July 11, 1961 H. D. LEE 2,991,852

DRILLING RIG AND METHOD OF EXTENDING AN UPPER SECTION OF THE MAST THEREOF

Filed Nov. 29, 1956 4 Sheets-Sheet 1

Fig. 1

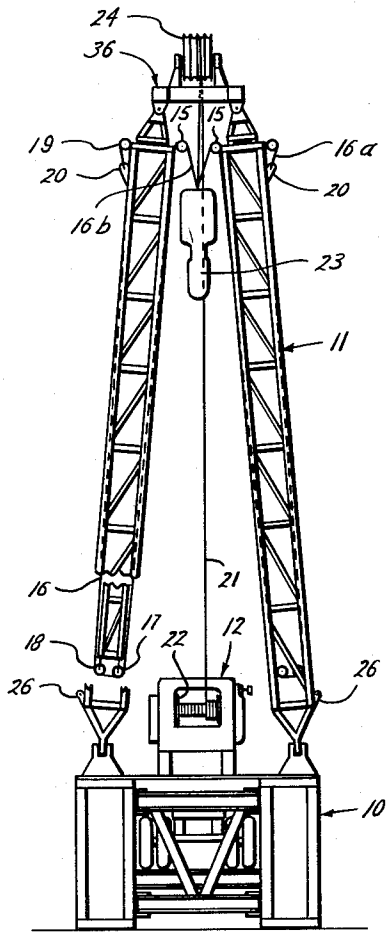
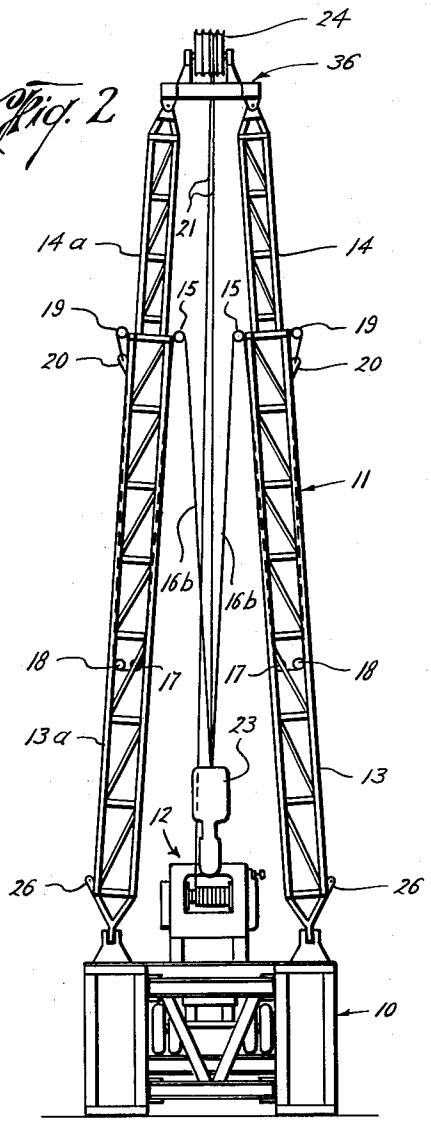


Fig. 2



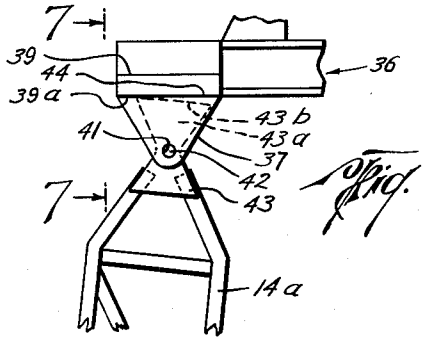


Fig. 6

Harold D. Lee
INVENTOR.

BY

Browning Simms & Hyer
ATTORNEYS

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DRILLING RIG AND METHOD OF EXTENDING AN UPPER SECTION OF THE MAST THEREOF

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Fig. 4

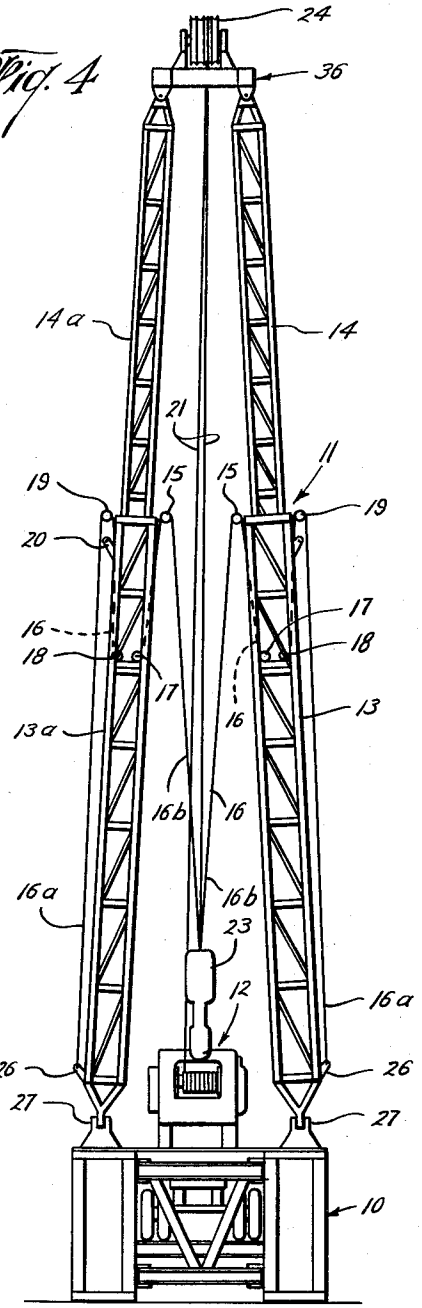


Fig. 3

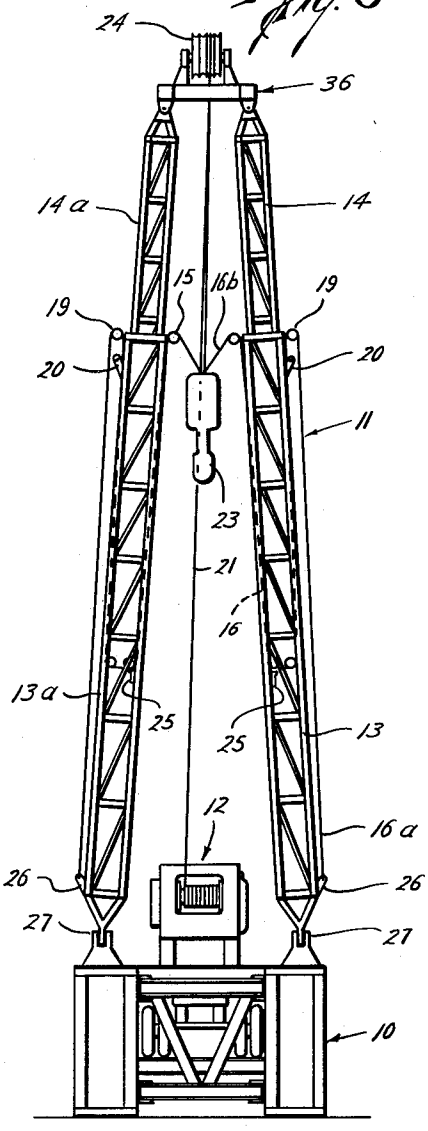
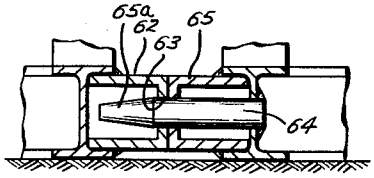


Fig. 13



Harold D. Lee
INVENTOR.

BY

Browning, Simmons & Hyer
ATTORNEYS

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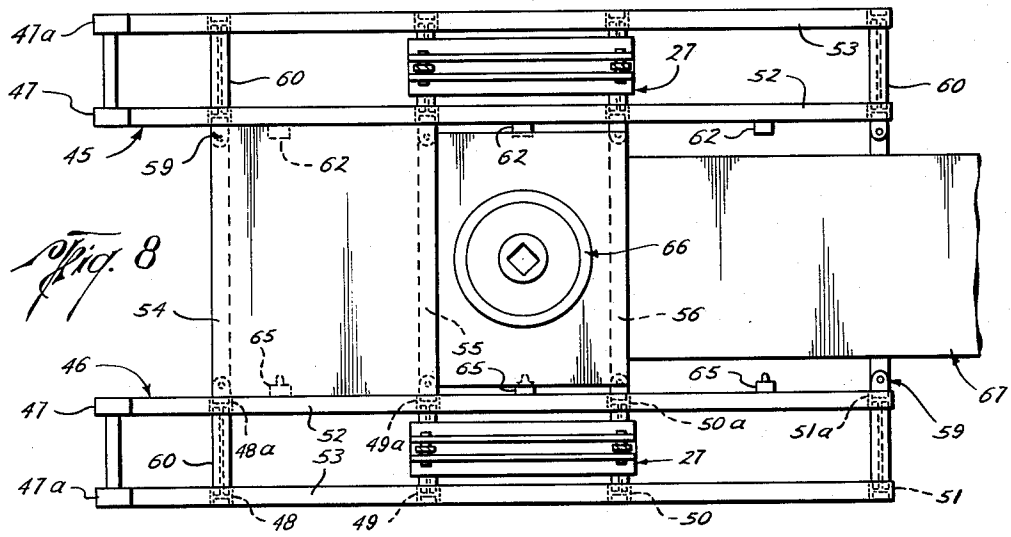


Fig. 8

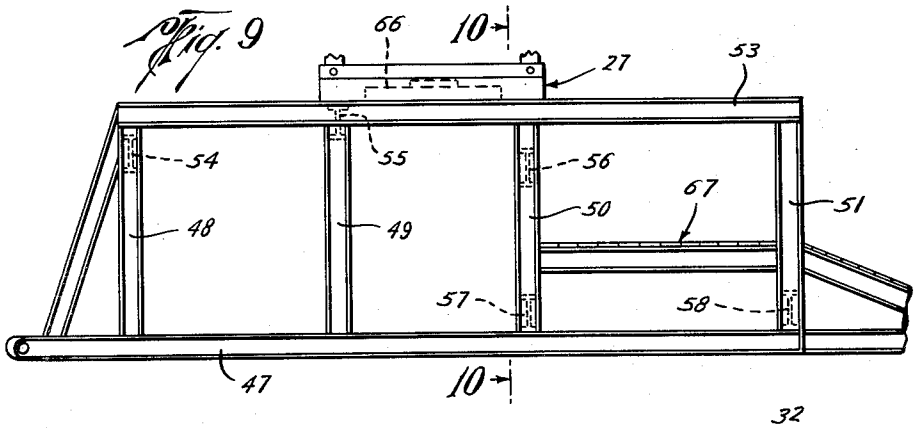


Fig. 9

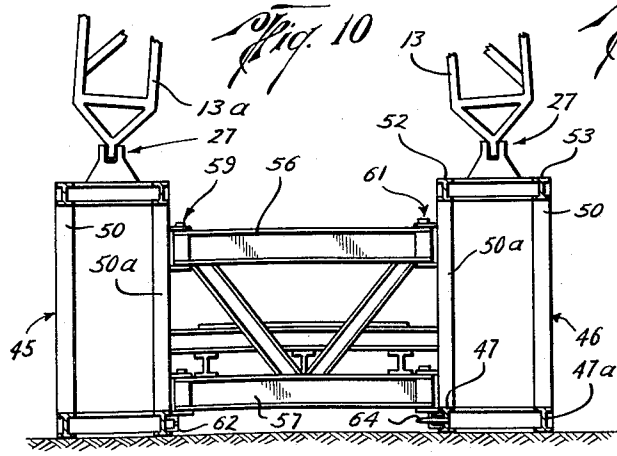


Fig. 10

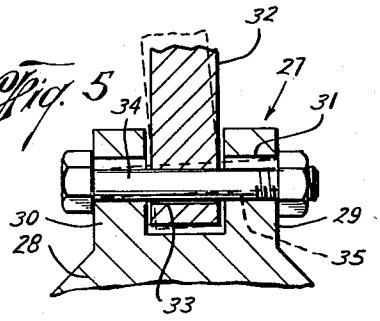


Fig. 5

Harold D. Lee
INVENTOR.

BY Browning Simmons & Hyer
ATTORNEYS

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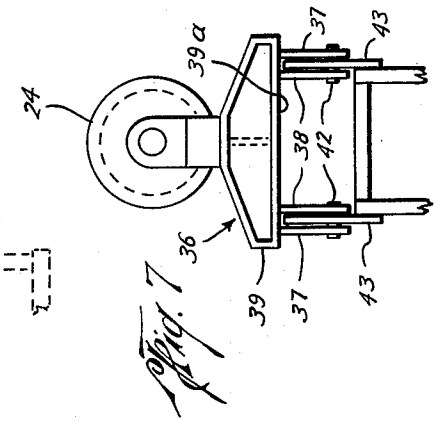


Fig. 7

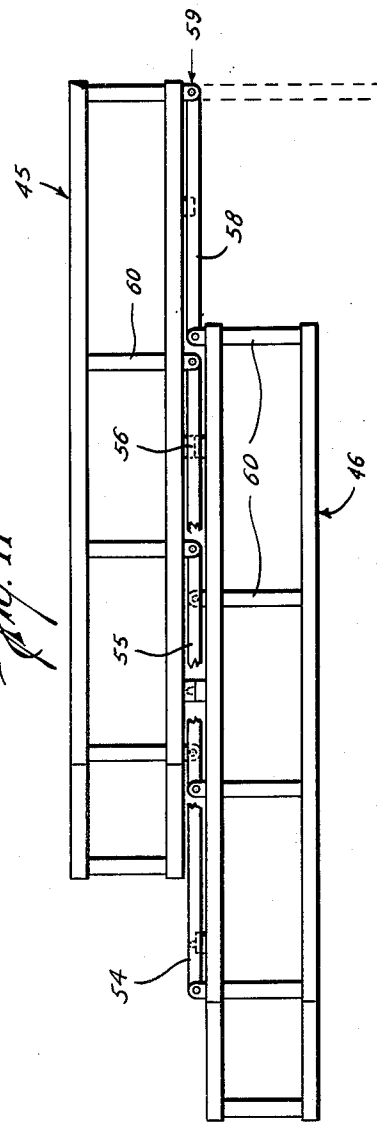


Fig. 11

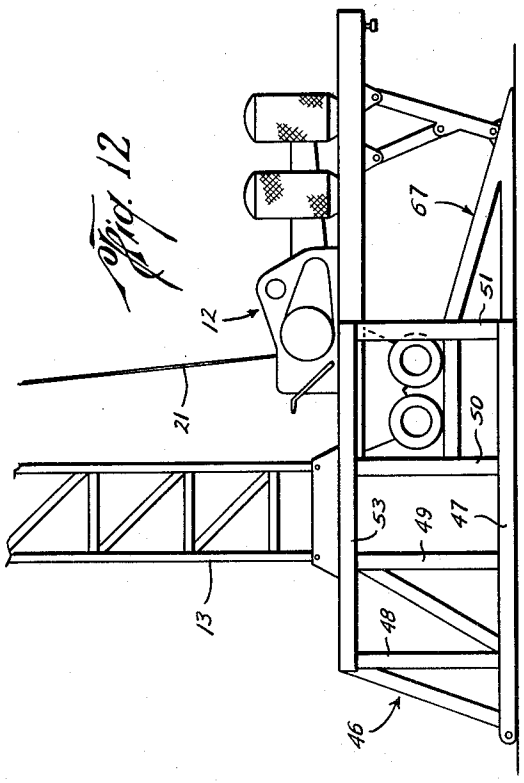


Fig. 12

Harold D. Lee
INVENTOR.

BY

Browning Simmons & Hyer
ATTORNEYS

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2,991,852

DRILLING RIG AND METHOD OF EXTENDING AN UPPER SECTION OF THE MAST THEREOF

Harold D. Lee, Houston, Tex., assignor to C. N. Housh, Houston, Tex.

Filed Nov. 29, 1956, Ser. No. 625,119
6 Claims. (Cl. 189—14)

This invention relates to drilling rigs and more particularly to drilling rigs designed to be easily and quickly transported between locations and erected. In one important aspect it relates to a means and method for extending sections of a telescoping mast. In another important aspect it relates to a telescoping mast in which the legs converge in an upwardly direction. In a still third important aspect it relates to a collapsible base.

Modern drilling practice presents a number of instances in which it is desirable to use a portable mast. One form of popular portable mast employs telescoping sections which extend to a suitable height for well operations but collapse to a length which is within road limits. The previously successful masts of this type have employed parallel mast legs notwithstanding the well known fact that a mast employing upwardly converging mast legs is stronger and, therefore, for a given rating can be less expensively manufactured. The converging leg mast is extensively used in non-telescoping mast but has not been successfully applied to the telescoping mast, probably due to the difficulty of obtaining rigidity in the mast when extended.

In extending the telescoping mast it is customary to employ a fast line wrapped around the drum of the draw works for the rig. The mast has been extended with a number of various types of rigging. The fast lines so used will usually not spool well due to the smaller size of this line than the drill line which is wrapped on the spool under the fast line and the fact that it first passes over a pulley pinned to the platform close to the drum. Thus, there has been a tendency in the past for the fast line to ball-up on the draw works and give trouble.

In the event the fast line parts or in some way becomes disengaged either from the draw works or the mast, there is nothing to support the telescoping section and it will fall. This possibility has been guarded against by providing auxiliary safety equipment, but this is both expensive and creates dead weight in the mast which must be supported. The prior art methods have also sometimes created abnormal side pull on the mast while it was being extended.

The substructure for supporting the mast is usually built up from a number of individual pieces and requires considerable time to assemble and disassemble. Across its narrowest dimension the substructure may be much larger than normal road limits permit and it cannot be transported across public roads without dismantling.

Even when the rig is to be moved only a short distance to another location in the same field, it must be dismantled and disassembled before it can be moved unless the rig is built about a vehicle mounted on wheels which vehicle provides the substructure. A vehicular substructure cannot, due to road limits, provide a mast with a broad base.

An object of this invention is to provide a method of raising and lowering a section of a telescoping mast in which there is provided as a part of the raising and lowering rigging a safety line to guard against dropping of the mast.

Another object is to provide a telescoping mast and method of raising and lowering a section of the mast in which there is no side pull on the mast.

Another object is to provide an apparatus and method for raising and lowering a section of a telescoping mast

in which the drill line is used instead of a telescoping line to avoid ball-ups of the line on the draw works.

Another object is to provide a telescoping mast in which the two legs of the mast converge upwardly and in which the legs of the mast are free to tilt relative to each other as the mast is raised and lowered and in which the mast is automatically rigid when extended.

Another object is to provide a telescoping mast as in the preceding object in which interengaging stops are provided which abut when the mast is fully extended to provide the desired stability for the mast.

Another object is to provide in combination a mast and substructure in which the legs of the mast converge toward each other when extended and when retracted permit the legs at their base to move inwardly toward each other, the substructure having an intermediate section which is collapsible to permit the two outer sections to move toward each other with the legs for transporting.

Another object is to provide a base for a drilling rig which is collapsible for roading and which may be extended with minimum effort to provide a substructure for a drilling rig which is larger than can be transported over public roads.

Another object is to provide a base as in the preceding object in which the base is collapsed without dismantling the base.

Another object is to provide a substructure for a drilling rig in which two structural sections each of which is designed to support a leg of a drilling mast are secured together by a collapsible linkage.

Other objects, features and advantages of this invention will be apparent from the drawings, the specification and the claims.

In the drawings wherein there is shown an illustrative embodiment of this invention and wherein like reference numerals indicate like parts:

FIGS. 1 through 4 are views in front elevation of a drilling rig constructed in accordance with this invention with a portion of the lower section of the mast of FIG. 1 broken away for illustration of detail, and showing progressively the steps of raising the upper section of the mast;

FIG. 5 is a view on an enlarged scale of the hinge connection between the substructure and the legs of the mast;

FIG. 6 is a fragmentary view on an enlarged scale of one corner of the crown of the mast illustrating the manner of connecting the crown to the legs of the mast and of providing a means for stabilizing the mast once it has been raised;

FIG. 7 is a view along the line 7—7 of FIG. 6;

FIG. 8 is a plan view of the substructure for the drilling rig;

FIG. 9 is a view in side elevation of the substructure shown in FIG. 8;

FIG. 10 is a view along the lines 10—10 of FIG. 9;

FIG. 11 is a plan view of the substructure when collapsed and showing, in part, the position of the substructure when extended in dashed outline;

FIG. 12 is a side elevational view of the drilling rig of this invention showing the trailer mounted draw works in position; and

FIG. 13 is a view on an enlarged scale of means for interlocking the two structural sections of the substructure together when collapsed.

The rig illustrated in the drawings includes a substructure indicated generally at 10 and a telescoping mast indicated generally at 11. Power for the rig is provided by a trailer mounted draw works indicated generally at 12.

The mast 11 is a two-legged structural mast. The legs are made up of identical lower structural sections 13 and 13a and upper identical telescoping sections 14 and 14a.

The upper sections of the mast slide within the hollow columns formed by the lower sections of the mast.

A novel apparatus and method for raising and lowering the upper sections of the mast is provided by utilizing the traveling block or similar weight for raising and lowering the mast. A rigging between the telescoping sections of the mast with at least a two to one mechanical advantage is provided. Preferably, two riggings, one for each leg of the mast, are utilized to avoid unequal stresses on the mast and to prevent the mast from falling in the event one rigging breaks or becomes inoperative in any way. These riggings are identical and, therefore, only one will be described.

The rigging for raising and lowering the mast includes a pulley **15** on the inside top of lower section **13** of the mast. A line **16** passes over this pulley and down to pulley means on the bottom of the upper section **14** of the same leg of the mast. This pulley means should preferably transfer line **16** from the inside of the mast to the one of the other three sides of the mast to provide sufficient space for the rigging. This pulley means may be provided by two small single pulleys **17** and **18** positioned at the inner and outer edge of the mast section **14** as illustrated. The line **16** passes over pulleys **17** and **18** and thence upwardly to an anchor point on the lower section of the mast. As the dead line portion **16*a*** of line **16** will be moved as hereinafter more fully explained, it is preferred to pass the line **16** over a pulley **19** at the upper end of section **13** of the mast and thence to an anchor means **20** just below pulley **19**. With the dead line portion of line **16** secured to anchoring means **20**, the fast line portion **16*b*** of line **16** will be very short as indicated in FIG. 1.

With the mast erected but collapsed as shown in FIG. 1, the drilling line **21** from drum **22** of draw works **12** will be fastened to the traveling block **23** in the usual manner. (The traveling block **23** and crown block **24** are provided with a number of sheaves and the drilling line is normally looped over these sheaves to provide a substantial mechanical advantage. For clarity of the drawings the drilling line is shown to pass over the crown block only one time and to be directly secured to the traveling block.)

In raising the upper section of the mast, the traveling block **23** will be raised to a point adjacent the crown of the mast and the fast line portion **16*b*** of line **16** secured to the traveling block. The traveling block is usually a very heavy member and will often weigh more than one half the weight of the upper section of the mast. When this is true the weight of the block will be sufficient to overcome the weight of the upper section of the mast and by lowering the traveling block with the drilling line **21** the upper section of the mast will be raised to the FIG. 2 position. If the weight of the traveling block is not greater than the weight of the upper section of the mast by an amount sufficient to overcome the weight of the upper mast section and friction in the rigging, additional weight may be added to the traveling block. As an alternative, the rigging may be designed to increase the mechanical advantage as will be understood by those skilled in the art. With the mast raised to the position shown in FIG. 2, the upper section of the mast may be temporarily suspended in any desired conventional manner as diagrammatically illustrated by supports **25** releasably secured to lower mast section **13** and supporting the upper mast section.

With the mast in partial raised position, the drilling line is taken in to raise the traveling block to a position just below the pulley **15** at the top of the lower mast section. The dead line portion **16*a*** of rigging line **16** is then removed from anchor **20** and the slack in the rigging taken up. The dead line is made fast preferably by securing it to a second anchor means spaced from the first anchor means **20** such as anchor means **26**. This arrangement of the rigging is shown in FIG. 3. The drilling line is payed out to lower traveling block **23** again. This raises

the upper section of the mast to its fully extended position as shown in FIG. 4. The mast may then be latched in extended position in any convenient conventional manner and rigging line **16** removed from the traveling block and secured in an out-of-the-way position. The drilling rig is now ready for use.

As two riggings are used there is no side thrust on the mast during raising or lowering and in the event of malfunction of one of the riggings, the other rigging will prevent falling of the upper section of the mast. Therefore, the lifting mechanism gives an automatic safety device and no additional auxiliary safety means are required.

It would, of course, be possible to use a separate line from a separate power source to raise or lower the traveling block. It would also be possible to unrig the traveling block and wrap a telescoping line about the drill line on drum **22** and use this line to raise and lower the traveling block. The method illustrated is preferred as the traveling block remains rigged at all times thereby saving considerable man-hours of work. Furthermore, the drilling line will spool properly and there is little chance of a ball-up on the draw works.

A two-legged mast in which the legs converge upwardly toward the crown block is much stronger than a mast in which the legs are parallel to each other. Therefore, the converging leg mast is used whenever possible as it permits a lighter, cheaper mast. For a telescoping mast to have converging legs necessitates that the legs be permitted to tilt toward and away from each other during raising and lowering of the mast. On the other hand, the mast must be stable when in fully erected position.

Provisions are made for tilting of the mast legs toward and away from each other by special hinge means at the top and bottom of the mast. Referring particularly to FIG. 5, one of the four bottom hinge means indicated generally at **27** is shown. This hinge means permits the hinge pin to rock longitudinally and as the pin extends across the mast, the leg of the mast will be permitted to tilt. The hinge means includes an upstanding base **28** carried by substructure **10**. The base **28** carries spaced hinge parts **29** and **30**. An in-line bore **31** extends through the hinge parts **29** and **30**. The lower ends of lower sections **13** and **13*a*** are each provided with a hinge part **32** which fits loosely between the hinge parts **29** and **30** of the base. The mast hinge part **32** has a bore **33** of smaller diameter than bore **31** through hinge parts **29** and **30**. A hinge pin provided by bolt **34** extends through bores **31** and **33**. The relationship of the hinge pin and two bores permits the mast legs to tilt toward and away from each other. In the preferred form shown, the bolt **34** fits snugly within bore **33** of the mast hinge part and loosely within bore **31** of the base hinge parts. As the mast is lowered and tilts inwardly, the hinge pins rest upon the bore in hinge part **30** but is not supported by hinge part **29** as shown in dashed outline at **35**. With the mast fully extended the weight of the mast and the load imposed thereon will be squarely supported by both base hinge parts **29** and **30** in the same manner in which a hinge having a tight hinge pin would support a mast and this support for the mast will be stable. The hinge **27** shown in FIG. 5 is provided at the front and rear of each mast leg and functions in each location as explained above.

The connection between the crown and each mast leg is preferably provided by hinge means in association with stop means which provide a substantial rigid connection between the crown and mast legs when the mast is fully extended. The connection is best shown in FIGS. 6 and 7. The crown of the mast indicated generally at **36** is provided with depending spaced hinge parts **37** and **38**, preferably on the front and rear side of each mast leg. While four hinges are used, they are identical and only one will be described. These hinge parts depend from the bottom of the crown beam **39**. At a point spaced some distance from the crown beam, in-line bores **41** are provided in the hinge parts **37** and **38**. A hinge pin **42** is

mounted in the bore 41 and passes through a hinge part 43 carried at the upper end of each mast leg. The hinge pin 42 extends fore and aft of the mast and permits the mast legs to rotate about the hinge pin and tilt toward and away from each other.

In order to stabilize the mast when erected, the hinge part 43 carried by the mast leg has a stop or abutment section 43*a* which extends beyond the hinge pin 42 and close to the bottom face 39*a* of the crown beam 39. Preferably, plate 43*a* has a flat terminal portion 43*b* which as the mast tilts will engage the bottom surface 39*a* of the crown beam 39. This plate should be designed to be in firm abutment at point 44 (FIG. 6) when the mast is fully extended. As identical hinges and stops are provided on opposite sides of the mast, these abutments will stabilize the mast and prevent further tilting or rocking of the mast.

Referring now to the substructure indicated generally at 10, it will be seen to include spaced structural sections indicated generally at 45 and 46. Each structural section carries supports 28 to which the lower sections of the mast are hinged as heretofore explained. The structural sections are secured together by a collapsible means extending therebetween whereby the substructure may be extended to the FIG. 8 relationship and collapsed to a size suitable for roading as for instance as shown in FIG. 11.

Each structural section is built around skids 47 and 47*a* and may include any arrangement of beams desired such as the vertical I-beams 48, 48*a*, 49, 49*a*, 50, 50*a*, 51, and 51*a*, and the deck beams 52 and 53. The sections may be cross braced by structural members such as I-beams 60. The two structural sections are mirror images.

The collapsible linkage for securing the substructure sections together may be provided in any convenient manner such as by the I-beam structural members 54, 55, 56, 57 and 58. The linkage member 57 is best seen in FIG. 10. The linkage members have hinged connections at each end with the respective structural sections 45 and 46. These hinged connections are identical and are indicated generally at 59. The hinge pins 61 preferably are removable at least at a common end of the linkage members to provide an alternate means of collapsing the substructure.

When the substructure is delivered to a site, it is collapsed in the manner indicated in FIG. 11. The linkage means holds the two structural sections parallel to each other and permits them to move together and apart in the manner of parallel rulers. It will be noted from FIG. 9 that the linkage members are staggered vertically so that they may be longer than the distance between adjacent hinges 59.

In folded position the two sections are preferably interlocked by a plurality of pin and socket connections carried by the structural members and best shown in FIG. 13. These members include a box 62 projecting outwardly from one structural section. A bore 63 is provided in the outer extremity of the box for receiving a pin 64 carried by the other structural section. The pin 64 is surrounded for a portion of its length by a box 65. With the substructure folded as shown in FIG. 11, the boxes 62 and 65 are in abutment. The nose of the pin 64 is beveled as at 65*a* for ease of insertion into box 62. It will be noted that these interlocking means are spaced along the substructure at points opposite each other and are spaced apart along each structural section a distance equal the length of the interconnecting members 54, 55, etc. Thus, some of these interlocking means will engage when the substructure is collapsed in the manner indicated in FIG. 11 or when they are collapsed in the manner explained below.

As an alternative means of collapsing the substructure, the pins 61 may be removed from the hinges at a common end of the interconnecting links to completely disengages the two structural sections 45 and 46. The linkage members may be folded as in FIG. 11. The structural members may then be skidded together until the interlocking means provided by the confronting pins 64 and sockets 63 are engaged. The substructure may be firmly secured together by wrapping chains around it if desired.

When the rig is delivered on location, the collapsed substructure of FIG. 11 is expanded to the dotted line position of FIG. 11 or the position shown in FIG. 8. Here the connecting links are fully extended. A turntable indicated generally at 66 may be installed. A ramp indicated generally at 67 may be built up on one end of the substructure. It will be noted that there is no interconnecting linkage between the two structural sections at the top of the substructure above platform 67. This permits the trailer mounted draw works indicated generally at 12 to be backed onto the ramp 67 in a position for use as indicated in FIG. 12.

The mast will be brought in on a separate lowboy truck and a pair of hinges 27 will be utilized to connect one side of the mast to the substructure. Thereafter the mast may be raised to a vertical position in any desired manner and the other two hinge connections made up. At this time the upper section of the mast may be extended in the manner heretofore explained and the rig is ready for use.

When it is desired to change locations the rig may be dismantled by reversing the procedure just explained. However, if it is desired to move the rig only a short distance such as, for instance, in the same field and it is not desired to bring in the necessary vehicles for hauling the rig, the following breakdown procedure may be used. A head rest mounted on skids may be provided and the top of the mast lowered onto the head rest after one pair of the hinge means 27 has been released. The interconnecting links between the two structural sections of the substructure are then disconnected by removing the hinge pins on one side of the substrucure. The several links are folded into an out-of-the-way position and the two structural sections are then skidded closer to each other. It will be recalled that the crown of the mast is hinged for limited movement to the two legs and, therefore, although the connections of the legs to the crown prevent the lower ends of the legs from moving closer together when they are extended, the bottoms of the two legs may be moved in toward each other when they are telescoped. With the two structural sections of the substructure close to each other they may be secured together by chains or the like and the mast and substructure skidded across country to a new location. Furthermore, because the two legs of the mast may be telescoped to different degrees, two sections of the substructure may even be moved toward each other and longitudinally of each other when the mast is reclining, without disconnecting the hinge pins 61. By providing for collapse of the substructure before skidding, the rig may be skidded between obstructions or over a narrow roadway.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus and method.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A drilling rig comprising, a pair of rectangular structural sections, collapsible spaced links between the sections selectively holding them in spaced apart relationship while supporting a mast and collapsible to per-

mit the sections to be positioned side by side for transporting, a two-legged telescoping mast each leg of which is comprised of an upper and a lower section, spaced lower hinge means securing the lower section of each leg of the mast to one of the rectangular structural sections, a mast crown, and hinge means securing the crown to the upper sections of the mast, the hinge pins of said last mentioned hinge means extending fore and aft of the mast to permit slight tilting movement of the legs of the mast toward and away from each other and permitting the structural sections to be moved toward and away from each other while the mast is secured to one of the pair.

2. A drilling rig comprising, a pair of rectangular substructural sections, collapsible spaced links between the sections selectively holding them in spaced-apart relationship and collapsible to permit the sections to be moved toward and away from each other, a two-legged telescoping mast each leg of which is comprised of an upper and a lower section, spaced lower hinge means securing the lower section of each leg of the mast to one of the rectangular substructural sections, a mast crown, upper hinge pins securing the crown to the upper sections of the mast, the hinge pins of said upper hinge means extending fore and aft of the mast to permit slight tilting movement of the legs of the mast toward and away from each other during extension and retraction of the mast, and stop means carried by the upper section of each leg of the mast and the crown, said stop means being engageable to lock the mast legs against tilting movement when the mast is fully extended, and means releasable when the mast is in a retracted position to free the mast legs for said tilting movement to permit said substructural sections to be moved toward and away from each other while each leg of the mast is connected to one of said structural sections by one of said hinge means.

3. A drilling rig comprising, a pair of rectangular substructural sections, collapsible spaced links pivotally connecting the sections for selectively holding them in spaced-apart relationship and collapsible to permit the sections to be moved toward and away from each other and longitudinally with respect to one another without disconnecting said links, a two-legged telescoping mast each leg of which is comprised of upper and lower sections, spaced lower hinge means securing the lower section of each leg of the mast to one of the rectangular substructural sections, a mast crown, upper hinge means securing the crown to the upper sections of the mast, the hinge pins of said upper hinge means extending fore and aft of the mast to permit slight tilting movement of the legs of mast toward and away from each other during extension and retraction of the mast, and stop means carried by the upper section of each leg of the mast and the crown, said stop means being engageable to lock the mast legs against tilting movement when the mast is fully extended and releasable when the mast is in a retracted position to free the mast legs for said tilting movement to permit said substructural sections to be moved toward and away from each other and longitudinally with respect to one another while the mast is connected thereto and without requirement of disconnecting said collapsible spaced links.

4. The method of raising the telescoping upper section of a telescoping mast, which comprises rigging a weight hoisting apparatus to the upper end of the upper section while the two sections are telescoped relative to each other, rigging tackle between the upper end of the lower section and the lower end of the upper section of the mast with a part adjacent the upper end of the lower section of which a downward movement will result in raising the upper section, by said hoisting apparatus and with said sections upright hoisting to a point adjacent the upper end of the lower section a weight sufficient to act through said tackle to substantially overcome the weight of said upper section, connecting said weight to said part of said tackle adjacent the upper end of the lower section, lowering the weight to raise the upper section, supporting said upper section against retrograde movement when it has been raised a predetermined amount within the limits of downward movement of said weight, releasing the weight from the tackle, again hoisting said weight by said hoisting apparatus to a point adjacent the top of the lower section, again connecting it to the tackle at such point, and repeating the weight lowering and raising, releasing and connecting and the upper section supporting steps until said upper section is at the desired level.

5. The method of raising the telescoping upper section of a telescoping mast, which comprises rigging a weight hoisting apparatus to the upper end of the upper section while the two sections are telescoped relative to each other, rigging tackle between the upper end of the lower section and the lower end of the upper section of the mast with a part adjacent the upper end of the lower section of which a downward movement will result in raising the upper section, by said hoisting apparatus and with said sections upright hoisting to a point adjacent the upper end of the lower section a weight sufficient to act through said tackle to substantially overcome the weight of said upper section, connecting said weight to said part of said tackle adjacent the upper end of the lower section, and lowering the weight to raise the upper section, said hoisting apparatus being the apparatus with which the mast is operated in use after its erection.

6. The method of raising the telescoping upper section of a telescoping mast, which comprises rigging a weight hoisting apparatus to the upper end of the upper section while the two sections are telescoped relative to each other, rigging tackle between the upper end of the lower section and the lower end of the upper section of the mast with a part adjacent the upper end of the lower section of which a downward movement will result in raising the upper section, by said hoisting apparatus and with said sections upright hoisting to a point adjacent the upper end of the lower section a weight sufficient to act through said tackle to substantially overcome the weight of said upper section, connecting said weight to said part of said tackle adjacent the upper end of the lower section, and lowering the weight to raise the upper section, said weight being the traveling block with which the mast is operated in use after its erection.

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