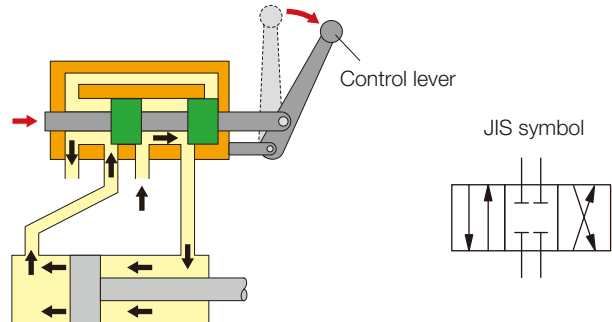
### (3) Hydraulic pressure controller

Includes the pressure control valve, flow control valve, and directional control valve that control the pressure, flow rate, and direction of oil flow respectively.

#### ① Control valve

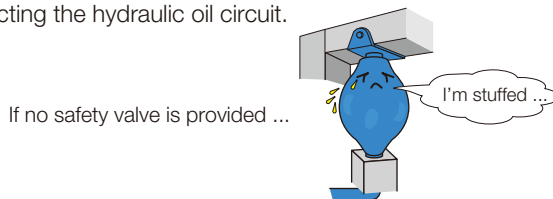
Control valve is a directional control valve that switches the pressurized oil flow direction (moving direction of the hydraulic cylinder and hydraulic motor). In the crane, an operator operates this valve using the control lever to control the operation direction and speed.

All terrain cranes are equipped with the electrical operating system that switches the directional control valve (proportional solenoid control valve) with electrical signals generated by operating the electrical lever.



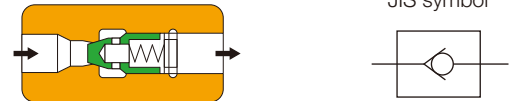
#### ② Relief valve (safety valve)

Relief valve is a pressure control valve that prevents the pressure from exceeding the set pressure by releasing part or all of the oil automatically when the pressure in the hydraulic circuit reaches and exceeds the set pressure, protecting the hydraulic oil circuit.



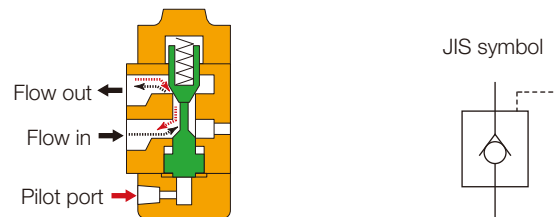
#### ③ Check valve

Check valve is a directional control valve that allows the oil to flow in one direction freely, but completely stops it to flow in the opposite direction.



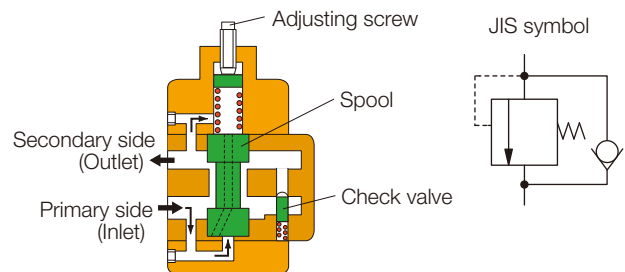
#### ④ Pilot check valve

Check valve is a directional control valve that allows the oil to flow in one direction freely, but completely stops it to flow in the opposite direction. The pilot check valve has a function to allow the oil to flow in the opposite direction by using the pilot pressure (pressure delivered for operation) and used as the hydraulic cylinder lock device to prevent each jack cylinder from being retracted.



#### ⑤ Counterbalance valve

The boom telescoping cylinder and elevating cylinder are equipped with the counterbalance valve that allows the oil to flow freely when the boom is raised, but prevents the boom from lowering suddenly due to self-weight by generating a pressure (back pressure) on the return side when the boom is lowered. This valve also acts as a hydraulic cylinder lock device to prevent the boom from lowering when any hose or pipe is damaged.



# 2 KNOWLEDGE OF HYDRAULIC PRESSURE

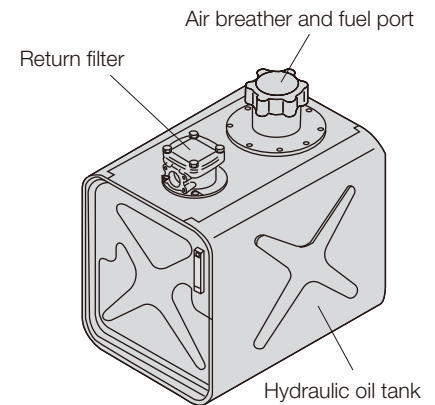
### (4) Hydraulic oil tank and accessories

#### ① Hydraulic oil

Use the TADANO genuine hydraulic oil “TADANO Hydraulic Oil LL” which has been especially refined for the use in hydraulic equipment. The hydraulic oil is a medium to transfer the pressure or power and also has other roles such as lubricating, sealing, preventing corrosion, and cooling. Therefore, sufficient maintenance and control are required.

#### ② Hydraulic oil tank

Hydraulic oil tank is a tank that stores the hydraulic oil and supplies it to the hydraulic circuit. It is equipped with the air breather on the fuel port, and the return filter in the pipe for returning the hydraulic oil in order to store and supply purified hydraulic oil without fail.



#### ③ Air breather

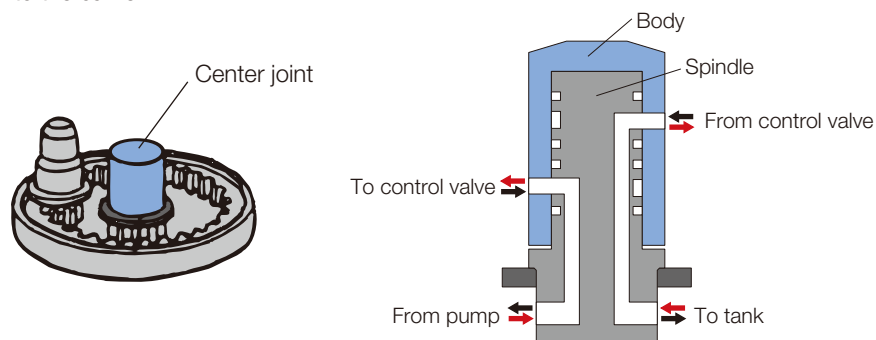
During crane operations, air will enter and exit from the hydraulic oil tank because the oil surface moves up and down. Air breather filters the passing air to prevent any dust and dirt in the air from entering the hydraulic oil tank. If the air breather is clogged, cracking will be caused on the hydraulic oil tank, causing hydraulic oil leak. Therefore, periodical replacement is required.

#### ④ Return filter

Return filter removes dust and dirt by filtering the hydraulic oil in the hydraulic circuit. Return filter is installed in the pipe returning the oil to the hydraulic oil tank. Replace the filter cartridge periodically.

#### ⑤ Center joint

Center joint is a joint used for preventing the hydraulic piping and electric wiring from being twisted by slewing of the crane. It is composed of the body and spindle. The body slews while being fixed onto the superstructure, and the spindle is fixed onto the carrier.



#### ⑥ Oil cooler

Continuously operating hydraulic equipment will increase the oil temperature. If the temperature becomes excessively high, the viscosity of the hydraulic oil will be lowered, and then the force and speed are also decreased, accelerating deterioration of sealing materials such as packing. The oil cooler is a device to lower the oil temperature.

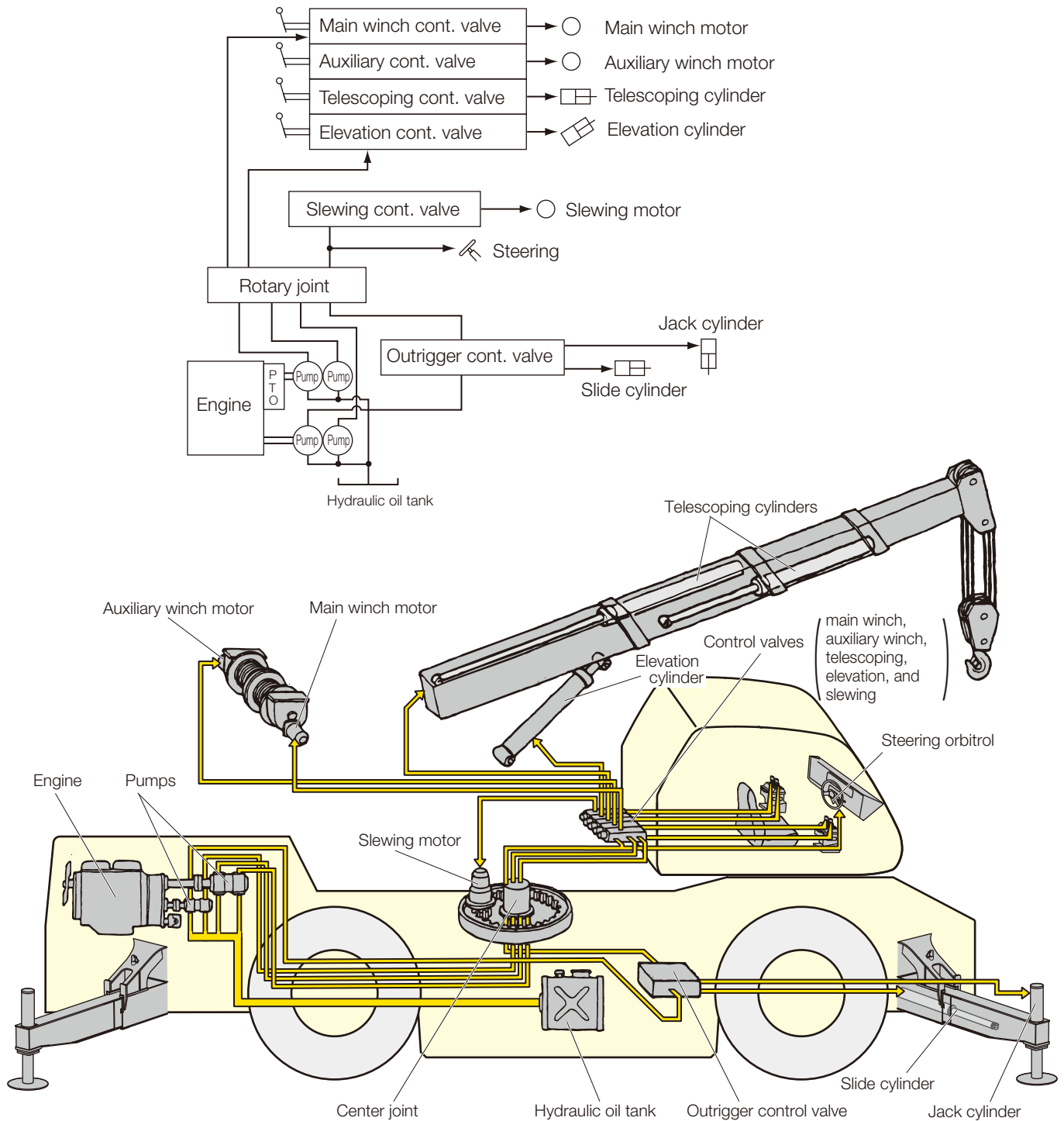
## 2 KNOWLEDGE OF HYDRAULIC PRESSURE

### [3] Hydraulic systems

The major hydraulic systems for equipment of rough terrain cranes are shown in the figure below.

When the operator operates a hydraulic control lever or pedal in the operator's cab, the hydraulic pressure generated by the hydraulic pressure generator operates the corresponding hydraulic pressure drive device such as a hydraulic cylinder and hydraulic motor.

An example of major hydraulic systems for rough terrain crane



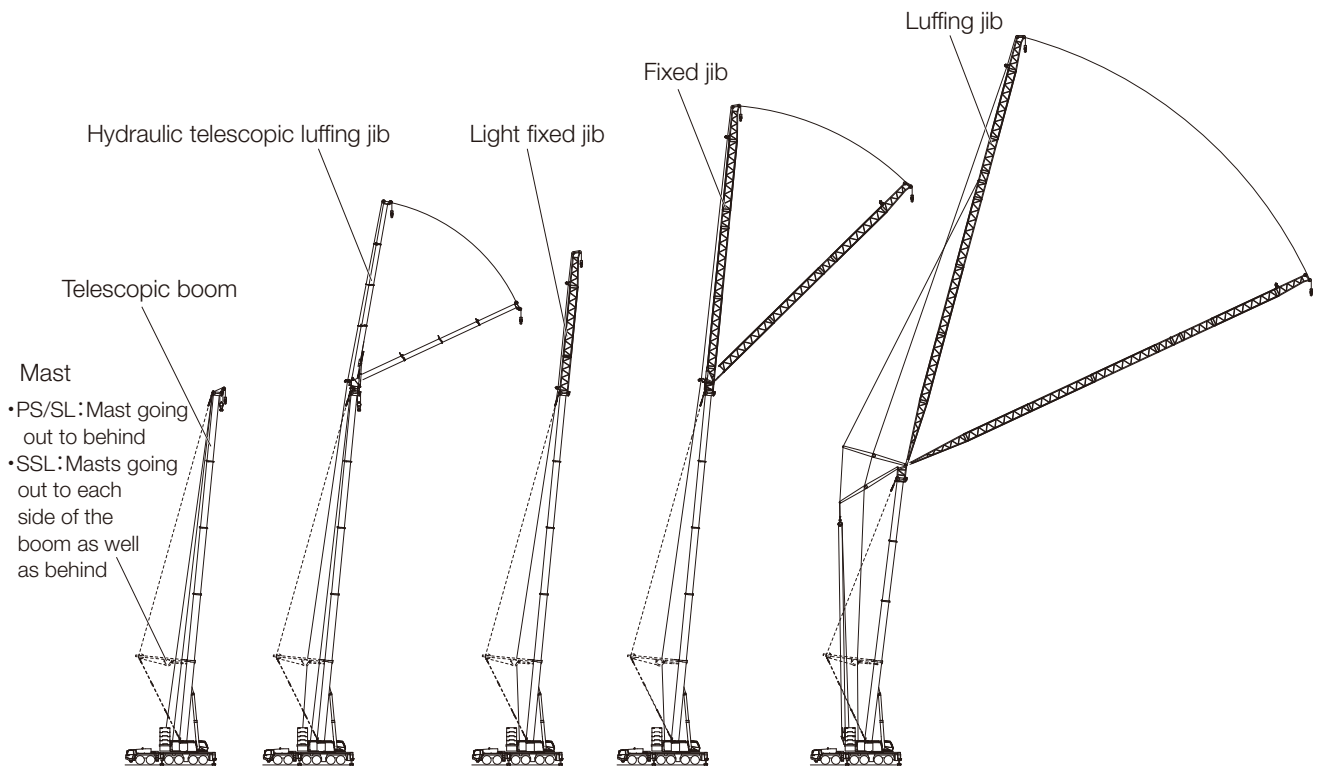
### 3 COMPONENT NAMES

Component names of rough terrain crane



## 3 COMPONENT NAMES

Component names of all terrain crane



### 4 BASIC TERMS ON CRANE

#### [1] Terms representing workable range

##### ① Boom length

The distance in the boom axial direction from the center of the boom foot pivot (foot pin) to the center of the sheave pin at the boom head

##### ② Boom angle

The angle formed between the boom center line and horizontal line

##### ③ Jib length

The distance in the jib axial direction from the center of the jib foot pivot (foot pin) to the center of the sheave pin at the jib head

##### ④ Jib offset angle

The angle formed between the boom center line and the jib center line when the jib is mounted on top boom

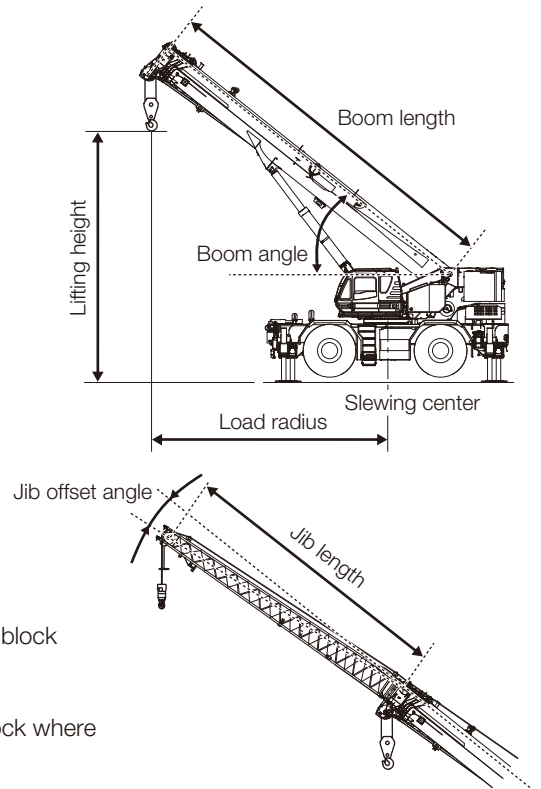
##### ⑤ Load radius

The horizontal distance from the slewing center to the center of the hook block

##### ⑥ Lifting height

The vertical distance from the upper limit to the lower limit of the hook block where it can be moved up and down effectively in each load radius

The lifting height is the vertical distance from the ground where the crane is placed to the lower end of the hook block.



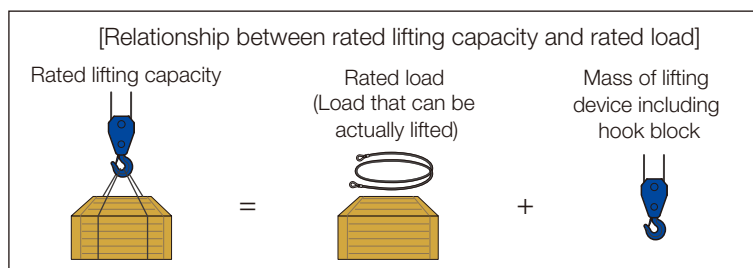
#### [2] Terms representing lifting loads and capacities

##### ① Rated lifting capacity

The maximum load that can be applied depending on the boom length, jib length, and load radius  
The total mass of the lifting device including the hook block, wire rope for rigging, and lifted load

##### ② Rated load

Load that can be actually lifted and calculated by subtracting the mass of the lifting device including the hook block from the rated lifting capacity



##### ③ Lifting capacity (maximum value of rated lifting capacity)

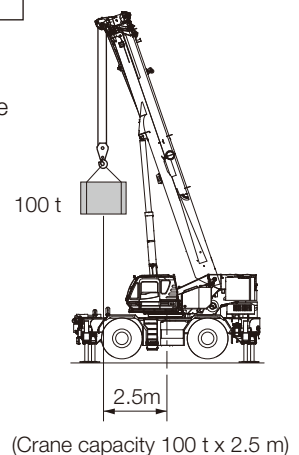
The maximum load that can be applied depending on the structure and materials of the crane

##### ④ No load

Status without any load lifted

##### ⑤ Crane capacity

The capacity of the crane is represented by "Rated lifting capacity x Load radius".  
The maximum value described above is the maximum crane capacity.





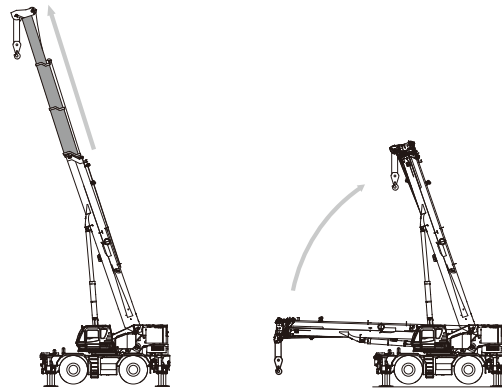
## 4 BASIC TERMS ON CRANE

### [3] Terms representing work-related speeds

#### ① Boom extension speed

Highest boom extension speed. Given in time (s) necessary for extension from the fully retracted to the fully extended conditions.

The speed 19.5 m in 82 s means 82 seconds are required for the boom to extend to 19.5 m.



#### ② Boom elevation speed

Time necessary for the fully retracted boom to be elevated from the lowest point to the highest.

The speed 0° to 83° in 58 s means that it takes 58 seconds to rise from 0° to 83°.

#### ③ Single line speed (hoist-up speed)

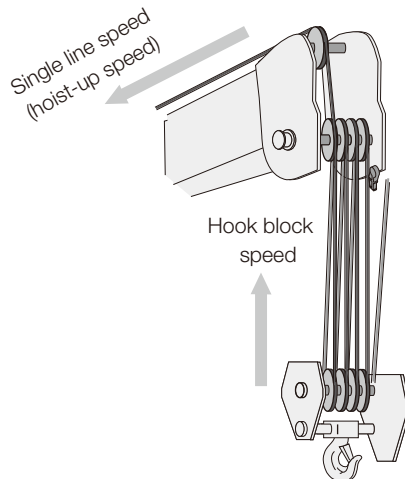
Highest speed for the winch to hoist up in a minute.

The speed 125 m/min (at the 4th layer) means that the winch can hoist up a load to 125 m in a minute with the winch drum having 4 layers on.

#### ④ Hook block speed

The maximum speed for the hook block to rise per minute.

Hook block speed is gained by dividing the single line speed (hoist-up speed) by the number of parts of line.



Example:

Single line speed (hoist-up speed) - 126 m/min

Number of parts of line - 7

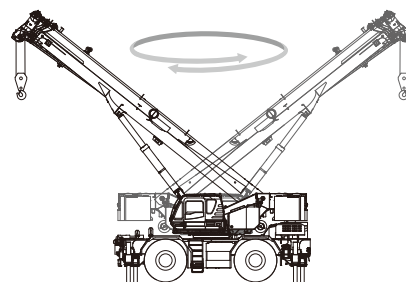
Hook block speed, then, is

$$\frac{126 \text{ m/min}}{7} = 18 \text{ m/min}$$

#### ⑤ Slewing speed

The maximum number of revolutions of the slewing table per minute.

The speed 3.0 rpm means 3 revolutions per minute.



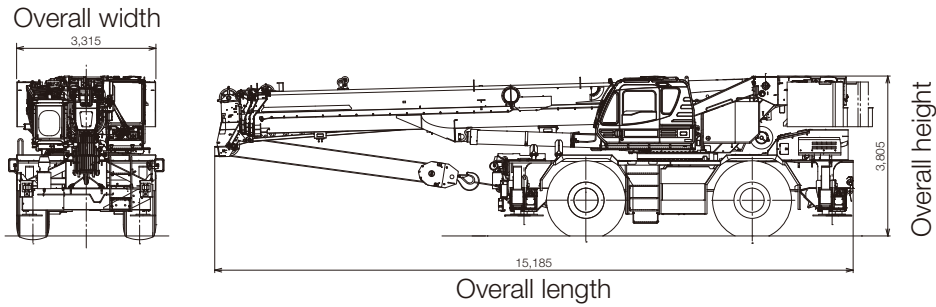
## 4 BASIC TERMS ON CRANE

### [4] Terms representing dimensions of vehicle

#### ① Overall length, overall width, and overall height

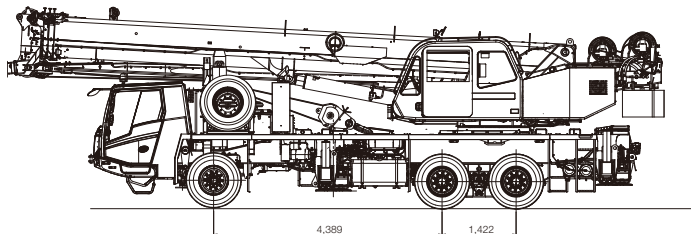
Dimensions as shown in the figure below, with the boom and outriggers fully retracted.

Antenna and rear-view mirrors are not included.



#### ② Wheel base

The distance between the axle centers. In the case of 3 axles or 4 axles, it is shown by both their interaxle distances and the total of distances.

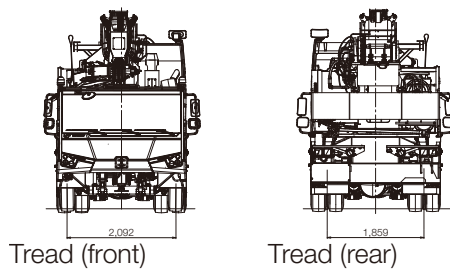


Wheel base:  $4389+1422=5811$

#### ③ Tread (track)

The distance between the centers of contact face formed by tires and road surfaces.

In the case of double wheels, the distance between the centers of double wheels.

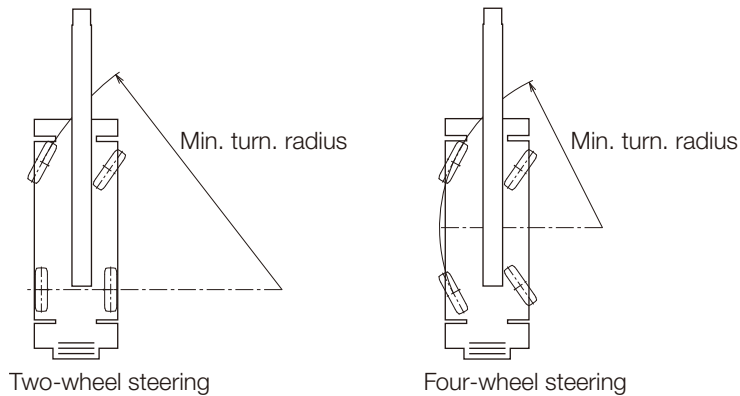


## 4 BASIC TERMS ON CRANE

### ④ Minimum turning radius

Performance showing how small a turn of the vehicle is.

Shown by a radius of the locus drawn slowly by the outermost wheel when driving on the flat pavement with the steering wheel turned utmost.

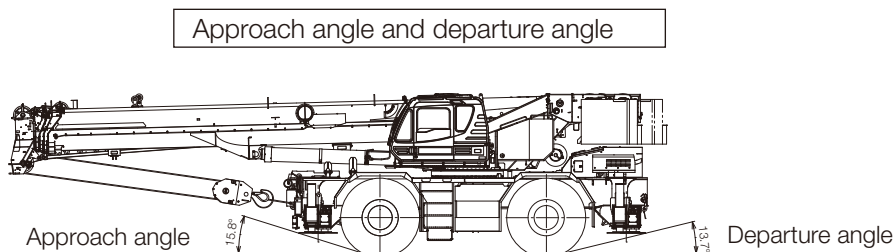


### ⑤ Approach angle

The angle formed between the ground surface and the contact face of the vehicle's front bottom and the circumference of the foremost wheel.

### ⑥ Departure angle

The angle formed between the ground surface and the contact face of the vehicle's rear bottom and the circumference of the rearmost wheel.



## 4 BASIC TERMS ON CRANE

### [5] Terms representing weights of vehicle

#### ① Vehicle weight (VW)

Weight of vehicle only without persons and loads.

Exactly, fuel, oil, cooling water and so on are provided as specified, but a spare tire and wheel and tools excluded.

#### ② Gross vehicle weight (GVW)

Vehicle weight plus weight of the occupants of seating capacity and maximum loading (maximum weight of a load to be carried on the truck).

However, for rough-terrain cranes and truck cranes having no maximum loading, this comes out;

$$GVW = VW + \text{Weight of the occupants of seating capacity (65 kg/person)}$$

### [6] Terms representing traveling performance of vehicle

#### ① Maximum traveling speed

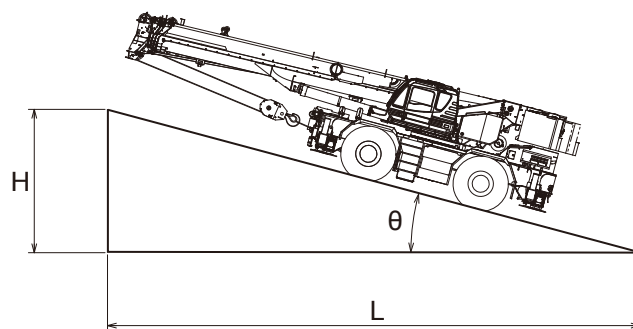
Performance showing how fast the vehicle with its GVW runs.

Shown in km/h.

#### ② Gradeability

Performance showing how steep an inclination the vehicle can climb up.

The maximum inclination in  $\tan \theta$  (dry paved road) where the vehicle can start with GVW condition.



Note: This is a value calculated from the engine torque (rotating force), powerline, variable-speed, etc.

The approaching angle and departure angle may also be considered.

In reality, the value is determined by the friction coefficient between the road surface and tires.

When the friction coefficient is 0.4, the maximum climbable inclination will be approximately 20°.

$$\tan \theta = \frac{H}{L}$$

Example: When  $\tan \theta = 0.60$ ,  $\theta = 30.9^\circ$

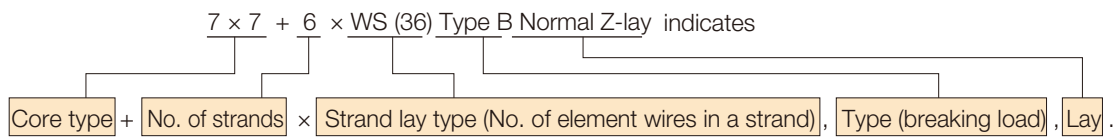
When  $\tan \theta = 0.57$ ,  $\theta = 29.6^\circ$

## 5 COMPONENT STRUCTURE (CRANE)

### Wire rope

Wire rope for the main and auxiliary winches is represented by the diameter × length. Twist resistant wire rope is a wire rope that is hard to be twisted.

Wire rope description

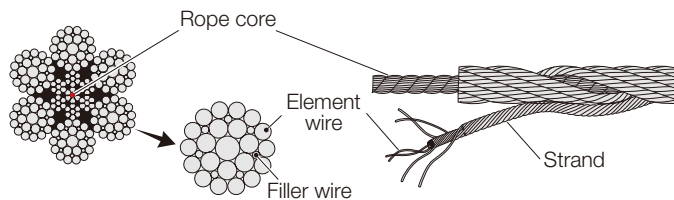


IWRC is a steel core of 7 × 7.

WS: Warrington Seale type

FI: Filler type

SeS: Semi-Seale type

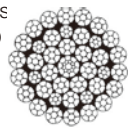


[No-spin wire rope]

With the following excellent characteristics this wire rope is mainly used for TADANO models with high lifting height.

Characteristics

- Hard to be tangled
- Excellent wear resistance



$$\text{Safety factor} = \frac{\text{Wire rope breaking load (kN)}}{\text{Max. load applied to wire rope (t)} \times 9.8}$$

[Precautions]

If a wire rope is broken, a serious accident will result in.

Check each wire rope periodically. If the replacement criteria are reached, immediately replace the applicable one.

Wire ropes used in cranes shall satisfy the safety factors specified in the standards for each country and region. The safety factors to be specified vary depending on the sections where wire ropes are used.

# 5 COMPONENT STRUCTURE (CRANE)

### ① Boom type

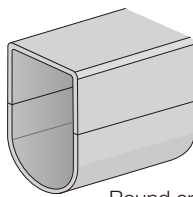
For the boom, the following structure is adopted; high tensile strength steel plates are bent and welded into box-shaped members which are assembled into a boom section, and telescoping is available by using the boom telescoping device provided inside. Light weight and high rigidity\* are required as well as sufficient strength against various loads as a crane.

High tensile strength steel\* ... Steel with higher tensile strength than normal steel.

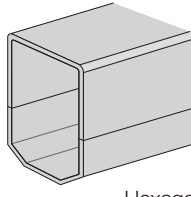
With the same strength, this steel can be thinner, resulting in reduced weight.

Rigidity\* ..... Hardness against dimensional change caused by bending or twisting force  
Changes depending on the thickness or boom sectional shape.

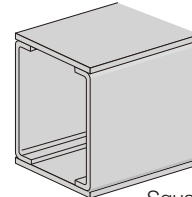
Round type The round type can use steel with higher tensile strength because the buckling strength of the lower plate is higher than that with the conventional cross section. For this reason, with the same strength, the weight can be reduced.



Round cross section



Hexagon cross section

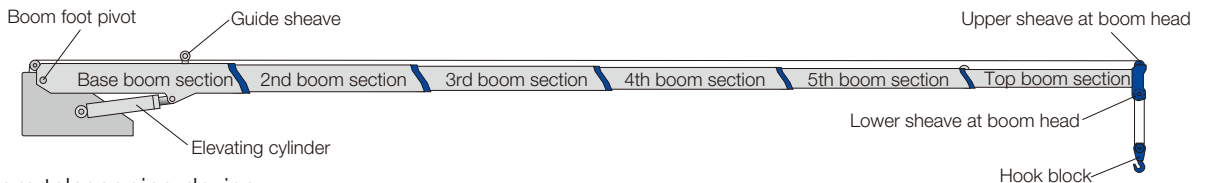


Square cross section

Six-section hydraulic telescoping type (2nd and 3rd boom sections simultaneously, and 4th, 5th, and 6th boom sections simultaneously)

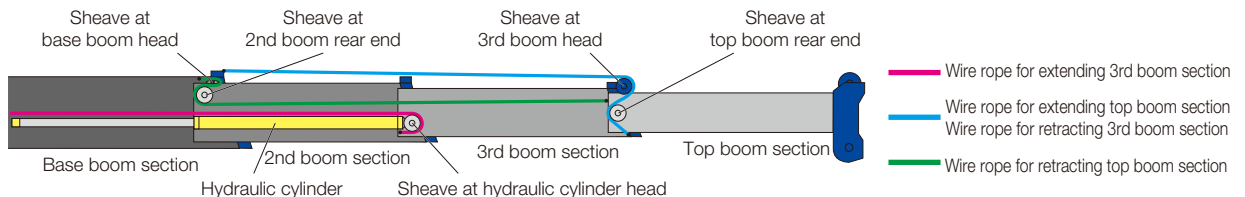
The telescoping type in which the 2nd and 3rd boom sections telescope simultaneously, and 4th, 5th, and 6th boom sections telescope simultaneously

Example of 6 boom sections



### ② Boom telescoping device

The boom telescoping device extends or retracts the boom sections using the hydraulic cylinder alone or hydraulic cylinder and wire ropes in combination.



### ■ Mechanism of wire-rope-type telescoping device

The wire-rope-type telescoping device consists of wire ropes for extending and retracting the boom sections and sheaves. Look at the figure above.

#### - When extended

When the hydraulic cylinder is extended, the 2nd boom section is then pulled out.

The wire rope for extending 3rd boom section is applied to the base boom rear end, sheave at hydraulic cylinder head, and 3rd boom rear end in this order.

When the hydraulic cylinder is extended, the 3rd boom section is then pulled out by the wire rope for extending 3rd boom section.

The wire rope for extending top boom section is applied to the base boom head, sheave at 3rd boom head, sheave at top boom rear end, and 3rd boom head in this order.

When the 3rd boom section is extended by the hydraulic cylinder, the top boom section is then pulled out by the wire rope for extending top boom section.

#### - When retracted

When the hydraulic cylinder is retracted, the 2nd boom section is then pulled in.

The wire rope for retracting top boom section is applied to the top boom rear end, sheave at 2nd boom rear end, sheave at base boom head, and top boom rear end in this order.

When the 2nd boom section is retracted, the top boom section is then pulled back by the wire rope for retracting top boom section.

The wire rope for retracting 3rd boom section is applied to the base boom head, sheave at 3rd boom head, sheave at top boom rear end, and 3rd boom head in this order.

When the top boom section is retracted, 3rd boom section is then pulled back by the wire rope for retracting 3rd boom section.



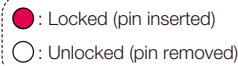
## 5 COMPONENT STRUCTURE (CRANE)

### ■ Pin lock (ESP) boom

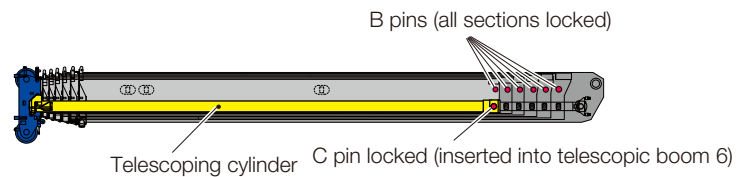
The pin lock boom is telescoped by one hydraulic cylinder and fixed by the pins. Just select the boom length on the Load Moment Indicator screen menu and operate the telescoping lever. The computer then automatically controls telescoping operations.

B pin: Pin fixing each boom section

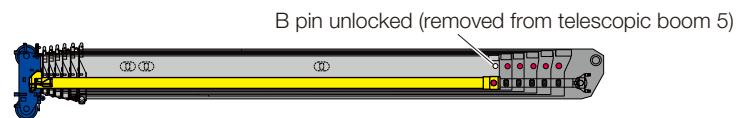
C pin: Pin fixing the telescoping cylinder tube and boom



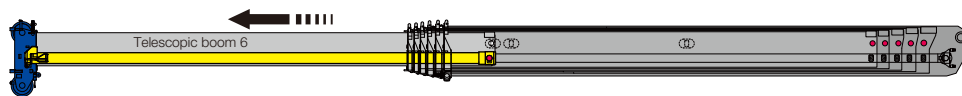
(1) Boom fully retracted



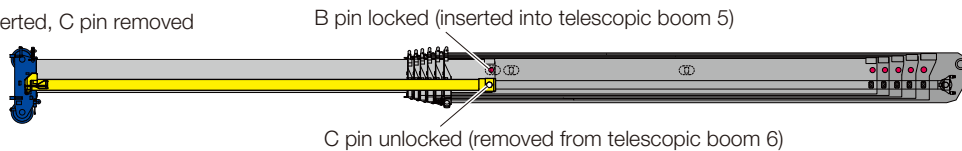
(2) B pin removed



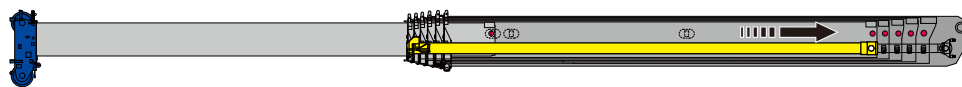
(3) Telescopic boom 6 extended



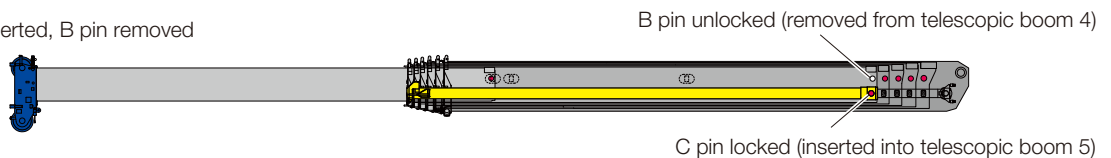
(4) After B pin inserted, C pin removed



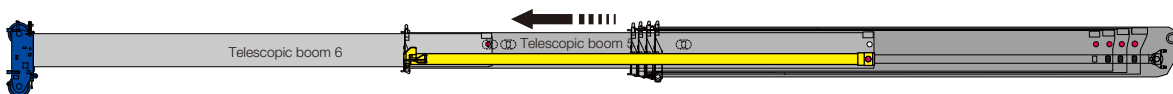
(5) Telescoping cylinder retracted The telescoping cylinder is retracted up to the telescopic boom 5 position.



(6) After C pin inserted, B pin removed



(7) Telescopic boom 5 extended (being extended) Repeat steps (3) to (6) to extend the boom fully.

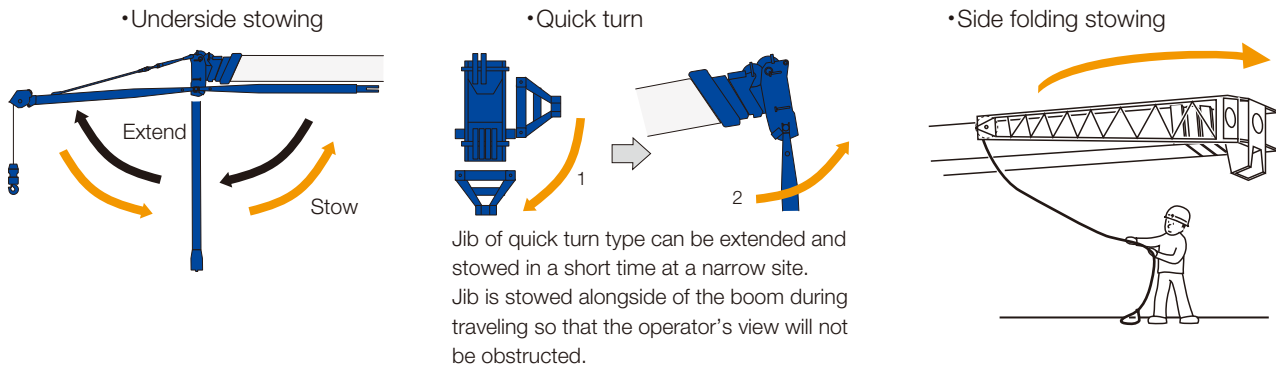


## 5 COMPONENT STRUCTURE (CRANE)

### ③ Jib

Jib is attached to the top of the boom for performing high reaching works that cannot be done only by using the boom. Jib is stowed alongside or underside, or removed during traveling or when not used.

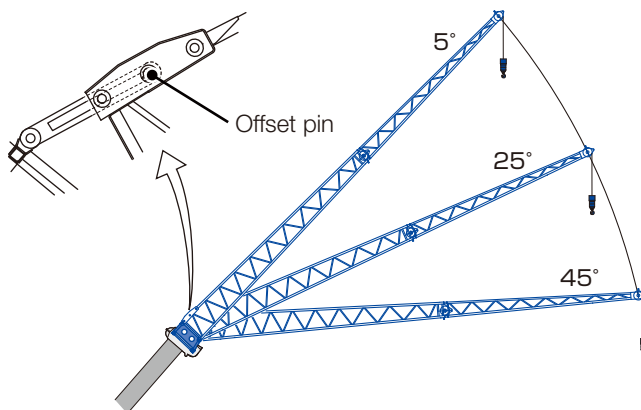
#### ■ Jib types based on ways of stowing



#### ■ Jib types based on ways of tilting and telescoping

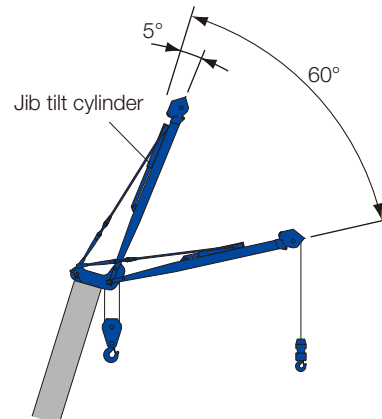
##### ● Standard jib

The offset angle can be changed in the specified levels by replacing the pins before operation.



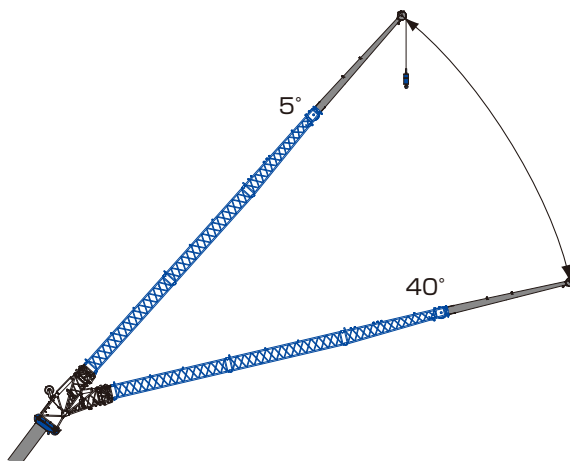
##### ● Power tilt jib

The offset angle can be changed continuously by the hydraulic cylinder in response to an operation in the operator's cab.



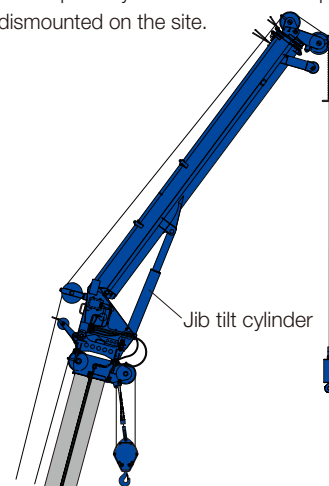
##### ● HLJ (Hydraulic Tilt Jib)

The offset angle can be changed continuously by the hydraulic cylinder in response to an operation in the operator's cab.



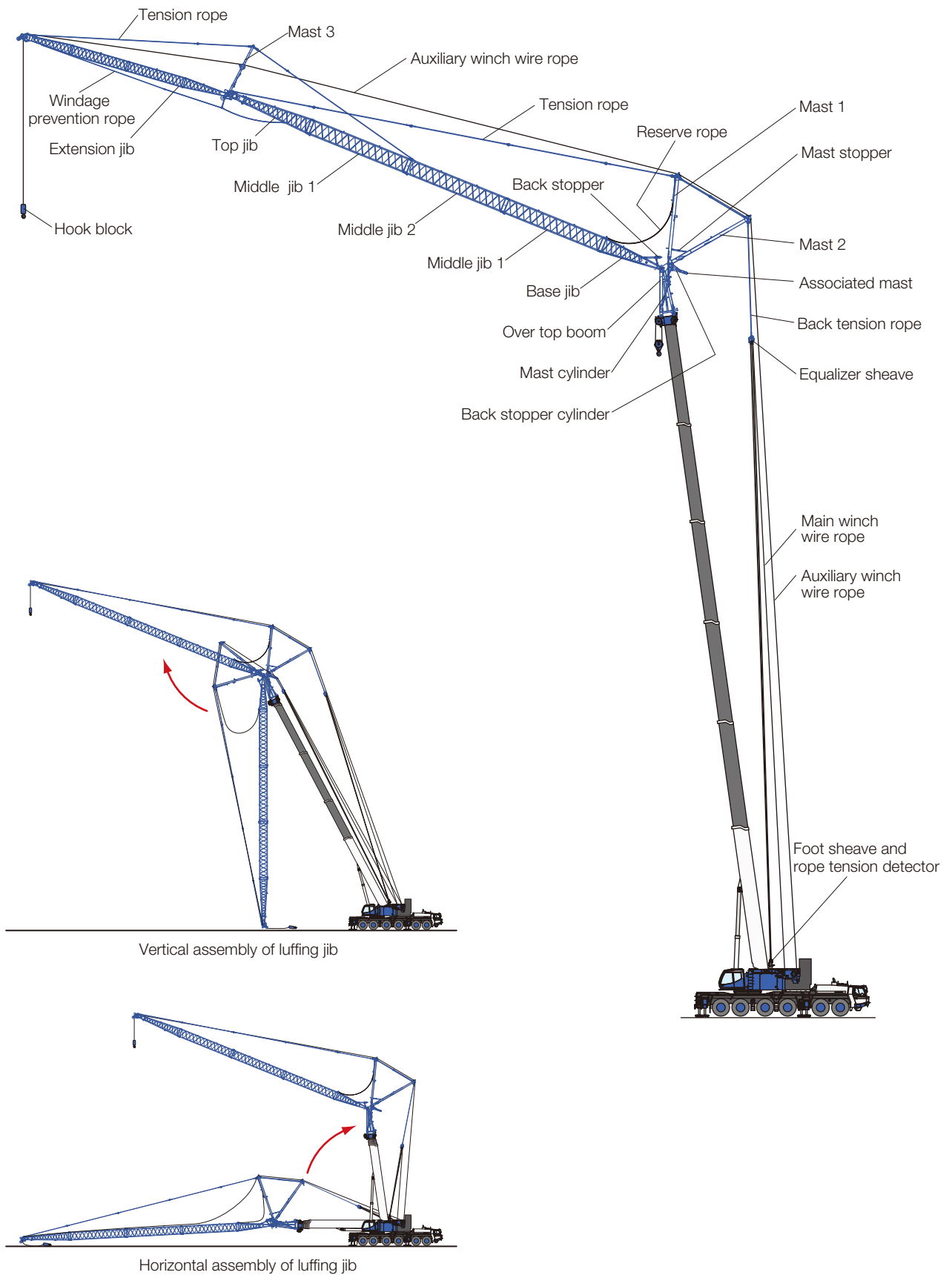
##### ● HTLJ (Hydraulic Telescoping Luffing Jib)

For jib of this type, jib telescoping and offset angle adjustment are performed by the corresponding hydraulic cylinder. The above operations can be performed in the operator's cab. Jib of this type is transported separately from the boom on a public road, and mounted/dismounted on the site.



## 5 COMPONENT STRUCTURE (CRANE)

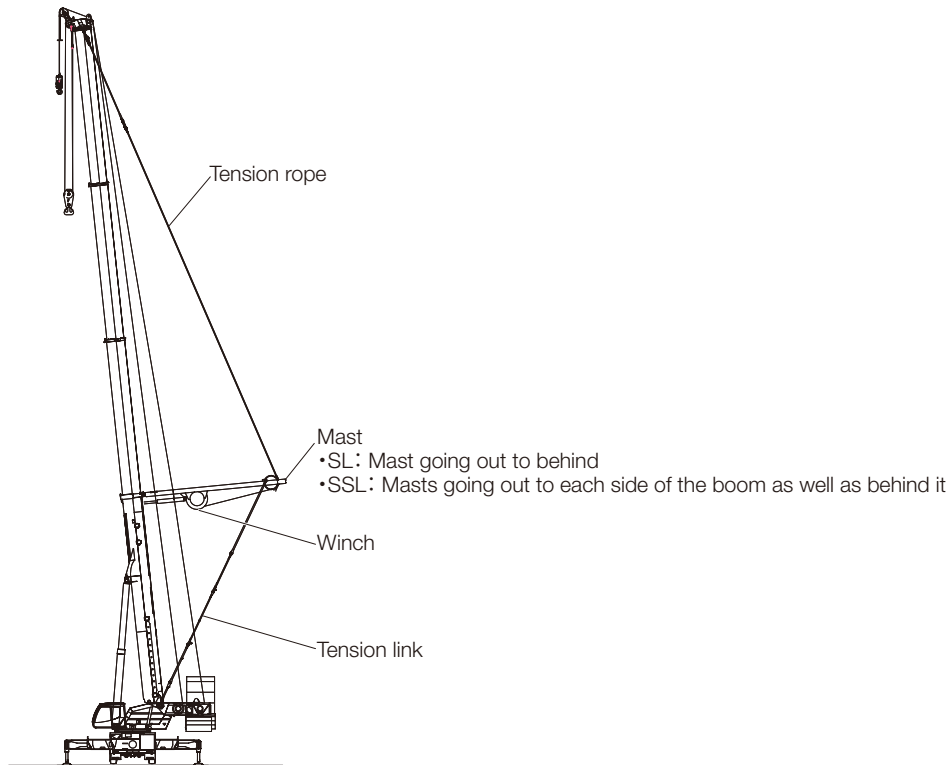
### ● Luffing jib



## 5 COMPONENT STRUCTURE (CRANE)

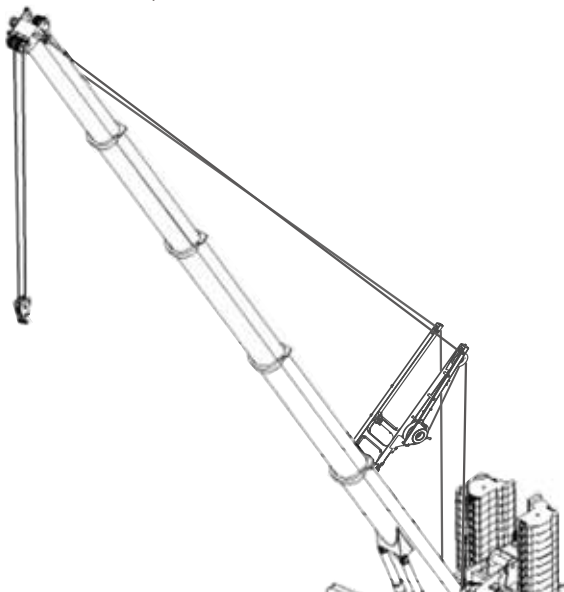
### ● Attachment for telescoping boom

"PS" and "SL" are attachments for telescoping boom for increasing a Crane's lifting capacity.  
In addition, SSL enhances the lifting capacity by providing extra lateral stability.  
When lifting with the boom in near vertical position at a low radius.

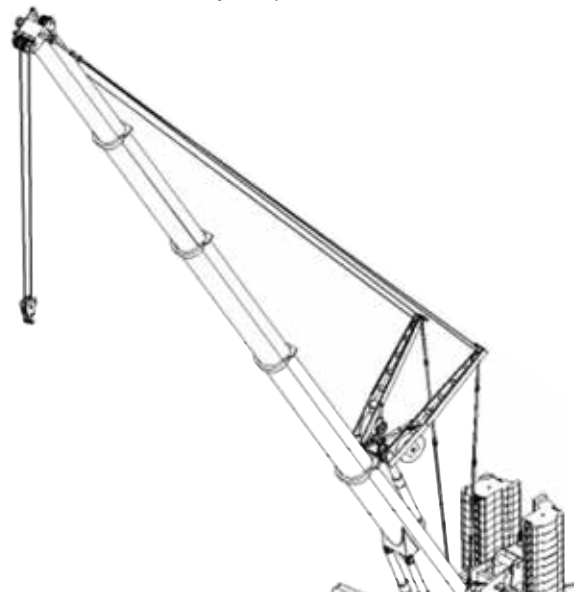


PS: Power System

SL: Super Lift



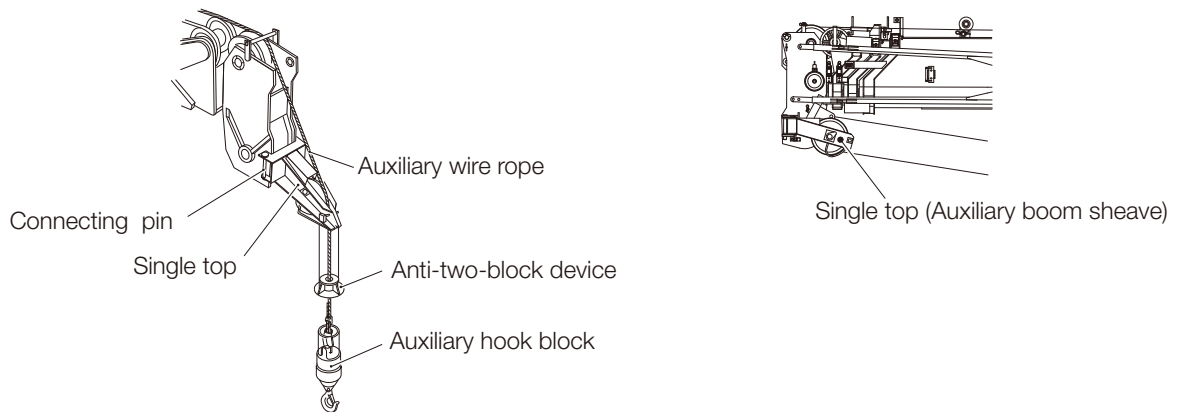
SSL: Sideways SuperLift



## 5 COMPONENT STRUCTURE (CRANE)

### ④ Single top (Auxiliary boom sheave)

This device is installed on the boom head and used for efficient lifting of a lighter load on a single-limited hook block.



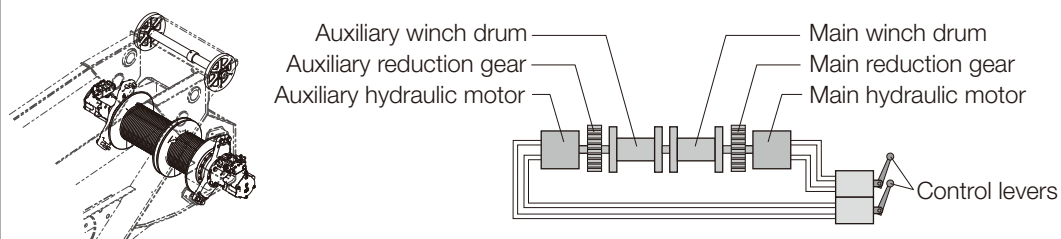
### ⑤ Winches

Usually composed of a main winch for boom operation and an auxiliary winch for jib or auxiliary boom sheave operation.

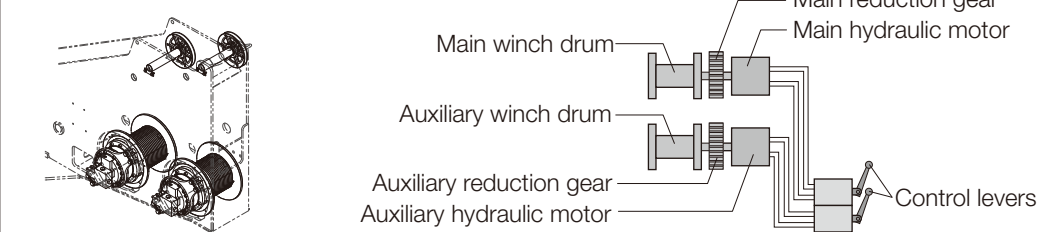
Each winch winds up the wire rope for load lift while operating the control lever, and the driving force is transmitted in the order of the winch hydraulic motor, reduction gear, clutch and winding drum.

#### ■ Placement of hoisting device

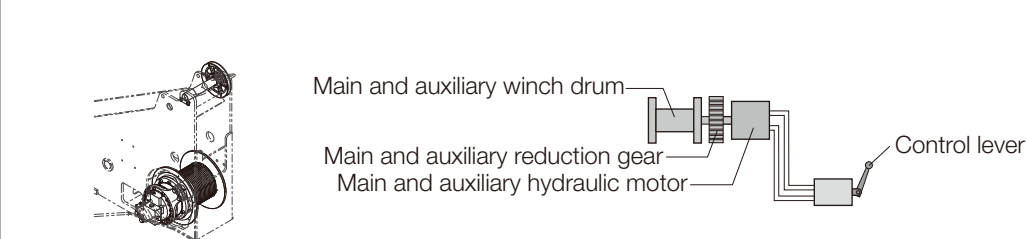
Two motors and two drums (two units of single winch-one axis)



Two motors and two drums (two units of single winch-two axis)



One motor and one drum



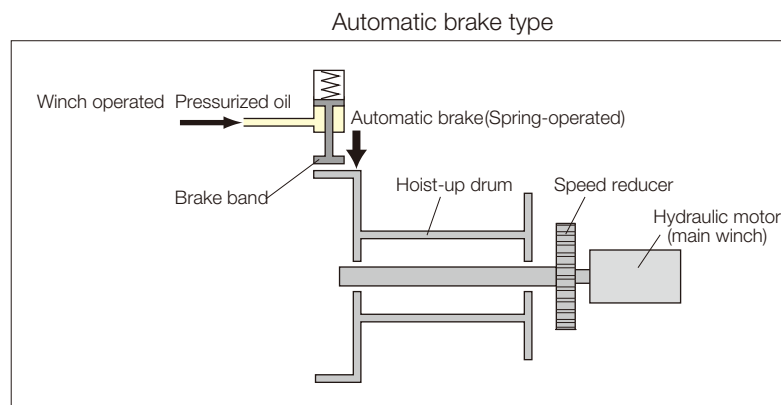
### 5 COMPONENT STRUCTURE (CRANE)

When the control lever is operated, the winch hydraulic motor is driven to rotate, decelerated by the winch speed reducer, and at the same time, generates a large torque proportional to the speed reduction ratio to rotate the drum. The hoist-up device is equipped with the winch brake to prevent the hook block from falling. The winch brake is an automatic brake system to be active all the time while no winch operation is performed. Models equipped with the free-fall device have the clutch to cut off power transmission during free-fall operation and foot-operated brake system.

#### High-speed hoist-down function

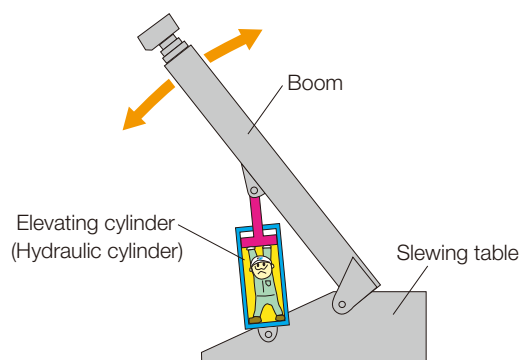
Models of automatic brake type not equipped with the free-fall device have the high-speed hoist-down function instead of the free-fall device, enabling highly safe and efficient hoist-down operations.

#### ■ Brake and clutch system



#### ⑥ Boom elevating device

A device that supports, raises and lowers the boom, and consists of 1 to 3 elevating cylinders (hydraulic cylinders). This device is connected to the boom with the upper pivot pin, and to the slewing table with the lower pivot pin.

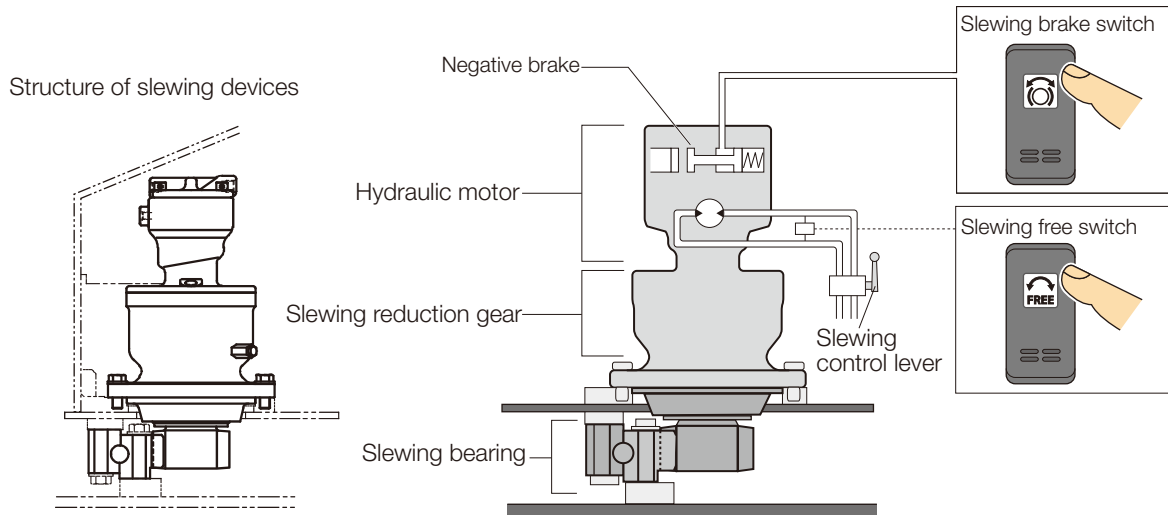




## 5 COMPONENT STRUCTURE (CRANE)

### ⑦ Slewing device

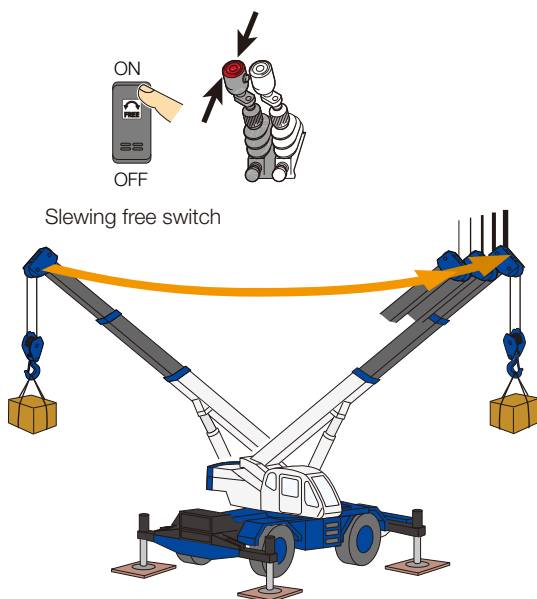
This device is to make the slewing table rotate. Operate the slewing control lever to transmit the power in the following order: Slewing motor → Slewing reduction gear → Pinion gear, to turn the external ring of slewing and the slewing table.



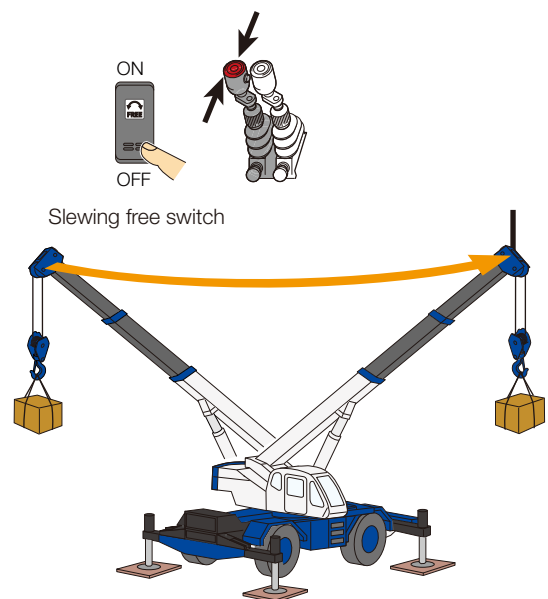
### Free slewing

There are two ways of boom slewing control. When the slewing control lever is returned to the neutral position, the slewing motion does not stop immediately but goes adrift in the case of "Free slewing". Instead, it stops instantly in the case the free slewing function is disabled.

The free slewing function is enabled



The free slewing function is disabled



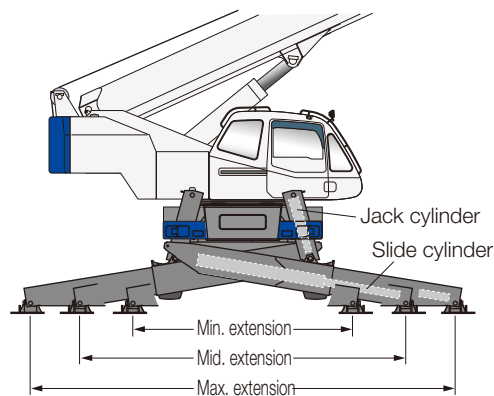
## 5 COMPONENT STRUCTURE (CRANE)

### ⑧ Outriggers

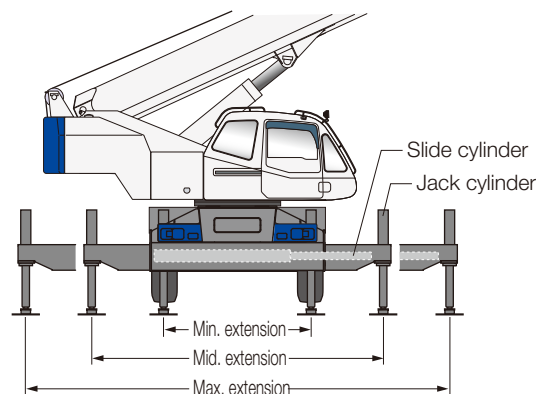
Outriggers are extended outside the chassis to support the crane for the purpose of increasing the crane stability. They include hydraulic cylinders called slide cylinders and jack cylinders. The receptors of the outriggers which make contact with ground are called outrigger floats. The distance between the centers of the right-side and left-side floats is called the outrigger extended width.

#### ■ Outrigger types

##### X-type outriggers



##### H-type outriggers

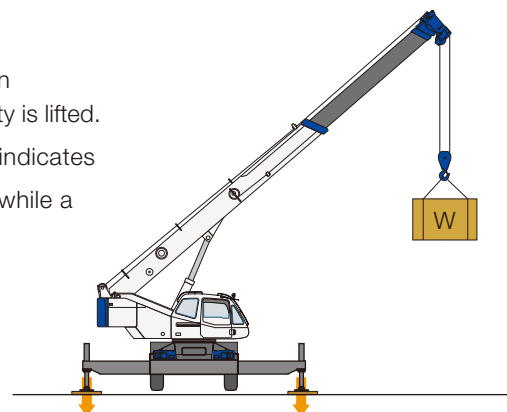


#### Maximum ground bearing load in service

This indicates the maximum load applied to the installation ground by one jack while a load of the rated lifting capacity is lifted.

The maximum ground bearing load in service of 42.6 t indicates that the maximum load of 42.6 t is applied to one jack while a load of the rated lifting capacity is lifted.

In creating a work plan, it is necessary to consider protection of the installation ground for the crane to withstand the maximum ground bearing load.

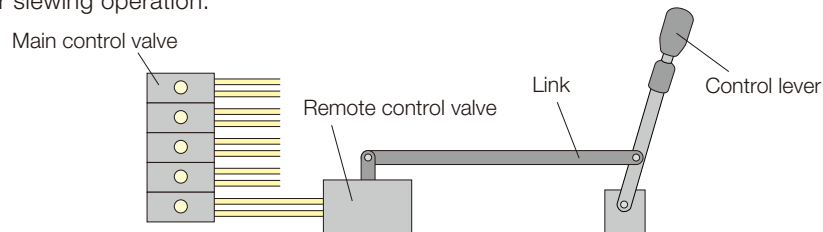


## 5 COMPONENT STRUCTURE (CRANE)

### ⑨ Control methods

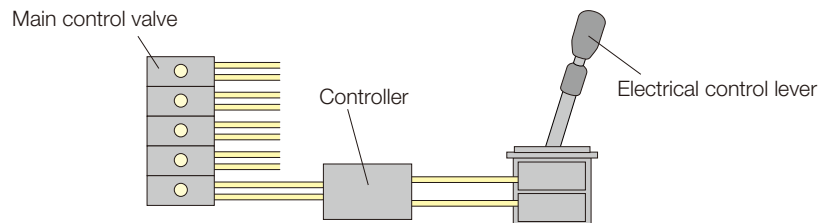
#### Hydraulic pressure pilot control method

By operating the control lever or control pedal for a boom elevating, main winch, auxiliary winch, telescoping, or slewing operation, the remote control valve is operated by the link and controls the corresponding main control valve using the pilot hydraulic pressure, conducting the boom elevating, main winch, auxiliary winch, telescoping, or slewing operation.



#### Electrical control method

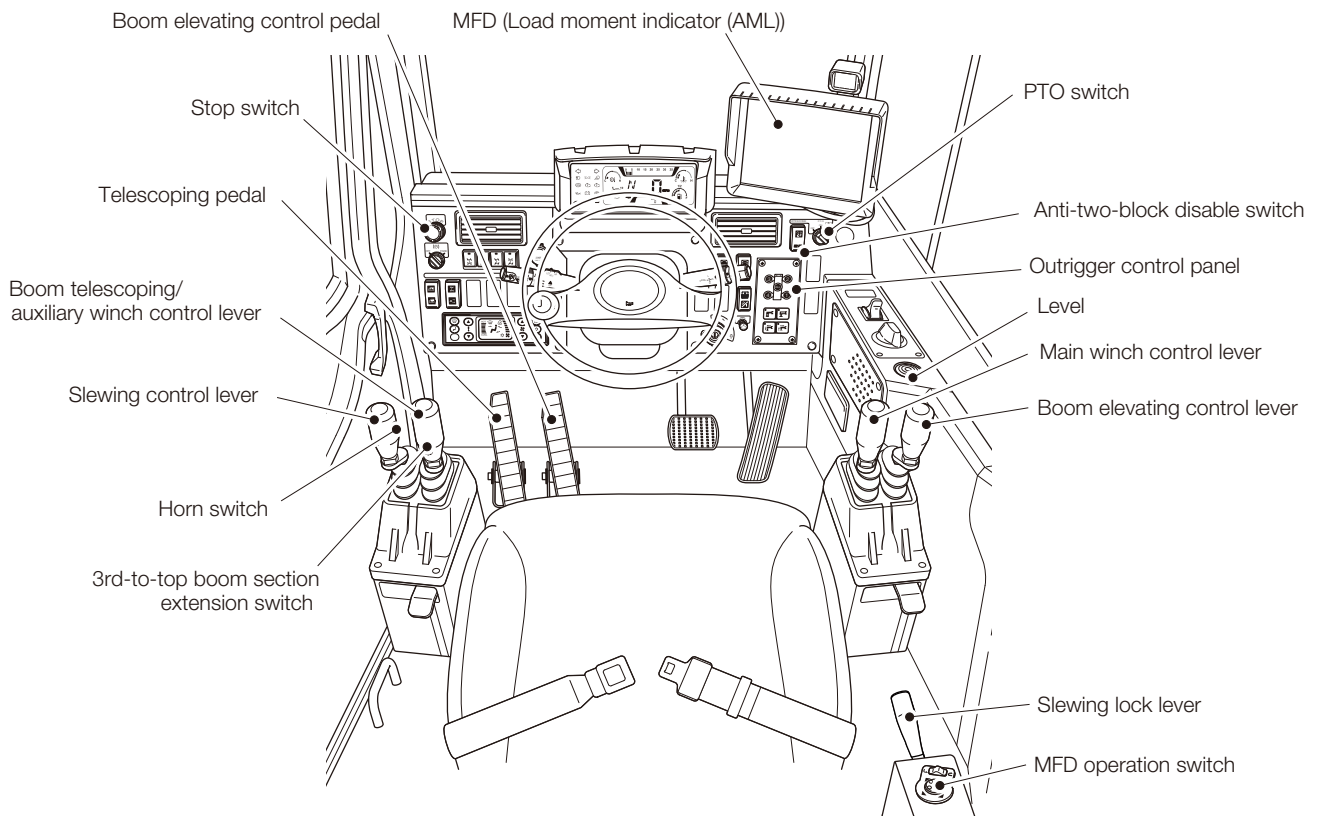
By operating the control lever or control pedal for each operation, the controller outputs the current corresponding to the electrical control lever operating amount to control its main control valve, conducting the intended operation of the crane.



### ■ Control devices

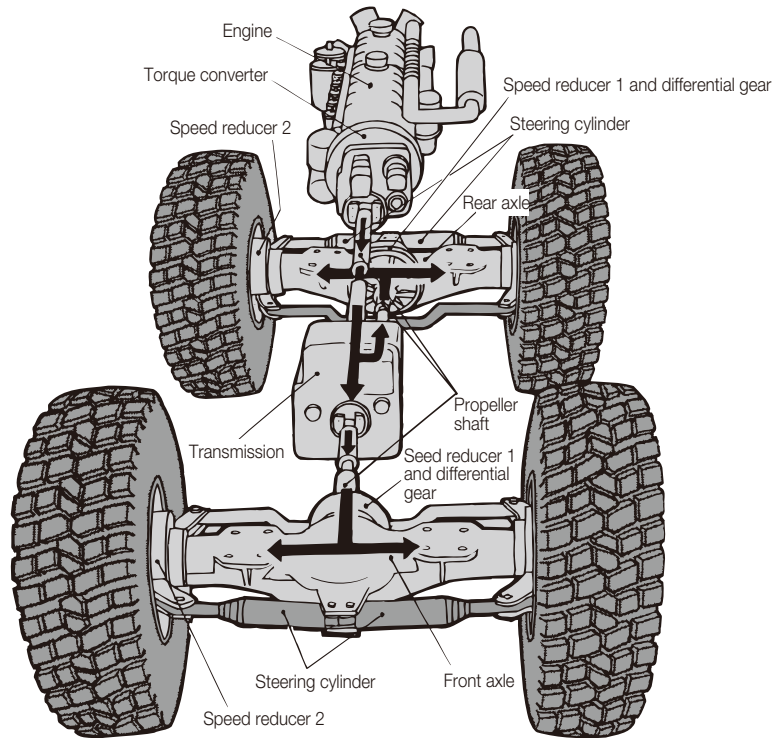
Note: This figure shows the layout of a specified model of rough terrain crane.  
Layout of the control levers and pedals varies depending on the model.

#### Inside Cab



## 6 COMPONENT STRUCTURE (CARRIER)

### ■ Configuration of engine, transmission, tires and wheels

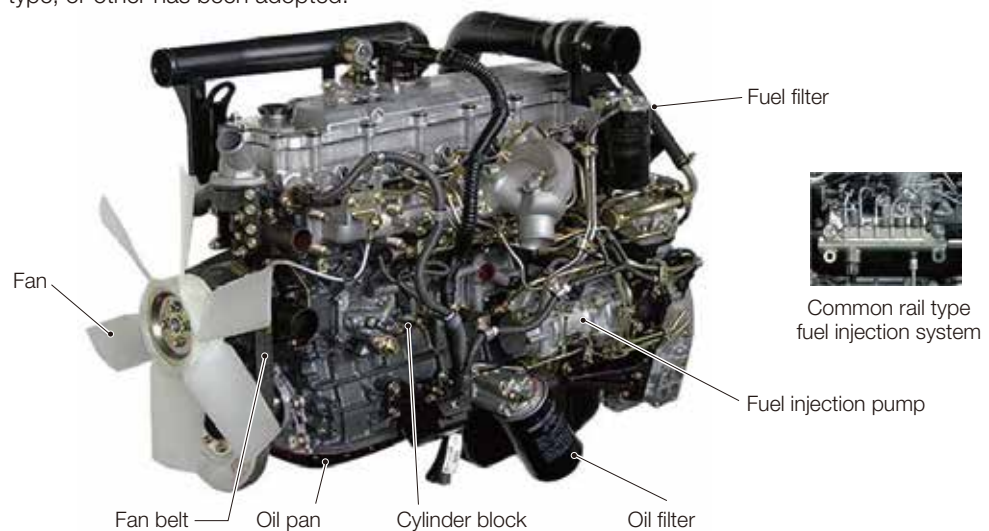


#### ① Engine

As the engine, a water-cooled diesel engine is used. The diesel engine has the following mechanism: the fresh air is strongly compressed and heated by compression heat in the cylinders, and the fuel is directly injected into the cylinders at high temperatures, spontaneously ignited and combusted. Compared with the gasoline engine, the compression rate is higher and therefore the thermal efficiency is better, reducing the consumed fuel. The diesel engine is mainly characterized with lower risk of failures and larger torque at a low engine speed.

To comply with the emission regulation, an electronically controlled high-pressure fuel injection system of common rail type, unit injector type, or other has been adopted.

#### ● Diesel engine



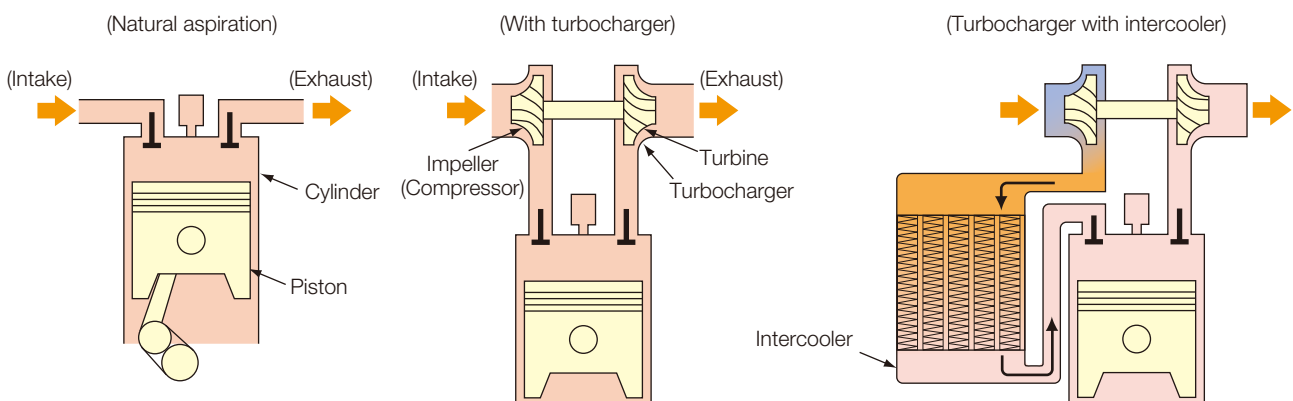
## 6 COMPONENT STRUCTURE (CARRIER)

### Turbocharger (supercharger)

The turbine of the turbocharger is rotated by the energy of the emission gases. On the other hand, the intake air passing through the air cleaner is compressed by the impeller (compressor) located coaxially with the turbine and forcibly fed into the cylinder. As described above, a lot of air is fed into the cylinder by using the emission gas force to compensate shortage of air in combustion and increase the fuel amount in order to obtain higher output easily.

### Intercooler (charge air cooler)

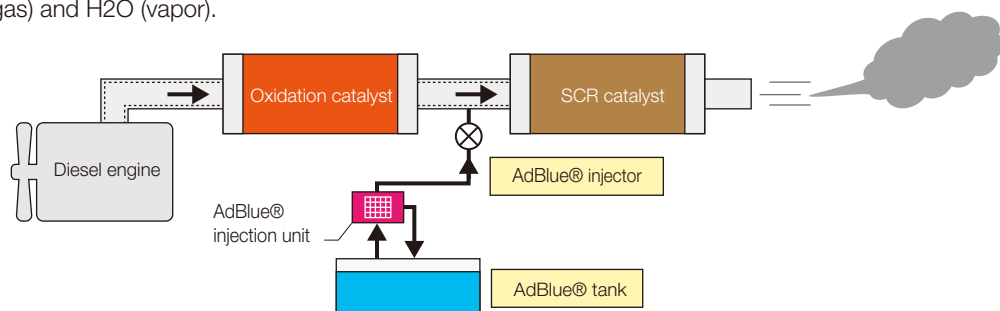
When the air is compressed very quickly, the temperature will be increased. To make better use of the turbocharger effects, the air is cooled to increase the density and then fed into the cylinder, resulting in higher output than that of the normal turbocharger. A turbocharger having a mechanism to cool the air to increase the air density is called the turbocharger with intercooler.



### ■ Emission purifying devices

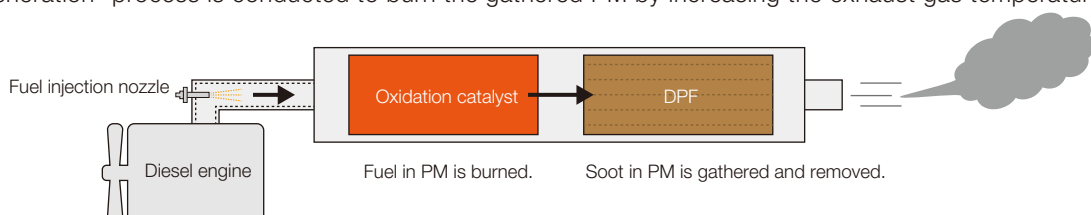
#### ● Urea SCR system

Urea SCR system represents an emission purifying device converting nitrogen oxides (NOx) into harmless N<sub>2</sub> (Nitrogen) to reduce NOx, one of the emission components from the engine. By injecting urea solution (AdBlue) stored in the tank into the emission gases, a chemical reaction is caused by a high temperature to convert NOx into N<sub>2</sub> (nitrogen gas) and H<sub>2</sub>O (vapor).



#### ● DPF

DPF represents an emission purifying device gathering PM with a filter to reduce particulate matters (PM), one of the emission components from the engine. To prevent the function from being deteriorated by the clogged filter, "regeneration" process is conducted to burn the gathered PM by increasing the exhaust gas temperature.

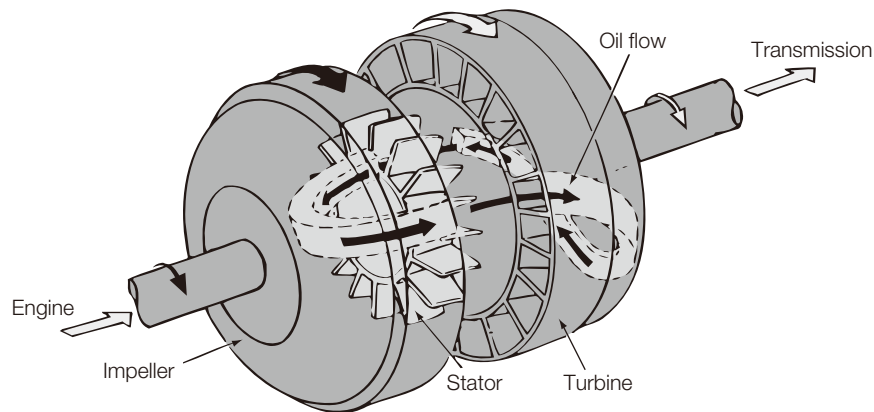


## 6 COMPONENT STRUCTURE (CARRIER)

### ② Torque converter

The torque converter is a device increasing the torque (rotating force) generated at the engine via the fluid (oil), transmitting it to the transmission, and working also as the automatic clutch. Driver's clutch operation is no longer necessary and smooth traveling is available without any concern about an engine stall. The torque converter consists of different rotors; the impeller, turbine, and stator, and that having one each is called a three-member single-stage torque converter. Number of members indicates the number of rotors, and number of stages indicates the number of turbines.

#### ● Principle of torque converter

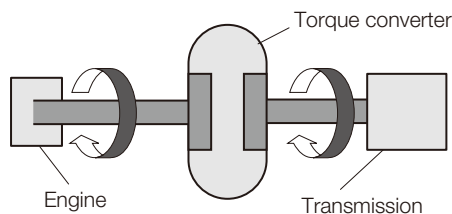


#### Automatic lockup mechanism

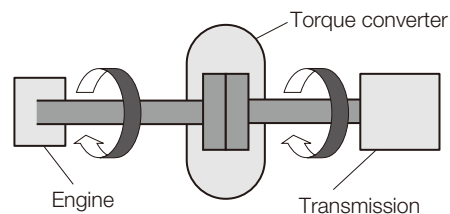
A mechanism automatically connecting the engine directly to the transmission without intervention of the torque converter when the vehicle shifts to high-speed traveling

This can improve the fuel economy because no energy loss is made by the working fluid.

#### Normal traveling



#### High-speed traveling



### ③ Transmission

A large drive force is required at start-up, hill climbing, and other similar situations, and a high rotation speed of the drive wheels is required at traveling on a flat road. To supply sufficient torque or speed in any traveling status, a device to change the torque and speed is required in between the engine and drive wheels. In addition, because the engine cannot rotate in the opposite direction, a device to transmit the power in the opposite direction is also required for the vehicle to travel backward. The above functions are made by the transmission. The transmission changes the traveling speed and traveling direction (forward and reverse) by changing the engagement pattern of several sets of gears.

#### Automatic and manual transmission type

This type is equipped with the automatic transmission for normal traveling and manual transmission for traveling on a slope.

#### Power shift type

This type changes gear engagement by means of a remote operation using hydraulic pressure, etc.

### ④ Speed reducer

The torque (turning force) transmitted by the transmission is reduced by a combination of gears and delivered to the wheels. Speed reduction is done in two steps by 1st and 2nd reduction gears both equipped on the front and rear axles.

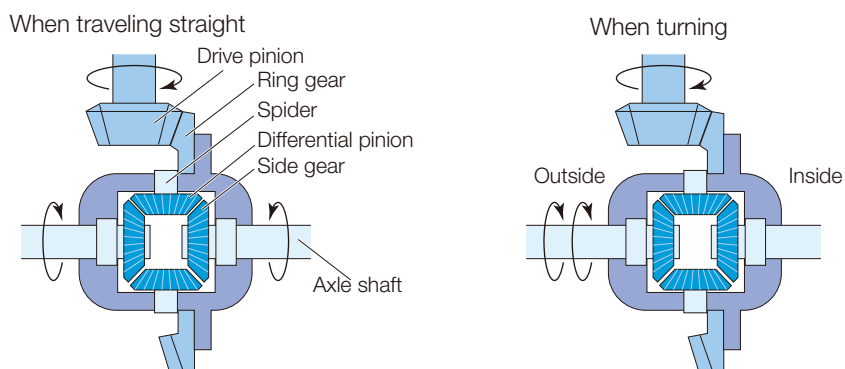
## 6 COMPONENT STRUCTURE (CARRIER)

### ⑤ Differentials

When a vehicle turns a curve, the travel distance varies between the inner and outer wheels at the curve, and that of the outer wheels will be slightly longer. The role of the differentials is to make the turning this time smooth by absorbing the speed difference between the inner and outer wheels at the curve, while transmitting the power from the engine to the wheels on the right and left sides.

The most popular differential is the device called an open differential shown below.

If, however, the wheels on one side are stuck and those on the other side spin, the rotation of the wheels contacted on the ground is 0 and that on the other side is 100 (free-wheel). Then the vehicle cannot get out of the rough ground. To address this situation, the differential limit device called “No-spin differential” is available.

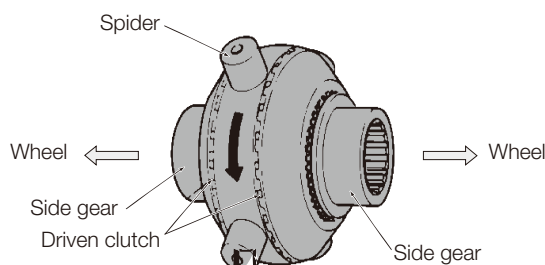


#### No-spin differential

The rear axle of the rough terrain crane, depending on the model, is equipped with differentials, called “no-spin differential”, which have a good traveling ability on rough terrains.

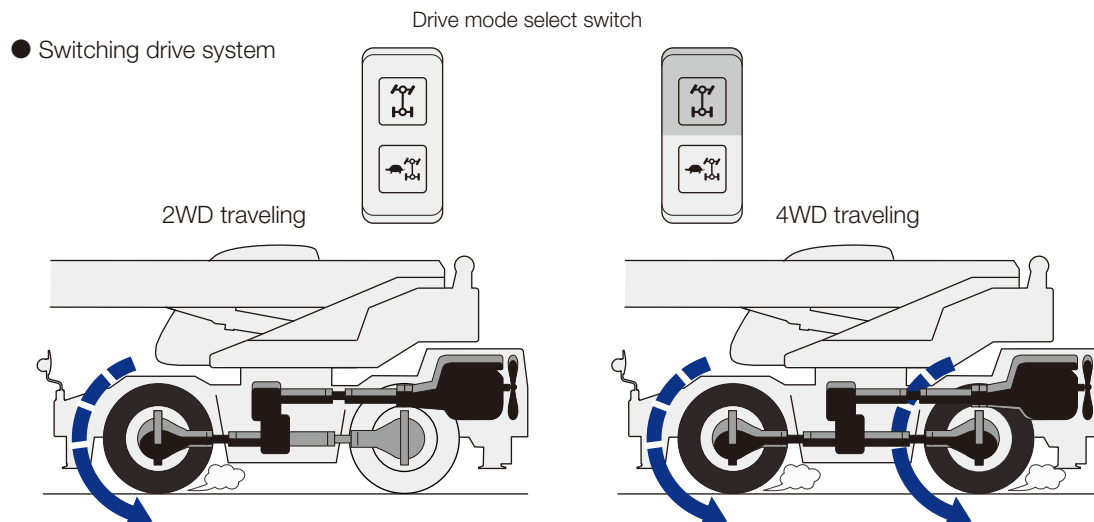
A special kind of differential to prevent one wheel from racing on a very bad road.

Order of power transmission — Spider → Driven clutch → Side gears → Wheel



### ⑥ Drive system

2WD (4 x 2) for normal traveling on an ordinary road and 4WD (4 x 4) for traveling on a rough or snow-covered road can be switched.





# 6 COMPONENT STRUCTURE (CARRIER)

### ⑦ Axles

Both the front and rear axles are of the full floating type which has been adopted for heavy-duty trucks and construction machinery.

### ⑧ Suspension

Suspension has roles to join the axles to the frame and to dampen shocks and vibrations caused by an uneven road surface during traveling. Two suspension types have been adopted to rough-terrain cranes; the leaf type and hydropneumatic suspensions. In this section, the hydropneumatic suspension that hydraulically absorbs pitching and rolling of the chassis caused by changes on the road surface is introduced.

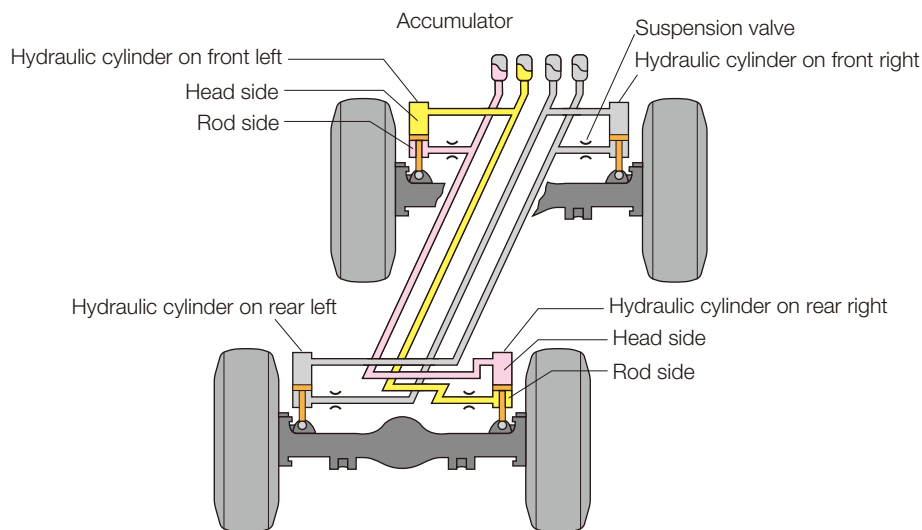
#### Hydropneumatic suspension

The hydraulic cylinders on the front right and rear left wheels and those on the front left and rear right wheels are diagonally connected with pipes respectively via the accumulator (nitrogen gas filled) with the head (extending) side connected to the rod (retracting) side and the rod (retracting) side to the head (extending) side of each hydraulic cylinder.

In this arrangement, the suspension will act as a stabilizer which keeps the chassis horizontal even during rough road traveling, cornering, and braking. This allows stable traveling with less pitching and rolling and also prevents nose dive (forward inclination) on braking.

The suspension (hydraulic cylinders) must be locked during an on-rubber operation of the crane without setting up the outriggers to maintain the stability. The suspension also has a function to adjust the vehicle height.

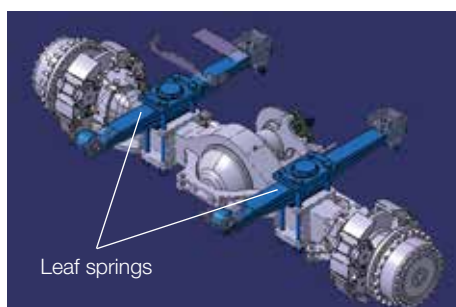
#### ● Hydraulic suspension



#### ● Leaf spring type suspension

Leaf springs have two functions.

One is to connect the axles to the chassis, and the other is to absorb vibrations that come from an uneven road surface during traveling.



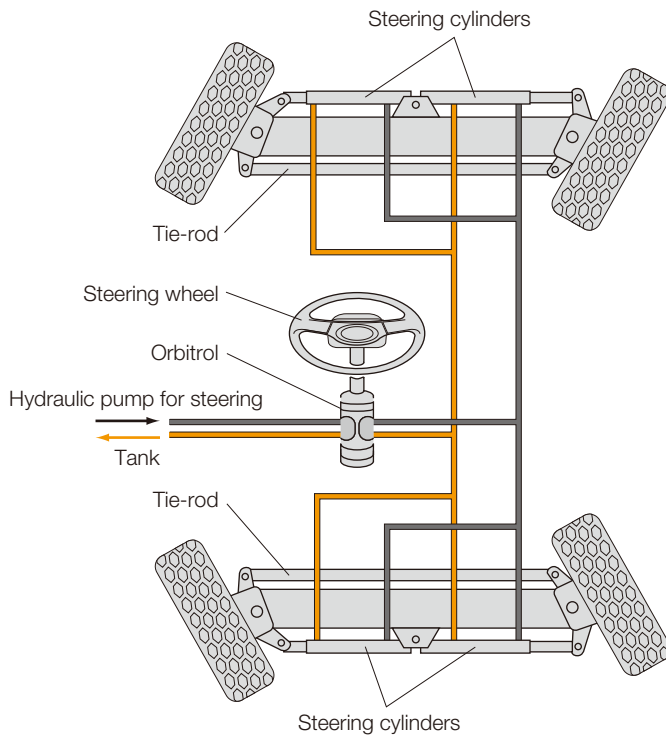


## 6 COMPONENT STRUCTURE (CARRIER)

### ⑨ Steering system

The steering system is a device to change the vehicle traveling direction to any desired direction. The steering wheel controls the pressurized oil coming from the hydraulic pump for steering to drive the steering cylinders. The steering cylinders change the direction of the wheels.

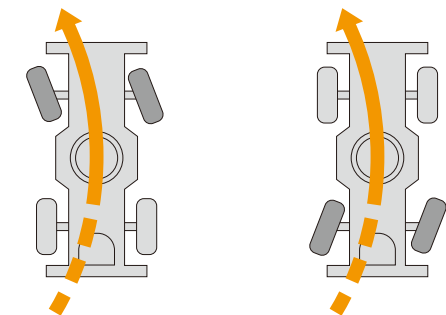
#### ● Steering configuration (example of 4-wheel steering)



#### ● 2-, 4-wheel, and crab steering

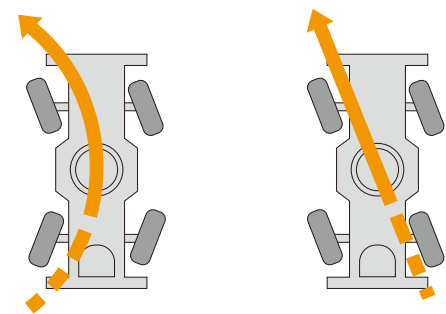
Using the switches in the cab, any of the following steering types can be selected; front 2-wheel, rear 2-wheel, 4-wheel, and crab steering. To enter a narrow site, mainly the 4-wheel steering, and to move the vehicle sideways, the crab steering is used.

Front 2-wheel steering    Rear 2-wheel steering



4-wheel steering

Crab steering



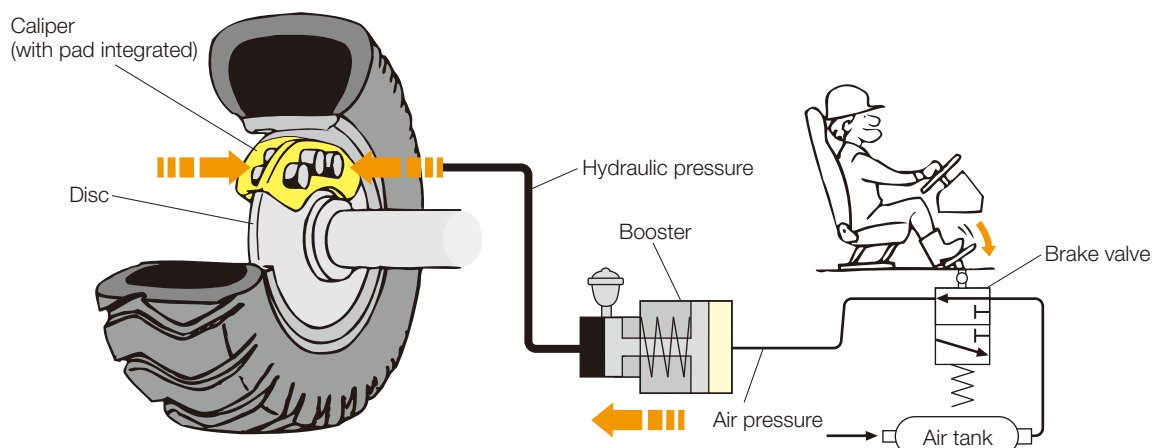
### ⑩ Brake system

The vehicle is equipped with the main brake (service brake), parking brake, and auxiliary brake as the brake system for braking the vehicle.

#### ● Main brake (service brake)

A foot-operated brake normally used during traveling. When the brake pedal is depressed, the disc brake of the air over hydraulic brake system activates the booster using the air pressure and presses the pads onto the both sides of the disc brake using the hydraulic pressure to apply the brake force. The disc brake has excellent heat radiation property and provides an outstanding effect, in particular, on braking at a high speed.

Operation of air over hydraulic brake system

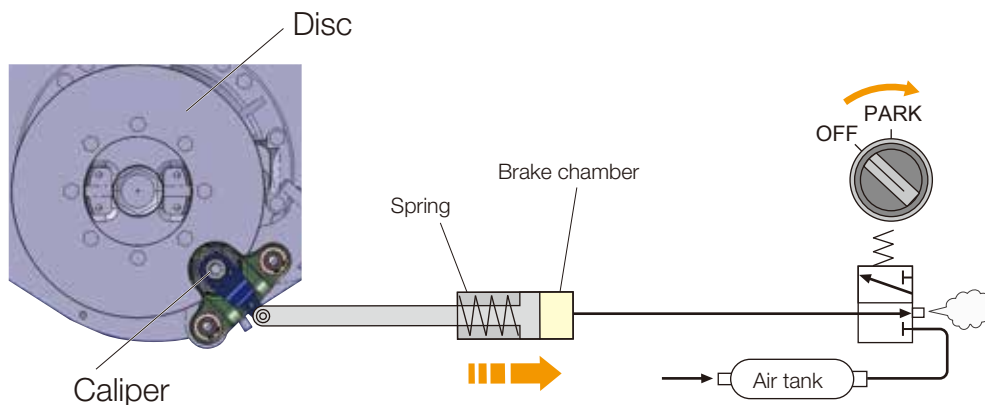


# 6 COMPONENT STRUCTURE (CARRIER)

### ● Parking brake

A brake used during parking. The brake is applied to the front wheel input shafts by pressing the brake pad integrated in the brake caliper on each side against the corresponding brake rotor from inside with the spring force. The brake is released pneumatically.

Application of parking brake

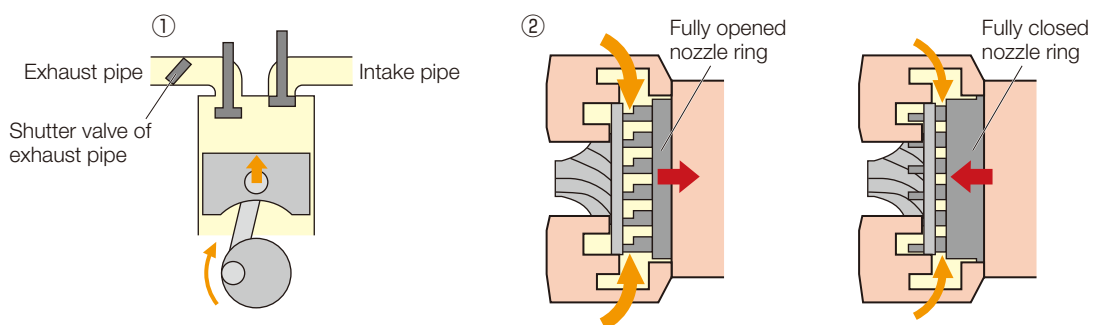


### ● Auxiliary brake

#### Exhaust brake

There are two generating methods for the exhaust brake.

- (1) By closing a valve installed in the exhaust pipe, the exhaust pressure in the engine is increased to generate a brake force.
- (2) By closing the sliding nozzle in the turbine housing, the exhaust pressure is increased to generate a brake force.



## 6 COMPONENT STRUCTURE (CARRIER)

### ⑪ Wheels

Wheel consists of the tire and disc wheel.

#### ● Tire size indication

29.5 - 25 36PR(OR)

(OR): Usage. (OR) means construction vehicle.  
36PR: 36 Ply-rating (The greater figure, the greater the tire strength)  
25: Rim diameter (Tire inner dia.) (unit: inch)  
29.5: Tire width (unit: inch)

385/95R25 170E

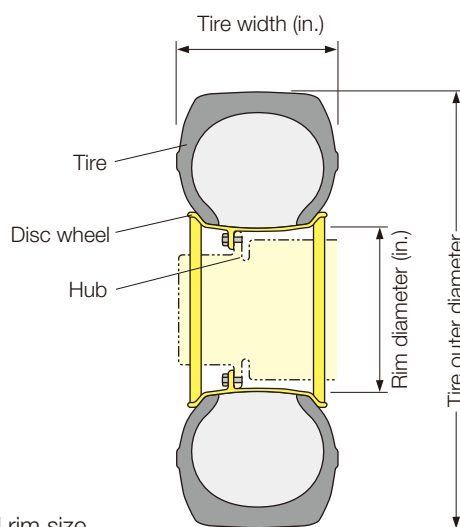
Speed rating (e.g.: E → 70 km/h)  
(Letter representing the maximum permissive traveling speed per hour with the mass corresponding to the load index applied under the specified conditions)  
Load index (e.g.: 170 → load bearing capacity 6000 kg)  
(Index representing the maximum mass permitted to apply to the tires under the specified conditions)  
Nominal rim diameter (tire inner diameter) [unit: in.]  
R: Radial construction  
Nominal aspect ratio [unit: %]  
Nominal tire sectional width [unit: mm]



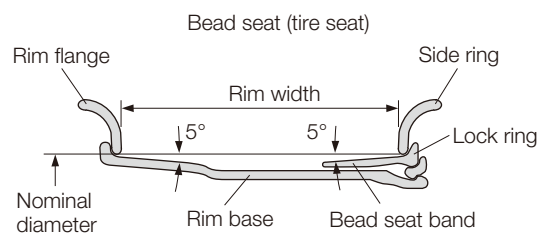
#### ● Disc wheel

Disc wheel consists of the rim section holding the tire and disc section attaching the wheel to the vehicle hub.

Wheel sectional shape and names



Nominal rim size



Indicated according to ISO standards

25×10.00-1.5 TB

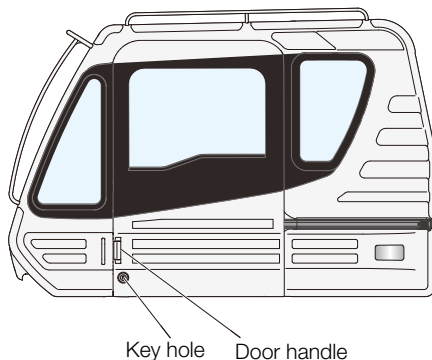
Rim type symbol  
Flange height [unit: in.]  
Nominal rim width [unit: in. . . . up to two decimal places]  
Nominal rim diameter [unit: in.]

### 6 COMPONENT STRUCTURE (CARRIER)

#### ⑫ Operator's cab

Cab is used to protect the operator from bad weather such as wind and rain to ensure safe operations and equipped with the crane control devices, various instruments, seats, and other inside. It also has the air conditioner as a device to operate the crane comfortably and safely. Cab for a rough terrain crane is also equipped with the control devices for traveling such as the steering wheel, traveling brake pedal, shift lever, and lighting switches.

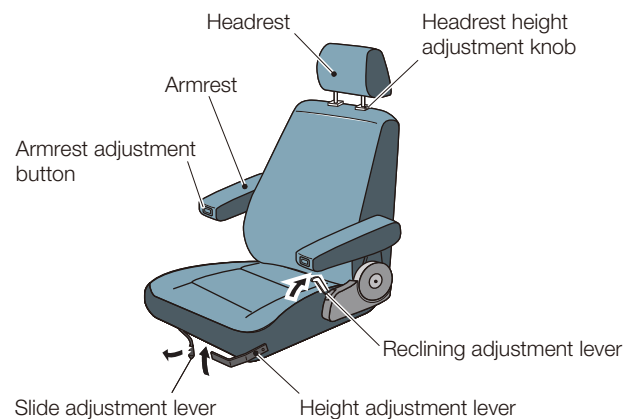
Cab for rough terrain crane



Full adjustable seat

#### Seat adjustment

Multiple seat adjustment positions for ease of operation.



#### ⑬ Safety devices

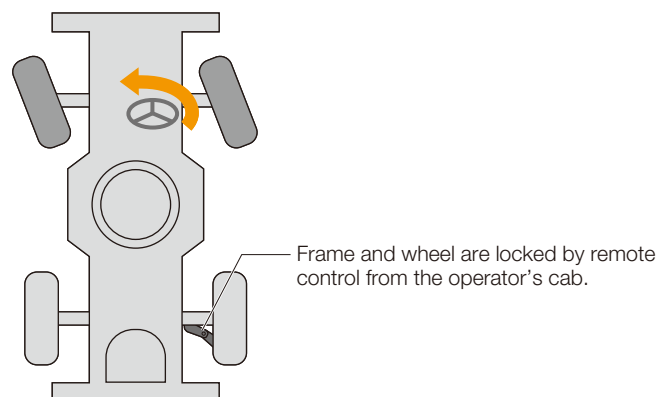
##### Emergency steering device

Because the hydraulic steering pump is driven by the engine, if the engine stops or a failure occurs in the pump, steering operations are disabled. In such an emergency, the emergency pump directly connected to the transmission automatically feeds the oil to enable steering operations.

##### Rear wheel steering lock device

In normal traveling, the steering of two rear wheels is locked before traveling so that two front wheels only can be steered. There are two types of locking methods; mechanical type and hydraulic type.

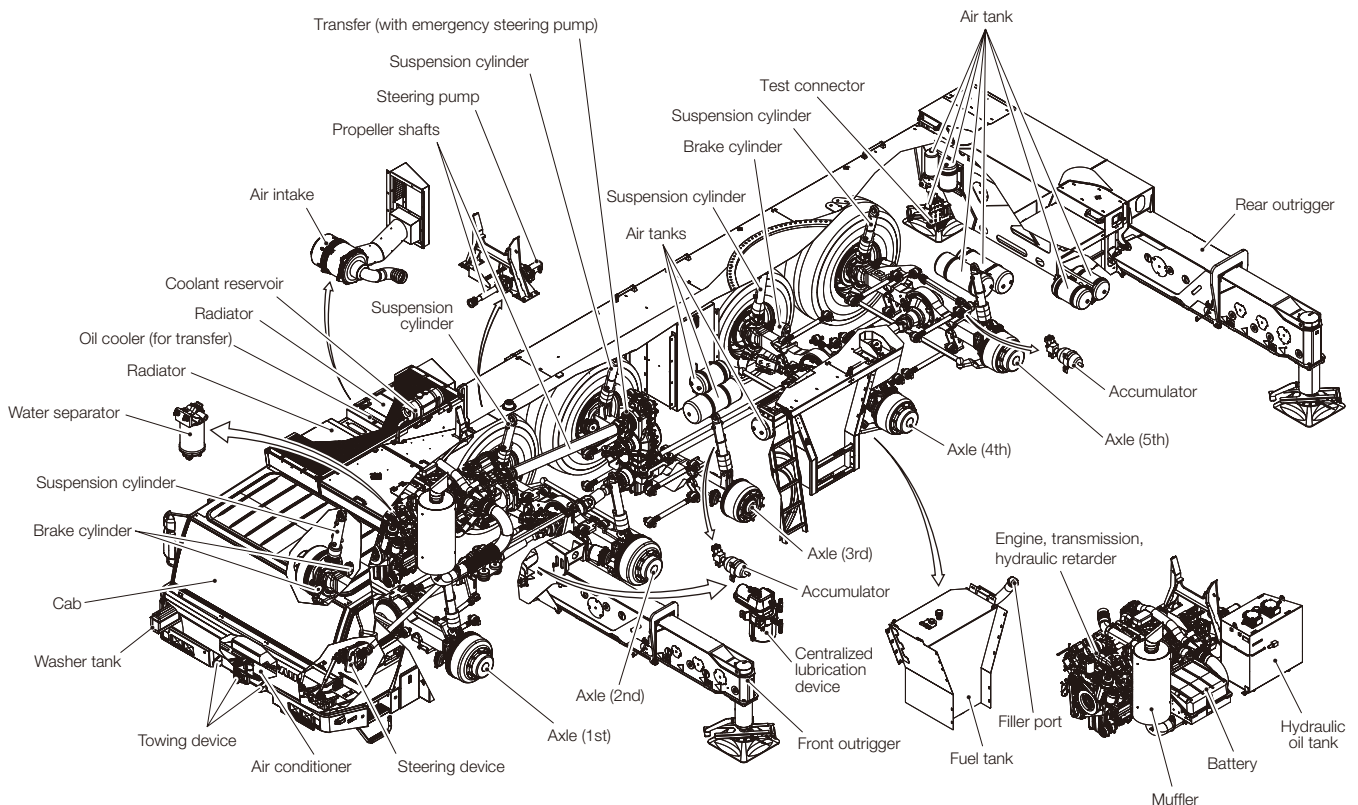
Rear wheel steering lock device (mechanical type)



### 7 CARRIER OF ALL TERRAIN CRANE

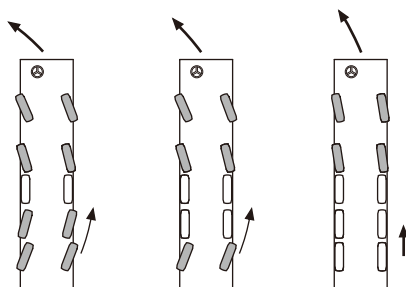
All terrain crane is, different from a rough terrain crane, equipped with the driver's cab on the carrier, allowing high-speed traveling. It also has the multi-axle drive and multi-steering functions and can travel on an uneven ground or narrow passage in work sites or other locations using these functions. In addition, it normally has the hydraulic suspension for better riding comfort, and the ground clearance adjustment function.

#### Example of carrier of all terrain crane

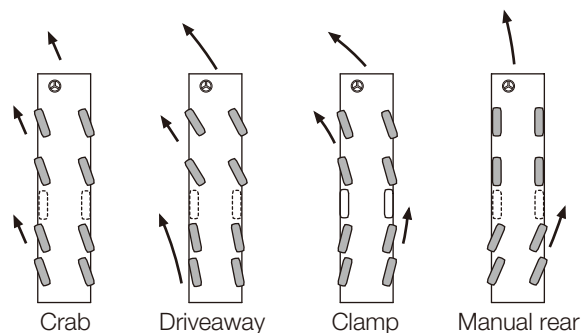


#### Steering mode for traveling on road

25 km/h or less    25 - 50 km/h    50 km/h or more



#### Steering mode for traveling in work sites (traveling on road not allowed)





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