Jan. 11, 1966 J. R. WOOLSLAYER ET AL 3,228,151

DRILLING APPARATUS FOR DEEP OIL WELLS

Filed Feb. 15, 1962 4 Sheets-Sheet 1

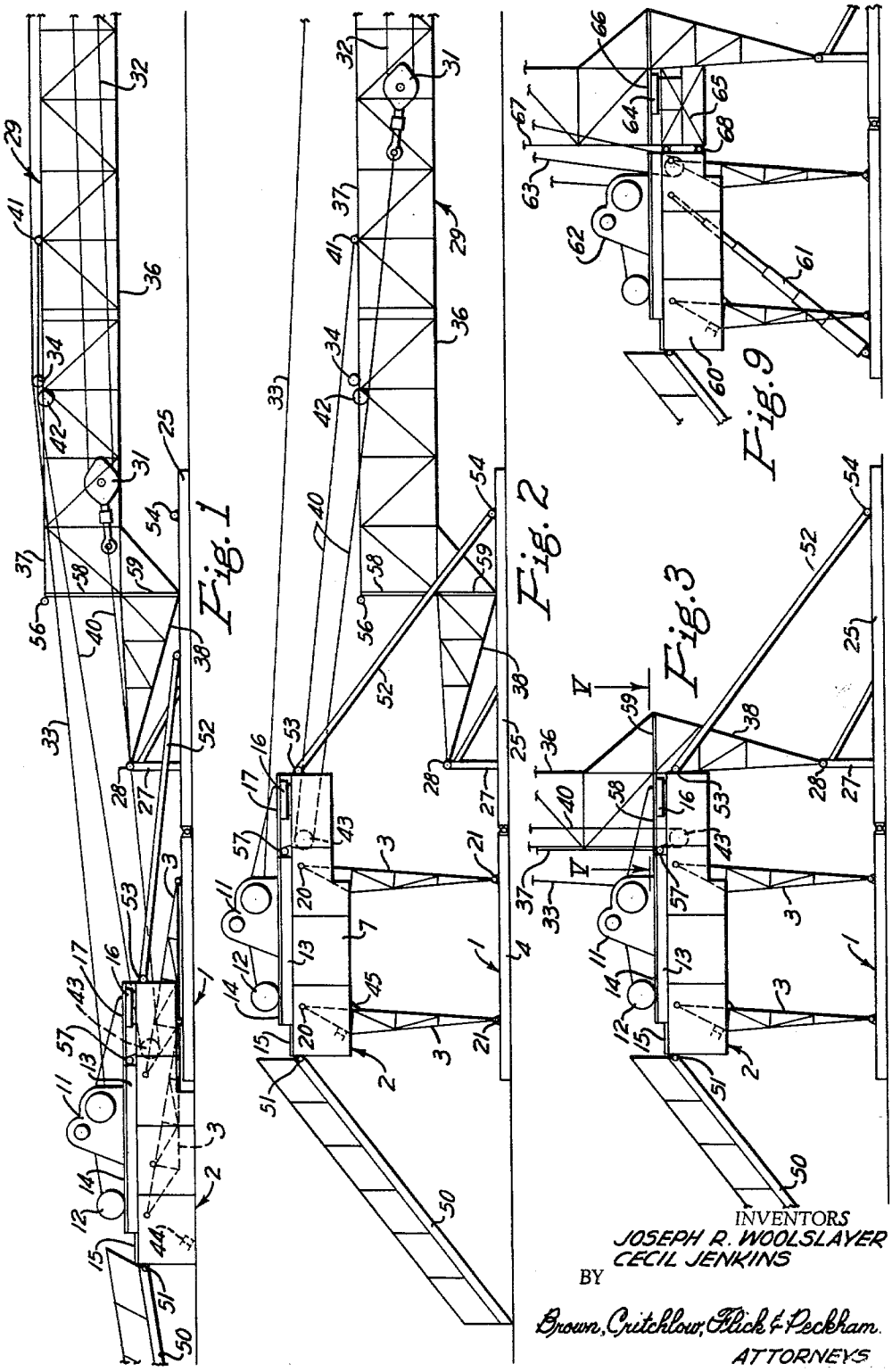


Fig. 1

Fig. 2

Fig. 3

Fig. 9

INVENTORS
JOSEPH R. WOOLSLAYER
CECIL JENKINS
BY
Brown, Critchlow, Flick & Peckham.
ATTORNEYS

Jan. 11, 1966 J. R. WOOLSLAYER ET AL 3,228,151

DRILLING APPARATUS FOR DEEP OIL WELLS

Filed Feb. 15, 1962 4 Sheets-Sheet 2

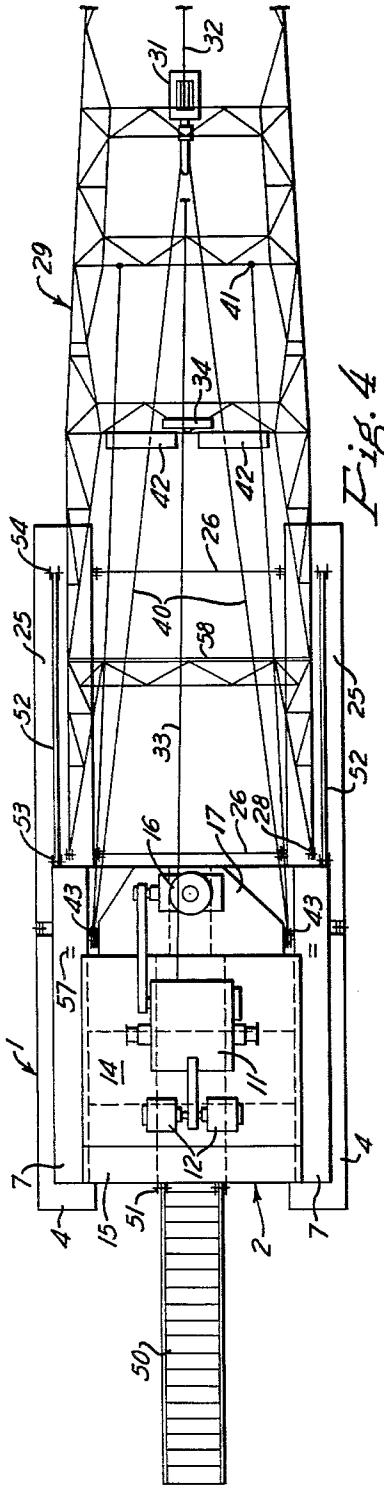


Fig. 4

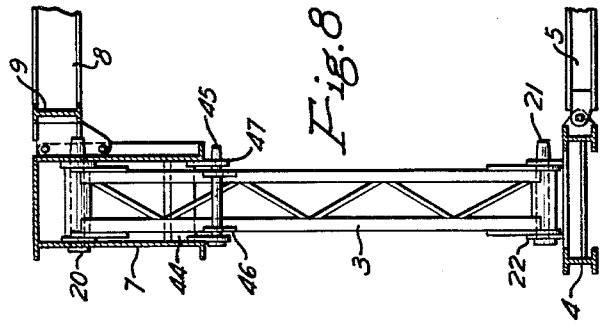


Fig. 8

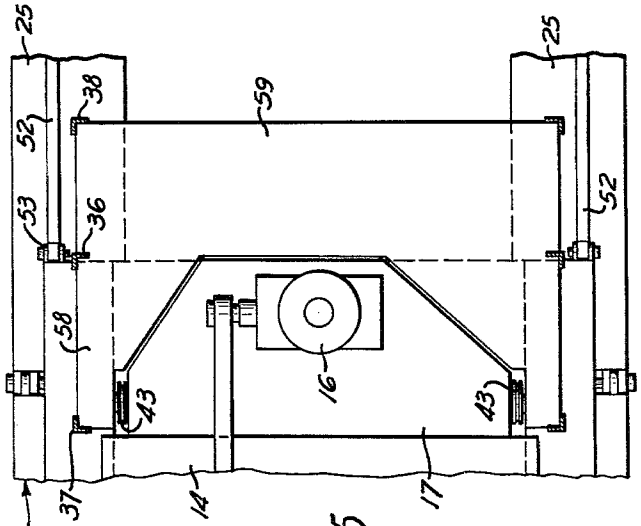


Fig. 5

INVENTORS
JOSEPH R. WOOLSLAYER
CECIL JENKINS

BY

Brown, Critchlow, Flick & Peckham.
ATTORNEYS

Jan. 11, 1966 J. R. WOOLSLAYER ET AL 3,228,151

DRILLING APPARATUS FOR DEEP OIL WELLS

Filed Feb. 15, 1962 4 Sheets-Sheet 3

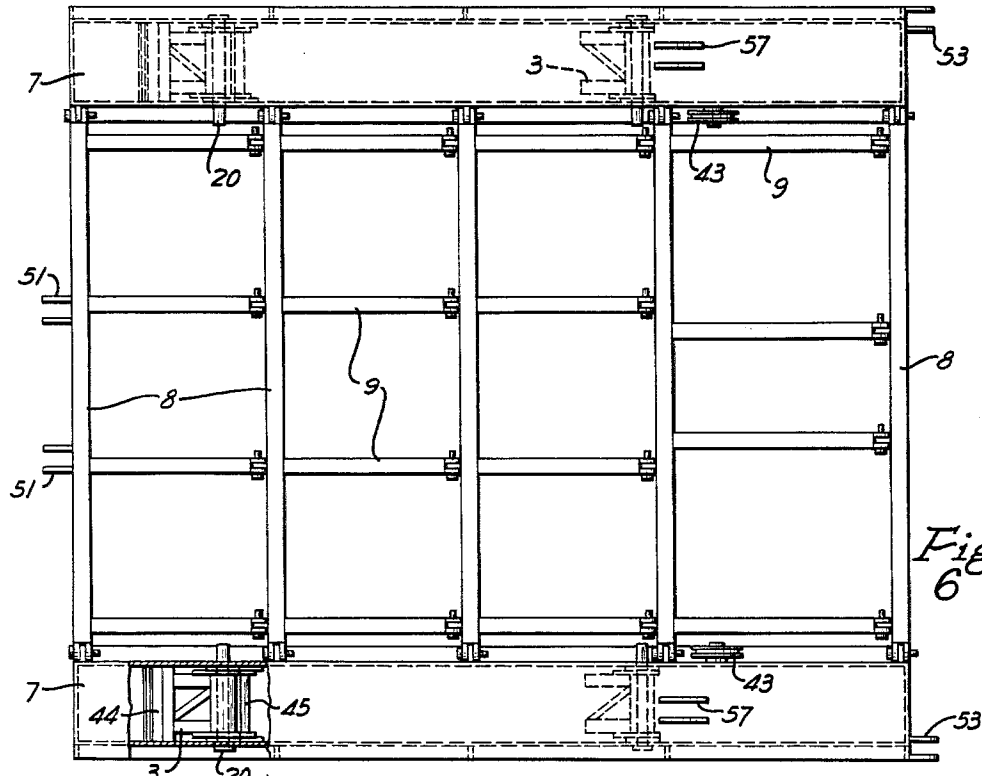


Fig. 6

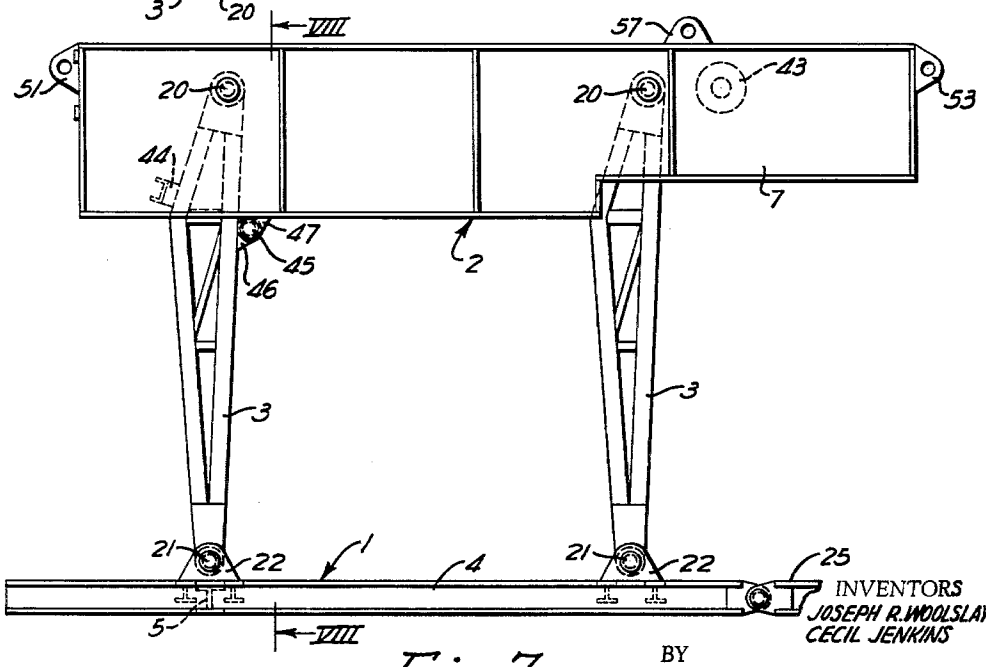


Fig. 7

INVENTORS
JOSEPH R. WOOLSLAYER
CECIL JENKINS

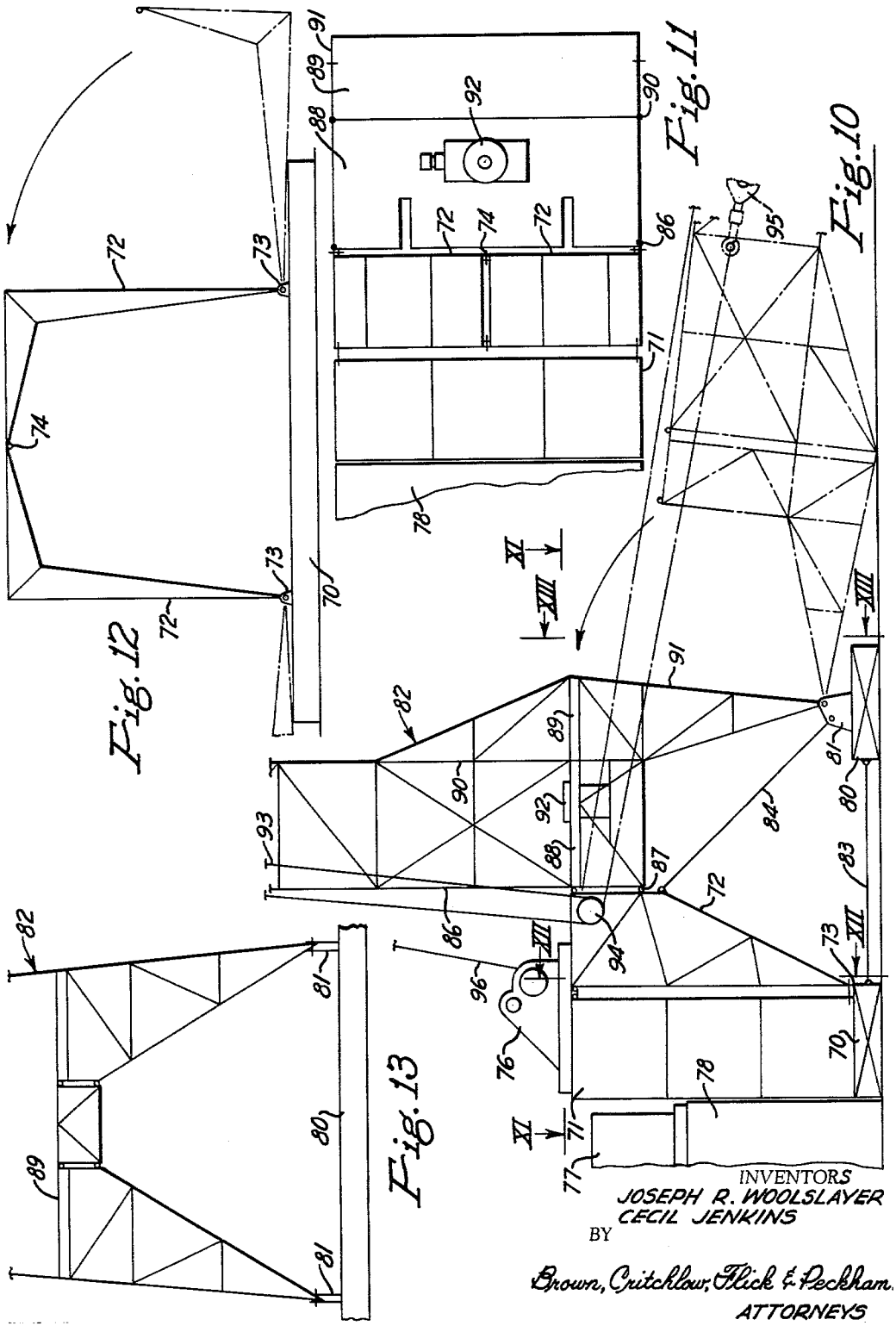
BY

Brown, Critchlow, Flick & Peckham.
ATTORNEYS

Jan. 11, 1966 J. R. WOOLSLAYER ET AL 3,228,151

DRILLING APPARATUS FOR DEEP OIL WELLS

Filed Feb. 15, 1962 4 Sheets-Sheet 4



INVENTORS
JOSEPH R. WOOLSLAYER
CECIL JENKINS

BY

Brown, Critchlow, Flick & Peckham.
ATTORNEYS

United States Patent Office 3,228,151 Patented Jan. 11, 1966

3,228,151

DRILLING APPARATUS FOR DEEP OIL WELLS

Joseph R. Woolslayer and Cecil Jenkins, Tulsa, Okla., assignors to Lee C. Moore Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed Feb. 15, 1962, Ser. No. 173,385
10 Claims. (Cl. 52—64)

This invention relates to oil well drilling apparatus, and more particularly to drilling rigs requiring extremely tall substructures.

As oil wells are drilled deeper and deeper it becomes an economic necessity to use taller masts and higher substructures. The taller the mast, the fewer the joints that have to be broken in a given length of drill pipe coming out of the hole, so trips can be made more rapidly. Also, deep wells encounter high pressures, so safety regulations require a great deal of safety equipment between the well head and the floor of the substructure. To provide clearance for that equipment, the substructure must be very high. The taller the mast and substructure, the greater the problem of erecting them, disassembling them and transporting them from one location to another. In some cases, for example it is desirable to use a 26 foot high substructure with a 142 foot mast on it, making a total height of 168 feet.

A tall substructure, such as 20 or more feet high, can be constructed at the drilling location from prefabricated subassemblies, but it requires several of them and considerable equipment to set one subassembly on top of another to reach the desired height. Even after that has been done there is the greater problem of raising the drawworks and its power plant to the top of the substructure. In the past, there has been accomplished by constructing long ramps, up which trailers carrying the machinery were backed. Such ramps for substructures around 20 feet high have cost nearly $9,000.00, and of course they are used only for placing equipment on and removing it from the top of a substructure. They are useless during drilling. Also, it is a hazardous undertaking to back a long and heavy trailer up ramps to such a great height.

Another serious problem has been the elevation of the feet of a reclining mast to the top of a tall substructure before the mast is swung up. This too has generally been done by means of ramps, which cost as must as $3,000.00 and which are used only at the time of erection of the mast or its removal from the substructure.

It can be seen that the various ramps are highly undesirable and that they materially increase the cost of the drilling rig without serving any purpose during drilling.

Finally, there is the ever-present problem of erecting a gin pole on a substructure before the mast can be raised.

It is among the objects of this invention to provide oil well drilling apparatus which is suitable for very deep drilling, which has a tall substructure made of a minimum number of parts that are easy to assemble at ground level with ordinary oil field equipment, which does not require the drawworks and engines to be lifted to the top of a tall substructure, which does not require the use of ramps or the like in erecting the mast, which permits the substructure and the mast to be erected by the drawworks without the use of a gin pole, and in which the erection of the substructure and the mast is effected easily and rapidly.

In accordance with this invention a tall substructure has a drawworks-receiving area at its top. A mast has rear legs extending at least upward from the front part of the substructure, preferably from on top of it, and has front legs extending downward in front of the substructure. The rear legs may be detachably connected to the upper part of the substructure. The lower ends

of the front legs are pivotally supported so that after the rear legs have been disconnected from the substructure the mast can be swung forward and away from it and down to a reclining position in front of the substructure. It also is highly desirable to be able, in erecting this equipment, to raise the floor unit of the substructure, with the drawworks mounted on it, from a ground position to an elevated position above the substructure base. One way of doing this is to swing the floor unit forward and upward before the mast is swung up. The power for both operations may be furnished by the drawworks.

The invention is illustrated in the accompanying drawings, in which

FIG. 1 is a diagrammatic side view of our oil well drilling apparatus just before it is erected;

FIG. 2 is a similar view showing the substructure erected;

FIG. 3 is a side view of the apparatus after the mast has been swung up to upright position;

FIG. 4 is a plan view of the apparatus as shown in FIG. 2;

FIG. 5 is an enlarged fragmentary horizontal cross section taken on the line V—V of FIG. 3;

FIG. 6 is an enlarged detailed plan view of the substructure without its floor;

FIG. 7 is an enlarged side view of the erected substructure;

FIG. 8 is a fragmentary vertical section taken on the line VIII—VIII of FIG. 7;

FIG. 9 is a fragmentary side view, similar to FIG. 3, of a modification;

FIG. 10 also is a diagrammatic side view of another modified embodiment of the invention;

FIG. 11 is a horizontal section taken on the line XI—XI of FIG. 10; and

FIGS. 12 and 13 are vertical sections taken on the lines XII—XII and XIII—XIII, respectively, of FIG. 10.

Referring to FIGS. 1 to 8 of the drawings, a substructure may be formed from three principal parts; a base **1**, an elevatable floor unit **2** and means between them for raising the floor unit. Preferably, the raising means are legs **3** hinged to the base and floor unit so that the legs can swing lengthwise of the base. The base includes two parallel mats **4** that are long and narrow but have sufficient ground-engaging area to support the rest of the substructure. These mats are spaced apart a considerable distance and are detachably connected near their rear ends by a cross beam **5** (FIG. 7). Before the substructure is erected, the floor unit **2** rests on the ground behind the base as shown in FIG. 1. The floor unit includes a pair of parallel side members that are several feet deep. Each side member may be in the form of a box beam **7** that is open at its bottom and part way up its front end. The bottom of the front portions of the beams may be recessed to receive the rear portion of the mats **4** below them. The two beams are spaced apart about the same distance as the mats and are detachably connected by a plurality of parallel cross beams **8**, which in turn are detachably connected by shorter longitudinal beams **9**.

Since the floor unit **2** is on the ground, it is not difficult to skid the drawworks **11** and its power unit onto it from a trailer. The power unit shown consists of electric motors **12**, but internal combustion engines can be used just as well, as is the usual practice. The skids **13** that support the drawworks and motors are covered by a floor **14**, behind which another floor section **15** may be laid directly on the floor unit. A rotary table **16** is mounted on the floor unit in front of the drawworks, from which it is driven in the usual way. Around the upper part of the table on a level with floor **14** there is a floor section **17** of the general shape shown in FIGS. 4 and 5. If de-

sired, the dog house (not shown) can likewise be mounted on the floor unit while it is on the ground.

Inside each box beam **7** there is a pair of parallel heavy pivot pins **20**, one near the rear end of the beam and the other near its front end. Both pins are near the top of the beam. Pivotally mounted on these pins are the upper ends of trussed legs **3** which, while the floor unit is on the ground, extend forward and downward and have their front ends pivotally mounted on pins **21** in brackets **22** secured to the adjoining base mat **4**. Pins **21** are the same distance apart as pins **20** so that the legs will be parallel. When the legs are swung forward in a manner to be described presently, the floor unit will be raised. When the various elements of the substructure are disconnected from one another, they are small enough to be handled by the usual oil field equipment and can be trucked over highways.

Detachably connected to the front ends of the substructure mats are a pair of base mats **25** for a mast. These mats are similar to the substructure mats, but generally are longer. They are detachably connected together by cross members **26** near their front and rear ends, as shown in FIG. 4. Mounted on each of the mats **25** near its rear end is an elevated support, such as a braced post **27** with a shoe **28** on its upper end for receiving one of the feet of a reclining mast **29** that extends forward away from the shoe. The mast is assembled along the ground from prefabricated sections in a well-known manner. It has a traveling block **31** inside of it connected with the usual crownblock (not shown) by wire lines **32**. The usual fast line **33** extends from the crownblock back along the upper side of the mast and over a roller **34** journaled in the mast and is connected to the drawworks. The lower legs **36** of the reclining mast are referred to herein as the front legs and they extend from the supporting shoes **28** to the top or front end of the mast. The upper or rear legs **37**, however, do not extend all the way back to the foot of the mast. The rear end of the reclining mast is reinforced by trusses **38** below the lower legs and extending from the shoes forward to a point beyond the rear ends of the upper legs.

The substructure is erected by swinging legs **3** forward so that the floor unit will rise as it moves forward. Although this can be done by an independent power plant, it is preferred to utilize the drawworks. To do that, the ends of a sling **40** are anchored to the upper side of the reclining mast at points **41**, and the sling is extended back and over horizontal rollers **42** journaled in the mast to large sheaves **43** pivotally mounted on the inner sides of the two box beams **7** of the substructure floor unit. The sling extends down around the sheaves and then forward to the traveling block that is hooked onto it. When the drawworks is operated to reel in the fast line **33**, the traveling block simultaneously is pulled toward the outer end of the mast and so the substructure, which offers less resistance to rising than the long mast, is pulled upward by the fast line and the sling. When the floor unit reaches its upper position, stops **44** (FIGS. 6, 7 and 8) mounted inside the rear ends of the box beams engage the back of the rear legs and prevent pulling the floor unit over frontwards. Pins **45** are then driven into overlapping brackets **46** and **47** on the front of the rear legs and the bottom of the box beams to lock the floor unit in its elevated position.

It also is desirable to have the rising floor unit of the substructure carry a stairway up with it to avoid lifting and attaching the stairway after the substructure has been erected. Accordingly, a stairway **50** can be laid out along the ground behind the floor unit while it is down, and the front end of the stairway hinged to the back of the floor unit at **51**. Then, as the floor unit is raised, it will drag the lower end of the stairway forward and simultaneously elevate the front end to give access to the top of the substructure as soon as it is erected.

Before the floor unit is raised, the rear ends of long braces **52** can be pivotally connected to brackets **53** projecting from its front ends above base mats **4**. The front ends of these braces will rest on base mats **25**, along which they will slide as the floor unit is raised. At the time the back legs **3** engage stops **44**, the front ends of the braces will be in position for attachment to brackets **54** mounted on the front ends of mats **25**, as shown in FIG. 2. The braces further stabilize the substructure and also perform another function in some cases, as will be explained in the next paragraph.

After the substructure has been erected, the drawworks is operated again to reel in more of the fast line, but since the floor unit **2** can move no further, the sling line **40** pulls the mast upward and backward toward the substructure. If the load on top of the substructure is not great enough to prevent the substructure from tilting forward at this time, due to the weight of the mast, braces **52** will prevent it because brackets **54** are located at about the center of gravity of the rig shown in FIG. 2. More stability during raising and lowering the mast also is provided by locating the joint between the front and rear base mats behind posts **27** rather than in front of them.

The rear legs **37** of the mast are short enough for their feet **56** to clear the substructure as the mast is swung up, and the mast shoes **28** are located below the front end of the floor unit so that the front legs **36** of the mast can engage the front of the substructure at the same time that the back feet seat in shoes **57** mounted on the substructure several feet behind its front end, as shown in FIG. 3. The back feet then can be pinned to the shoes. After the sling has been disconnected, the mast is ready to use.

The mast may carry up with it to the top of the substructure a built-in floor **58** that will overlie the substructure and that is shaped to straddle the rotary table and register with floor section **17**, as shown in FIG. 5, to complete the substructure flooring. Floor **58** has a forward extension **59** that projects in front of the front legs of the mast between trusses **38** to form a pipe setback supported by the mast. The recess in mast floor **58** that accommodates floor section **17** prevents the mast floor from interfering with sling line **40** when it starts to raise the substructure floor unit **2**.

The posts **27** hold the feet of the reclining mast high enough to allow it to extend substantially horizontally along the ground. Another reason for the elevated shoes **28** is to shorten the distance that the traveling block must move up through the mast to erect it.

It will be seen that in the practice of the invention just described, the substructure and mast are assembled at or near ground level, the drawworks and power units and rotary table are mounted on the substructure before it is raised, and the necessary flooring is laid on the substructure and in the mast before erection. Consequently, none of those things have to be done after erection, when it would be much more difficult and expensive. Ramps are unnecessary. The mast requires none because it is not pivoted to the top of the substructure. The same force that is exerted lengthwise of the mast to raise it is first employed to erect the substructure. The two operations follow each other with no changes in the connections of the lines and sling. The drawworks furnishes all of the power. There is no problem of erecting a gin pole, because none is used. The tall substructure itself serves as the elevated support for the sling line.

It will be realized, of course, that there are other ways of raising the substructure and mast. The substructure can be raised by screw jacks or hydraulic rams and then the mast pulled up by means of the drawworks in the manner that has just been described. Or, the mast could also be raised by hydraulic rams or other means. In FIG. 9 there is shown a substructure having a floor unit **60** that was swung up from its ground position by means of hydraulic rams **61** pivotally connected to it and to the base of the substructure. The mast was raised by the

drawworks 62 and a sling 63 in the same manner as previously described. In some cases it may be desirable to build up the substructure from subassemblies piled on top of one another. FIGURE 9 also shows a rotary table 64 carried by a section 65 of the mast between the front and downwardly extended rear legs of the mast below the mast floor 66. The rear legs 67 are secured to brackets 68 on the front of the shortened substructure to connect it and the mast rigidly together. The top of the rotary table projects above the upper level of the substructure. In this example the back of the mast butts against the front of the substructure instead of standing on it. Of course, if desired, the rear legs of the mast could be extended down to the ground, but that is not necessary and it would add to the weight and cost of the mast. Consequently, although the rear legs always extend upward from the front part of the substructure, they may or may not also extend downward to the ground. The front legs always extend both upward and downward from the level of the top of the substructure.

In the modification shown diagrammatically in FIGS. 10 to 13 the substructure is not self-erecting, but would have to be erected by a crane or the like. The substructure includes a base 70, on which tall box frames 71 are set. In front of these frames is a pair of L shaped members 72, the lower ends of which are pivoted on parallel axes in brackets 73 projecting up from the front of the base. These two units initially extend away from each other along the ground as shown in dotted lines in FIG. 12, but then they are swung up to upright position and their upper ends are pinned together at 74 and to the box frames behind them. After the substructure has been erected, a drawworks 76 is mounted on it. A drawworks engine 77 can be mounted on a lower engine foundation 78 directly behind the substructure.

Spaced a considerable distance in front of the substructure is a mast base 80, on which there is a pair of shoes 81 that the front feet of a mast 82 are pivotally connected to. The two bases are detachably connected together by beams 83. The shoes 81 are connected to the upper part of the front of the substructure by removable braces 84. The rear legs 86 of the mast are detachably connected by brackets 87 to the front of the upper part of the substructure and do not extend down to the ground. The inside of the mast is provided with a permanent floor 88 that has an extension 89 in front of the front legs 90 to form a pipe setback. Trusses 91 in front of the front legs reinforce the lower portion of the mast and help support the setback. A rotary table 92 was mounted in the mast before it was raised.

In order to raise the mast, it was pulled up by the drawworks in the same way as the mast in FIGS. 2 and 3. That is, a sling 93, connected to the upper side of the reclined mast, extended back and over sheaves 94 in the substructure and then forward to the hook 95 of the traveling block in the mast. When the drawworks reeled in the fast line 96 leading to the crownblock, the mast was swung upward and backward toward the substructure, to which it was then attached by brackets 87.

We claim:

1. Deep oil well drilling apparatus comprising a tall substructure having front and rear ends, a rotary table mounted on the front end of the substructure, a floor on top of the substructure surrounding said table, a mast having rear legs extending upward from the substructure at opposite sides of said floor and spaced therefrom, the mast having front legs extending downward in front of the substructure, pivotal means supporting the lower ends of the front legs, and a floor mounted in the mast above the substructure and recessed to receive said first-mentioned floor in substantially coplanar relation, the mast being swingable on said pivotal means with its floor forward away from the substructure and down to a reclining position in front of it.

2. Deep oil well drilling apparatus comprising a tall substructure having front and rear ends, a rotary table mounted on top of the front end of the substructure, a mast having rear legs standing on the front part of the substructure behind said table and having longer rigid front legs extending from the top of the mast downward in front of the substructure in close proximity thereto, pivotal means adjacent the bottom of the substructure supporting the lower ends of the front legs, and means detachably connecting the lower ends of said rear legs to the top of the substructure so that the mast can be swung forward away from the substructure and down to a reclining position in front of it after said rear legs have been disconnected from the substructure.

3. Deep oil well drilling apparatus comprising a substructure base having front and rear ends, parallel reclining front and rear legs extending lengthwise of the base with their front ends pivotally connected thereto, a substructure floor unit, means pivotally connecting the rear ends of the legs to said unit, a mast base in front of said substructure base, a mast support mounted on the mast base, a reclining mast having a foot end pivotally connected to said support, the mast extending forward from said support and having an outer crownblock end, drawworks mounted on said floor unit, a traveling block in the mast, a line operatively connecting the traveling block with the crownblock end of the mast and the drawworks for pulling the traveling block toward the crownblock, sheaves mounted in the floor unit, and a sling having its ends fastened to the mast, the sling extending from the mast back around said sheaves and forward to the traveling block, whereby when the traveling block is pulled toward the outer end of the mast the sling will swing said floor unit forward and up with its legs to a predetermined upright position and then will swing the mast upward and backward to upright position at the front of the substructure.

4. Deep oil well drilling apparatus according to claim 3, including a floor in the reclining mast at a distance from said mast support that will locate the floor at the top of the substructure when the mast is upright, said floor having a downwardly extending recess receiving said sling.

5. Deep oil well drilling apparatus comprising a tall substructure having front and rear ends, a mast having rear legs detachably connected at their lower ends to the upper part of the front of the tall substructure and having rigid front legs spaced forward from said tall substructure and extending downward in front of it from the top of the mast, a floor mounted in the mast in front of the top of the substructure, and pivotal supports in front of the substructure for the lower ends of said front legs so that after said rear legs have been disconnected from the substructure the mast and floor can be swung forward away from the tall substructure and down to a reclining position in front of it.

6. Deep oil well drilling apparatus comprising a substructure base having front and rear ends, an elevatable substructure floor unit, movable means on the base operable to raise said unit from a ground position to a predetermined elevated position above the base, a mast base in front of said substructure base, a mast support mounted on the mast base below the front end of said elevated position of the floor unit, a reclining mast having a foot end pivotally connected to said support, the mast extending forward from said support, drawworks mounted on said floor unit, means including a flexible line connecting the drawworks and mast and substructure unit for exerting a force lengthwise of the reclining mast to raise the floor unit and swing the mast upward towar the floor unit, the weight of the mast being sufficient to maintain it reclining until said line has actuated said movable means to raise said floor unit to said elevated position, and means for bracing the elevated floor unit, the mast having rear legs positioned to seat against the elevated floor unit when the mast is upright.

7. Deep oil well drilling apparatus comprising a base, a reclining mast having a foot end, means hinging said foot end to said base, a rotary table supporting floor disposed on edge inside of the reclining mast and spaced from said foot end, means connected with the reclining mast for swinging it up to upright position, and means for holding the raised mast in said position, the position of said floor in the reclining mast being such that it will be carried upward by the mast to an elevated horizontal position when the mast is swung up to said upright position.

8. Deep oil well drilling apparatus, comprising a base, an upright well-drilling mast above the base having a foot, means hinging the foot to the base, structural means behind the mast normally holding it upright, an elevated rotary table support mounted inside the mast as a part thereof and spaced above said foot, a floor supported by said structural means at about the same elevation as said table support, and means connected with the mast for swinging it with said rotary table support forward on said hinging means away from said structural means and down to a reclining position.

9. Deep oil well drilling apparatus comprising a base, a reclining mast having lower front legs and upper rear legs provided with feet, means hinging the front feet to said base, the back feet being spaced forward along the reclining mast from said front feet, a rotary table support disposed on edge inside of the reclining mast adjacent said back feet, means connected with the reclining mast for swinging it upward and backward on its front feet to upright position, and upwardly extending means behind the mast engageable by its rear legs when in upright position for holding the mast upright, the rotary table support being adapted to be carried upward by the mast to an elevated horizontal position when the mast is swung up to said upright position.

10. Deep oil well drilling apparatus comprising a tall substructure having front and rear ends and a working floor, a mast having rear legs detachably connected at their lower ends to the upper part of the tall substructure and having rigid front legs extending from the top of the mast downward in front of the substructure, pivotal means mounted in front of the substructure supporting the lower ends of said front legs so that the mast can be swung forward and down to a reclining position in front of the substructure after said rear legs have been disconnected from the substructure, and an elevated rotary table support mounted in the mast at the front of said working floor, the rotary table support being swingable with the mast forward and down to said reclining position.

References Cited by the Examiner

UNITED STATES PATENTS

1,481,219	1/1924	Miller	175—195 X
1,575,687	3/1926	Hollick	212—39
2,336,305	12/1943	Selberg	52—117
2,480,330	8/1949	Kump	52—90
2,751,635	6/1956	Donnahue	52—69
2,963,124	12/1960	Woolslayer	52—120
2,991,852	7/1961	Lee	52—118
3,145,786	8/1964	O'Neill et al.	175—170 X

FOREIGN PATENTS

870,386	3/1953	Germany.
528,594	11/1940	Great Britain.

RICHARD W. COOKE, JR., *Primary Examiner.*

JACOB L. NACKENOFF, *Examiner.*

D. H. SWITZER, K. E. PAYNE, *Assist Examiners.*