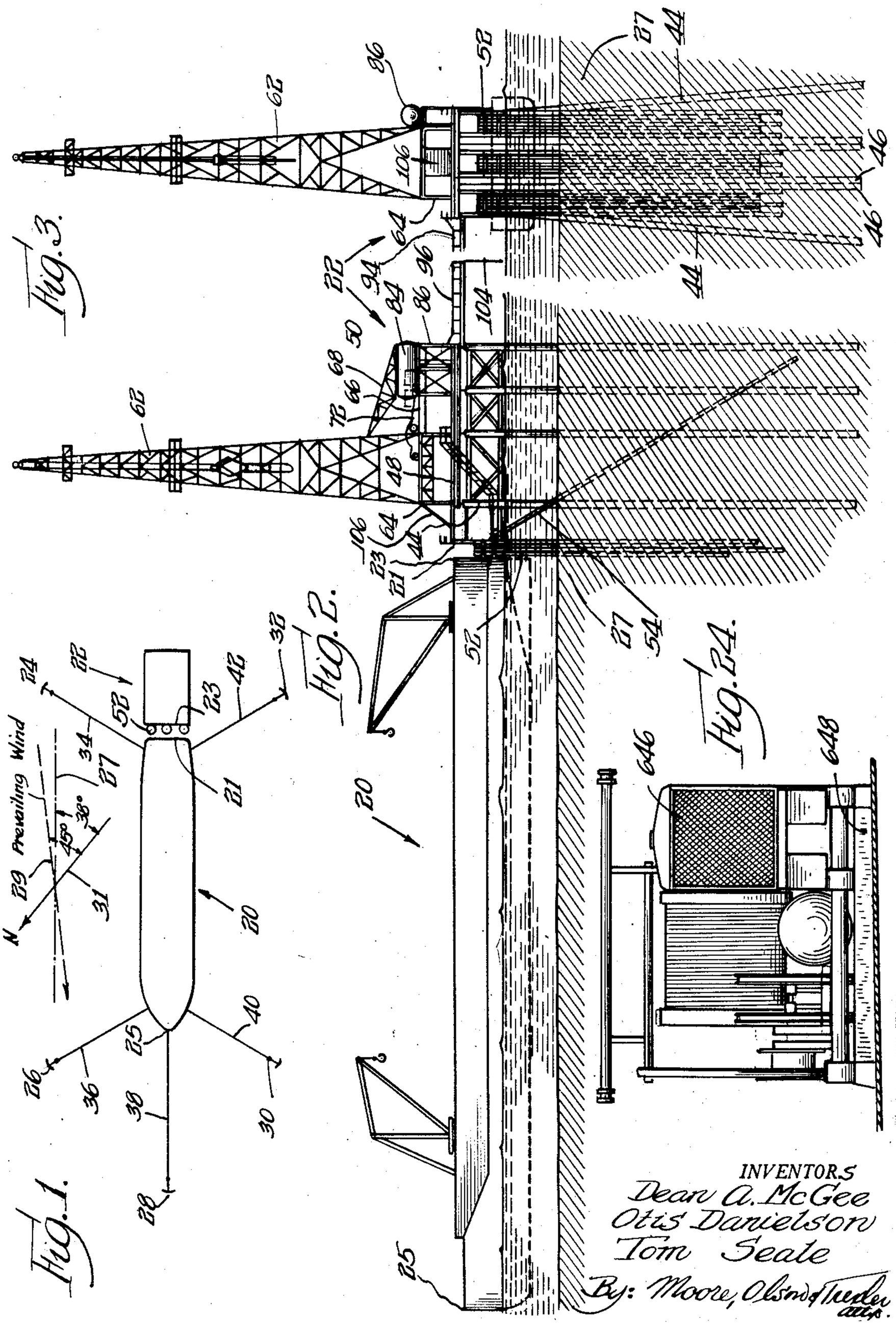
Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 1



Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 2

Fig. 4.

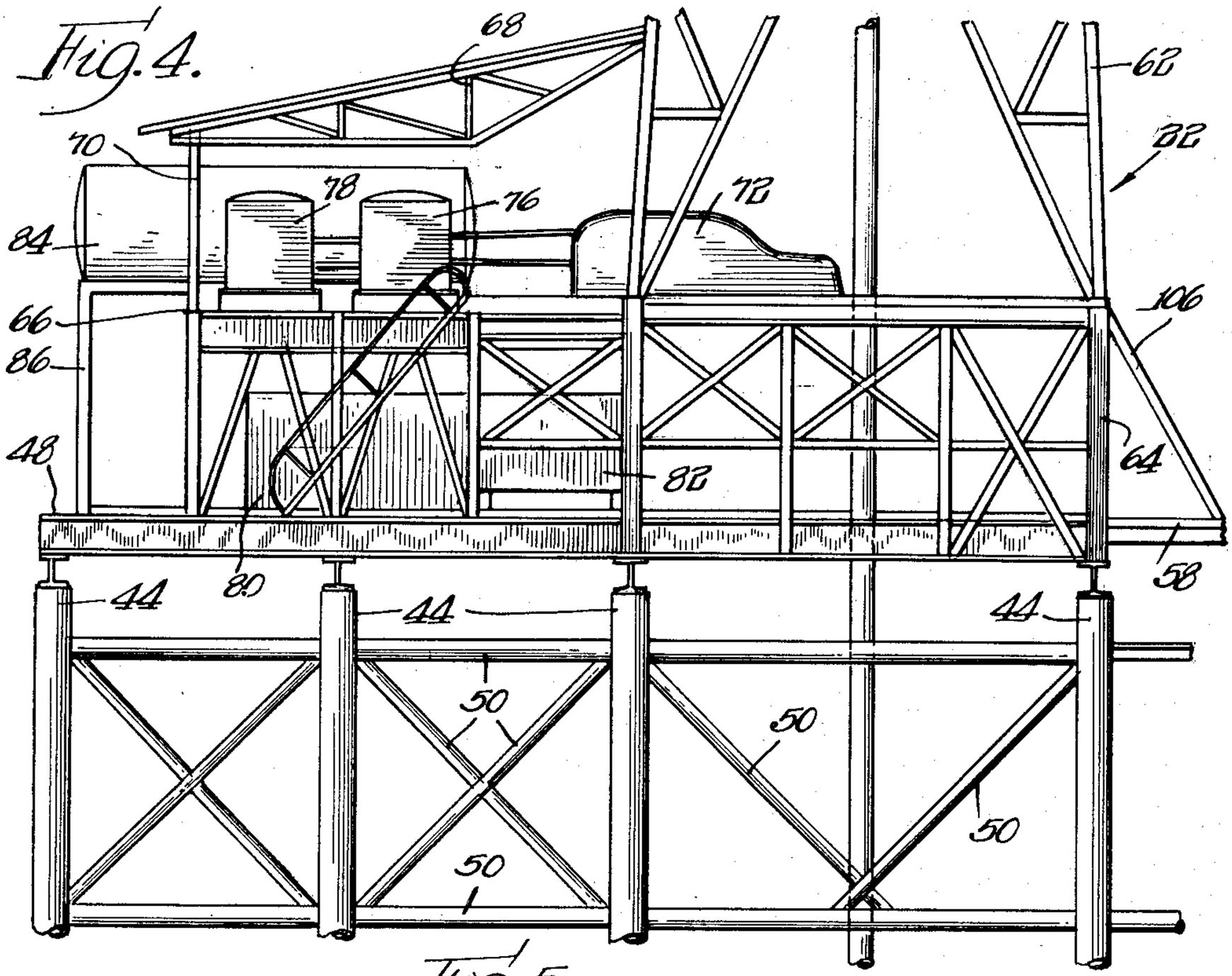
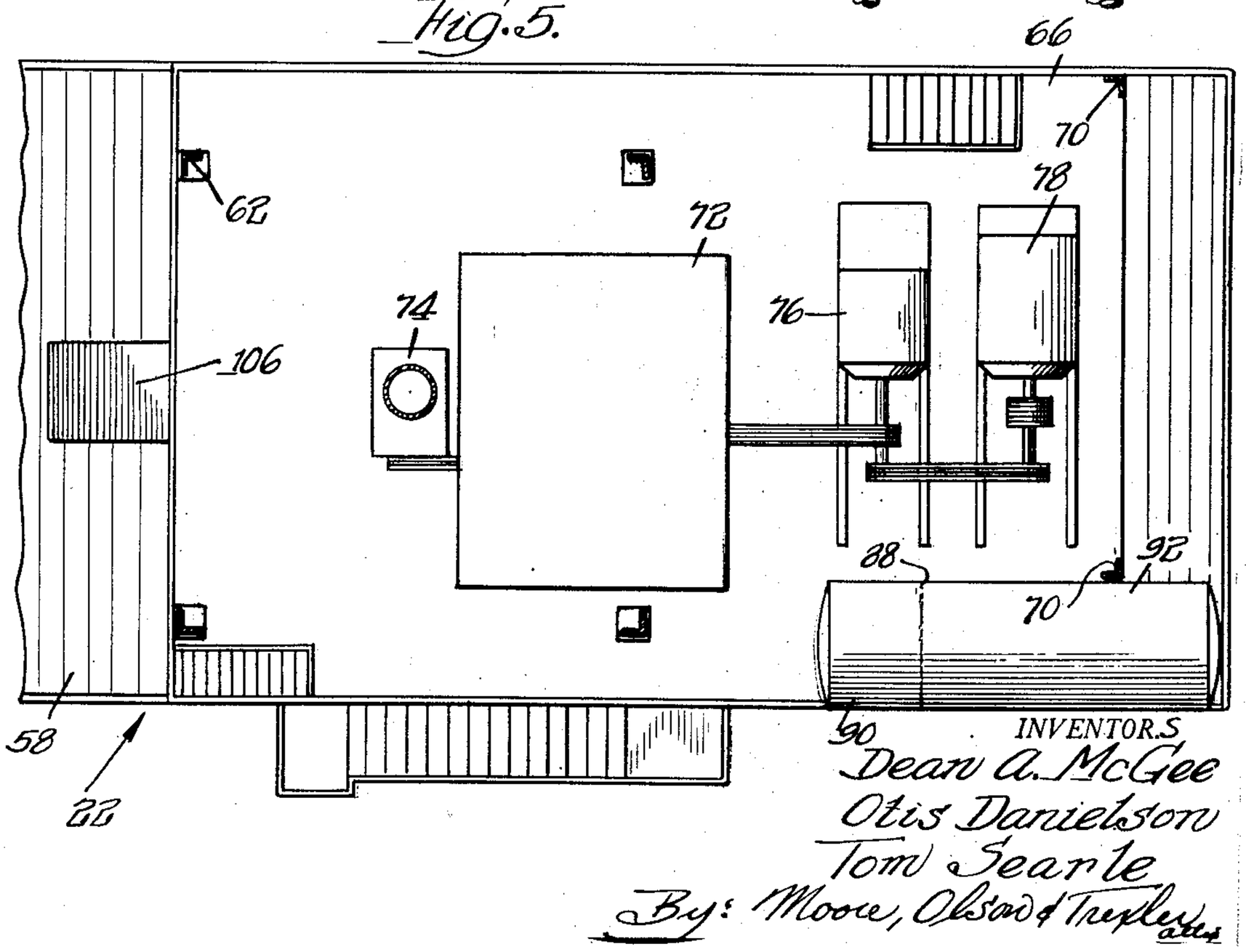


Fig. 5.



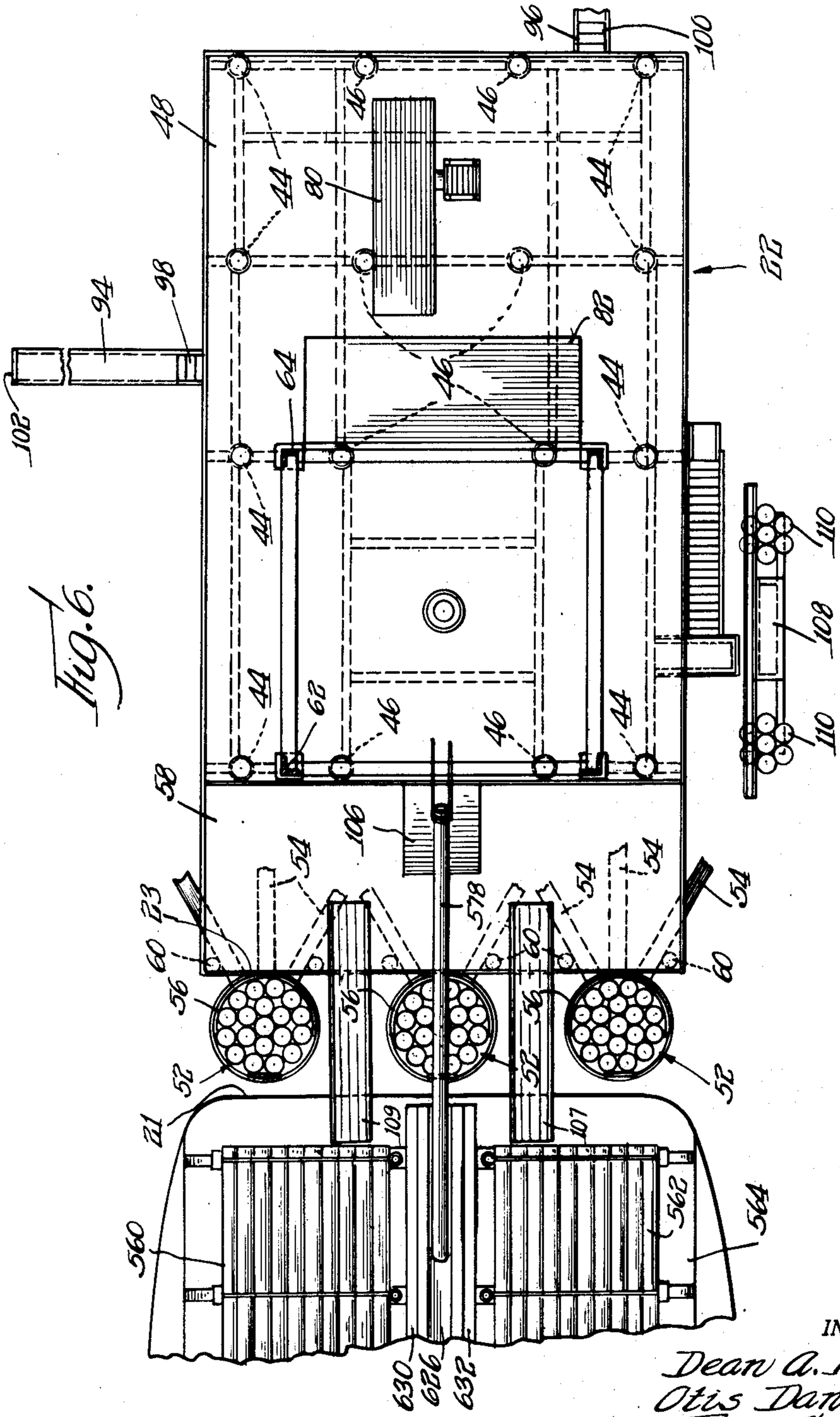
INVENTORS
Dean A. McGee
Otis Danielson
Tom Searle
By: Moore, Olsen & Tripplett
Attys

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 3

Fig. 6.



INVENTORS.
Dean A. McGee
Otis Danielson
Tom Seale
By: Moore, Olsen & Thedey
Attys.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 4

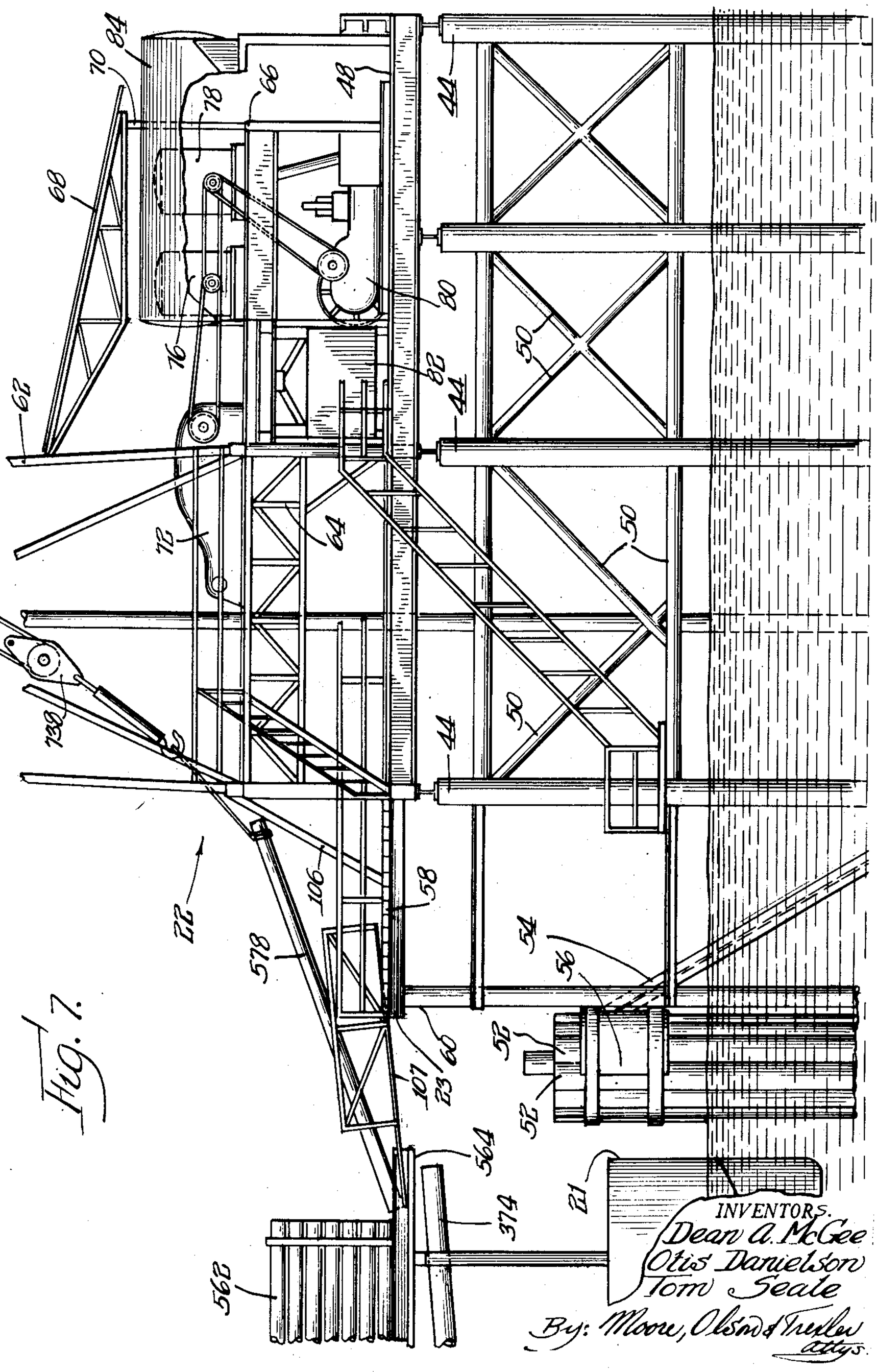


Fig. 7.

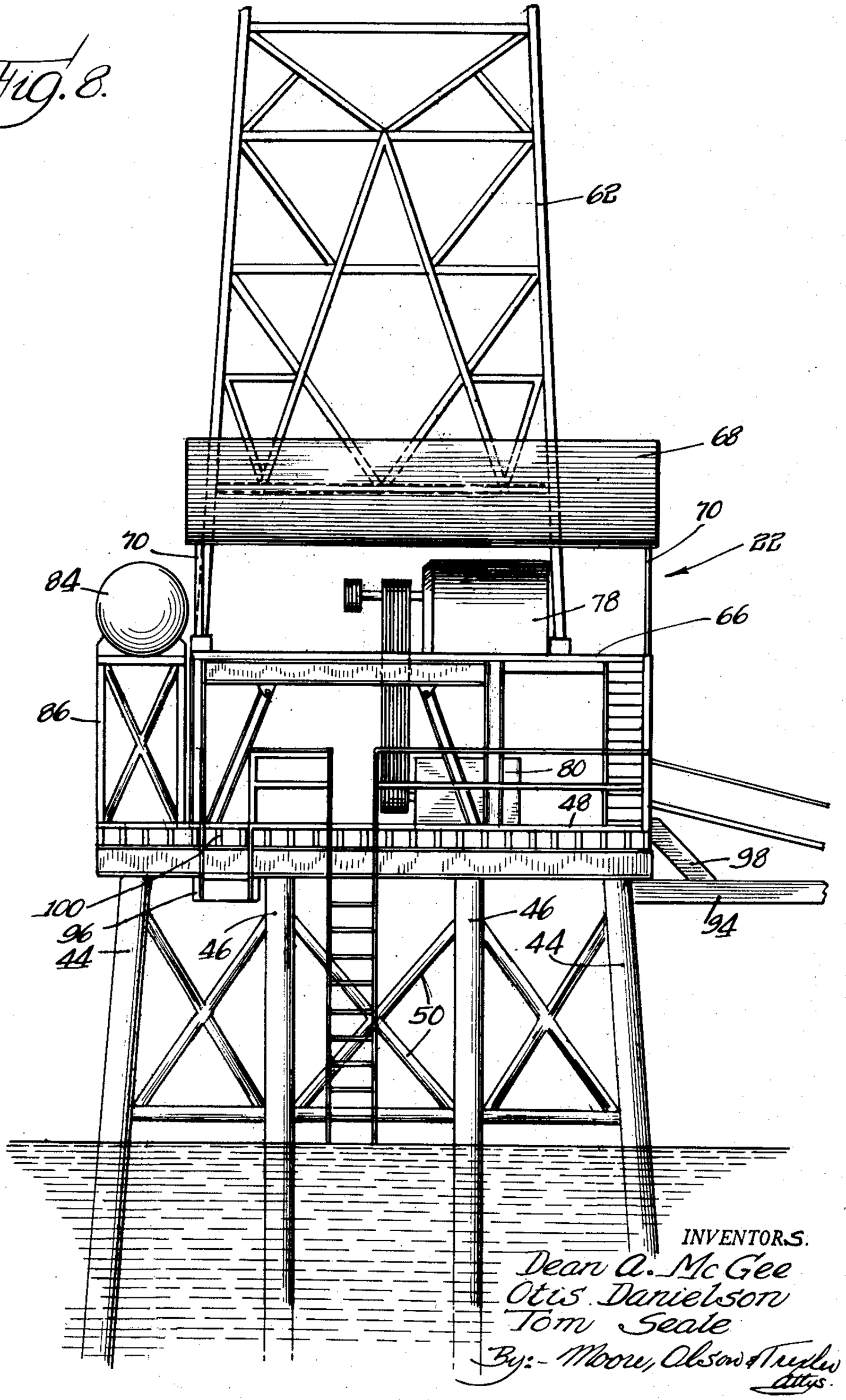
INVENTORS.
Dean A. McGee
Otis Danielson
Tom Seale
By: Moore, Olson & Trexler
attys.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 5

Fig. 8.



INVENTORS.
Dean A. McGee
Otis Danielson
Tom Seale
By:- Moore, Alson & Turpin
Attys.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 6

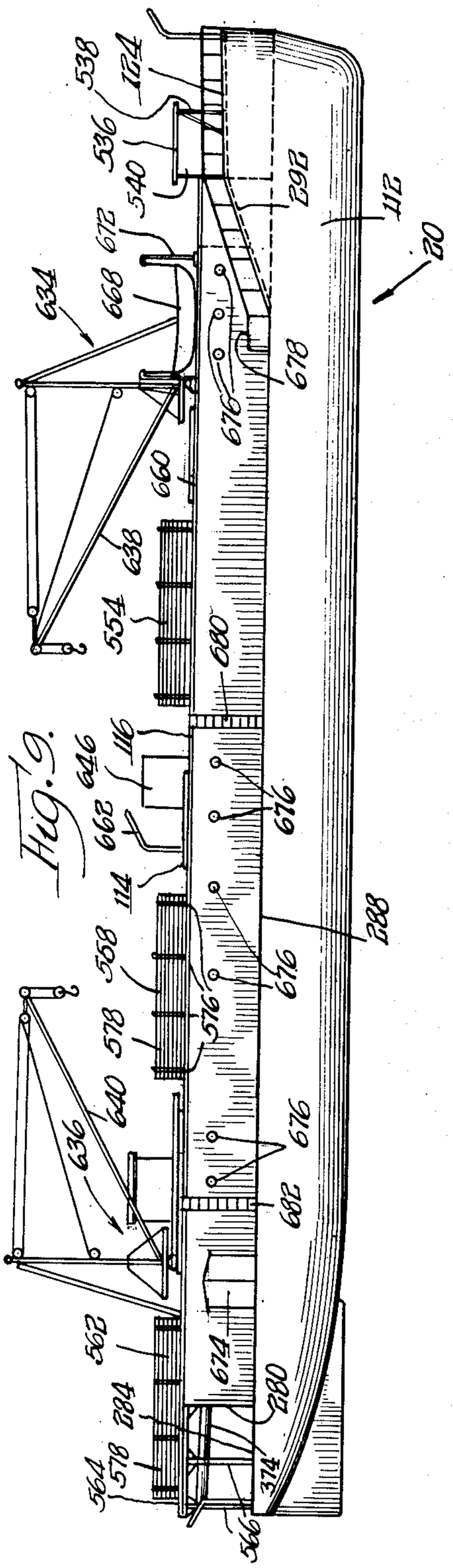


Fig. 9.

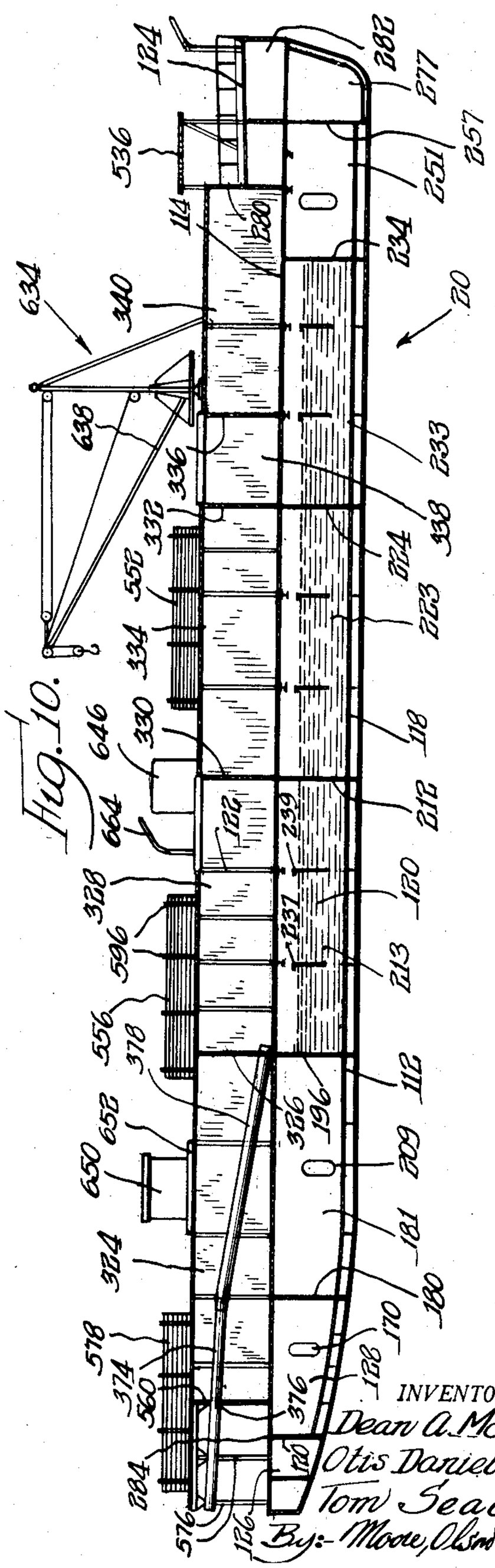


Fig. 10.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 7

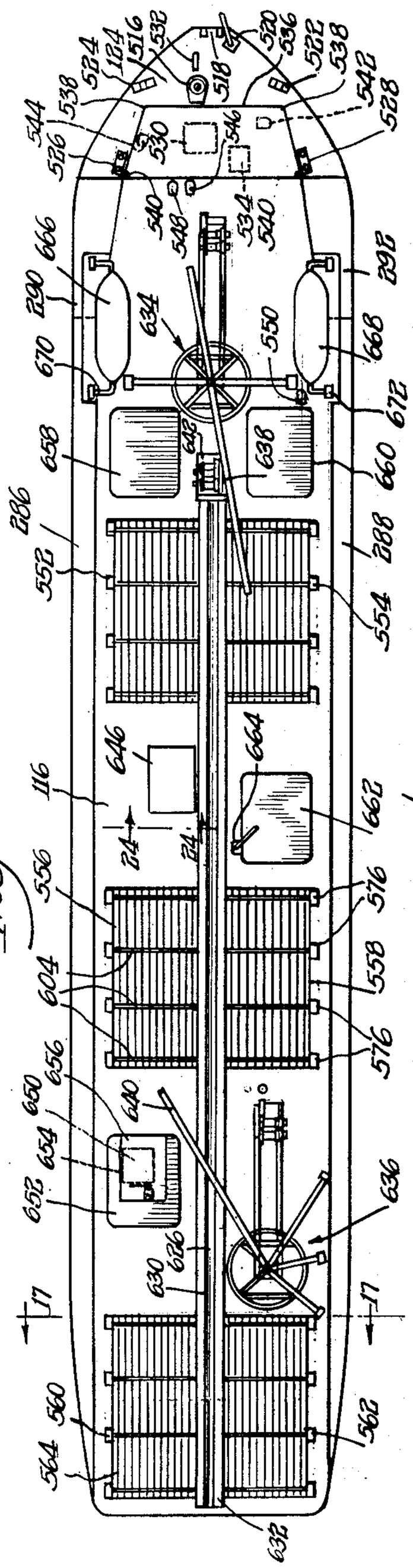


FIG. 11.

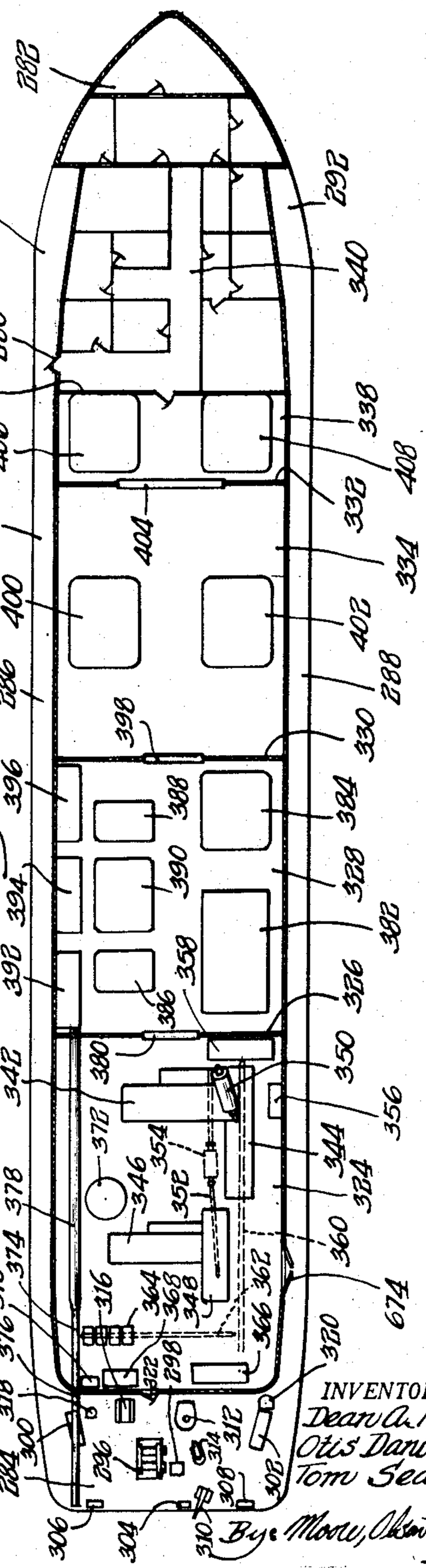


FIG. 12.

INVENTORS
Dean A. McGee
Otis Danielson
Tom Seale

By: Moore, Alexander & Taylor
Attys.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 8

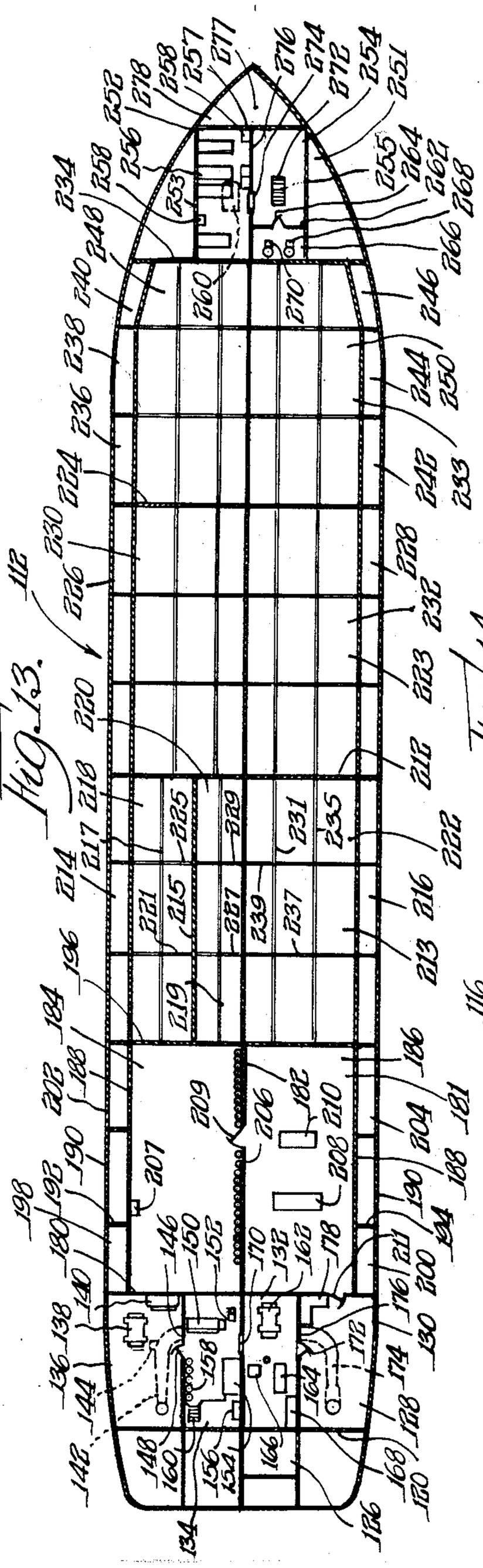


FIG. 13.

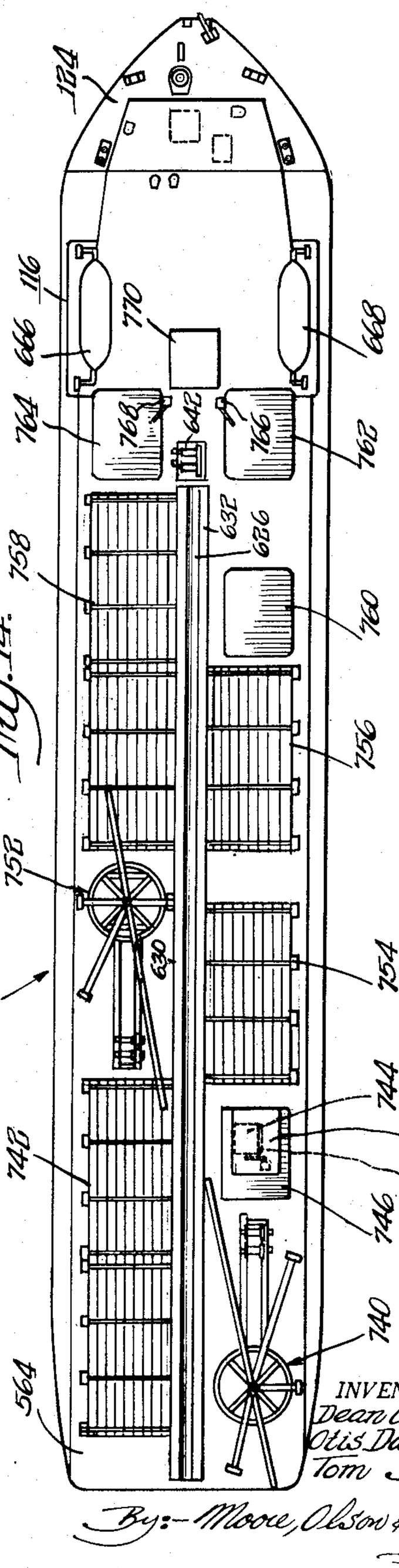


FIG. 14.

INVENTORS
Dean A. McGee
Otis Danielson
Tom Seale

By:- Moore, Olson & Trexler
attys

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 9

Fig. 15.

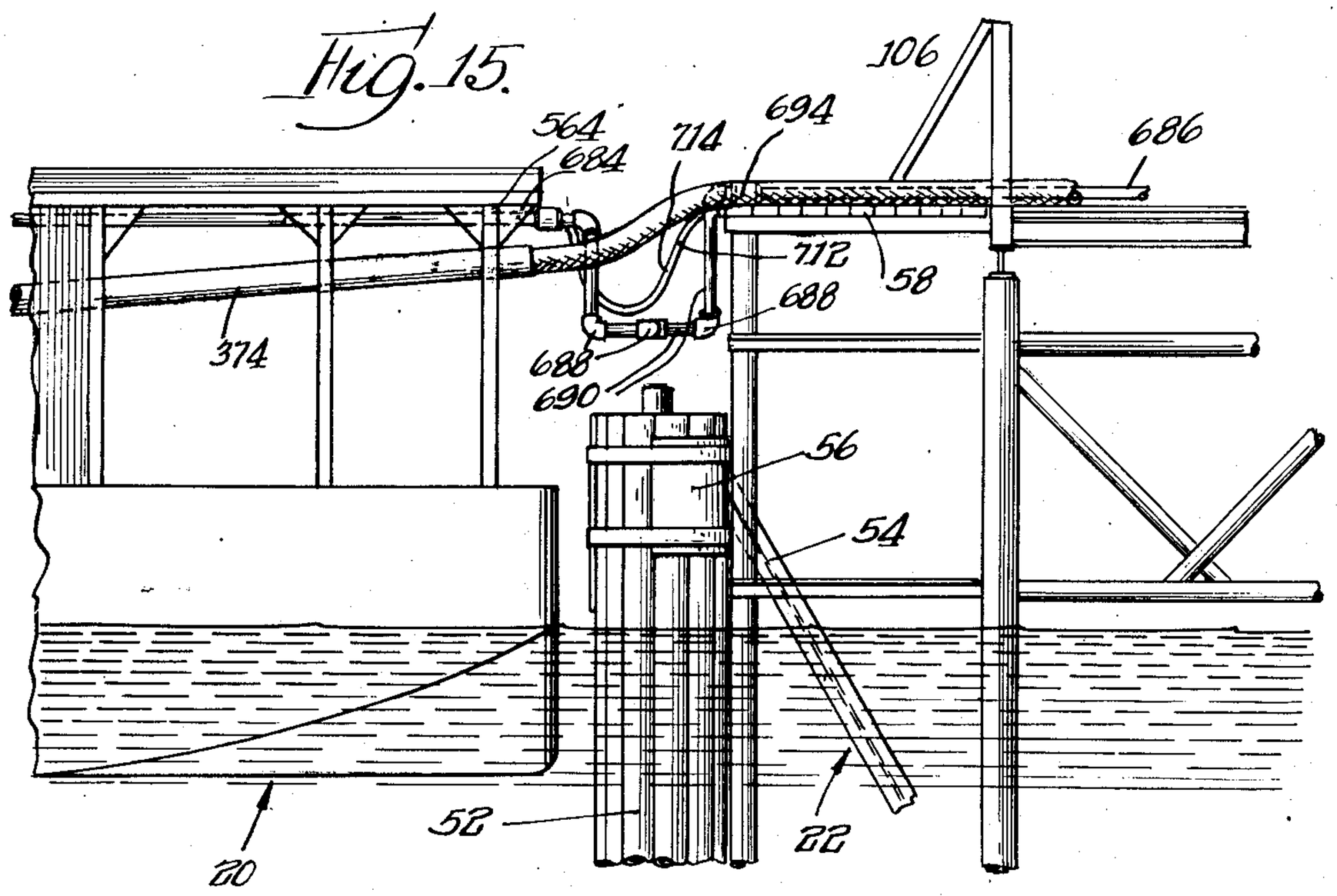
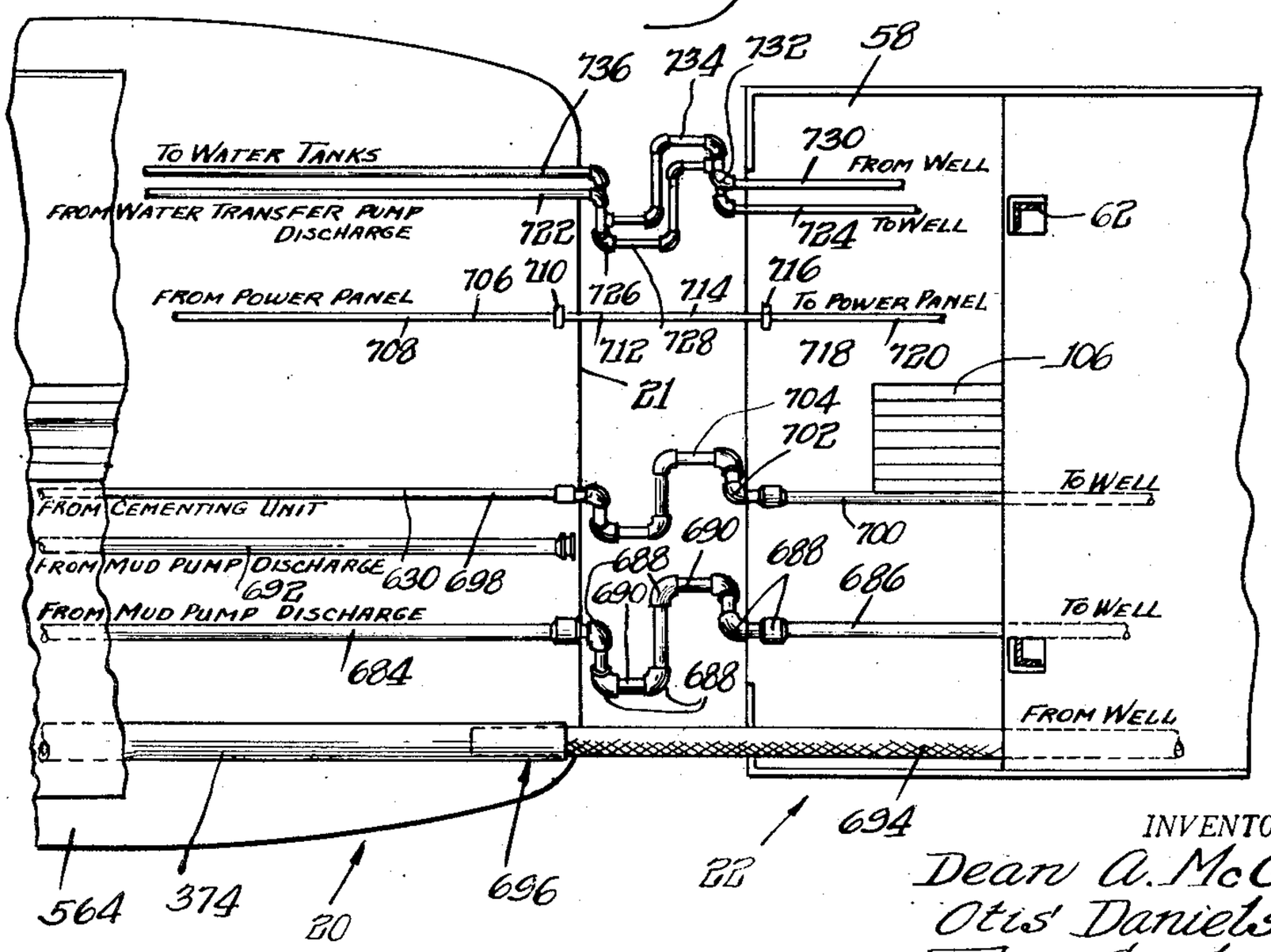


Fig. 16.



INVENTORS.
Dean A. McGee
Otis Danielson
Tom Seale
By:- Moore, Olson & Treplin Attys.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 10

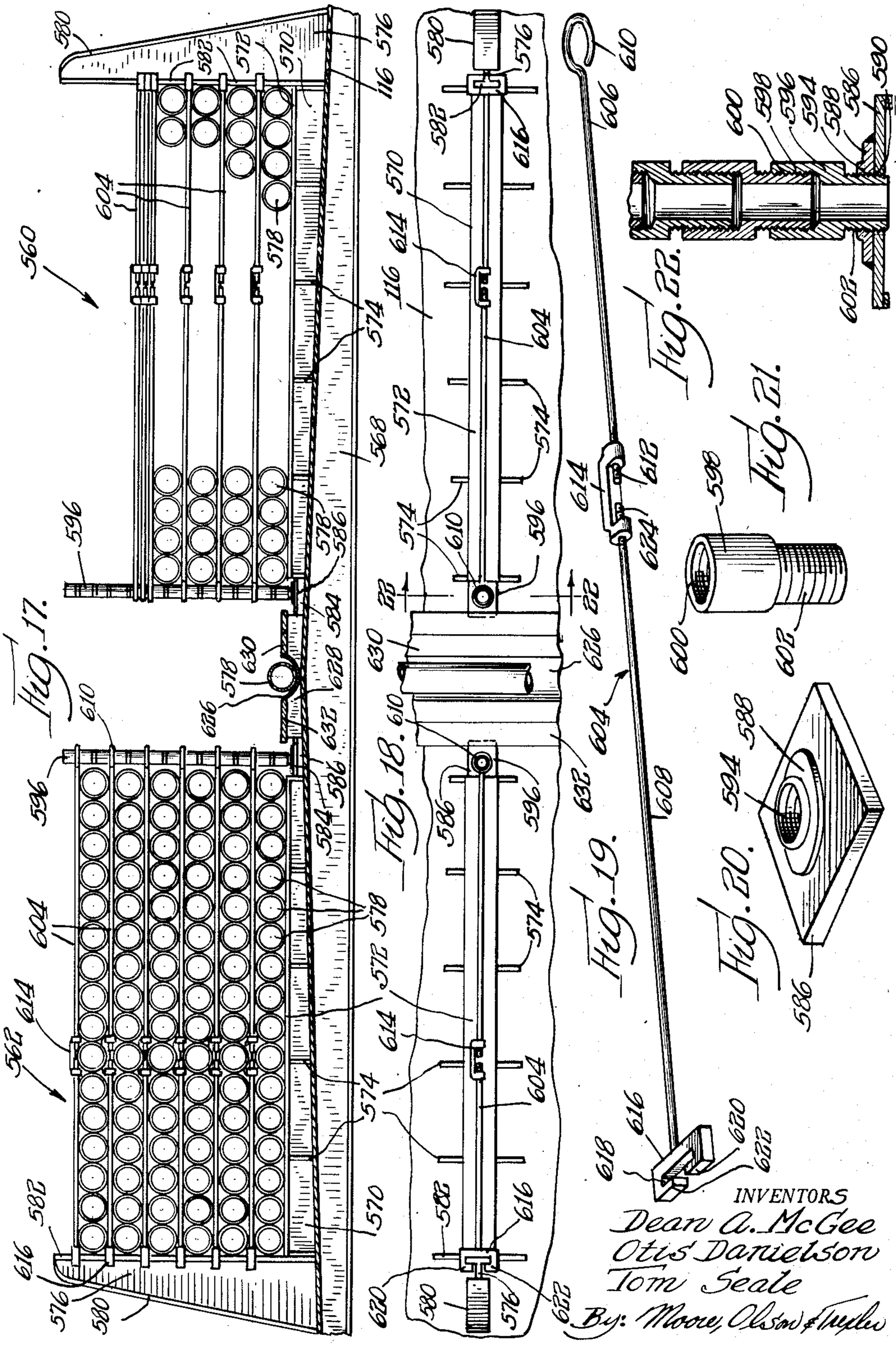


Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 11

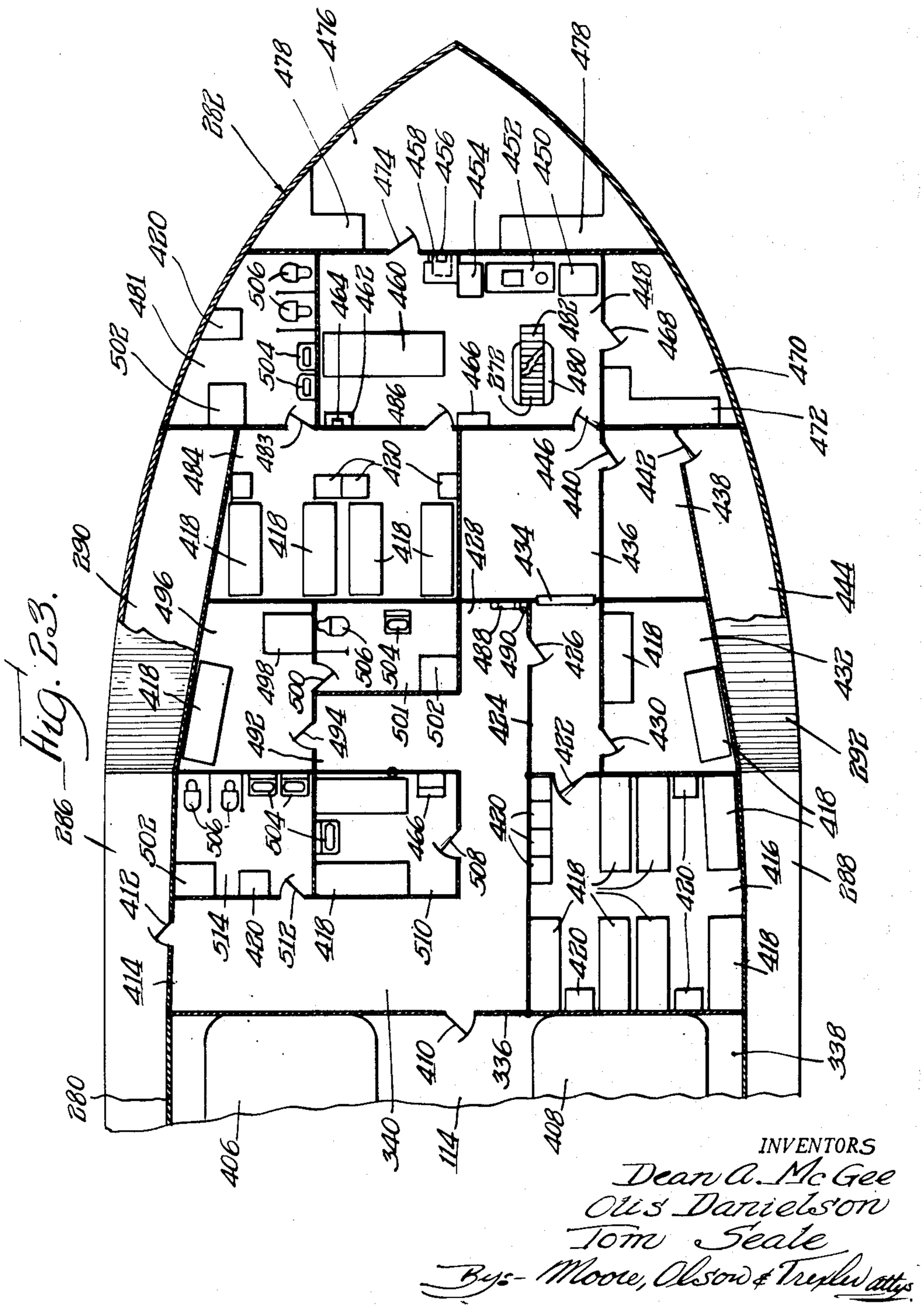


Fig. 23.

INVENTORS
Dean A. McGee
Otis Danielson
Tom Seale
By: Moore, Olson & Treplewatty's

Sept. 29, 1953 D. A. McGEE ET AL 2,653,796

APPARATUS FOR DRILLING WELLS

Filed May 20, 1948 12 Sheets-Sheet 12

Fig. 26.

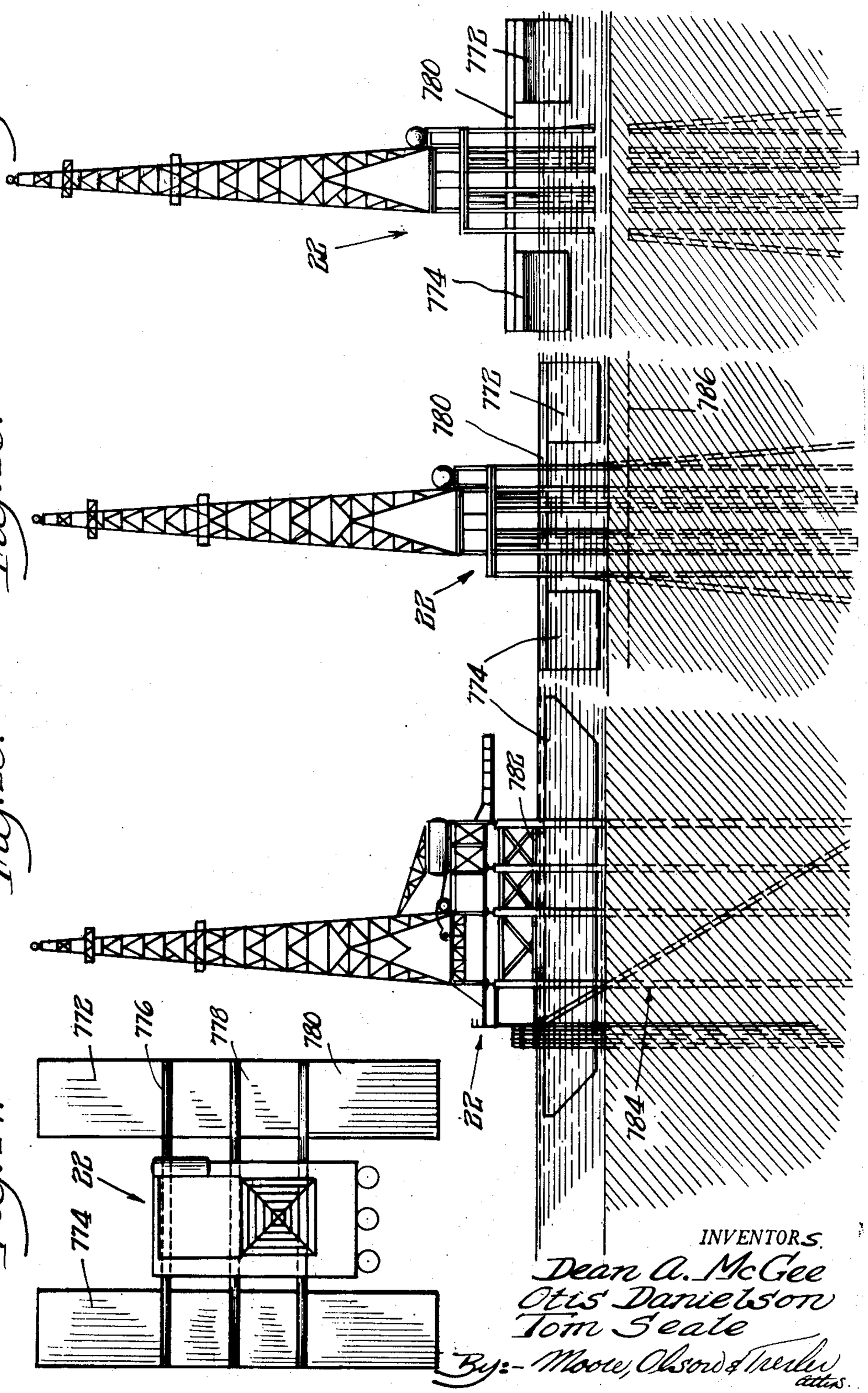


Fig. 25.

Fig. 27.

INVENTORS.
Dean A. McGee
Otis Danielson
Tom Seale
By:- Moore, Olsord & Keeley
attys.

Patented Sept. 29, 1953

2,653,796

UNITED STATES PATENT OFFICE

2,653,796

APPARATUS FOR DRILLING WELLS

Dean A. McGee, Otis Danielson, and Tom Seale, Oklahoma City, Okla., assignors to Kerr-McGee Oil Industries, Inc., Oklahoma City, Okla., a corporation of Delaware

Application May 20, 1948, Serial No. 28,206

6 Claims. (Cl. 255—2)

1

This invention relates to an apparatus and a method for drilling wells. More particularly, it relates to an apparatus and method for drilling oil wells in open, unprotected water.

Although oil wells have been drilled under water heretofore, such drilling has been done in relatively shallow water protected to some extent at least by shoals or reefs or other bodies of land. In such prior operations various types of structures have been employed to support the equipment required to drill the well including platforms supported on pilings and sunken barges. Such structures are not suited to drilling in open water, however, because the cost of constructing and protecting them is too great.

It is the object of this invention to provide an oil well drilling rig adapted to be used in open, unprotected water.

A further object is to provide a drilling rig of this type which is relatively inexpensive to construct and which can be recovered and reused in large part at a number of widely separated points.

Still another object is to provide a drilling rig of this type which in large part at least can be protected against destruction during severe weather conditions.

Other objects will appear hereinafter.

It has now been found that the foregoing objects are accomplished by a combination of a floating structure and a small cooperating platform structure fixedly supported on the bed of the body of water under which the well is to be drilled, for example, on pilings. All of the equipment required to drill an oil well can be mounted on this combination of structures in such a way as to make it feasible to drill oil wells in water which is open and unprotected by any adjacent land.

In order that the invention may be better understood reference is made to the accompanying drawings which form a part of this specification and in which:

Figure 1 is a plan view of an open water drilling rig embodying features of the present invention;

Figure 2 is a view in side elevation of the drilling rig shown in Figure 1;

Figure 3 is an end elevation of the drilling rig shown in Figure 1;

Figure 4 is an enlarged, detailed, fragmentary, elevational view of the platform portion of the drilling rig shown in Figure 1 taken from the side opposite to that shown in Figure 2;

Figure 5 is a plan view of the upper level of the platform;

2

Figure 6 is a plan view of the main platform level;

Figure 7 is an enlarged, detailed, fragmentary, end, elevational view of the end of the platform opposite to that shown in Figure 2;

Figure 8 is an enlarged, detail, fragmentary view of a portion of the elevation shown in Figure 3;

Figure 9 is an outboard profile of the floating portion of the rig shown in Figure 1;

Figure 10 is a longitudinal, inboard profile of the floating portion of the rig shown in Figure 1;

Figure 11 is a plan view of the top of the deck house of the floating portion of the rig shown in Figure 1;

Figure 12 is a plan view of the main deck of the same structure;

Figure 13 is a plan view of the hold of the same structure;

Figure 14 is a view similar to Figure 11 showing an alternative arrangement;

Figure 15 is an enlarged, detailed view of a portion of the elevation shown in Figure 2 showing the manner in which the platform and floating portions of the drilling rig are interconnected;

Figure 16 is a plan view of the portion of the structure shown in elevation in Figure 15;

Figure 17 is a view of the deck house roof construction, partly in cross section, on the line 17—17 in Figure 11;

Figure 18 is a plan view of the structure shown in Figure 17;

Figure 19 is an enlarged, detailed view in perspective of one of the members forming part of the construction shown in Figures 17 and 18;

Figure 20 is another view in perspective of a portion of the construction shown in Figures 17 and 18;

Figure 21 is still another view in perspective of a portion of the construction shown in Figures 17 and 18;

Figure 22 is an enlarged, detailed view in cross section on line 22—22 in Figure 18;

Figure 23 is an enlarged, detailed, fragmentary, plan view of the fore part of the main deck as shown in Figure 12;

Figure 24 is a view in cross section on the line 24—24 in Figure 11;

Figure 25 is an elevational view similar to Figure 2 and illustrating the manner in which the fixed portion of the drilling rig may be moved;

Figure 26 is another elevational view similar

to Figure 3 and also illustrating how the fixed portion of the structure is moved;

Figure 27 is a plan view of the embodiment of the invention shown in Figures 24, 25 and 26; and

Figure 28 is a view similar to Figure 26 showing the fixed structure in raised position.

Figure 1 shows in more or less outline form the two main portions of the drilling rig which forms the subject of the present invention, one of which is a floating structure **20** and the other a relatively small platform **22**. As will be further explained hereinafter, the floating structure **20** is a reconstructed Navy YF type barge which is several times the size of the platform **22**. It is normally anchored in position adjacent the platform **22** which is fixedly supported on pilings driven into the bed **27** of the body of water through which an oil well is to be drilled.

An important feature of the construction shown herein is a method by which the long, narrow floating structure, for example, barge **20** is maintained in operative relation with the platform **22** and is secured so as to eliminate or substantially eliminate the possibility that the barge **20** may be driven by the forces of wind or water against the platform **22**, which, for reasons of economy, is preferably small and of relatively light construction which cannot withstand continued buffeting by the barge **20**. The preferred plan for securing the barge is illustrated in Figure 1. Five 3200-pound anchors **24**, **26**, **28**, **30** and **32** are used and are attached to the barge **20** by the usual anchor chains **34**, **36**, **38**, **40** and **42**, respectively. It will be apparent from a study of Figure 1 that a much stronger force is required to move the barge **20** toward the platform against the resistance of the anchors than is required to move the barge **20** in any other direction. This resistance to movement of the barge **20** against the platform is provided principally by the bow anchor **28** and to a slightly lesser extent by the forward port and starboard anchors **30** and **26**, respectively. The stern anchors **24** and **32**, although serving principally to hold the stern of the barge **20** against lateral movement, also aid in maintaining it stationary by opposing in part the action of the forward anchors **26**, **28** and **30**. This anchor system, except in severe weather conditions, is capable of maintaining the barge at all times in operating position with respect to the platform **22**, as shown, and so long as any one of the three anchors **26**, **28** or **30** holds, the barge **20** will be prevented from bumping against the platform **22**.

It will be observed from the foregoing description that the means for maintaining the floating structure in operative relation with the platform is carried by the floating structure. Furthermore, in the embodiment shown, the floating structure **20** is not held in place even in part by any means connecting it to the platform **22** and instead is secured in operative position independently of the platform by anchors carried by the floating structure **20** and cooperating solely with the bed of the body of water under which the well is drilled.

The anchors, as a means of maintaining the barge **20** in operative relation with the platform **22**, permit or do not prevent rolling, pitching, vertical shifting and limited horizontal shifting of the barge or floating structure **20** with respect to platform **22** in response to the action of the water and wind including rises and falls of the water level due to tidal action, and still maintain the barge **20** in operative relation with the platform **22** except under severe weather conditions. The anchors provide a releasable means for maintaining barge **20** in operative relation with platform **22** and can also be used to move the barge **20** away from the platform **22**, when such movement is desired, as, for example, when danger of damage to the platform by the floating structure due to weather conditions arises. This movement is accomplished by pulling up the proper anchors and using the other or others to move the barge **20** in the desired direction. This function of the anchors is important because ordinarily it is the only available means by which the barge **20** can be moved on short notice.

In operative position with respect to the platform **22**, the barge **20** has its stern end **21**, which is blunt and of approximately the same width as the widest part of the barge, juxtaposed to a side **23** of the platform **22**. The positioning of the barge **20** or other long, narrow floating structure with a narrow end juxtaposed to a side of platform **22** is preferred to protect the platform. Forces of wind and water which tend to push the barge toward the platform thus operate on a narrow end, the bow **25** of the barge **20** in the embodiment shown, and not against a long side.

The fixed platform **22** is also located with reference to the direction of the prevailing winds as indicated in Figure 1. The line **27** in this figure is parallel to the center line of the platform **22** which is perpendicular to the side **23** of platform **22** to which the stern **21** of the barge **20** is juxtaposed. It will also be observed that the line **27** is parallel to the longitudinal axis of barge **20** when the latter is in operative relation with platform **22**. Arrow **29** in this same figure represents the direction of the prevailing winds in the area in which the particular platform **22** illustrated is located. As indicated by the legends in the figure there is an angle of only 7° between the line **27** and the line **29** so that the direction of the prevailing winds is from platform **22** toward barge **20** substantially along the axis of barge **20**. Consequently, the effect of the prevailing winds is to drive barge **20** away from platform **22** whereby the latter is protected from damage by barge **20** and in addition the effect of these winds on barge **20** is minimized because they are directed against the narrow dimension of barge **20**. The third line **31** in Figure 1 indicates "North" and relates the other two lines **27** and **29** to the points of the compass.

The platform structure **22** with which the barge **20** cooperates is supported on steel pilings in the manner indicated in Figures 2, 3 and 6. In one installation the platform **22** is supported on 28 steel pilings, the principal support being provided by 16 24-inch O. D. steel pilings weighing 128 pounds per foot, eight of which are designated **44** and eight **46**. As may be seen in Figure 6, the pilings designated **44** are the eight which are spaced along the long sides of the platform structure **22**. These eight pilings **44**, as best seen in Figure 3, extend outwardly from the top down at an angle such that the distance between the axis of piling **44** and a vertical through the top of the piling increases approximately one foot for each 12 feet of length of the piling **44**. The upper ends of the various pilings **44** and **46** are positioned as indicated in Figure 6, the pilings **46** being driven directly down into the bed of the body of water. All 16 of the pilings **44** and **46** are driven to a minimum penetration of about 100 feet (actually 104 feet in one installation),

into the bed of the body of water and extend above the water sufficiently to position the main platform level 48 twenty feet above mean low tide. Above the water level the pilings 44 and 46 are tied together with a series of 9⅝ inch steel pipe braces 50 all welded together to create a rigid structure.

Three dolphin timber piles 52 are employed to provide a buffer between the barge 20 and the remainder of the platform structure 22. The dolphin piles 52 are each formed of 19 timbers driven in a cluster to a minimum penetration of 75 feet beneath the floor of the body of water. They are each braced by three steel H-beams 54 driven to a depth of 125 feet at an angle of 30° and welded to a steel plate 56 fastened to the timbers.

At the main level 48 the platform extends out for a distance of about 16 feet beyond the center of the row of pilings 44 and 46 adjacent the dolphins 52 which brings it just up to the dolphins, as seen in Figure 6. This outward extension or apron 58 is additionally supported on six small pilings 60 along its edge adjacent the dolphins 52.

The derrick 62 is supported on a substructure 64 carried by the platform level 48 in a position centrally of the width of the level 48 and adjacent the end of the main portion of level 48 from which the apron 58 extends. Such location of the derrick 62 at an end of the platform level 48 makes it possible to drill a second directional well from the platform 22 if desired by moving the derrick 62 to the opposite end of the platform level 48 and making the other necessary alterations in the arrangements.

The derrick 62, as may be seen, is generally of the same type as is used for land operations, but is preferably constructed so as to withstand hurricane force without the aid of guy wires. As may be seen in Figures 2, 4 and 7, the platform 22 also includes an upper level 66. This upper level 66 is supported on the main platform level 48 and in the embodiment shown is roughly 13 feet above the platform level 48. The platform level 66 is of approximately the same width as the derrick substructure 64 and is level with the top of this substructure 64. As may be seen in Figures 2, 4 and 7, it extends about two-thirds of the distance from the derrick 62 to the end of the platform 22 remote from the derrick. A protective roof structure 68, supported at one end on the derrick 62 and at the other by posts 70 extending up from the platform 66, provides a protective covering for the upper level 66.

As indicated above, the equipment actually used in the drilling operation on the platform 22, as distinguished from its disposition and the manner in which it is supported, is all equipment which is conventional for use in land drilling operations. This conventional equipment includes the usual drawworks 72 which is supported in part on the platform level 66 and in part on the top of the derrick substructure 64, as best seen in Figure 7. It is connected in the usual way to the rotary 74 and is driven by a pair of diesel engines 76 and 78 mounted on the platform level 66. The engines 76 and 78 also drive the usual mud pump 80 which is mounted on the main platform level 48. Adjacent the mud pump 80 on this same platform is a small mud tank 82. The details of the piping for the mud pump 80, mud tank 82 and the well are not shown since these are of the usual type found in drilling rigs employed in land operations.

It was contemplated at the time this structure was designed, and has been found in practice to be true, that during the drilling of a well, weather conditions are encountered which necessitate a movement of the barge 20 away from the platform 22 for periods as long as a day or more in order to be sure that the barge will not be driven against the platform. In order to make it possible for drilling operations to continue during such periods the platform is provided with water and diesel fuel storage in the form of a tank 84 which rests on a frame structure 86 supported on the main platform level 48 near the end opposite that on which the derrick 62 is mounted, as may be seen in Figure 6. A partition 88 (Figure 5) divides the tank 84 interiorly into two compartments, the smaller of which 90 is for fresh water and the larger of which 92 is for fuel. Lengths of drilling pipe (not shown) can be stood up within the derrick structure 62 and with these and the water and fuel supplies and the mud carried in the mud tank it is possible for drilling operations to continue even when the barge 20 is driven away from the platform 22 as described above.

Extending out from one side and from the end of the platform opposite that carrying the derrick, respectively, are two escape platforms or runways 94 and 96. These platforms or runways 94 and 96 are supported from the underside of the main platform level 48 and extend outwardly therefrom over the water. Short flights of steps 98 and 100 extend down to these runways 94 and 96 from the platform level 48 to give workmen on the platform easy access to the runways 94 and 96. The extreme ends of these runways 94 and 96 are open and are provided with ladders 102 and 104 extending down toward the water. In the event that it becomes desirable for the workmen to leave the platform quickly because of a present or imminent catastrophe, these runways provide a means for departing hurriedly but with a minimum of danger.

Between the derrick 62 and the dolphins 52 a short ramp 106 extends downwardly from the upper level of the derrick substructure 64 to the apron 58. This ramp 106 is provided to guide drill pipe or other like articles during transfer of such articles from the barge 20 to the inside of the derrick 62.

As seen in Figure 6 a personnel landing platform 108, supported on dolphins 110, is provided alongside the main part of the platform 22. This platform 108 together with the various walkways, stairs, protective rails and ladders which are provided for the convenience of personnel in boarding and moving around on the platform 22 are not described in detail since they do not form important parts of the structure. They may be located at any convenient place as desired. Gang planks 107 and 109 facilitate movement of personnel between the barge 20 and platform 22.

Arrangement of the various pieces of equipment required for drilling, as described above, permits the main platform to be kept to a minimum size and thus minimum cost. In one installation which has been operated satisfactorily the overall dimensions of the platform 22 including the apron 58 were approximately 46 feet by 82 feet. This is in contrast to the platform structures used in previous drilling operations which have run from about 77 feet by about 173 feet on up. In general, it has been found that a platform having an area not substantially greater than about 4000 square feet and preferably somewhat less, is entirely satisfactory and highly desirable

from the standpoint of economy and risk of loss due to storm damage.

The above described platform structure **22** has the further advantage that when the drilling operation is completed at one location it is possible to move the platform structure to a new location as hereinafter described.

The cooperating floating structure or barge **20** which is readily floated at any time to a new location, and the use of which in turn permits the platform structure **22** to be floated also is illustrated in detail in Figures 9 to 14. Although the floating structure **20** illustrated is a reconstructed Navy YF type barge which has been found quite satisfactory, and is a preferred type of structure, the invention is not intended to be limited to this particular type of floating structure. Any other type of floating structure may be used which is adapted to contain and support in a convenient and accessible manner the various items of equipment hereinafter described as forming part of the barge or floating structure **20**.

The barge **20**, as illustrated in Figures 9 to 14, is approximately 260 feet long by 48 feet wide and the drawings are made substantially to scale in order accurately to show the relative size and plan of the various parts of the equipment carried by the barge **20**. The items of equipment on the barge **20** are arranged on three levels which are, respectively, the hold **112**, the main deck **114** and the deck house roof **116**. Figure 10 shows in a general way the frame construction of the barge **20** which includes an inner or false bottom **118** and various columns **122** which support the deck house roof **116**. At the bow end forecastle deck or foredeck **124** provides an intermediate level which supports various items of equipment employed in the anchoring of the barge **20**.

Figures 10 and 13 show the inboard profile and the plan of the hold of the barge **20**. As may be seen, the rearmost space which is utilized in the hold **112** is chain locker **126**. Immediately forward of this chain locker **126** is a compartment **128** extending across the entire width of the barge **20**. A bulkhead **120**, also extending across the entire width of the barge **20** and from the hull up to the main deck **114**, separates compartment **128** from chain locker **126** and the unused space in hold **112** aft of the bulkhead **120**. As may be seen in Figure 13 compartment **128** is subdivided by longitudinally extending partitions into four smaller compartments **130**, **132**, **134** and **136**.

The compartment **136** houses a 60 kilowatt 240 volt D. C. diesel electric generator **138** and a switchboard therefor **140**. The compartments **136** and **134** are ventilated by a duct **142** extending in the compartment **136** which opens into this compartment at **144** and into compartment **134** at **146**. Access to the compartment **136** is provided by a door **148**.

The space **134** houses a second switchboard **150** for the other generating equipment to be described and also provides space for a fire pump **152**, a workbench **154**, a tool locker **156**, a series of five carbon dioxide cylinders **158** and steps **160** leading up to a 36-inch by 48-inch raised hatch on the afterdeck to be described. The main pieces of equipment housed within the compartment **132** are a second 60 kilowatt generator **162**, a 20 kilowatt generator **164**, a fuel oil service tank **166** and a lubricating oil tank **168**. Access to the space or compartment **132** is obtained through an opening **170** connecting compartment **132** with compartment **134**.

Access to compartment **130** is provided by a door **172** connecting with compartment **132**. Compartment **130** contains a second ventilating duct **174** which opens into compartment **132** through an opening **176**. The compartment **130** is otherwise void except for some shelving **178** in one corner thereof.

The portion of the hold **112** forward of the space **128** is separated from that aft by a bulkhead **180** extending from the bottom hull of the boat up to the main deck **114** and from the outer hull of the boat on one side to the outer hull on the other. The space **181** in the hold **112** immediately forward of this bulkhead **180** is divided by a longitudinally extending partition **182** into two relatively large compartments **184** and **186** of substantially the same size and is further subdivided on either side by an inner hull **188**.

The space between the inner hull **188** and the outer hull **190** is further subdivided by a partition **192** on the port side and a similar partition **194** on the starboard side. The enclosure of the space **181** is completed at the forward end by a second bulkhead **196** similar to the bulkhead **180**. The small compartment **198** lying between the bulkhead **180** and partition **192** and between the inner hull **188** and the outer hull **190** on the port side and the similar compartment **200** on the starboard side are both void. However, the remaining spaces on both the port and starboard sides between the inner hull **188** and outer hull **190** designated respectively **202** and **204** are utilized for diesel fuel storage, each of these tanks having a capacity of 12,000 gallons of diesel fuel.

For the purpose of giving proper marine balance to the barge **20** the relatively large compartment **184** is substantially void of equipment. It contains only some piping, not shown, which serves to connect various pieces of equipment located elsewhere and a series of twenty-five 50-pound carbon dioxide cylinders **206** which are piped to the engine room on the main deck above the compartment **184**. Access to compartment **184** is provided by a ladder **207** leading to a hatch on the main deck **114**.

Compartment **186**, the other of the two large compartments, serves as an auxiliary engine room. It contains a water transfer pump **208** having a capacity of 80 gallons per minute at a pressure of 50 pounds per square inch and a diesel oil transfer pump **210** having a capacity of 40 gallons per minute at 30 pounds per square inch. A door **209** in partition **182** connects compartments **184** and **186** and a second door **211** in bulkhead **180** connects compartment **186** with compartment **130**.

The next major subdivision **213** of the hold **112** terminates at the bulkhead **212** which is also similar to the bulkhead **180**, previously described. This space **213**, like space **181**, is subdivided by the inner hull **188** to provide a space or compartment **214** on the port side and a similar compartment **216** on the starboard side. The remainder of the space **213** is occupied by three tanks **218**, **220** and **222**, each of a different size as shown in Figure 13. The tank **218** serves as the active mud pit, the tank **220** provides a reserve mud pit and the largest tank **222** is a water tank which has a capacity of 43,250 gallons.

The pit **218** is separated from the pit **220** by a longitudinal bulkhead **215** formed of $\frac{5}{16}$ inch plate and extending up to the underside of the transverse webs of the main deck **114**. The tanks

218 and 220 are also provided respectively with longitudinal bulkheads 217 and 219 similar to the longitudinal bulkhead 215 but having openings therethrough so that they do not actually subdivide the tanks 218 and 220 into smaller tanks but serve instead to prevent fluid in the tanks from swashing. To the same end, tanks 218 and 220 are further provided with laterally extending swash plates which, like longitudinal bulkhead 215, are formed of $\frac{5}{16}$ inch plate and extend up to the underside of the transverse webs of the main deck 114. These plates extend across tank 218 as indicated at 221 and 225 and correspondingly across tank 220 at 227 and 229.

Both longitudinally and laterally extending rows of swash plates, five feet high, are employed in the large water tank 222. Two rows 231 and 235 extend the full length of tank 222 and two more rows 237 and 239 extend across the full width. All of these swash plates are formed of ¼ inch plates and are suspended in the tank 222 intermediate the top and bottom thereof as indicated in Figure 10.

Section 223 of the hold 112 immediately forward of the bulkhead 212 and lying between it and the next similar bulkhead 224 is used entirely for water storage. The two tanks lying between the inner hull 188 and the outer hull 190 are designated 226 on the port side and 228 on the starboard side. The remaining space is also formed into two tanks 230 and 232. Tank 230 has a capacity of 22,800 gallons of water and tank 232 has a capacity of 43,250 gallons of water. Both the tanks 230 and 232 are provided with rows of swash plates like the rows 231, 235, 237 and 239 in tank 222.

The next main section 233 of the hold 112 also is utilized for water storage. It lies between the bulkhead 224 and another similar bulkhead 234. In this section the space between the inner hull 188 and the outer hull 190 is subdivided on each side into three parts providing tanks 236 and 238 and void space 240 on the port side, and tanks 242, 244 and void space 246 on the starboard side. The central portion of space 233 is divided into two large tanks 248 and 250 similar to the tanks 230 and 232 and similarly provided with rows of swash plates like the rows 231, 235, 237 and 239. The tanks 236, 238, 242 and 244 are used for the storage of potable water, tanks 236 and 242 each holding 5160 gallons, and tanks 238 and 244 each holding 4800 gallons. The water in tanks 248 and 250 is simply fresh water, tank 248 holding 38,160 gallons and tank 250 holding 52,140 gallons.

In the space 251 forward of the bulkhead 234 there are two main compartments 252 and 254 separated by a partition 276 and enclosed by the bulkhead 234, a partition 253 on the port side, a partition 255 on the starboard side and a partition 257 extending across the bow of the barge. The compartment 252 serves as crew's quarters and is provided with bunks 256 and lockers 258. From this compartment 252 a 15-inch by 30-inch air duct 260 extends up to a cowl on the foredeck to be described.

A partition 262 having a door 264 walls off a small room 266 at one end of the compartment 254. Located within this room 266 are a flushing tank and pump 268 and a fresh water tank and pump 270. The remainder of the compartment 254 is void except for steps 272 which lead up to the galley on the main deck to be described. Communication between compartments 250 and

254 is provided by an opening 274 in the wall 276 which separates the two. Half of the space 277 in the forepeak forward of the compartments 252 and 254 provides a chain locker 278, the other half being void, as are the other portions of space 251 lying outside compartments 252 and 254.

Referring now to Figure 12 which shows the plan of the main deck 114, it will be seen that the bulk of this deck is enclosed by a deck house 280. At the forward end of the boat the deck house extends up to the forecastle 282. The deck house 280 does not extend clear to the stern of the boat, however, so that there is a small, open afterdeck 284. The deck house 280 is also spaced inwardly from the sides of the barge 20 to leave small walkways 286 on the port side and 288 on the starboard side of the barge 20, each of which is about four feet wide. As best seen in Figures 9 and 11, the walkways 286 and 288 toward the forward end of the barge 20 communicate respectively with ramps 290 and 292 leading from the main deck 114 to the forecastle deck 124.

Referring back again now to Figure 12, it will be seen that the afterdeck 284 carries various items of equipment used in connection with the anchoring and mooring of the barge 20 including a warping winch 296, a control stand therefor 298, a pair of 14-inch double bitts 300 and 302, a stern chock 304, two closed chocks 306 and 308, an anchor davit 310, a windlass 312 and a chain pipe 314, which latter communicates with the chain locker 126, previously described. In addition to the foregoing pieces of equipment the afterdeck 284 is also provided with a 36-inch by 48-inch raised hatch 316, an 18-inch cowl 318 and a 24-inch cowl 320. The hatch 316 provides access to the steps 160 leading down to the hold compartment 134 and cowls 318 and 320 are connected, respectively, to the ducts 142 and 174 to complete the ventilating system for the hold space 128.

A door 322 in the rear wall portion of the deck house 280 gives access to the interior of the deck house from the afterdeck 284. The interior of the deck house 280 is divided into several rooms, the room 324 nearest the stern extending up to a partition 326 which extends directly above the bulkhead 196 in the hold. The next room forward designated 328 extends up to a partition 330 which is directly above the bulkhead 212. A third partition 332, located directly above the bulkhead 224 forms the forward wall of another room 334. Still another bulkhead or partition 336 forms the forward wall of an additional room 338 and separates the crew's quarters, designated generally 340, which lie forward of the partition 336 from the remainder of the main deck.

The room 324 nearest the stern of the boat is used as an engine room. The two main pieces of equipment housed within this room are the main mud pump 342 and the diesel engine for driving the same 344, and the mud mixing pump 346 and the diesel engine for driving it 348. The large engine 344 exhausts through a muffler 350 and the smaller engine 348 exhausts through a line 352 including a muffler 354. From the mufflers 350 and 354 the exhaust is carried up to outlets on the deck house roof 116, to be described.

To one side of the main mud pump engine 344 near the deck house wall is an electrically driven air compressor 356. Fuel for the diesel engines 344 and 348 is supplied from a 1000-gallon diesel

fuel oil day tank **358** supported in an elevated position adjacent one end of the engine **344**. To assist in handling the large machinery within room **324**, a one-ton chain block is suspended from the deck house roof upon a trolley riding on a track **360** secured to the underside of the deck house roof **116** and running longitudinally of the barge **20** over the main engine **344**. A similar one-ton chain block on a trolley rides on a track **362** suspended from the underside of the deck house roof **116** adjacent the after end of room **324** and extending laterally of the barge **20**. Approximately under one end of the track **362** a rack **364** is provided to contain four 55-gallon drums.

The rearmost portion of the room **324** serves as a machine shop. It is equipped with an electrically driven 300-ampere welding unit **366**, a work bench **368** and a tool locker **370**. In the above description of the hold, reference was made to a ladder **207** extending up in room **184**. Access to this ladder is provided through a hatch **372** opening through the main deck **114** into the engine room **324**. This hatch is approximately five feet in diameter and is provided with a 12-inch combing.

Mud returning to the barge **20** from the platform **22** enters a 12-inch outside diameter pipe **374** suspended from the deck house roof **116**. As will be further described hereinafter, the deck house roof **116** extends out over the afterdeck **284** and one end of the pipe **374** is located approximately vertically above the sternmost edge of the afterdeck **284**. From this point the pipe **374** extends forwardly and passes through the rear portion of the deck house wall **280** at **376**. Pipe **374**, as may be seen in Figure 10, inclines downwardly from the stern of the barge **20** toward the bow so that gravity flow of mud through the pipe is obtained. At its forward end within the engine room **324** the pipe **374** empties into an inclined trough **378** supported on the main deck **114** and extending through the partition **326** to empty into the active mud tank **218** through an opening in the main deck **114** to be described which opening is located in room **328**. Inclination of the trough **378** is such that at the partition **326** it is approximately eight inches above the main deck and at its after end trough **378** is approximately five feet above the main deck.

A relatively large central opening **380** in the partition **326** provides access between rooms **324** and **328**. The only piece of equipment housed within room **328** is an oil well cementing skid unit **382** which is located on the starboard side. On this same side of the barge **20** in the room **328** and forward of the unit **382** is a 12-feet by 14-feet covered hatch **384** which gives access to water tank **222**.

The main deck on the port side of room **328** overlies the active mud pit **218** and the reserve mud pit **220**. To facilitate various operations within these mud pits, six openings are cut through the main deck **114** in room **328**. Two of these **386** and **388** are approximately 6 feet, 6 inches by 9 feet, 11 inches, a third **390** is approximately 9 feet, 11 inches by 13 feet, two others **392** and **396** are each 4 feet, 11 inches by 13 feet, 6 inches and the sixth **394** is approximately 4 feet, 11 inches by 13 feet. It will be seen that it is through the opening **392** that the trough **378** empties into the active mud tank **218**.

An opening **398** through the partition **330**, which is similar to the opening **380**, connects

rooms **328** and **334**. This room **334** is used as a storage room and has a capacity of ten boxcar loads of mud, weight materials, chemicals and the like. Two 12-feet by 16-feet covered hatches **400** and **402** in room **334** open into water tanks **230** and **232**.

The relatively large central opening **404** through the partition or bulkhead **332** makes the next small room **338** substantially a part of the room **334**. This room **338** provides a portion of the storage capacity which accommodates the ten boxcar loads of material, as described above. Room **338** also contains two 12-feet by 14-feet covered hatches **406** and **408** through which water storage tanks **248** and **250**, respectively, may be reached.

From the after portion of the main deck **114**, the crew's quarters **340**, which are located in the forward portion of the main deck and in the forecastle **282** as set out above, are reached through a door **410** in the bulkhead or partition **336**, previously described. The crew's quarters may also be entered from the walkway **286** through a door **412** in the deck house wall **280**. The door **412** opens into a space **414** which serves both as a passageway and as a space for lounging and recreation.

Adjoining the bulkhead **336** on the starboard side of the barge **20** is a room **416** containing bunks **418** and lockers **420**. This room is entered through a door **422** from a passage **424**. From the passage **424** a door **426** opens into another passage **428** extending longitudinally of the barge **20** and communicating with the passage **414**. Another door **430** in the passage **424** opens into additional sleeping quarters **432** provided with bunks **418**. At the forward end of the passage **424** an opening **434** leads into still another passage **436**. From this passage **436** storeroom **438** may be entered through a door **440** and from the storeroom **438** a door **442** opens into a lamproom **444**. From passage **436** another door **446** leads into the galley **448**.

The galley **448** is provided with the usual equipment including a refrigerator **450**, a sink **452**, a range **454**, a fan **456**, bins **458**, mess table **460**, a dish rack **462**, a second fan **464**, and a medicine cabinet **466**. On the starboard side of the galley **448** a door **468** opens into a commissary storeroom **470** provided with shelving **472**. A door **474** in the forward wall of the galley **448** leads into boatswain's stores **476** provided with shelving **478** on both the port and starboard sides. A hatch **480** through the main deck **114** within the galley **448** gives access to steps **272** leading down into the hold **112**. Above the steps **272** a second flight of steps **482** leads up from the galley **448** to the foredeck **124**.

On the starboard side of the barge **20** additional sleeping quarters **484** are reached through a door **486** from the galley **448**. Sleeping quarters **484**, like the others described, contain bunks **418** and lockers **420**. A washroom **481** adjoins the sleeping quarters **484** and is reached through a door **483**. This washroom is equipped with a shower **502**, a locker **420**, two toilets **506** and two lavatories **504**.

Referring back now to the passage **428**, it will be seen that at the forward end thereof there is a hose rack **488** and a fire plug **490**. Leading off from the passage **428** toward the port side of the barge **20** is a short passage **492** at the end of which a door **494** leads into a room **496**. This room **496** is provided with bunks **418** for the men in charge of the drilling crews and also houses

the communications equipment **498**. From the room **496** a door **500** gives access to a washroom **501** provided with a shower **502**, a lavatory **504** and a toilet **506**.

Referring back once more to the passage **428**, it will be observed that a door **508** leads from this passage into a room **510** which serves as a hospital. It is provided with bunks **418**, a lavatory **504**, and a medicine cabinet **466**. Adjoining the hospital **510**, but accessible only from the passage **414** through a door **512**, is another washroom **514** which is also equipped with a shower **502**, a locker **420**, toilets **506** and lavatories **504**. From the foregoing, it can be seen that the barge **20** is provided with extensive and well-equipped crew's quarters which are adequate to accommodate two full drilling crews including the men in charge of the crews and also to leave space for the personnel who operate the galley or other personnel required from time to time to operate special equipment utilized in connection with the drilling operation.

As explained above, the foredeck or forecastle deck **124** carries equipment which is utilized in anchoring or mooring the barge **20**. This includes a windlass **516**, a bow chock **518**, a davit **520**, a pair of closed chocks **522** and **524**, a pair of 14-inch double bitts **526** and **528** and a warping winch **530**. Just forward of the windlass **516** a chain pipe **532** leads down into the chain locker **278**. The steps **482** leading up from the galley **448** are reached from the foredeck **124** through a 36-inch by 48-inch raised hatch **534**. The after portion of the foredeck **124** is covered by an awning **536** supported at its forward end on posts **538** extending up from the foredeck **124** and from short columns or posts **540** extending up from the roof **116** of the deck house. The crew's quarters in the forecastle are ventilated through a 10-inch cowl **542** and an 8-inch cowl **544** extending up from the foredeck **124**. The remainder of the crew's quarters in the forepart of the main deck and in the hold are ventilated by three 18-inch cowls, two of which **546** and **548** extend up near the forward end of the deck house roof **116**, and the third of which **550** extends up from the deck house roof **116** farther aft.

The bulk of the deck house roof **116** is utilized for pipe storage and to this end six pipe storage racks are provided. Racks **552** and **554** are located approximately over the room **334**, racks **556** and **558** are located about mid-way between the stern of the barge **20** and the first two racks, and racks **560** and **562** are mounted adjacent the stern end of the barge. These racks **560** and **562** extend out beyond the deck house **280** onto the extension **564** of the deck house roof **116** which extension overlies the afterdeck **284** as mentioned above. This extension **564** is firmly supported by a series of eight 5-inch pipe stanchions **566** extending up from the main deck **114**. Each of the pipe storage racks **552**, **554**, **556** and **558** has a capacity of approximately 50 tons of drilling pipe and the two racks **560** and **562** each have a capacity of approximately 60 tons of drilling pipe.

The details of the construction of the pipe racks **560** and **562** are shown in Figures 17 to 22. The construction of the racks **552**, **554**, **556** and **558** is the same as that of **560** and **562**, and it should therefore be understood that Figures 17 to 22 are also illustrative of the structure of these racks. As may be seen in Figure 17, the deck house roof **116** beneath the pipe racks

is supported on girders such as the girder **568** and is slightly higher in the center than it is at the sides of the boat having a pitch of about six inches in twenty feet. The base of each pipe rack is a series of four I-beam pieces **570** extending laterally of the barge **20** and spaced apart equal distances longitudinally thereof. As will more fully appear from Figures 9, 10 and 11, as the description proceeds, two of the four pieces **570** in each rack are placed respectively adjacent the fore and aft ends of the rack and the other two pieces **570** are located therebetween to provide equal spacing as set out in the preceding sentence.

The lower portion of each piece **570** is cut away on an angle as shown in Figure 17 so that when the piece rests upon the sloping deck house roof **116** the top flange **572** extends in a horizontal plane. The I-beam pieces **570** are each welded to the deck house roof **116** and are each braced with a series of twelve gusset plates **574**, six on each side, each of which is welded to the deck house roof **116** and to its associated I-beam **570**. At the outer end of each I-beam **570** adjacent the side of the barge **20**, a vertically extending I-beam piece **576** is secured to the deck house roof and to the I-beam **570** to form an abutment member which prevents pipe such as the pipe **578** from rolling off the barge **20**. To provide strength at the base without excessive weight, the vertically extending I-beam or abutment **576** is formed from a relatively large I-beam and one flange and a portion of the web of the I-beam are cut away on a diagonal as indicated in Figure 17, and a new flange **580** is welded on the cut surface. The flange **582** which remains on the I-beam or abutment **576** serves as a track as will be described.

There is also an abutment in the form of a column **596** at the inner end of each base **570**. This column is supported on a base comprising a small, hollow box-like structure **584** secured to the deck house roof **116** and supporting a plate **586** in raised position. Plate **586** is welded to the box-like structure **584** and as best seen in Figure 22, a flange **588** is in turn welded to the plate **586** which is provided with a central opening **590** which registers with the threaded opening **594** of the flange **588**. Column **596** has a threaded lower end which screws into the flange **588**, whereby the column **596** is supported in vertical position as shown.

As best seen in Figure 22 the columns **596** are formed of a plurality of nipples or couplings **598** each of which is internally threaded on one end as indicated at **600** and exteriorly threaded on the other end as at **602** with threads matching the threads **600**, whereby one nipple **598** may be threaded into another and so on to form a column **596** of a height determined by the number of nipples **598** which are threaded together. It will be apparent that the column **596**, in addition to being adapted to be increased or decreased in height rapidly by altering the number of nipples **598** included therein, is also readily removed from the flange **588** to facilitate the transfer of pipe into or out of the pipe racks **552**, **554**, etc.

To secure pipe **578** firmly in place in the racks each rack is provided with a series of tie rods **604**, one of which is shown in perspective in Figure 19. The tie rods **604** are formed of two rod portions **606** and **608**. The rod **606** is bent into a ring **610** at one end of proper size to re-

ceive the column 596 slidably therethrough, and is threaded on the other end at 612 into a tie member 614. The second rod 608 is secured at its outer end to a block 616 which is cut away at 618 to receive the flange 582 and the web portion of the vertically extending I-beam piece 576 loosely in slidable relation. It will be apparent that the arms 620 and 622 of the block 616 extending in behind the flange 582 will resist a horizontal pull tending to disengage the block 616 from the track or flange 582.

The rod 608 is also threaded into the tie member 614 at its inner end at 624. One of the threads 612 and 624 is a right-hand thread and the other a left-hand thread so that the tie member 614 with the inner ends of the rods 604 and 608 forms a turnbuckle whereby the total length of any rod 604 may be increased or decreased to permit it to slide up the column 596 and abutment 576 and be removed or to secure it firmly in place above a layer of pipe as illustrated in Figure 17 and to clamp a layer of pipe tightly between a column 596 and a cooperating abutment member 576.

To facilitate the transfer of pipe from storage racks 552, 554, etc., to the platform 22 under which the well is being drilled, a trough 626 is provided which extends longitudinally of the deck house roof 116 centrally thereof from just forward of the racks 552 and 554 to the after end of the deck house roof extension 564. The trough 626 is secured in place on the deck house roof 116 by supports 628 and lies between a pair of walkways 630 and 632 which are substantially coextensive with the trough 626 lengthwise.

Two derricks 634 and 636, each of five tons capacity, are used to handle the drilling pipe 578. Derrick 634 is supported on the deck house roof 116 centrally thereof and just forward of the forward end of the trough 626, and the derrick 636 is mounted just forward of the pipe rack 562 on the starboard side of the deck house roof 116. Each of the derricks 634 and 636 is provided with a pivotal mounting, the boom 638 on derrick 634 being of sufficient length to reach the racks 552 and 554, and the boom 640 on derrick 636 reaching the other four pipe racks 556, 558, 560 and 562.

With the aid of derricks 634 and 636, sections of pipe are lifted quite readily from any of the pipe racks and deposited in the trough 626. At the forward end of the trough there is a double drum winch 642. Sections of pipe 578 in the trough 626 are readily transferred along the trough 626 with the aid of a cable extending from the winch 642 to a sheave, not shown, secured at the stern of the barge 20 and back to the other drum of the winch 642.

The deck house roof 116, in addition to supporting the various items of equipment previously described, also supports on the port side in the space between racks 554 and 556, adjacent the walkway 630, an electric logging and side well coring device 646. As shown in Figure 24 a platform 648, secured to the deck house roof 116, provides a level area upon which the logging and coring device 646 may rest.

Also on the port side, but farther aft between the racks 556 and 560, there is a double width squirrel cage exhaust fan 650 with a capacity of 50,000 cubic feet of air per minute at half-inch static pressure. This fan 650 is supported on a 12-feet by 16-feet raised hatch cover 652. Beneath the fan 650 an opening, not shown, is provided in the hatch cover so that the fan 650 may draw air up from the deck house and exhaust it through the louvres 654 on the port side of the fan structure. Fan 650 is surrounded and protected by a housing 656.

Although a number of the original hatches of the YF type barge are covered over and rendered inaccessible by the various items of equipment carried on the deck house roof 116, as has been described, three 12-feet by 16-feet hatches 658, 660 and 662 are retained. These hatches are all raised slightly above the deck house roof and provided with removable covers. The hatch 662 is not accessible to either of the derricks 634 or 636 and for this reason a cargo davit 664 is retained adjacent this hatch.

As a safety precaution the barge 20 carries two lifeboats 666 and 668. These are supported near the forward ends of the barge on the deck house roof 116—666 on the port side and 668 on the starboard side. Each lifeboat is 20 feet by 6 feet by 2 feet, 6 inches and of metallic construction with a capacity of 18 persons and a volume of 180 cubic feet. The lifeboats are supported respectively on mechanical boom type davits 670 and 672 by means of which the lifeboats may be swung out over the sides of the barge and launched.

Figure 9, which shows the outboard profile of the barge 20, is closely related to Figure 11 since it shows many of the same items of equipment in elevation which are shown in plane in Figure 11 and have already been described in connection with the latter figure. It also has features in common with Figure 12. For example, it shows the 7-feet by 10-feet double door 674 which opens from the engine room 324 onto the walkway 288 on the starboard side of the barge. This door 674 facilitates the transfer of machinery into and out of the engine room 324. The interior of the deck house is lighted through a number of portholes 676, the location of which is indicated in Figure 9. Figure 9 also shows the handrail 678 which runs up the outer edge of the ramp 292, around the foredeck 124 and down the outer edge of the ramp 290 to the walkway 286, and ladders 680 and 682 which extend from the walkway 288 up to the deck house roof 116. The port profile, not shown, is substantially the same as the starboard profile shown in Figure 9.

For normal drilling operations the barge 20 is moored, as shown in Figure 1, with the broad stern end adjacent the dolphins 52. As shown in Figures 15 and 16, although the barge 20 is not in any manner secured to the platform 22, there are flexible connections running between the barge 20 and the platform 22 through which mud, water and electricity are supplied to the platform from the principal sources thereof located on the barge, as previously explained.

Referring particularly to Figure 16, it may be seen that there is a pipe 684 shown which extends longitudinally of the barge adjacent the port side. As indicated in the figure, the forward portion of this pipe which is not shown leads to the discharge from the mud pump 342. The pipe, as shown in Figure 15, is supported just under the deck house roof extension 564, and on the apron 58, opposite it, there is a corresponding pipe 686 which, as indicated by the legend, extends to the well. The adjacent ends of pipes 684 and 686 are connected by a series of swivel joints 688 and short lengths of steel pipe 690.

Such swivel joints for example as Chiksan swivel joints and metal pipe are preferred because of the high pressures which are employed in the mud lines. It is to be understood however, that other types of flexible connections

capable of withstanding high pressures may be employed to connect the pipes **684** and **686**. The need for flexible connections will be readily apparent when it is borne in mind that the platform **22** is fixedly secured to the bed of the body of water, whereas the barge **20** floats on the surface. For this reason, the barge will rise and fall with respect to the platform and will roll and pitch slightly even with moderate disturbances of the surface of the water which are normally encountered. This rising and falling and rolling and pitching and even slight lateral shifting will of course be increased if the severity of the disturbances of the surface of the water increases. The waters in which the drilling rig, involving the barge **20** and the platform **22**, are generally used, are tidal waters so that the action of the tide provides an additional source of shifting of the barge **20** vertically relative to the platform. In the drawings, the barge is illustrated in the position that it occupies at mean low tide when loaded.

Extending alongside the pipe **684**, but nearer the center of the barge is an auxiliary mud supply line **692** which may be used instead of the line **684** in the event that line **684** requires repair or cleaning. Lines **684** and **692** are both 4½-inch outside diameter 6000 pound test drill pipe.

On the other side of the line **684** and nearer to the port side of the barge **20** is the mud return pipe **374** which delivers mud into the active mud tank as previously described. The mud is returned from the platform **22** through a flexible rubber hose **694** having an outside diameter of about eight inches, the end of which is telescoped as at **696** into the pipe **374** which has an outside diameter of about 10 inches.

A separate line **698** is provided for the cementing unit **382**. As shown in Figure 16 this line extends adjacent the walkway **630**, but like the other lines described is supported just underneath the deck house roof extension **564**. Line **698** is preferably formed of a 3-inch 10,000 pound test Grade D drill pipe. A corresponding line **700** extends out over the apron **58** on the platform **22**. These lines **698** and **700** are also preferably connected with swivel joints **702** and short lengths of steel pipe **704**, similar to the joints **688** and pipes **690** but it is to be understood that other equivalent flexible connecting means adapted to withstand relatively high pressures may be used to connect these pipes or lines.

On the starboard side of the barge near the center are the power lines **706** and **708** which extend from the power panels or switchboards **140** and **150**, previously described. These lines **706** and **708** terminate in a connector box **710** which is supported adjacent the stern of the barge from the underside of the deck house roof extension **564**. From the connector box **710** a pair of looping leads **712** and **714** extend to a corresponding connector box **716** on the platform, from which lines **718** and **720** extend to a power panel or switchboard not shown on the platform.

Means for supplying water from the barge **20** to the platform **22** is also used in normal operation. Such means is provided near the starboard side. The 1½-inch line **722**, which is hung from the underside of the deck house roof extension **564** extends from the discharge side of the water transfer pump **208** and the corresponding 1½-inch line **724** secured on the apron **58** extends to the well. Connection between the lines **722** and **724** is also preferably provided through swivel joints **726** and short lengths of steel pipe **728** similar to the joints **688** and pipe **690** but other equivalent flexible connecting means may be employed. Correspondingly, water is returned from the well through a 2-inch line **730** which rests on the apron **58** and which is connected through a series of swivel joints **732** and short lengths of steel pipe **734** to another 2 inch line **736** supported under the deck house roof extension **564** adjacent the line **722**. This line **736** extends to the water tanks on the barge **20**. As explained with respect to the connections between pipes **684** and **686** other equivalent flexible connections may be provided to join the lines **730** and **736** as desired. In this connection, it is also pointed out that the invention is not intended to be limited to the exact size of pipe prescribed for the mud, water and cementing systems. Pipe of the size and other characteristics described above, however, has been found to give very good service in actual use.

Since the barge **20**, in addition to being the main source of mud and water for the platform **22**, is also a source of drill pipe **578**, means is provided for transferring this drill pipe from the barge **20** to the platform **22**. The trough **626** and means for transferring a piece of drill pipe **578** along this trough from the racks **552**, **554**, etc., has already been described. By the means described and with the aid of the derrick **636**, a section of drill pipe **578** may be brought to the end of the barge **20** and placed in a position where it is accessible to the hoist **738** on the drilling derrick **62**. By means of the hoist **738** the pipe is pulled from the barge **20** onto the platform **22** and guided up into the derrick **62** by the ramp **106**, as shown in Figure 7.

While the arrangement of equipment on the deck house roof **116**, which is illustrated in Figure 11, has given satisfactory service in use, it has been found that improved service is provided by the arrangement illustrated in Figure 14, particularly because it facilitates the transfer of the drill pipe **578** from the barge **20** to the platform **22**. In the arrangement illustrated in Figure 14, the after derrick **740** corresponding to the derrick **636**, is located on the starboard side like the derrick **636**, but is placed much nearer to the stern of the barge **20**, being located so that its base is approximately ten feet from the rear edge of the deck house roof extension **564**. Opposite the derrick **740** a double pipe rack **742**, twice the length of the pipe racks **552**, **554**, etc., is mounted on the port side of the deck house roof **116** with its stern end also spaced in ten feet from the rearmost edge of the roof extension **564**. To permit the desired alteration in the arrangement of pipes and derricks, the fan **744**, corresponding to the fan **650** is moved over to the starboard side of the barge where it is supported on a raised hatch **746**, similar to the raised hatch **652**, and enclosed in a housing **748** provided with louvres **750** similarly to the housing **656**.

The second or forward derrick **752**, corresponding to the derrick **634**, instead of being mounted well forward on the barge is located approximately amidships on the port side of the barge **20**, as shown. On the starboard side of the barge, opposite the derrick **752** are two single pipe racks **754** and **756**, similar to the racks **552** and **554**, and just forward of the derrick **752** is another double pipe rack **758** similar to the rack **742**.

This leaves room for three 12-inch by 16-inch

hatches **760**, **762** and **764**, corresponding to the hatches **662**, **660** and **658**, respectively. As may be seen, hatches **762** and **764** are in the same position as the hatches **660** and **658**, but the hatch **760** is located nearer to the bow of the boat than the hatch **662**. The hatch **760**, however, still opens into the storage space within the deck house **280** into which the hatch **662** opens. The hatch **760** is served by the derrick **752**, but to facilitate loading into the hatches **762** and **764**, cargo davits **766** and **768** are provided. The electric logging and side well coring unit **770**, corresponding to the unit **646** in Figure 11, instead of being located amidships on the port side, is moved up forward into approximately the position occupied in Figure 11 by the derrick **634**. Otherwise, the arrangement of equipment on the deck house roof **116** and on the foredeck **124** in the embodiment shown in Figure 14 is the same as that in the embodiment shown in Figure 11.

Figures 25, 26 and 27 illustrate how the platform structure **22**, which is fixedly supported in the bed of the body of water under which the well is being drilled, may be moved to be transported to a new location when it is no longer required for drilling operations at its existing location. The lifting and removal of the platform structure **22** is accomplished with the aid of two barges **772** and **774** which are sunk on opposite sides of the platform **22**, as indicated in Figures 26 and 27. After the barges **772** and **774** are in proper sunken position, three I-beams **776**, **778** and **780** are positioned beneath the bracing structure designated generally **782** on the underside of the platform **22** and over the barges **772** and **774** so that the ends of the I-beams rest on the barges and the mid-portions of the I-beams underlie the platform. The various pilings designated generally **784** are cut off at a depth of about 6 feet to 10 feet under the bed of the body of water, as indicated by the dotted line **786**. The platform **22** is then readily lifted by pumping out the barges **772** and **774** and rises to the position indicated in Figure 28. The entire unit can then be moved by tugs, not shown, to the desired new location.

Except as indicated in the above description, the operation of the drilling rig comprising the floating structure **20** and the platform **22** is substantially the same as the operation of drilling rigs heretofore known and used for drilling on land. For this reason, the details of the drilling operation need not be described.

The YF type barge is a convenient and economical base or unit from which to construct the floating structure **20**. It is of a very convenient size and does not require extensive alteration to fit it for use as a portion of an open water drilling rig. The invention is not intended to be limited to the use of YF type barges, however, and other floating structures carrying equipment like that described above as included in the floating structure **20** are within the scope of the invention. It is also preferable, but not essential, that the platform **22** should include equipment making it capable of independent operation for short periods of time. It is, however, within the scope of the invention to include in the fixed structure **22** only the equipment required for drilling and omit the mud pump, mud tank and water and diesel storage tanks.

The present invention has the outstanding advantage that it is the first drilling rig to be provided which is adapted to be used in drilling oil wells in open, unprotected water. It has been found to be entirely satisfactory in use in drilling wells in open water and is much more economical to construct than structures previously proposed for drilling under the bed of such a body of water. It is a further outstanding advantage that the bulk of the equipment required for drilling is carried on a floating structure which can be floated to a safe place in event of storms and can readily be removed to a new location to drill other wells. Furthermore, as pointed out above, even the fixed portion of the structure can be moved to new locations if desired. Other advantages will appear from the foregoing description.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and, therefore, it is not intended to be limited except as indicated in the appended claims.

The invention is hereby claimed as follows:

1. An oil well drilling rig adapted to be used in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying a portion of the drilling equipment, a long, narrow floating structure carrying the remainder of the drilling equipment and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent the other, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from the other narrow end thereof and the third anchor engaging said bed at a point spaced outwardly from said other narrow end and lying approximatly with a vertical plane passing through the longitudinal axis of said floating structure.

2. An oil well drilling rig adapted to be used in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying a portion of the drilling equipment, a long, narrow floating structure carrying the remainder of the drilling equipment, and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent an opposite narrow end, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from said opposite narrow end, and the third anchor engaging said bed at a point spaced outwardly from said opposite narrow end approximately within planes bounding the longitudinal sides of said floating structure.

3. An oil well drilling rig adapted to be used

in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying sufficient drilling equipment to carry on the drilling operation independently for a relatively short period of time, a long, narrow floating structure carrying additional drilling equipment to enable drilling of said well for a relatively long period of time, the drilling equipment on said floating structure including the main mud storage, the main water storage, and means for circulating mud and water from said storage to the platform, and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent an opposite narrow end, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from said opposite narrow end, and the third anchor engaging said bed at a point spaced outwardly from said opposite narrow end approximately within planes bounding the longitudinal sides of said floating structure.

4. An oil well drilling rig adapted to be used in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying a portion of the drilling equipment, the drilling equipment carried by said platform including a draw works, a mud pump, a mud tank, an engine for driving said draw works and said mud pump, a tank for storing fuel for said engine, and means for storing a supply of fresh water, a long, narrow floating structure carrying the remainder of the drilling equipment, and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent an opposite narrow end, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from said opposite narrow end, and the third anchor engaging said bed at a point spaced outwardly from said opposite narrow end approximately within planes bounding the longitudinal sides of said floating structure.

5. An oil well drilling rig adapted to be used in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying a portion of the drilling equipment, the drilling equipment carried by said platform including a draw works, a mud pump, a mud tank, an engine for driving said draw works and said mud pump, a tank for storing fuel for said engine, and means for storing a

supply of fresh water, a long, narrow floating structure carrying the remainder of the drilling equipment, said remainder of the drilling equipment including a source of drilling mud, means for circulating said mud from said source to mud receiving means on the platform, thence to a well being drilled under said platform and from the well back to said source, a source of fresh water, means for circulating fresh water from said source to said platform and for receiving water back from said platform, each of said means for circulating said mud and fresh water including flexible connections to permit relative movement between said floating structure and said platform, and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent an opposite narrow end, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from said opposite narrow end, and the third anchor engaging said bed at a point spaced outwardly from said opposite narrow end approximately within planes bounding the longitudinal sides of said floating structure.

6. An oil well drilling rig adapted to be used in drilling a well in the bed of a body of open, unprotected water and comprising in combination a relatively small platform fixedly supported by said bed and carrying a portion of the drilling equipment, a long, narrow floating structure carrying the remainder of the drilling equipment, fluid conduit means connecting portions of the drilling equipment on said floating structure with portions of the drilling equipment on said platform, said conduit means including swivel connections between said floating structure and said platform to permit movement of said floating structure relative to said platform, and anchor means carried by said floating structure for maintaining said floating structure releasably in operative relation with said platform with one of the narrow ends of said floating structure juxtaposed to a side of said platform including two anchors adjacent said one narrow end and three anchors adjacent an opposite narrow end, said first two anchors engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and outwardly beyond said one narrow end, two of said three anchors also engaging said bed at points spaced outwardly respectively from each of the long sides of said floating structure and also spaced outwardly from said opposite narrow end, and the third anchor engaging said bed at a point spaced outwardly from said opposite narrow end approximately within planes bounding the longitudinal sides of said floating structure.

DEAN A. McGEE.
OTIS DANIELSON.
TOM SEALE.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
89,794	Rowland	May 4, 1869
1,470,459	Lonsinger	Oct. 9, 1923
1,584,203	Upson	May 11, 1926
1,665,795	Sipe	Apr. 10, 1928
1,681,533	Giliasso	Aug. 21, 1928
1,764,779	Clements et al.	June 17, 1930
1,829,304	Schroeder	Oct. 27, 1931
1,829,879	Stephens	Nov. 3, 1931
1,852,632	Wagner et al.	Apr. 5, 1932
1,864,816	Hamer	June 28, 1932
1,938,829	Hamer	Dec. 12, 1933
1,998,803	Collins	Apr. 23, 1935
2,077,044	Grace et al.	Apr. 13, 1937
2,217,879	Willey	Oct. 15, 1940
2,237,387	Crites et al.	Apr. 8, 1941
2,248,051	Armstrong	July 8, 1941
2,475,933	Woolslayer et al.	July 12, 1949
2,476,309	Lang	July 19, 1949
2,512,783	Tucker	June 27, 1950

OTHER REFERENCES

Mills: The Oil Weekly, pages 17–22, May 25, 1936, and pages 34, 35, May 20, 1946.

Tucker: The Oil Weekly, pages 60, 61, 62, 64, 65, 66, Aug. 12, 1946, and pages 40, 41, Sept. 2, 1946.

Tucker: The Oil Weekly, pages 98, 99, 100, 103, 104, Sept. 16, 1946, and pages 31, 32, Oct. 28, 1946.

Humble Oil Co.: The Oil Weekly, pages 28, 29, 30, 31, Dec. 30, 1946.

Armstrong: The Oil Weekly, pages 40, 41, 48, Jan. 27, 1947.

Kastrop: The Oil Weekly, pages 33, 34, 35, Feb. 3, 1947.

Reed: The Oil and Gas Journal, pages 62, 63, 87, Nov. 2, 1946, and pages 56–60, Jan. 18, 1947.

Fagin: The Petroleum Engineer, pages 82, 84, 86, 88, 90, 93, 94, November 1946.