TOWER AND JIB CRANES, DERRICS

1. Jib Cranes

It is a stationary crane consisting of a vertical member (called pillar or column) from which extends a horizontal swinging arm called **jib**, carrying a trolley hoist or other-hoisting mechanism. The jib is generally made from a standard I-beam section, and can rotate in a horizontal plane (i.e. no luffing motion) between 180° up to 360°, so that loads can be lifted and deposited within the sector of circle having its radius equal to the length of the boom. The extreme end of the arm is often supported from the vertical member by a tie rod.

Above description matches with other types of crane like tower cranes, pillar crane etc. However, the difference is basically in terms of size and capacity and thus in specific applications. A normal jib crane is generally limited to a jib length of 8meters and hoist capacity of 15tons. A typical jib crane is shown in Fig. 1.

Jib cranes are inexpensive and widely used in manufacturing industries for:

(*i*) serving individual or a group of work places in machine shops.

(*ii*) loading and unloading of vehicles.

(*iii*) handling ladle, casting and mould in a foundry.

(*iv*) moving loads across shop bays and thus supplementing on overhead traveling crane.

Different design variations of a jib crane is possible which are as follows:

(A) **Revolving pillar jib crane** in which the pillar or vertical column consists of a structural pipe. On the top of the column a thrust bearing of sufficient capacity is mounted, on which the jib constructed from a standard I-beam is mounted.

The jib can rotate by 360° on the fixed column. The column base is bolted to the floor/ foundation or directly grouted in foundation. A manual or powered trolley type hoist is mounted on the jib. Stops are provided at the end of the track to prevent over travel. Fig. 2 shows photograph of such a jib crane.

(B) **Swinging pillar jib crane** in which the jib and it's tie rod are connected to the vertical column through swinging fitting supports, welded with the column. The fittings allow swinging of the jib and the tie by about 180° about the fixed column.

(C) **Swinging bracket supported jib crane** is similar to a swinging pillar jib crane, excepting that there is no independent vertical column. Instead, the swinging fittings are wall-bracket type which are fixed on a vertical wall. This jib crane has maximum 180° rotation.

(D) **Revolving mast jib crane** is one in which the vertical column or mast is supported at the top and bottom on bearings. The jib is bolted or welded to the column. The jib is supported by tie rod. The jib can rotate along with its supporting column. Fig. 3 shows such a jib crane.

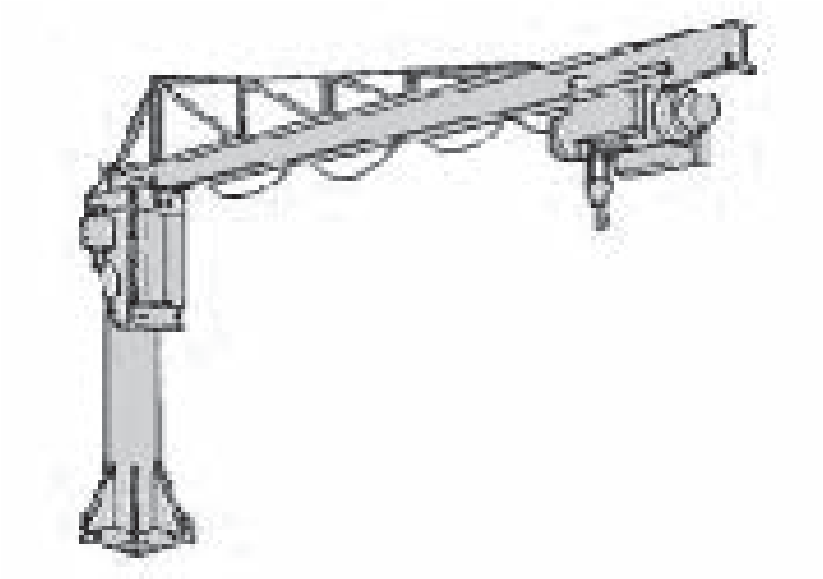


Fig. 1. A jib crane

Fig. 2 Revolving pillar jib crane

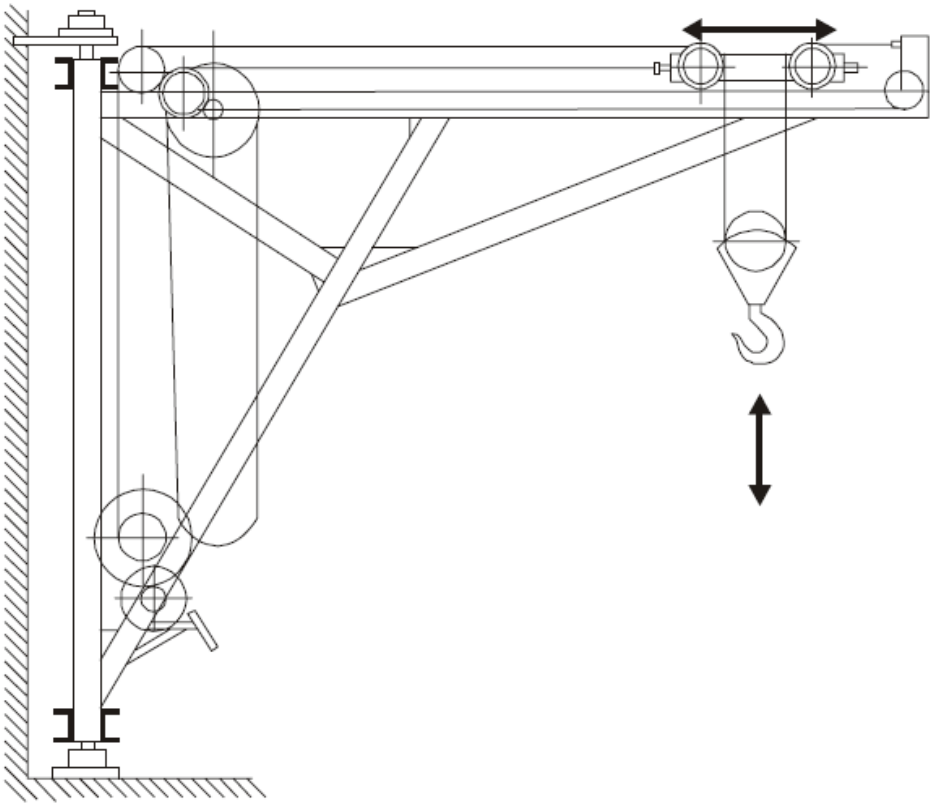
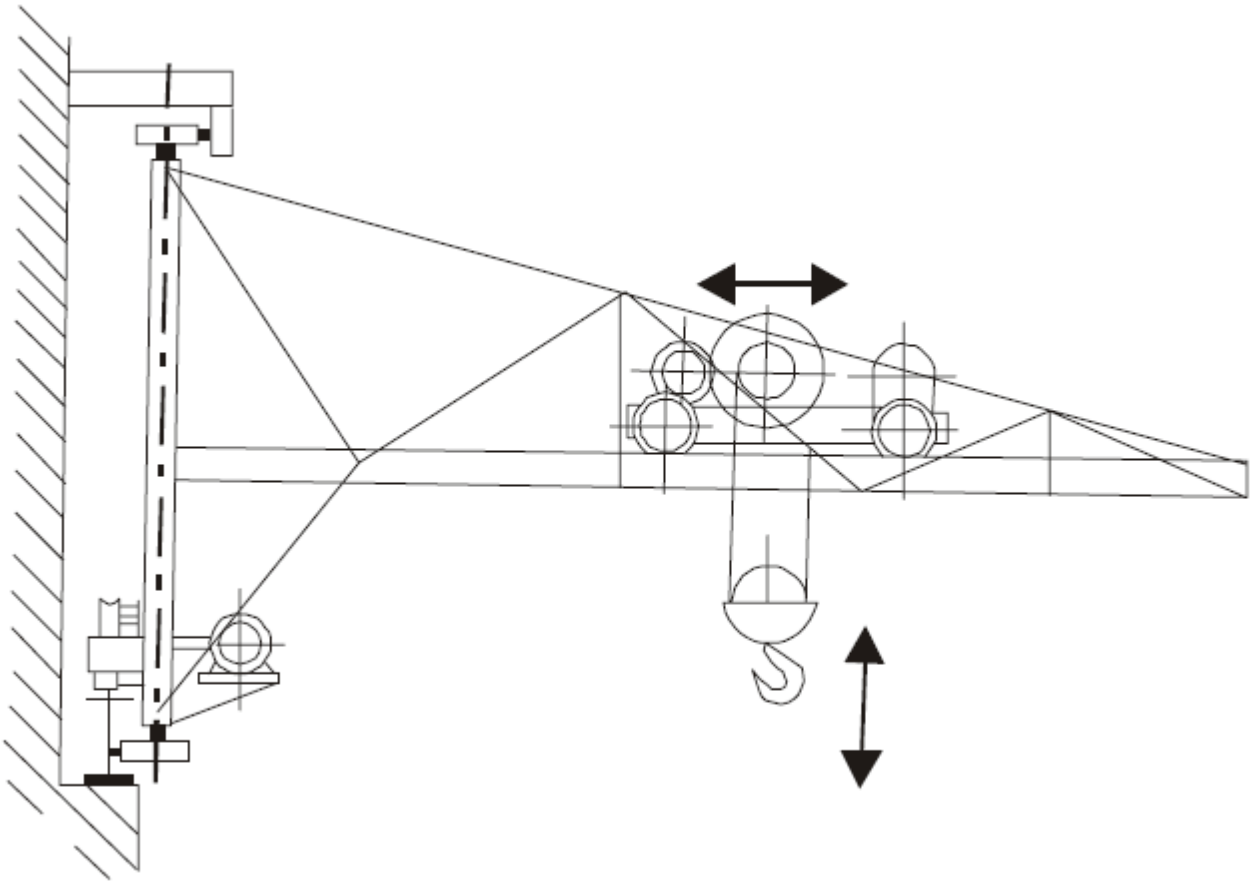


Fig. 3. Revolving mast jib crane

(E) **Rotary girder jib crane** is similar to a swinging bracket supported jib crane without a tie rod. Instead, the end of the jib is supported from a trolley by a chain, while the trolley is supported from a circular girder fixed to the roof or roof strusses.

(F) **Travelling jib crane** is a special type of jib crane which consists of a cantilevered arm similar to the bridge girder of a overhead traveling crane. One end of the girder is held from the side wall, and supported over wheels on rails laid parallel to the wall. A motorised arrangement drives the wheel and makes the arm to travel along the wall. The hoisting device travels along the arm. Travelling jib crane serves the purpose of a bridge crane for lighter loads. Fig. 4 shows the schematic diagram as well as a photograph of such a crane.



(a) Schematic view

(b) Photographic view

Fig. 4. Traveling jib crane

Fixed-tower hammerhead jib crane is a special type of jib crane, which is built in capacities from 6 te to as high as 350 te. The jib of this crane is of struss structure and looks like the head of the hammer, hence the name. The jib is mounted on a fixed tower. The front portion of the jib supports rail upon which one, two or three crane trolleys travel, and the rear portion of the jib houses the machinery for hoisting, trolley travel and slewing arrangement as well as necessary counterweight. When two trolleys are used, they are arranged to be operated individually or simultaneously. Fig. 5 shows a hammarhead jib crane.

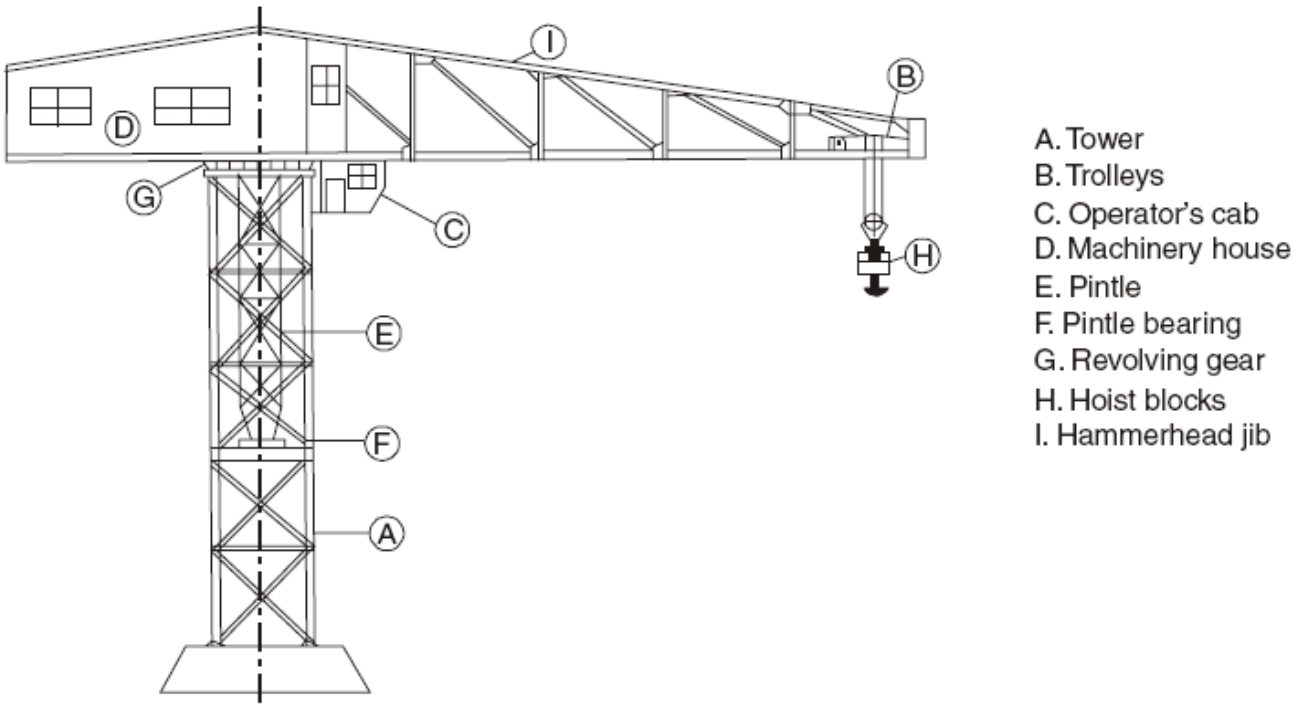


Fig 5. Fixed-tower hammerhead jib crane

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2. Wharf Cranes

Wharf cranes are versatile machines which are extensively used in shipyard and port for unloading and loading of ships to and from jetty and can handle a variety of cargo. These cranes essentially consist of a long boom which is mounted on a 3600 rotating frame which is supported on the sub-structure fixed on foundation or

travelling on rails along the jetty. The boom can be luffed up and down thus moving the load towards or away from the crane. A sheave is provided at the tip of the boom and ropes with a hook or grab bucket, depending on the type of load to be handled, is suspended from the sheave. The load is moved up or down by pulling the rope. The luffing motion in the boom is often **level luffing** type, which is explained later.

Depending on the design of the sub-structure, wharf cranes are grouped into following types:

(*a*) **High pedestal wharf crane.**

(*b*) **Portal crane** in which the sub-structure is a gantry structure. The gantry may be fixed in foundation or on wheels which can run on fixed rails or runways.

(*c*) **Semi-portal crane** which uses a semi-gantry sub structure.

Fig. 6 shows photograph of a wharf crane.

Level luffing system. In an ordinary design, when the boom is luffing up to bring the load closer to the crane, the load also moves vertically up, which requires considerable power for operating the luffing mechanism. In level luffing mechanism, it is possible to keep the load in the same horizontal plane during its movement by boom luffing. Compensation for the dead weight of the boom is achieved by using movable boom counterweight. This reduces the luffing effort and power substantially, and level luffing may be done easily through rope reeving, by mechanical linkage or by screw and nut. The later allows very accurate positioning of the load, required during lowering.

Level luffing may be achieved by using one of the following methods:

(*i*) **Toplis mechanism** is shown in Fig. 7. In this mechanism the guide pulley, fixed on the separate A-frame, is in such a disposition with respect to the top pulley at the end of the boom that when the boom is luffed upward, the distance between the two pulleys shortens and allows corresponding length of rope to be delivered out from top pulley. This allows the load to remain at the same height.

Fig. 6. 10 te capacity shipyard wharf crane

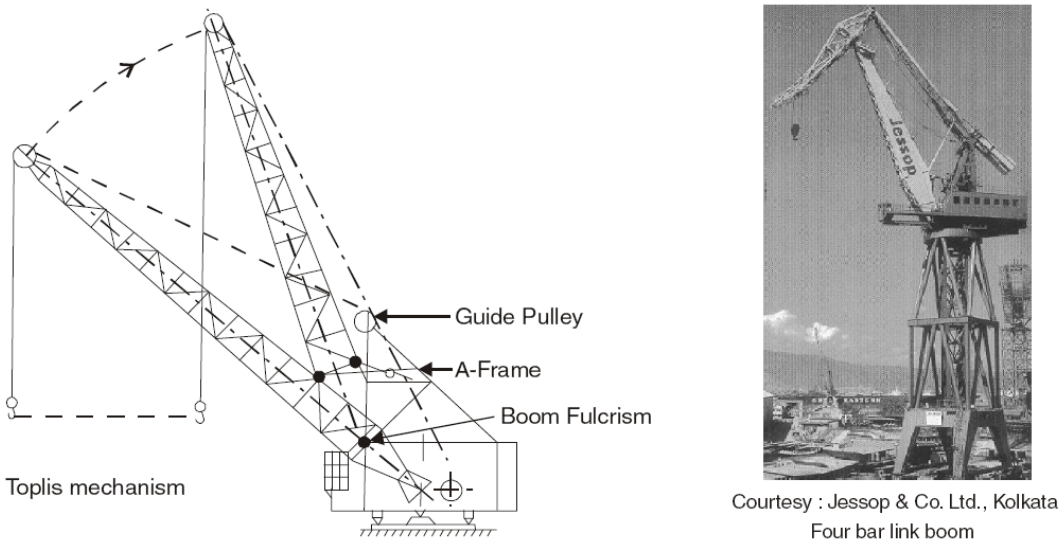

Fig. 7. Level luffing cranes

(*ii*) **Swing lever type level luffing mechanism.** In this design, the guide pulley is connected with a particular point of the boom through a link in such a way that when boom is luffed, the relative positions of the top and guide pulley go on changing in a manner that some length of rope will be delivered out or taken in such that the load remains at the same height.

(*iii*) Using a **four bar link** type boom. In this design, the front portion of the boom known as **jib lever**, gets folded with respect to the rest part of the boom, which form a four bar link, when the boom is moved up or down. This allows the top pulley fixed at the end of the front portion of the boom, to remain at the same horizontal level and achieve level luffing.

Technical specifications of wharf crane. The capacity of dock side wharf cranes generally varies from 3 tons to 20 tons and an outrich of 30 m maximum to 6m minimum. The inclination of the boom with horizontal, at the maximum out reach condition is kept about 34°. Typical specifications of high pedestal balanced level luffing wharf cranes, as per ‘‘Electric Crane’’ by H.H. Broughton are shown in Table 1.

Fig. 8. 26 te level luffing kangaroo type portal crane in luff out and luff in positions

Table 1. Important Specifications of Wharf Cranes

Working load, tons	3	5	6	10	20
Maximum out-reach, m	26	20	20	26	23
Minimum out-reach, m	8.5	6.7	6.7	9	10.6
Height of lift, m	26	21	23	29	22
Boom length, m	29	22	22	28.6	–
Height of boom fulcrum from ground, m	21	18	18.5	21	–
Hoist drum diameter, m	–	–	0.9	0.9	1.2
Rope size 6/37 construction, mm	24	32	32	38	–
Hoist speed, m/min	61	42.7	42.7	15	8
Slewing rpm	1.25	1.5	1.5	0.75	0.5
Luffing speed, m/min`	36	36	36	30	4
Traveling speed, m/min	15	15	15	15	18
HP of hoist motor	55	70	70	55	50
HP of slewing motor	10	15	15	15	20
HP of luffing motor	8	12.5	12.5	15	10

Stability of wharf crane. The margin of stability of a wharf crane is defined to be the percentage additional load required to bring the crane to the point of tipping, while handling any load at any radius from the centre of the crane and the boom is at right angles to the direction of the track on firm level ground. IS:4594-1968, ‘‘Code of Practice for Design of Portal and Semi-portal Wharf Cranes’’ provides in clause 4, the condition of tipping and margin of stability of wharf crane under storm condition and under service condition. As per the above standard, the following stability requirements should be met.

Stability under storm condition: The crane is subjected to a wind force of not less than 150 kg/mm^2 and a margin of stability of 25% of this wind force shall be met.

Stability under service condition: (*i*) 50% of the safe working load at the operating radius without causing any undue stress on centre pin or the centre column; and (*ii*) 75% of the safe working load at the operating radius and subjected to a wind force of 25 kg/mm^2 acting at the same time, without any of the track wheels leaving the track.

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3. Tower Cranes

A crane in which a horizontally swinging, usually non-luffing boom is mounted on a tall vertical mast or tower. A travelling hoist operates on the rails fixed to the boom, which is suitability counterloaded. A tower crane may be fixed standing on a tripod. It may also be mounted on rails, on a crawler or a truck, when it is called a **mobile tower crane**. These cranes are used for construction of tall buildings and erection of technological structures, blast furnaces, chimneys, air turbines etc.

A crane erected upon and supported by a building or other structure, which may be raised or lowered to different floors or levels of the building or structure is called a **climber tower crane**. Fig. 9 shows a tower crane in working position.

Fig. 9. Tower crane at construction site

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4. Derricks

Derrick is an apparatus consisting of one or two masts or fabricated strut members supported at the bottom by a pivoting arrangement and held at the top by guys or braces, with or without a boom, for use with a hoisting mechanism and

operating rope, for lifting and lowering a load and moving it horizontally. Derricks are principally used in construction work for erection of technological structures and heavy components to a height. Advantages of derricks are: (*i*) inexpensive, (*ii*) very easy to erect and dismantle, (*iii*) simple in design and may be fabricated easily at the working site, (*iv*) a number of derricks may be used together for manipulation of a large and/or weighty component.

Derricks may be of different types. Some of the common types of derricks have been described below:

(*a*) **Guy Derrick:** A fixed derrick consisting of a mast mounted on a turntable and capable of being rotated, supported in a vertical position by guys, and a boom whose bottom end is hinged or pivoted to move in a vertical plane with a reeved rope between the head of the mast and the boom point for raising and lowering the boom, and a reeved rope from the boom point for raising and lowering the load.

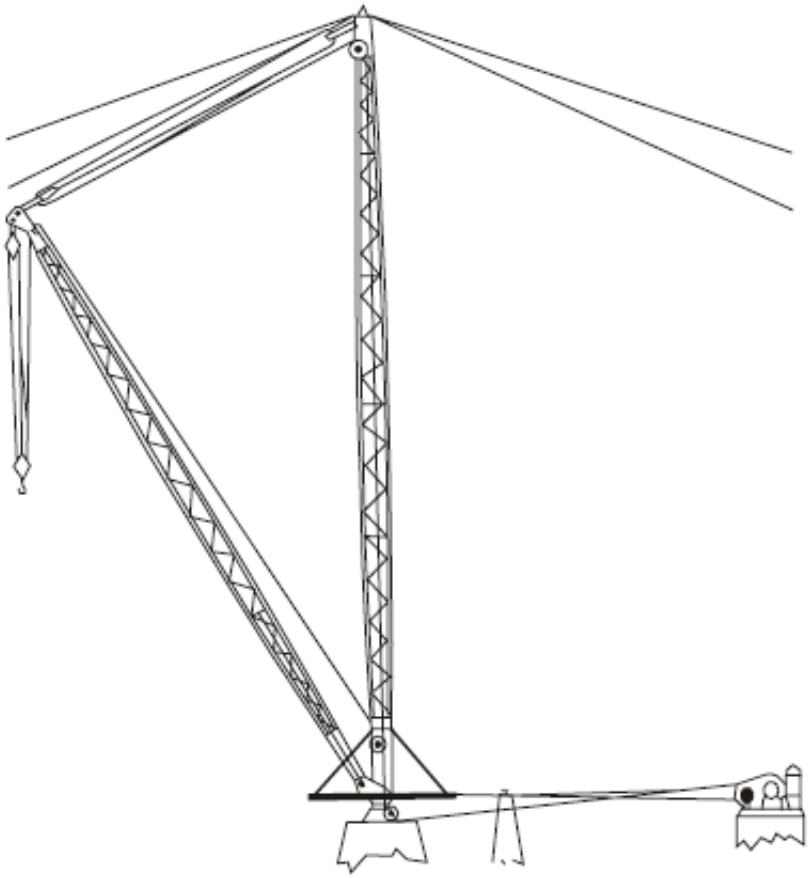

Fig. 10. Guyed derrick

Gin Pole Derrick: A derrick without a boom. Its guys are so arranged from its top to permit leaning the mast in any direction. The load is raised and lowered by ropes reeved through sheaves or blocks at the top of the mast.

A-frame Derrick: A derrick in which the boom is hinged from a cross member between the bottom ends of two upright members spread apart at the lower ends and joined at the top; the boom point secured to the junction of the side members, and the side members are braced or guyed from this junction point.

Stiffleg Derrick: A derrick similar to a guy derrick except that the mast is supported or held in place by two or more stiff members, called stifflegs, which are capable of resisting either tensile or compressive forces. Sills are generally provided to connect the lower ends of the stifflegs to the foot of the mast.

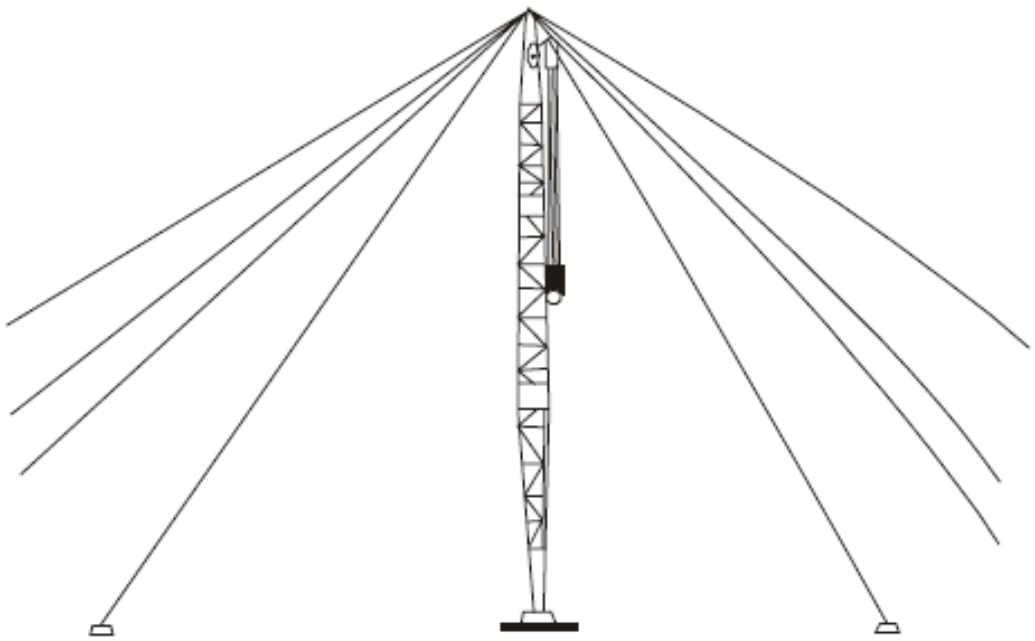

Fig. 11. Gin Pole derrick

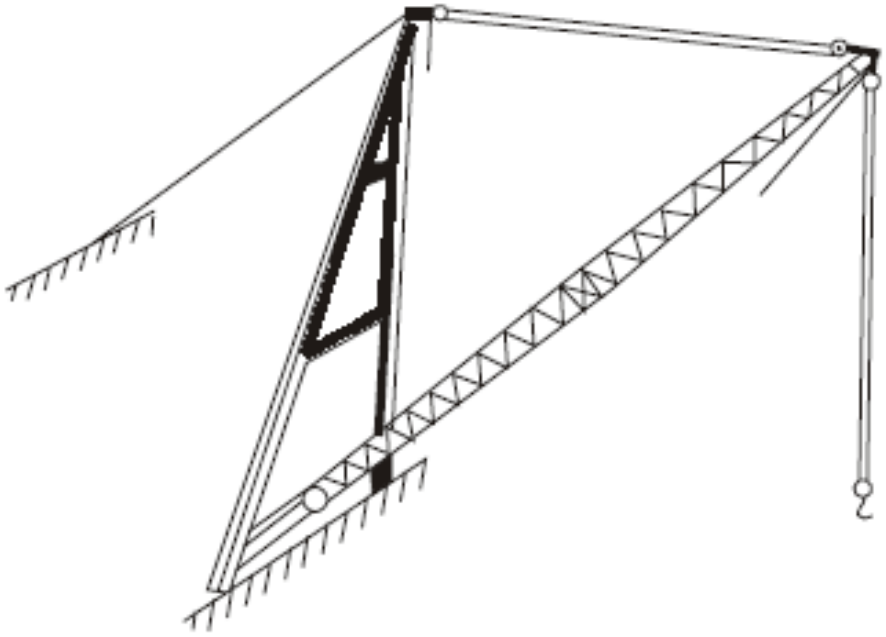

Fig. 12. A-frame derrick

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