

[54] **FLARE TOWER**

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[51] Int. Cl. **F23d 13/20**

[58] Field of Search **431/202; 23/277 C**

[56] **References Cited**

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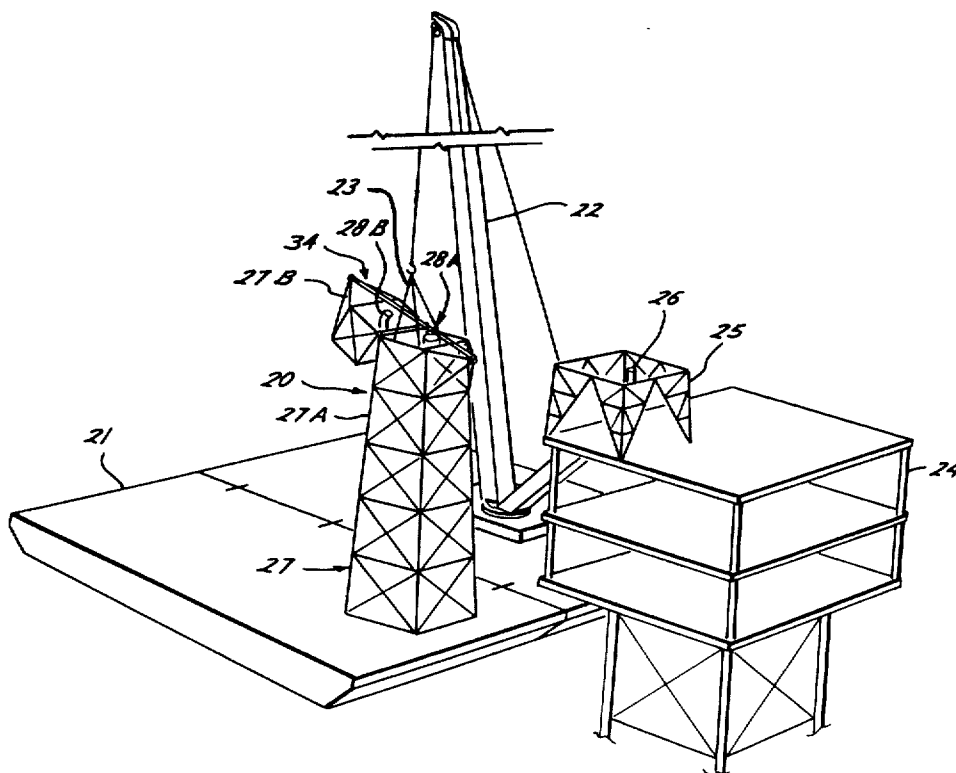
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[57] **ABSTRACT**

A flare tower having a lower tower section mounted on an offshore platform and supporting a lower pipe section with its lower end connected to a source of water gas on the platform, and an upper tower section supporting an upper pipe section and pivotally connected to the lower tower section for swinging from an inverted position to one side of the lower tower section and an erected position above said lower tower section in which the lower end of the upper pipe section is disposed for connection with the upper end of the lower pipe section, and the upper end thereof is disposed outwardly of the side of the platform.

12 Claims, 7 Drawing Figures



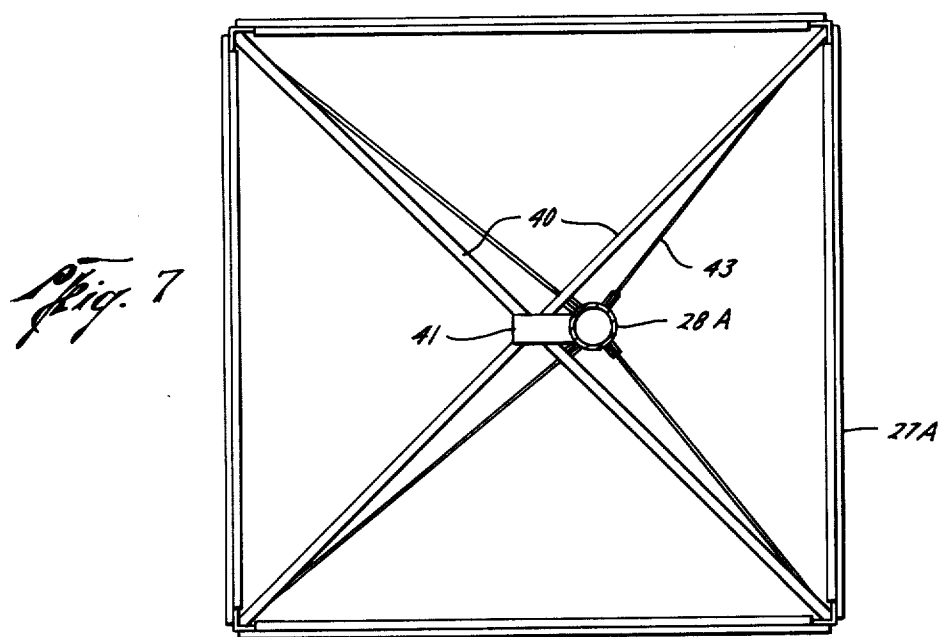
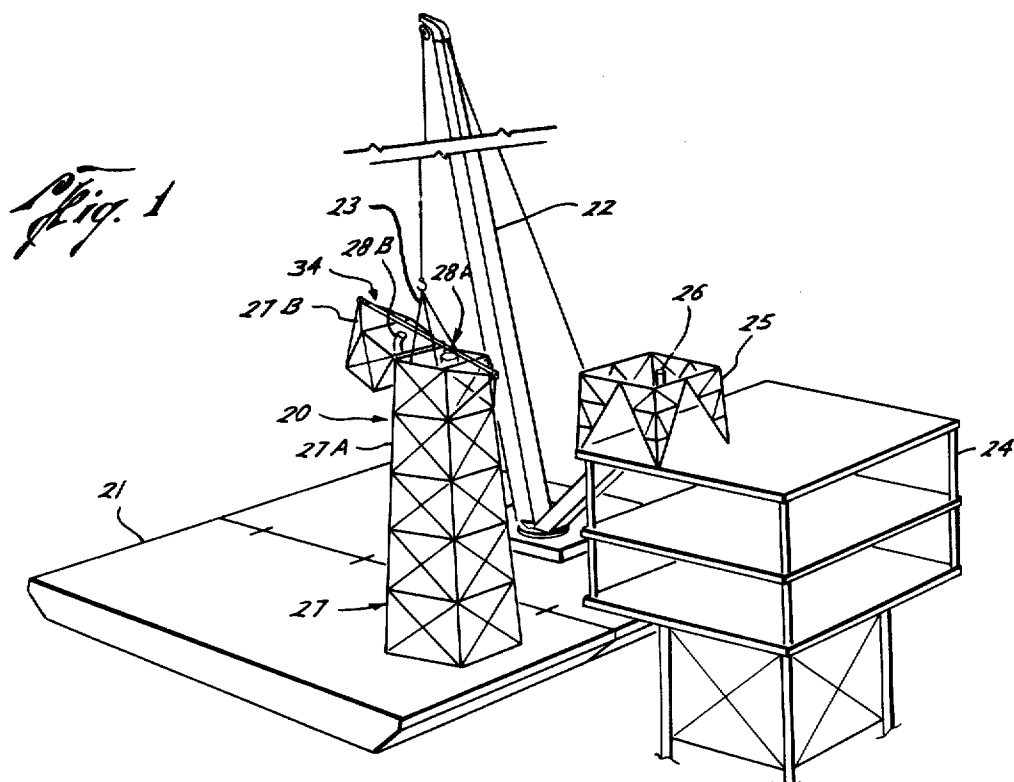


Fig. 2

Fig. 3

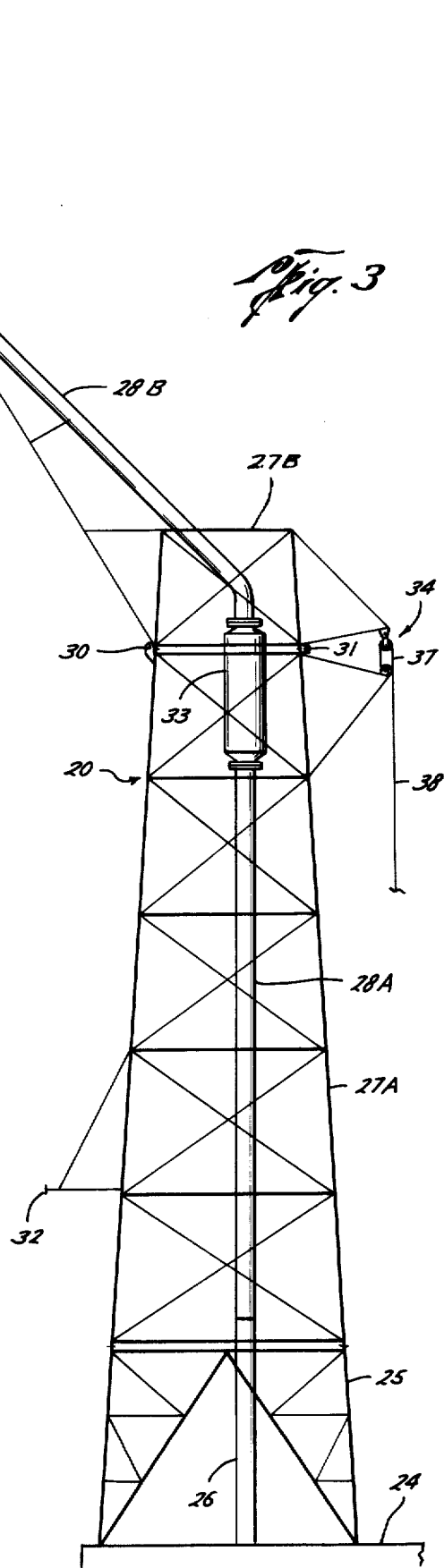
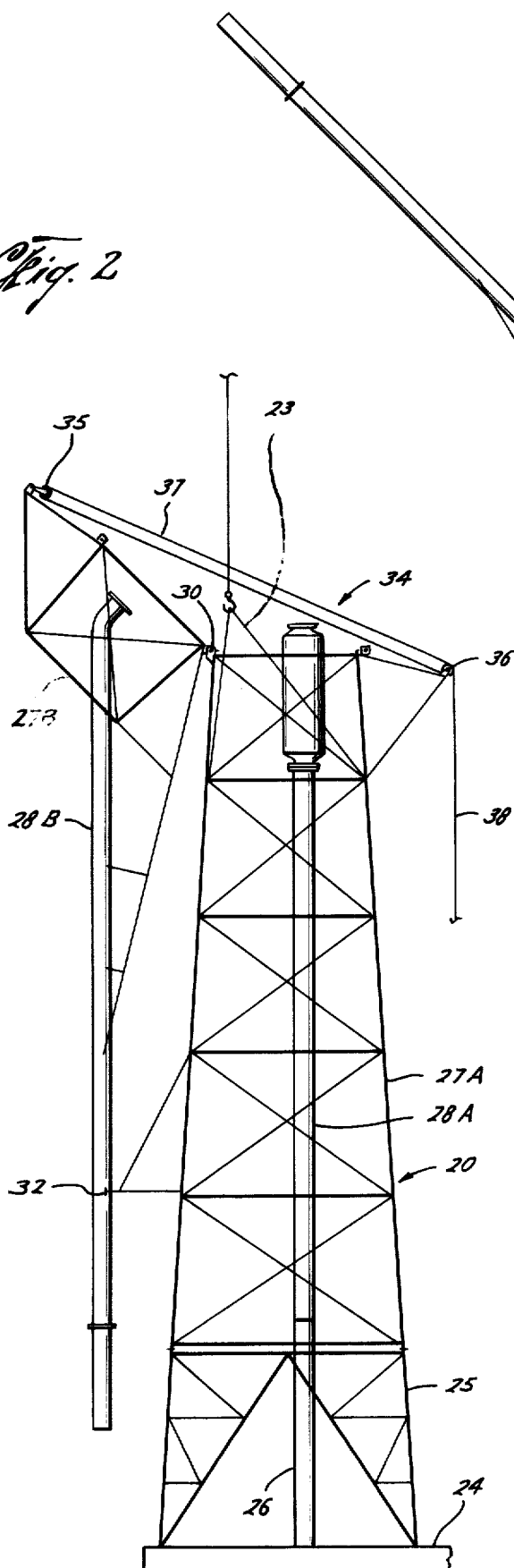
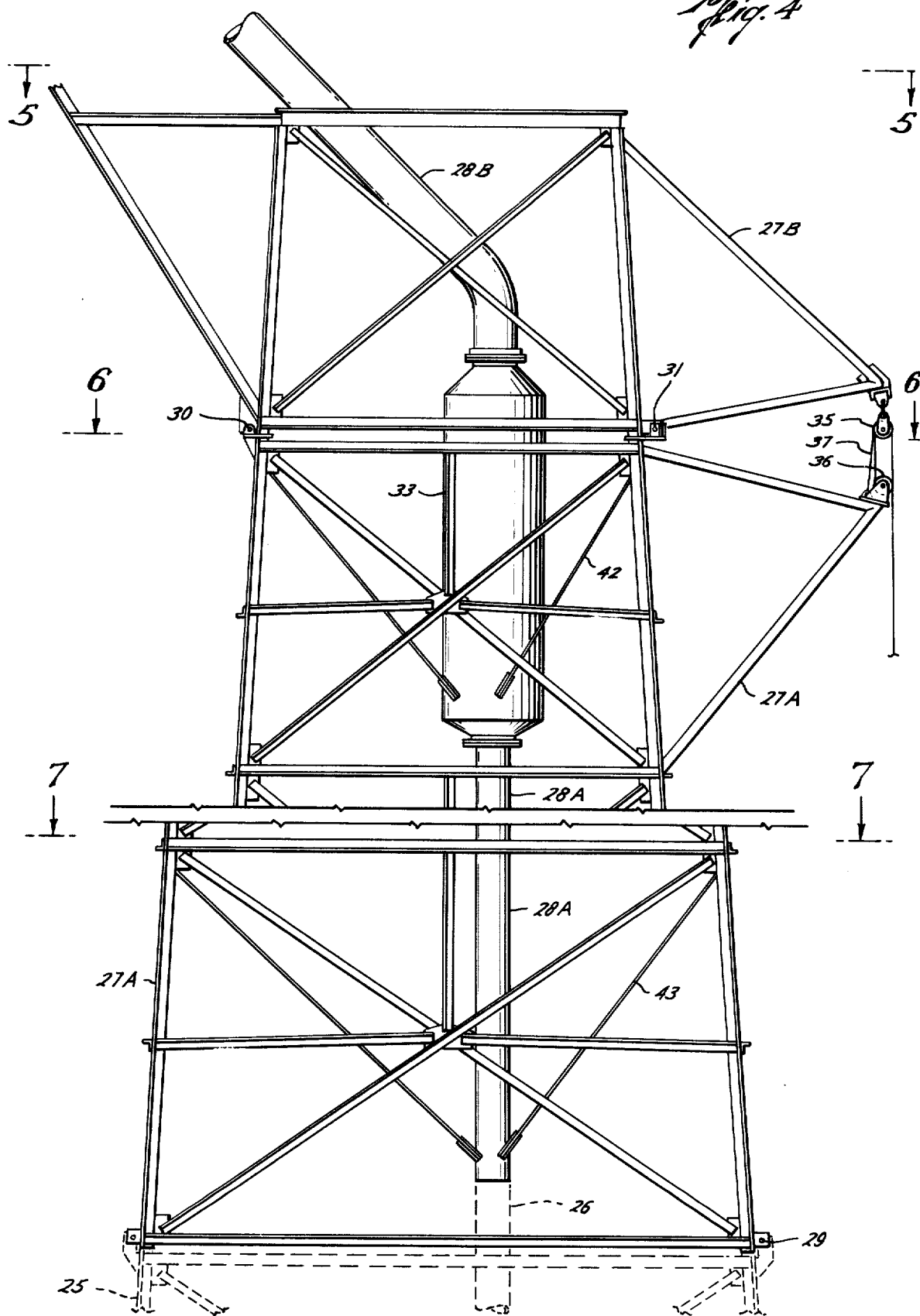


Fig. 4



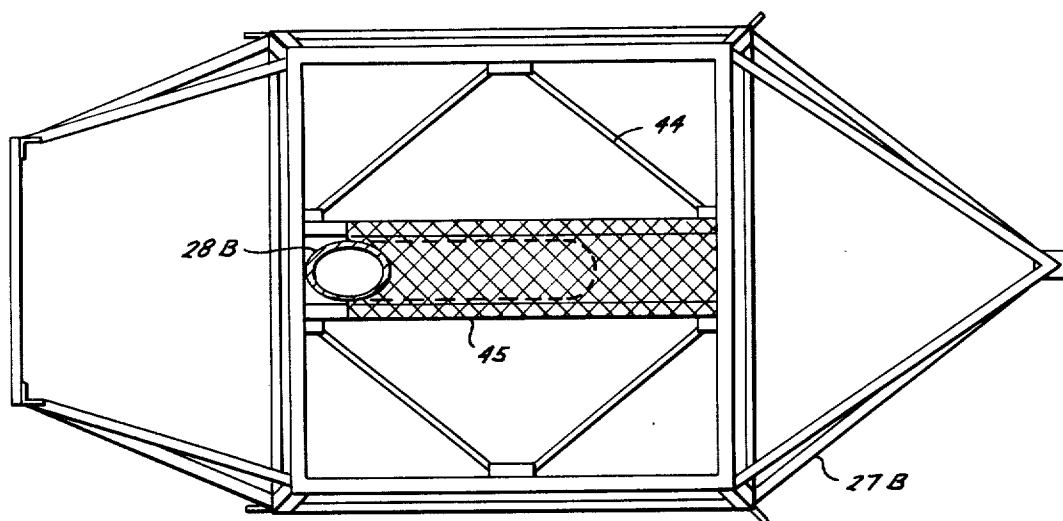


Fig. 5

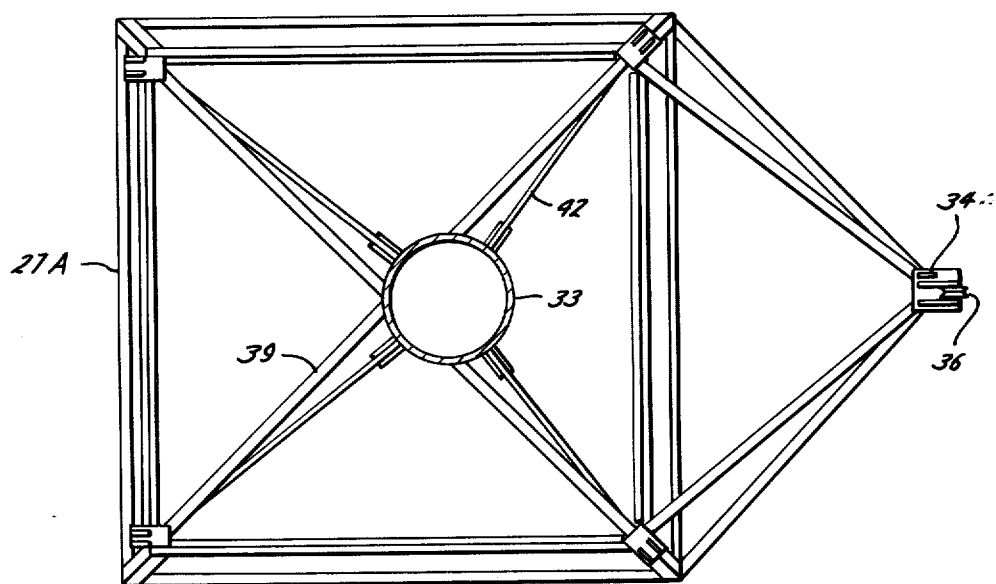


Fig. 6

FLARE TOWER

This invention relates generally to flare towers for use in burning waste gas at remote facilities, such as offshore oil and gas production platforms. More particularly, it relates to improvements in flare towers of this type which are prefabricated onshore, or at least at a location remote from the offshore platform, and then transported to and erected on such platform.

It is, of course, desired to dispose of waste gas by piping it to a remote location at which it may be burned without danger to persons and property. However, this would be a very expensive thing to do in the case of waste gas from hydrocarbons produced at offshore oil and gas production facilities. Consequently, it has instead been the practice to dispose of this gas, which has been released from pressure vessels on the platform, by burning it in a flare tower, which includes a tower mounted on the platform and supporting a pipe with its lower end connected to the gas source and its upper end a substantial distance above the deck. Thus, the gas, when ignited by pilots near the upper end of the pipe, will not be harmful to personnel and equipment on the platform. Although an effort is made to separate all liquid from the gas in the aforementioned pressure vessels, some may nevertheless enter the pipe of the tower; and, for this reason, it has also been the practice to bend the upper end of the pipe over the side of the deck, whereby burning liquid would ordinarily fall onto the surrounding water.

Due to the limited space on the platform, it is obviously preferable to prefabricate the flare tower elsewhere, generally onshore, and then transport it on a barge to the platform, at which time it may be lifted by a derrick onto the deck of the platform. However, due to the height of the tower, and constant movement of the barge due to wave action, it would be extremely hazardous to attempt to lift the tower in one piece from the barge onto the platform deck, and it has therefore been proposed to prefabricate the tower in separate sections, which may be lifted separately and stacked one above another. However, not only is the tower quite tall, but also the platform deck is a considerable distance above the water level. Thus, it is very difficult for the usual derrick to lift the top section of the flare tower into place above the lower section. Furthermore, even when the top section is so lifted, considerable time and effort must be expended in lining it up for connection to the lower section, and, in the meantime, it has been free to swing about freely due to movement of the barge due to wave action.

The primary object of this invention is to provide a sectional flare tower of the type above described in which the upper section thereof is easier to lift, and may be erected on the lower section with less time, effort and danger.

This and other objects are accomplished, in accordance with the illustrated embodiment of the invention, by a flare tower which includes a tower having a lower section which is mounted on the deck of the platform near one side thereof, and an upper section pivotally connected to the lower section for swinging about a generally horizontal axis from an inverted position to one side of the lower section to an erected position above the lower section. The pipe for receiving the waste gas to be burned in the tower includes a lower section supported by the lower tower section with its lower end positioned for connection to the source of

waste gas on the platform, and an upper section supported by the upper tower section for swinging with it, from its inverted to its erected position, into a position in which its lower end of the upper section is aligned for connection with the upper end of the lower pipe section. More particularly, an intermediate portion of the upper pipe section is bent to dispose its upper end outwardly of the one side of the platform, when the upper tower section is in erected position, so that, as previously described, burning liquid would ordinarily fall into the ocean surrounding the platform.

A flare tower of this construction may be mounted and transported on a barge with its upper tower section in inverted position, so that, when the barge arrives at a position adjacent the platform, a derrick on another barge adjacent the platform need lift the tower a distance above the platform substantially less than it would have to lift an upper tower section to be mounted on the lower section, in accordance with prior practices. Consequently, derricks of more conventional size may be used with the assurance that the tower, with its upper section inverted, would be relatively stable while so lifted and lowered onto the platform. Then, with the lower tower section mounted on the platform, and the sling on the derrick released therefrom, the upper tower section may be pulled from its inverted into its erected position and then secured to the lower tower section in such position. More particularly, the center of gravity of the upper tower and pipe sections is disposed outwardly of the pivotal connection of the upper tower section to the lower tower section, in all positions of the upper tower section as it moves from inverted to erected position, so that the means for so lifting the upper tower section is at all times in tension. Preferably, this lifting is accomplished by a block and tackle connecting the upper and lower tower sections on sides thereof opposite the sides which are pivotally connected to one another.

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 is a perspective view of a flare tower constructed in accordance with the present invention and mounted on a barge in position to be lifted onto the top deck of an offshore platform for erection thereon;

FIG. 2 is an enlarged elevational view of the flare tower lowered onto a base on the platform;

FIG. 3 is another elevational view of the flare tower mounted on the base and with its upper section lifted into erected position;

FIG. 4 is an enlarged elevational view of a portion of the erected flare tower shown in FIG. 3, with the lower section thereof discontinued for purposes of illustration; and

FIGS. 5, 6 and 7 are horizontal cross-sectional views of the flare tower, as seen along broken lines 5—5, 6—6 and 7—7, respectively, of FIG. 4.

With reference now to the details of the drawings, the flare tower, which is designated in its entirety by reference character 20, is shown in FIG. 1 to be mounted upon a barge 21 located adjacent a derrick 22 mounted on another barge adjacent the platform, and preferably secured to barge 21 for lifting the flare tower on a sling 23 from barge 21 onto the deck of an offshore platform 24. As previously mentioned, the flare tower has been prefabricated and transported to the position shown in FIG. 1 from an onshore location, or some other location remote from the platform. As also shown in FIG.

1, a base 25 is mounted on the deck in position to support the lower end of the flare tower near one side of the platform as it is lifted onto the platform.

As well known in the art, the platform may be a considerable distance from shore, and, when used as a production facility, carries vessels (not shown) in which the liquid and gas phases of the hydrocarbons produced from wells connecting with the platform may be separated. Some means must be provided for venting the gas from these vessels in the event pressure therein exceeds allowable limits, and this in turn requires connection of the vessels with the flare tower 20 for burning the waste gas. For this purpose, a pipe 26 extends upwardly within the base 25 for connection at its lower end with the pressure vessels, and/or other sources of waste gas, and at its upper end with the flare tower to be mounted on the base.

The flare tower 20 includes a tower 27 having an open framework including a lower section 27A which tapers upwardly from a broad base 25, and an upper section 27B which, when erected, extends upwardly and outwardly from the lower section in a direction toward the near side of the platform. When so erected, as shown in FIG. 3, the tower sections support a pipe 28 with its lower end connected to pipe 26 and its upper end outward of the near side of the platform, when the flare tower is erected thereon. Thus, as previously mentioned, if liquids should escape from the separating vessels with the gases, the burning liquid would fall from the upper end of pipe 28 into the water surrounding the platform. Similarly to the tower, pipe 28 includes a lower section 28A, which is supported by the lower tower section in a generally upright position, and an upper section 28B, which is supported by the upper tower section for extension therewith upwardly and outwardly of the near side of the platform.

As best shown in FIG. 4, the lower end of the lower tower section 27A is connected to the upper end of the base 25 by means of pins 29 extending through plates at the corners of the sides of the adjacent faces of the lower tower section and the base. As previously mentioned, the lower end of the lower tower section corresponds in cross section to the upper end of the base 25, so that it may be lowered onto and supported by it by means of the sling 23. The upper tower section 27B is pivotally connected to the lower tower section 27A by means of pins 30 to permit the upper tower section to swing about a horizontal axis from its inverted position of FIG. 2 to its upright or erected position of FIG. 3. More particularly, the pins extend through plates on the sides of the tower sections parallel to the near side of the platform 24. When the upper tower section has been swung to its erected position, as shown in FIG. 3, it is connected to the lower tower section and thus secured in such position by pins 31 extending through plates on the opposite sides of the tower sections.

As previously described, and as shown in FIGS. 1 and 2, the flare tower 20 is lifted from the barge onto the platform while its upper tower section 27B is inverted. During this time, the upper section is located in inverted position by means of a stop 32 projecting from the outer side of the lower tower section. With the upper tower section so located, the upper and lower pipe sections extend generally parallel to one another, so that the tower is of a minimum width and thus less unstable when lifted. In order to further maintain the flare tower in as stable a position as possible as it is so

lifted, the sling is connected to it along a vertical line near the center of gravity of both tower sections.

Furthermore, since the tower may be lifted in this position, the sling on the derrick may connect with it along an intermediate portion of its height, and in particular with an upper portion of the lower tower section. Consequently, the derrick need be of sufficient size to lift the tower only about one-half of its height above the base on which it's to be erected.

As shown in FIG. 3, when the lower tower section is mounted upon and connected to the base 25, the lower end of lower pipe section 28A is adjacent to and aligned with the upper end of the pipe 26, thereby permitting them to be welded or otherwise connected to one another in a simple manner. In order to avoid interference between the adjacent ends of the pipes, the upper end of the pipe 26 terminates near the upper end of the base 25, and the lower end of the lower pipe section 28A terminates near the lower end of the tower section 27A.

The lower pipe section 28A is supported within the lower tower section 27A, in a manner to be described, with its upper end terminating near the upper end of tower section 27A, and thus in a position near and aligned with the lower end of upper pipe section 28B, which terminates near the lower end of tower section 27B when the upper tower section 27A has been moved to the erected position of FIG. 3. At this time, of course, the adjacent ends of the pipe sections may be connected together in any suitable manner.

An intermediate portion of the upper pipe section 28A is bent near its lower end, so as to permit the portion thereof above the bend to extend upwardly and outwardly with the upper tower section 27B. This bent portion of pipe section 28B extends through the framework of the lower end of the upper tower section 27B, which corresponds to the upper end of lower tower section 27A. The framework of the upper end of the upper tower section 27B extends upwardly and laterally from the lower framework at an angle which disposes the upper end of the upper pipe section 28B not only outwardly of the near side of the platform, but also a desired distance above the deck of the platform.

As well known in the art, pilots (not shown) are provided in the pipe 28 near the upper end of its upper section for igniting gas as it flows upwardly therethrough. In order to minimize the possibility of air backflowing through the pipe and into the separators, the lower pipe section includes a molecular seal 33, which as well known in the art, comprises internal baffles which, together with the use of a purge gas is lighter than air, is effective to prevent substantial backflow of air through the pipe.

The upper tower section is pivoted from inverted to erected position by means of a block and tackle 34 connecting the tower sections at their sides opposite those pivotally connected together by pins 30. Thus, as shown in FIGS. 2 and 3, one or more sheaves 35 are swingably connected to an extended portion at the lower end of the upper tower section, and a corresponding number of sheaves 36 are connected to an extended portion on the upper end of lower tower section 27A, and tackle 37 extends between them in the usual manner. Thus, as will be apparent from FIGS. 2 and 3, the tackle is free of entanglement with the opposed ends of the tower section, and when the upper tower section is erected, its extended portion is generally

above the extended portion of lower tower section so that the sheaves 35 and 36 are close to one another. The tackle has a dead end (not shown) which may be connected to a plate 34A (FIG. 6) near the sheaves 36, and a live end 38 which extends outwardly from the sheaves 36 to a winch (not shown) on the platform. Thus, upon taking up of the tackle by means of the winch, the upper tower section is caused to swing about the pins 30 and thus from inverted to erected position.

More particularly, the center of gravity of the upper tower section and upper pipe section is so located that it remains outwardly or to the left of the pivot pins 30 during swinging of the upper tower section from its inverted to its erected position. Consequently, the tackle is at all times maintained in tension during erection of the tower, so as to prevent its weight from falling onto the lower tower section. Of course, this tension may be maintained in the tackle after the upper tower section has been erected, until the upper tower section has been secured to the lower tower section by means of the pins 31.

As shown in FIGS. 4, 6 and 7, the lower tower section is also reinforced with internal diagonal braces 39 and 40. The pipe 28 is disposed slightly to the right of center of the interior of the lower tower section, and thus to one side of the intersection of the diagonal braces. The inner ends of the braces 39 are welded to the sides of the molecular seal 33, and part 41 is welded to the intersection of the braces 40 to provide a curved side for fitting against and thus supporting an adjacent side of the lower pipe section 28A. The lower pipe section 28A is also supported by arms 42 and 43 which extend downwardly and inwardly.

As shown in FIG. 5, the lower portion of the upper tower section is also internally reinforced by diagonal braces 44. As also shown in FIG. 5, a deck 45 extends between the opposite sides of the upper end of the lower portion of the upper tower section, and the upwardly and outwardly extending portion of the upper pipe section is held between a cutout portion in the deck and the oppositely facing side of the tower section. The upper pipe section is welded or otherwise secured to these and other parts of the upper tower section, including that which extends along a substantial length of the pipe section above its bend.

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

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

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

The invention having been described, what is claimed is:

1. Apparatus, comprising an offshore platform having a source of waste gas, and a flare tower on the platform for burning said waste gas, said flare tower including a tower having a lower section mounted on the deck of the platform near one side thereof, and an upper sec-

tion pivotally connected to the lower section for swinging about a generally horizontal axis from an inverted position to one side of the lower section to an erected position above said lower section, and a pipe having a lower section supported by the lower tower section with its lower end connected to said source of waste gas, and an upper section supported by the upper tower section for swinging with said upper tower section, from its inverted into its erected position, into a position in which its lower end is aligned for connection with the upper end of the lower pipe section and its upper end is disposed outwardly of the one side of the platform, said upper pipe section having means thereon near its upper end for igniting waste gas flowing upwardly through said pipe, the center of gravity of the upper tower and pipe sections being disposed outwardly of the pivotal connection of said upper tower section to said lower tower section, in all positions of said upper tower section as it moves from inverted to erected position, and said tower including means for securing said upper tower section to said lower tower section to hold it in its erected position.

2. Apparatus of the character defined in claim 1, wherein said lower pipe section is supported by said lower tower section in a generally upright position, and said upper pipe section is bent between its upper and lower end.

3. Apparatus of the character defined in claim 2, including means on said lower tower section for locating said upper pipe section generally parallel to said lower pipe section in the inverted position of said upper tower section.

4. Apparatus of the character defined in claim 1, including means connecting said upper tower section to said lower tower section for lifting said upper tower section from its inverted to its erected position.

5. Apparatus of the character defined in claim 4, wherein said tower sections are pivotally connected at said one side of the lower tower section, the lower pipe section extends within the lower tower section and the lower end of the upper pipe section extends within the upper tower section, and said lifting means comprises extendible and retractable means connecting said tower sections on the opposite sides thereof.

6. Apparatus of the character defined in claim 4, wherein the lifting means comprises block and tackle means.

7. Apparatus of the character defined in claim 1, wherein said one side of the lower pipe section is substantially adjacent said one side of the platform.

8. A flare tower for burning waste gas from a source on an offshore platform or other remote facility, comprising a tower having a lower section adapted to be mounted on the platform and an upper section pivotally connected to the lower section for swinging about a generally horizontal axis from an inverted position to one side of the lower section to an erected position above said lower section, and a pipe having a lower section supported by the lower tower section for disposal in a generally upright position above said platform, and an upper section supported by the upper tower section for swinging therewith, the upper end of said lower pipe section being near the upper end of said lower tower section, the lower end of said upper pipe section being near its lower end, and the intermediate portion of said pipe section being bent near its lower end, so that, in the erected position of said upper pipe section, said

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lower end of the upper pipe section is disposed near and aligned with the upper end of said lower pipe section and said upper end is disposed outwardly of the one side of the lower tower section, said upper pipe section having means thereon near its upper end for igniting waste gas flowing upwardly through said pipe, the center of gravity of the upper tower and pipe sections being disposed outwardly of the pivotal connection of said upper tower section to said lower tower section, in all positions of said upper tower section as it moves from inverted to erected position, and said tower including means for securing said upper tower section to said lower tower section to hold it in its erected position.

9. Apparatus of the character defined in claim 8, including means on said lower tower section for locating said upper pipe section generally parallel to said lower

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pipe section in its inverted position.

10. Apparatus of the character defined in claim 8, including means connecting said upper tower section to said lower tower section for lifting said upper tower section from its inverted to its erected position.

11. Apparatus of the character defined in claim 10, wherein the lower pipe section extends within the lower tower section and the lower end of the upper pipe section extends within the upper tower section, and said lifting means comprises extendible and retractable means connecting said tower sections on the opposite sides thereof.

12. Apparatus of the character defined in claim 10, wherein the lifting means comprises block and tackle means.

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