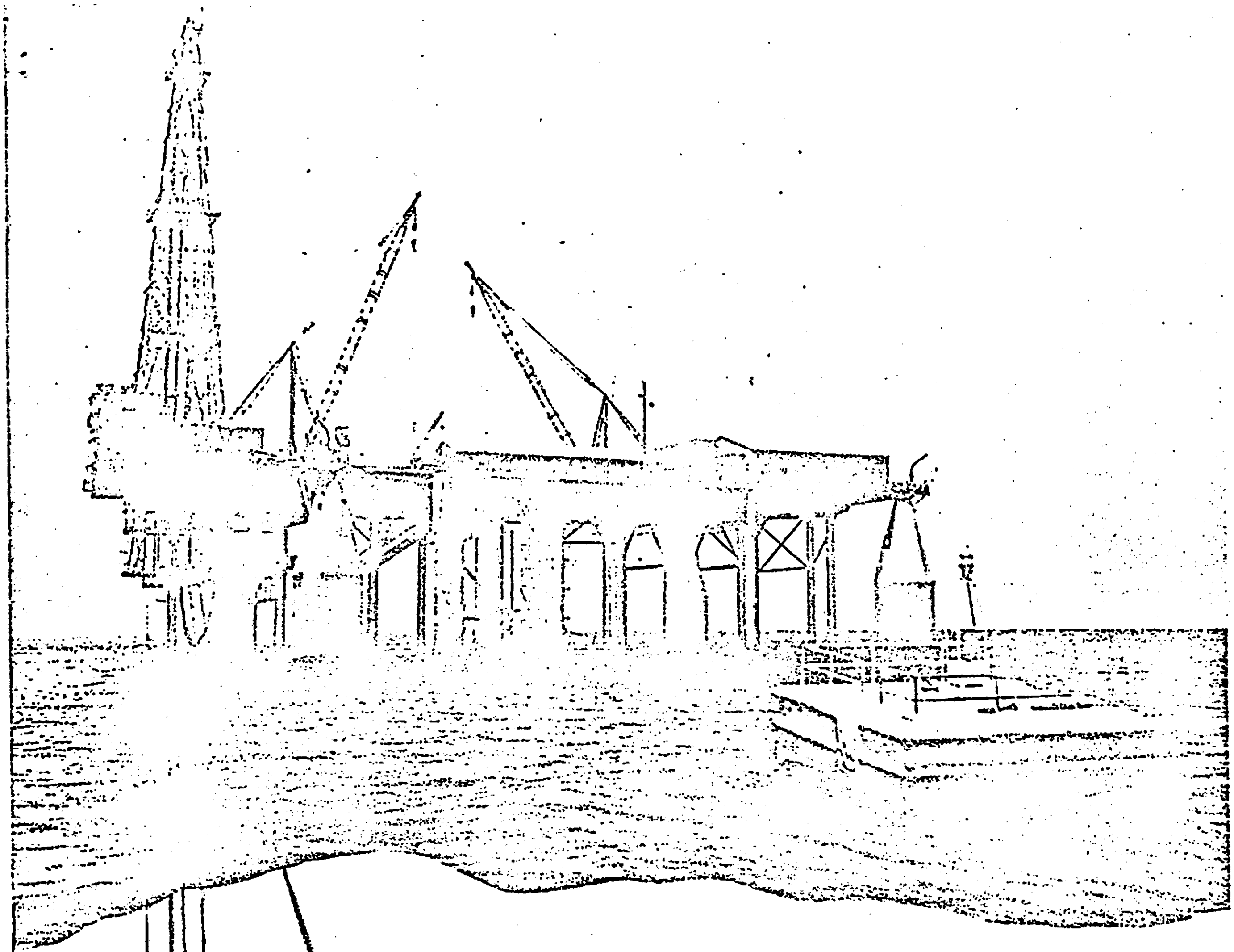
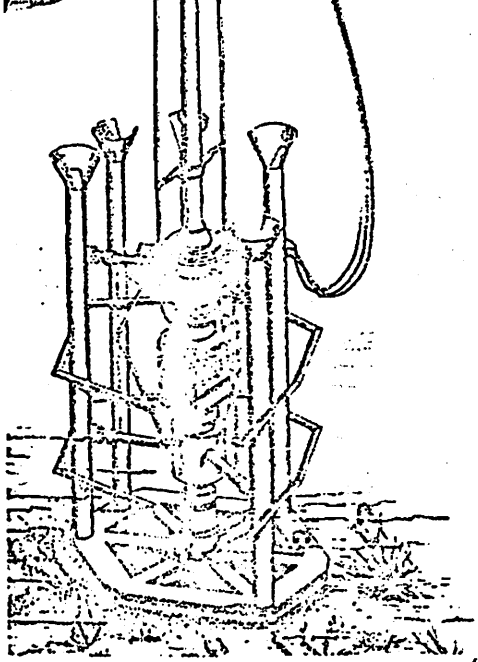




WHERE NO DIVER can go, the wellhead is at the mudline and all connections are made remotely. Thus, no expensive underwater platform is necessary and 1,000-ft water is as easy to drill as 300-ft water. Large-diameter pipe from wellhead to surface is "marine conductor" which carries return mud flow and guides bit back into the hole. Choke line and kill line run alongside marine conductor.

How Shell plans to Complete and produce

PART 2 OF TWO PARTS

SHELL OIL CO. believes it now has the know-how necessary to:

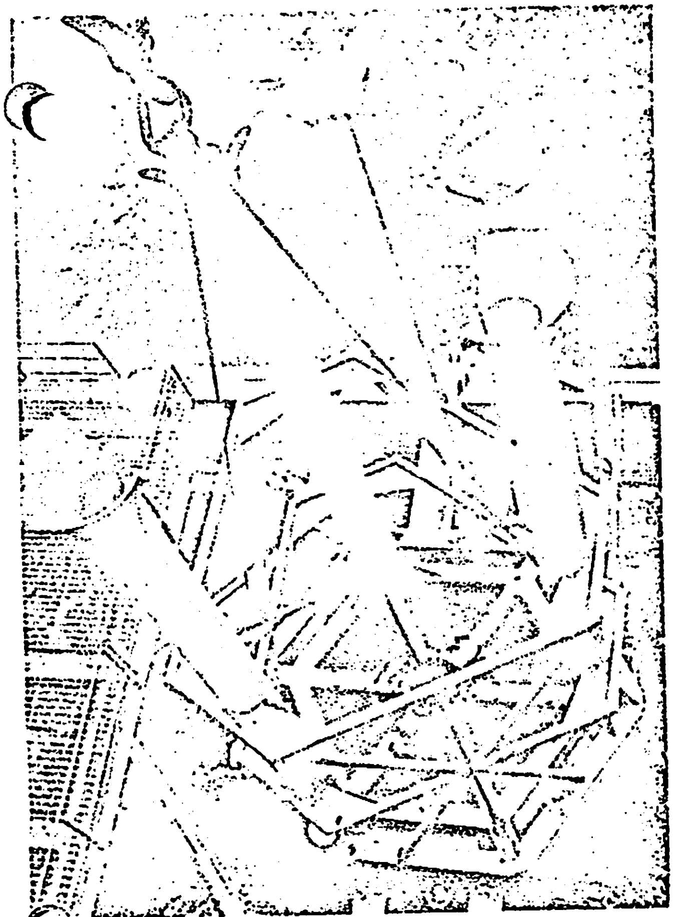
1. Complete a producing well with the wellhead on the ocean floor under as much as 600 to 1,000 ft of water.
2. Produce that well to depletion in a regular fashion even if gathering facilities must be mounted on floating structure.
3. Service the producing well remotely for common jobs like paraffin removal, flow-valve running and removal, bottom-hole-pressure testing, and corrosion-inhibitor treating.
4. Develop means to work the well over without a rig in any manner now possible with wire-line tools.

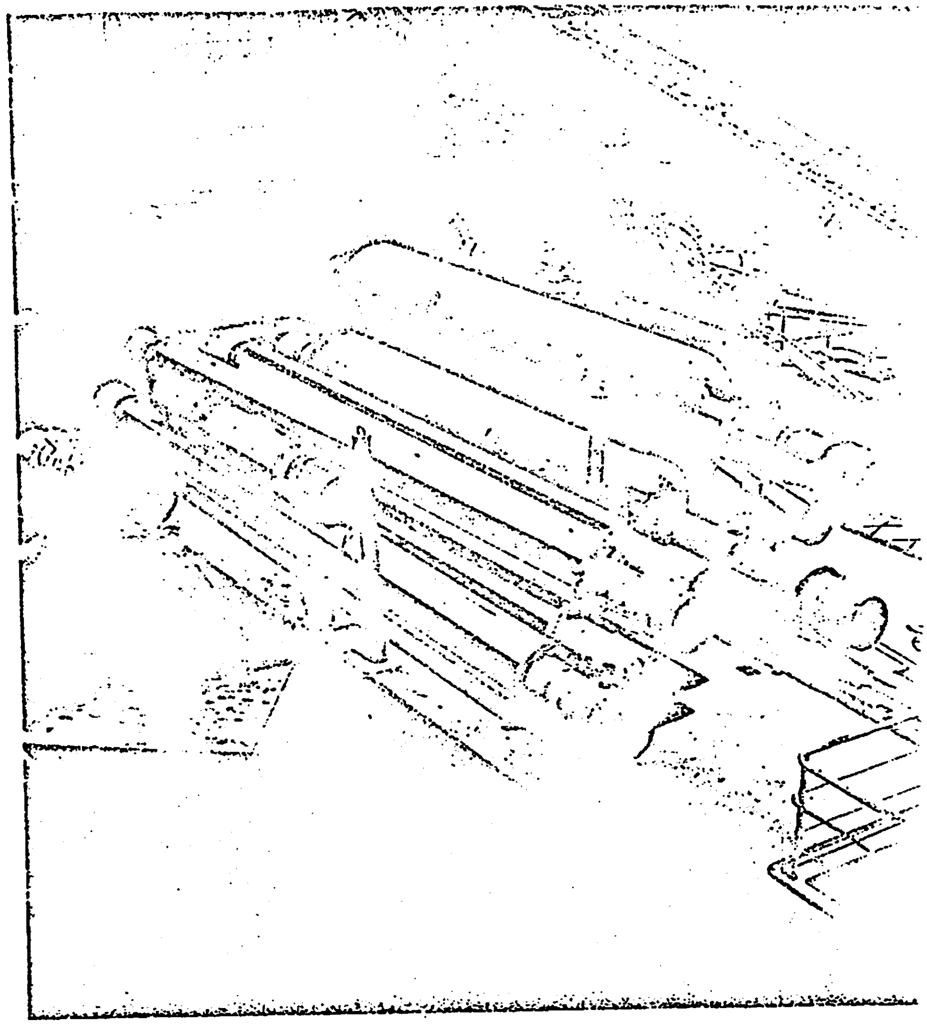
Most of these possibilities are backed up by solid field tests:

1. The company has already drilled five exploration wells in 300 ft of water, using an underwater-wellhead technique which requires no divers.
2. Gained producing know-how from an underwater, remotely controlled oil well completed some 2 years ago.
3. Perfected techniques to perform downhole service jobs by running tools through the well flow line.

Moreover, company engineers have spent several years in preliminary studies on these and many other aspects of developing deep-water leases. As a result, Shell men believe they have developed two things: first, the best method yet suggested for underwater completion; and, two, the means to produce the underwater well to depletion without normally requiring any kind of rig to return to the location.

As experience accumulates with





FIRST PIECE TO GO DOWN to the ocean floor is this guidance and support structure, left, which is lowered to bottom on the 20-in. surface pipe. The three large-diameter columns are used for all principal drilling and production equipment. The two smaller columns carry auxiliary equipment like underwater television camera and carriage to connect the well's flowlines to producing equipment. Stacked on deck, the marine conductor, right, waits during a move. Two joints have concentric floating tanks which support part of the weight of the string when it is in the water.

underwater wells

BY ED McGHEE, Drilling Editor

underwater completions, company engineers believe the method may compete in water depths now the province of conventional fixed platform. Water as shallow as 75 to 100 ft may be more economical with underwater wellheads. And, wells in 600 ft of water may be no more expensive to drill and produce than those in 200-ft depths.

License agreements are now being negotiated with wellhead-equipment manufacturers. These firms can then sell the Shell-designed equipment which required millions of dollars and years of work to develop to its present state of safety and practicality. Shell hopes other oil companies will use the system and help improve the design by accumulating field experience with it.

How it's different. Shell emphasizes this fact about its techniques: the methods are a "total solution." There are no narrow limits of use. The equipment is not restricted to the viewpoint of a wellhead-equipment manufacturer. The techniques are not limited to those of the exploration driller. The operations are not limited to fair weather and sheltered water. Rather the method aims to give the operating oil company the same freedom of operation it enjoys on land, to find and economically produce oil regardless of the topography.

Here is how the Shell methods differ from others suggested thus far:

1. The Shell underwater completion can be made in any water depth from 75 to 1,000 ft.

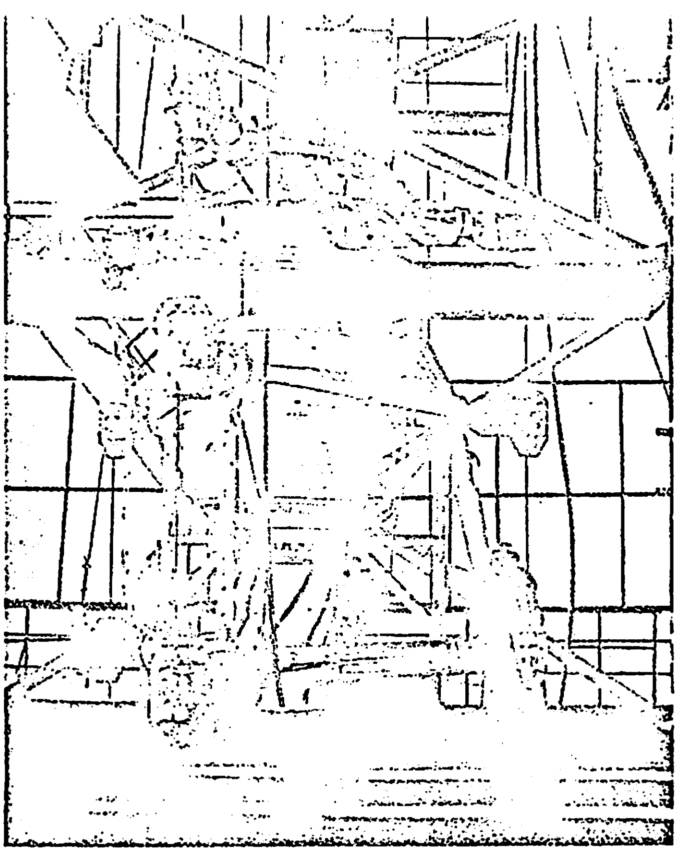
2. The wellhead is at the mud line so that no expensive underwater structure is needed. Nor is any diver required.

3. The equipment comes packaged in large, multiple-use packages which must be pulled to the surface but rarely.

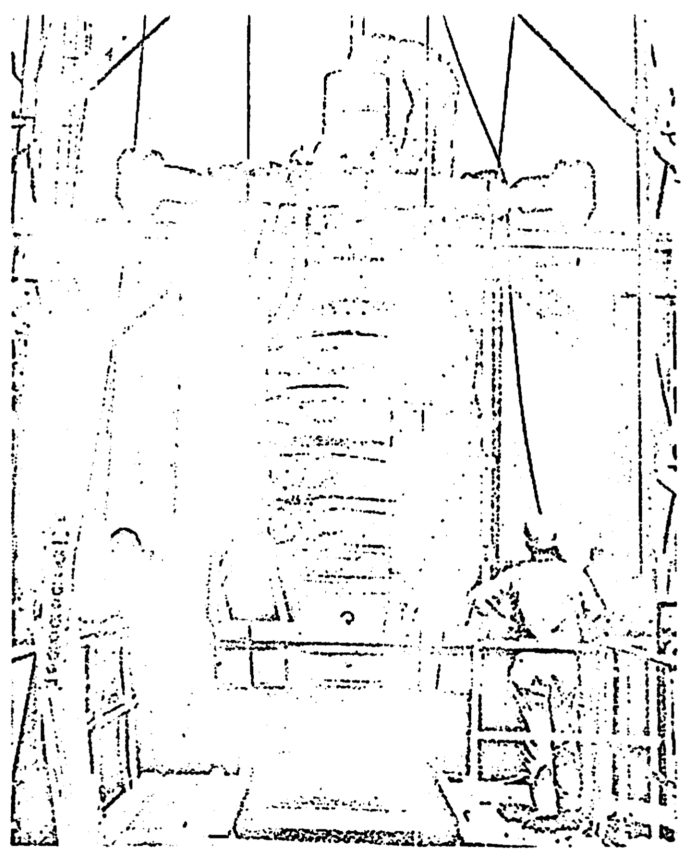
4. The methods are not for exploration alone; they carry on through to producing and well servicing.

Company engineers say they kept several things in mind in designing the underwater equipment. First, it must be as simple as possible so that crews could be trained quickly in its use. Second, the equipment had to be reliable so that the well, either when drilling or producing, would be under full control at all times. And, lastly, the equipment should consist of as few separate units as possible to reduce the time spent in handling it.

Shell already had gained experience with underwater wellheads when the company participated in



TWENTY-INCH PREVENTER PACKAGE containing a Hydril blowout preventer is run onto the guidance structure while hole is being drilled for 13⅜-in. intermediate. If no 13⅜-in. is needed, this package need not be run. Note the three sets of guideline cones which ride the guidelines to the wellhead. Notice also the bundle of hydraulic lines the crewman is attaching to the package.



FOURTEEN-INCH PREVENTER PACKAGE, shown here during tests, contains not only a Hydril preventer but also two ram-type, space-saver preventers. This entire stack runs as a single unit and protects the well while hole is drilled for 9⅝ and 7-in. casing strings. Hydraulically-actuated dogs inside the bottom portion of the stack engage the wellhead to help form a seal.

drilling offshore California with the the CUSS group (Continental Oil, Union Oil of California, Shell, and Superior Oil). The CUSS group developed a system depending on guidelines for running equipment to the sea floor. The guideline principle was retained in the new system Shell evolved for itself.

Foundation equipment. The first thing run on the underwater well is a 30-in. conductor pipe. In the Louisiana operations, this conductor has been about 100 ft long and jetted into the bottom. In other areas, different lengths might be required. Three temporary guidelines connect the 30-in. to the surface. By means of these guidelines, the drill pipe (on which the 30-in. was run) can reenter the conductor to drill the surface hole.

After the surface hole is drilled, a 20-in. string of casing is run and cemented. Before the last of this 20-in. is lowered from the surface, the crews attach a "guidance and support structure." This structure serves throughout the remainder of drilling and, if necessary, through production and well servicing.

The guidance and support structure does several jobs as follows:

1. It is the base from which all subsequent strings of pipe are suspended.
2. It is fitted with the main guidelines on which all subsequent drilling and production equipment is lowered.
3. Alignment columns (through which the guidelines rise) have funnel-shaped tops and slotted sides to hold all subsequent wellhead equipment in perfect alignment with that run previously.
4. It has two auxiliary guidelines and alignment columns to run miscellaneous equipment such as an underwater television camera and equipment for connecting the flow line to the producing wellhead.

Preventer packages. After the surface pipe is in place, the underwater well requires blowout preventers just as any other well would. Shell has simplified its drilling wellhead by packaging the preventer stacks into only two units. The first package contains a 20-in. Hydril-type preventer.

This 20-in. preventer package stays on the wellhead while the intermediate hole is drilled and while a 13⅜-in. casing string is run and cemented. In some wells, there may be no need for the 13⅜-in. string. If not, the string may be omitted. And, the 20-in. preventer package is not needed.

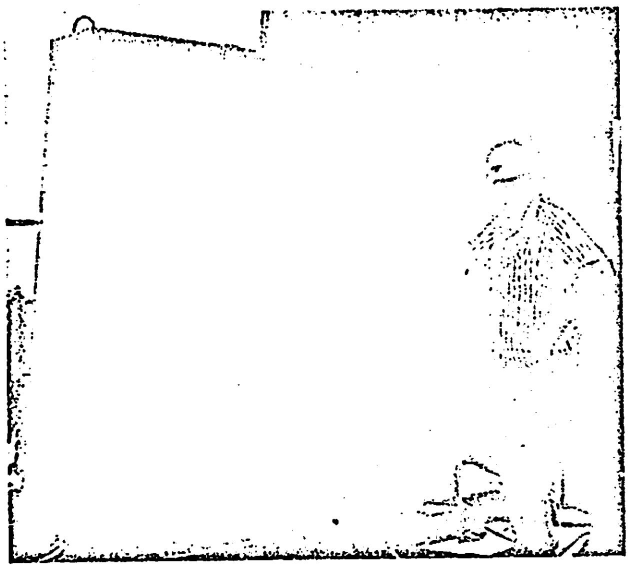
If the 13⅜-in. is run, Shell attempts to cement it completely to the surface.

After the 13⅜-in. is cemented, the 20-in. blowout-preventer stack is pulled to the surface before the plug is drilled. This package is replaced immediately by a 14-in. blowout-preventer package. In addition to the 14-in. Hydril-type preventer, this unit also carries two ram-type space-saver (two sets of rams in one body) preventers.

Both a 9⅝-in. and a 7-in. casing string may be run and hung through the 14-in. preventer package.

All preventer packages and casing are run on drill pipe. The guidelines carry no weight but serve only to steer the equipment to its proper place on bottom.

Eliminating flanges. Shell engineers report that the biggest hurdle they faced in designing underwater wellheads was uprooting the popu-



GRAPHIC PANEL on derrick floor shows the condition of the underwater wellhead. Here, Shell Engineer Finis Martin prepares to operate a control valve which will operate equipment on the 20-in. preventer stack more than 400 ft below him. Lights show which preventers are open, which closed, and whether there is pressure behind the rams. A similar panel is used with the 20-in. preventer.

lar belief that flanged connections are the only practical wellhead connector.

The connection Shell evolved to replace flanges depends on a pressure-energized flexible seal between male-and-female mating parts. The joint is held together mechanically by a series of "dogs" in the female portion which latch into a recess in the male portion. When these dogs are latched, they are held in place by an annular ring which can be moved only by applying hydraulic pressure. However, no hydraulic pressure is required to keep the connection leak tight once it is made up.

As an example, the 20-in. casing has a male portion of the connection "looking up." The bottom of the blowout-preventer packages have the corresponding female portion "looking down." When the preventer package is run, the female portion slips over the male. Then, hydraulic pressure from above moves the annular rig down onto the latching dogs, forcing them out to latch in the recess on the male connection.

The flexible seal prevents any well pressure from reaching the area of the dogs and the hydraulically operated annular ring. Also, this flexible seal does not need to be compressed to seal as does a conventional flange.

When time comes to hoist the preventer package to the surface, hydraulic pressure is put on the opposite side of the annular ring in the connection. The annular ring moves away from the latching dogs so that they release when the preventer package is picked up.

Shell engineers feel that many items of the equipment developed in this program may find good use in onshore operations.

Auxiliaries. Earlier it was mentioned that there are a number of auxiliary devices which may be run to the underwater wellhead. These run on the two auxiliary guidelines and do not interfere with anything run or retracted on the main guides. One such auxiliary device is the television camera which allows the man on the rig floor to see the underwater wellhead and its vicinity.

The television plays no part in actual operation. It is simply to reassure the men on the surface that things are progressing smoothly.

Rising to surface. Since the blowout preventers are on the ocean floor, some method is necessary to get the return mud flow back aboard the drilling platform. Shell accomplishes this with a pipe which acts like an extremely long "bell nipple," but which is called a "marine conductor." This marine conductor is large-diameter and rises almost all the way to the rotary table.

Hollow flotation chambers in the marine conductor help to support part of its weight. Thus, it is easier to keep the pipe straight. The rest of the job of supporting the marine conductor is performed by lines and counterweights attached to the rig.

The upper end of the marine conductor must be attached firmly to the drilling barge so that mud can flow out continuously. The lower end, of course, must be fixed rigidly to the top of the blowout preventers. Since the floating rig rolls and pitches, a "slip joint" is used near the top of the conductor. This joint telescopes as the rig rises and falls with the sea.

There can be no slip joints in the guidelines. And, of course, they too must be fixed at both ends. For this reason, they are spooled at the surface on constant-tension winches. These air-pressure-operated devices, automatically hold the same pull on the line at all times. A greater pull on the line allows it to unwind from the winch. A lesser pull allows the winch to spool line in.

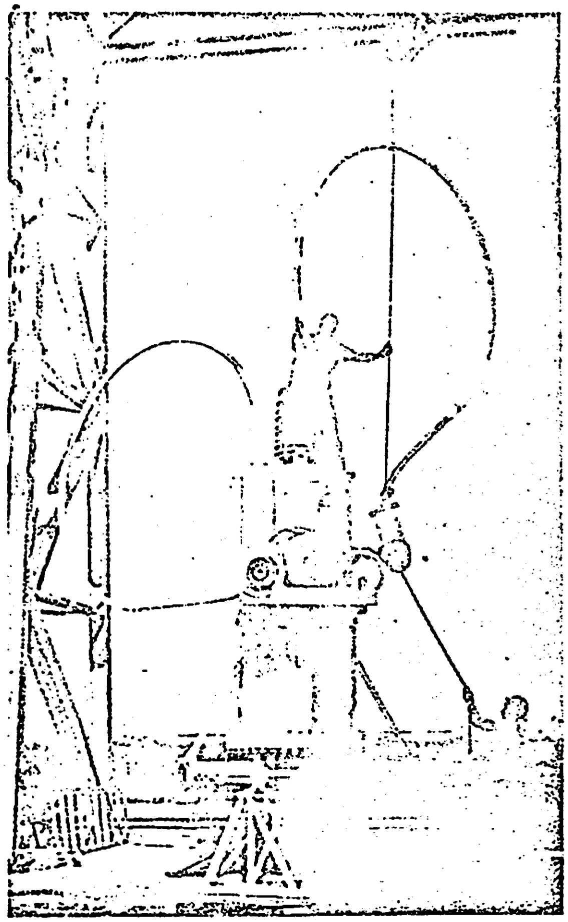
Hydraulic controls. All of the underwater equipment is hydraulically operated. High-pressure oil for the underwater jobs is carried through a bundle of flexible lines. This bundle is tied off to the marine conductor but only loosely so that the conductor bears none of the weight.

The hydraulic-line bundle has at both ends a cap which mates with similar caps on the wellhead and on the rig. Each cap is mechanically arranged so that it cannot be mismated. As a result, each hydraulic line in the bundle mates with the proper one on the subsea wellhead or on the surface control panel.

The surface control panel shows graphically all of the equipment on the subsea wellhead. Valves on the panel will open and close the various preventers, kill-line valves, and choke-line valves. Lights on the panel show whether each preventer and valve is opened or closed.

Friction drop through the hydraulic lines becomes larger as the lines become longer. As a result, at extreme depths, the response of the hydraulic equipment might be very slow. Shell engineers figure that about 1,000 ft of water is about the practical limit of the present hydraulic-control equipment.

Once the blowout-preventer package is in place, there is little to distinguish drilling from that with abovewater wellheads. Round trips with the drill pipe are routine since there is no rotating head. Mud is circulated in the same manner. Blowout preventers are operated in the usual ways. Formation logs and drill-stem tests require no unusual preparation. Making hole is simply a matter of turning the bit to the



PRODUCTION PACKAGE is being assembled here for testing. The 5-ft-radius bends in flow lines insure that tools can be pumped through flow line and into well bore. Hydraulically operated connectors on ends of these bends will attach to flow line proper which is laid separately. Inside the case are master valves, tubing-wing valves, and safety valves for the two parallel tubing strings. Also contained are two electrically operated hydraulic pumps which operate the valves. Later models of the production package will not carry the oil-bath case.

right until it wears out and then pulling it to run another.

Production equipment. No attempt has been made to complete a producing well from Shell's Blue Water rig in the current drilling program. (See Part 1 of this two-part series, Oct. 1, p. 80.) The only underwater producer Shell has made with its new methods was completed 2 years ago in 56 ft of water.

Let us assume that the floating driller finds enough pay formation to warrant completion. We can follow that completion through to see how Shell expects to work.

After the well has been logged, it is cased. Before the casing is perforated, two parallel strings of tubing are run. A dual, hydraulic-set packer may be run on one of the strings or a wire-line packer may be strings are run to the same zone.

Function of the two parallel tubing strings is to allow pumping production-maintenance tools into the well. Shell engineers are confident they could operate with but a single tubing string and circulate back up the annulus.

The tubing is landed in the underwater wellhead and the 14-in. blowout-preventer stack is pulled to surface. Then the tubing is retrieved and upper end of the strings are attached to a "production package." This package runs on the three main guidelines just as the blowout-preventer packages did. Since the connection between tubing strings and production package is a critical one, Shell prefers to make it above water.

Then, the tubing strings and production package are lowered onto the wellhead by means of extra tubing attached to the top of the production package. When the tubing is lowered into the tubing hanger, the well is ready to be brought into production.

Through-tubing perforators are run down the extra tubing, through the production package, through the well tubing, through the downhole packer, and opposite the producing zone. After the pay zone is perforated, the well can be washed into production.

When the well begins to flow, diverter plugs are run on wire line into the production package so that the extra tubing atop the production package may be pulled.

Production package. The production package contains the conventional master valve for each of the two tubing strings. It also contains a flow-line valve with a high-low-pressure shutin feature for each string. All these valves are operated (or reset) by hydraulic pressure.

The hydraulic pressure needed for valve operation comes from a pair of pumps contained in the production package. The pumps get their power from a 440-v electric-supply line connected to surface gathering facilities.

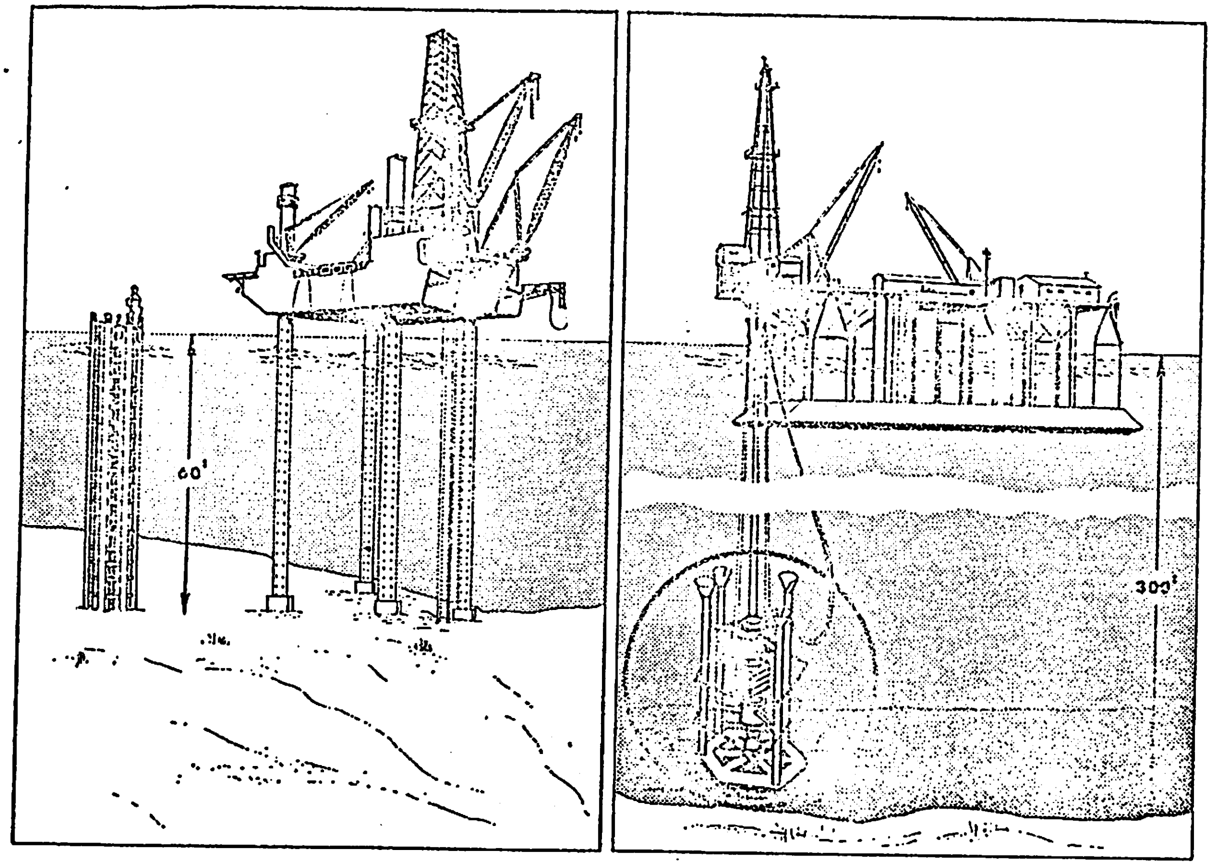
In the production package, there are no right-angle turns for the oil flow. Instead, there are smooth curves of not less than 5-ft radius in the lines. These curved lines make it possible to pump tools through flow line and down into well bore. Since there are two tubing strings in the subsea well, there must also be two flow lines. These are not connected until the production package is in place. Then, the well ends of the flow lines are lowered on a carriage riding the auxiliary guidelines which had previously served the underwater television camera. End of each flow line is fitted for the hydraulically operated connection used elsewhere on the wellhead. When the flow-line connectors and the production package are aligned, oil pressure from the surface forces out from the production package a corresponding portion to the connectors. Thus, wellhead and flow lines are locked and sealed.

Well servicing. In offshore fields which are in extra-deep water and which are a long distance from shore, Shell men expect it will be necessary to produce the subsea wells into a gathering station placed on a floating structure. Of course, this gathering station would contain the usual separators, treaters, meters, test facilities, etc. Besides, it would also have control panels for each of the subsea wells connected to it.

The individual-well control panel would show graphically each of the valves on the wellhead and lights would indicate whether each valve was open or closed. The "pumper" could remotely operate these valves by switches on the panel. The switches would send current to the hydraulic pumps in the production package in the wellhead. And, hydraulic pressure would operate the valves.

Routine well-service work would also be performed from the gathering station. Since each well has two tubing strings and two flow lines, fluid could be pumped from the gathering station into one flow line. The fluid would go down one tubing string, back up the other tubing string, and back to the platform in the second flow line.

Using this method of circulation, Shell expects to be able to pump tools through the flow line and into the well bore. The company believes it can duplicate any well-service job which can be done with wire-line tools. Shell has already tested a number of through-the-flow line tools and others are under



(Courtesy Shell Oil Co.)

FIG. 1—Comparison of new remote control submarine completion method (at right) with conventional offshore method shows how drilling and completion control equipment have been transferred from surface to the ocean floor. The subsea technique is applicable in much deeper waters since elaborate bottom-to-surface structures are eliminated.

Shell perfects new submarine completion technique

Completely remote controlled underwater drilling and completion method used successfully in 300-foot water depths

M. X. Hobbs, Jr.
Engineering Editor, WORLD OIL

SHELL OIL COMPANY has perfected a new submarine drilling and completion technique which can be utilized to develop oil and gas fields in the open sea in water depths to 1,500 feet. Blowout preventers and completion Christmas tree are positioned on the ocean floor, and all work is remote controlled from an all weather floating rig. Divers are not required for any phase of the operations. Figure 1 compares the new method with conventional offshore drilling-completion practices.

After five years of research and testing, Shell completed its first subsea well in West Cameron Block 192 in 56 feet of water. This was the first well in the Gulf of Mexico in which all blowout prevention equipment and the Christmas tree were positioned on the ocean floor and remotely operated from the surface. This initial subsea well has been produced successfully to an adjacent production platform 2,000 feet away since completion in December 1960. The well is controlled entirely by electro-hydraulic controls on the production platform.

After minor modifications of the operational technique, Shell moved Blue Water Rig No. 1 into deeper waters of the Gulf in the fall of 1961, for exploratory drilling in 300 foot water depth. The rig is an all weather, semi-submersible unit which is submerged to the 40 foot level in normal drilling operations. Bruce Collipp, area mechanical engineer for Shell in New Orleans, designed the unique mooring system which precisely positions the rig on location, even during periods of high wind and waves. The rig has withstood 72 mph winds and 28 foot waves, so far.

Shell has recently completed drilling its fifth subsea well along the 300-

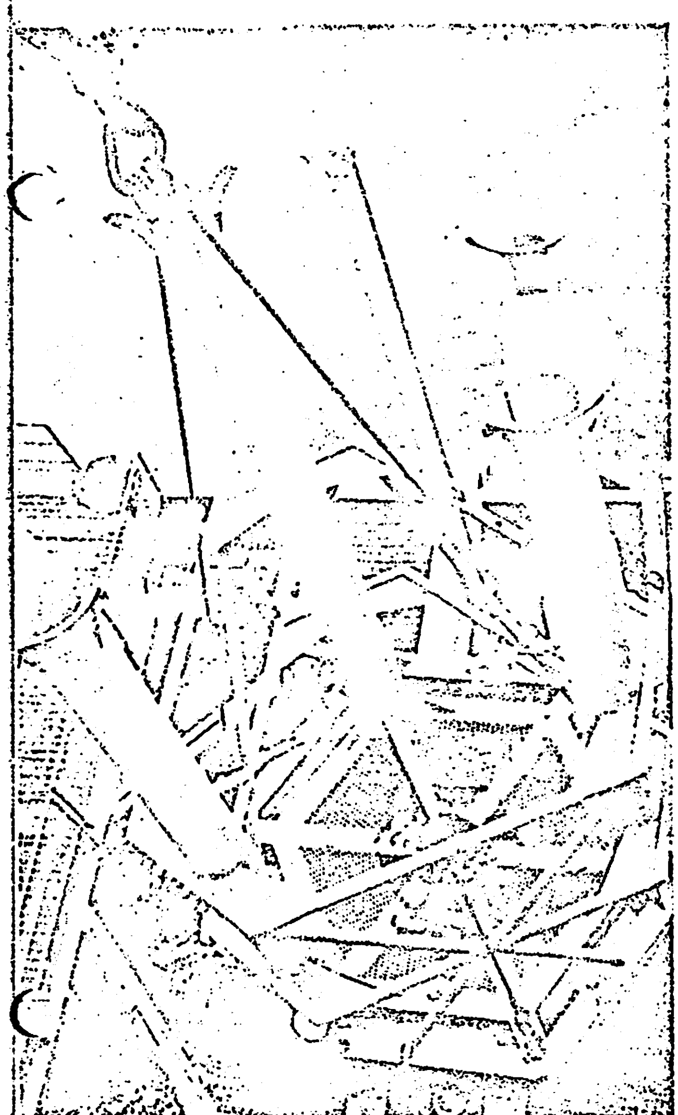


FIG. 2—This guidance and alignment structure is a key component in the Shell submarine drilling and completion technique. The structure is positioned on the ocean floor. The three main columns guide large equipment packages (BOP's etc.) into place, while the two smaller columns guide the underwater television camera frame and flowlines.

FIG. 3—Submarine BOP hookup is guided into position on the ocean floor by means of Universal guide frame (top). Cone shaped outrigger arms ride guide line cables to bottom.

Courtesy Shell Oil Co.

foot water contour in the Gulf. Although all five wells were dry holes, submarine techniques were used to complete all phases of the *drilling* operation. Had any of the wells been producers, subsea *completion* methods (installation of the christmas tree, all production controls etc. on the ocean floor) would have been used.

Major components of the submarine drilling-completion system include:

Guidance-alignment structure. This piece of equipment (see Figure 2) consists essentially of five slotted tubes mounted on a hexagonal base. After 100 feet of 30-inch conductor pipe is jetted into the ocean floor, the structure is run on 20-inch foundation pipe and positioned in place over the hole on the ocean bottom. Each of the five columns is provided with a guide line which extends from the structure to the floating rig.

The three main columns are used to guide and align larger packages, such as the BOP shown in Figure 3, into proper latching position. The columns also provide lateral support for the larger equipment. The two smaller columns are used for running the underwater television camera frame and flowlines. The guidance system allows the rig to be approximately 10 percent off location while installing any submarine component.

Underwater television system. The TV system consists of a zoom boom, pan and tilt unit, three lights with individual intensity control and remote focus. The zoom boom allows the television camera to be moved near the subject in case surrounding water is turbid.

The pan and tilt feature allows the camera to move right or left about 350° pan. The unit also can be tilted 190°. This provides almost

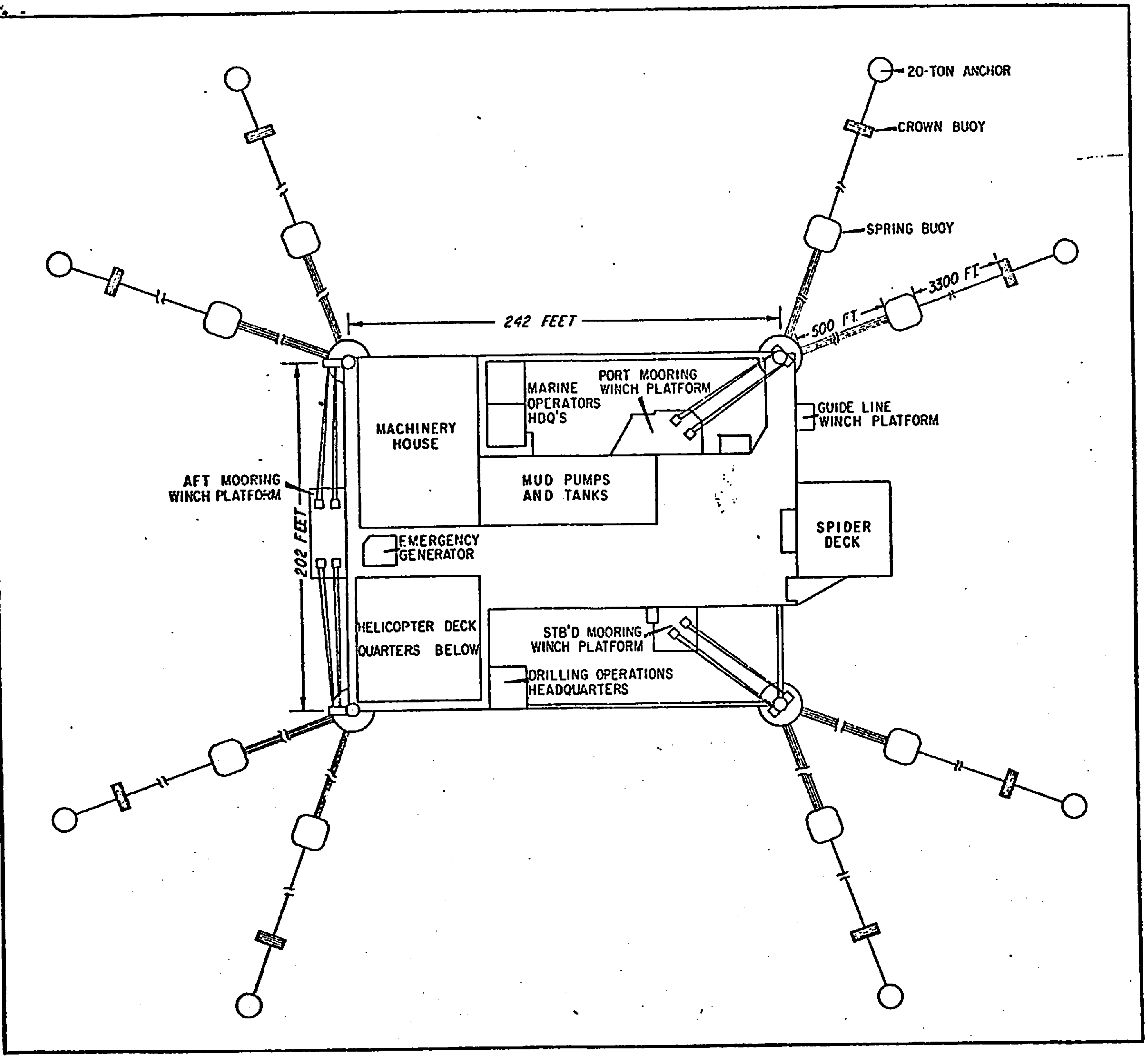


FIG. 4—Details of eight point mooring system used to position floating rig on location. System designed to hold rotary within a 10-foot square area.

complete visual coverage of the work area when combined with the zoom boom feature, remote focus and adjustable light intensity.

Mooring system. The rig, submerged to the 40-foot level is moored by an eight anchor system. Four 1½-inch lines lead to a spring buoy (see Figure 4) located 500 feet from the rig. From the spring buoy, a single 3-inch line extends 3,300 feet to a crown buoy, which is connected to a specially modified 20,000-pound Baldt LWT anchor by a 1¼-inch tripping line. The system has been effective in holding the rig on location in rough weather. So far, pitch and roll of the structure has been less than 5 degrees.

Automatic controls. An XY plotter is used to indicate vessel position. The position is obtained by a tilt meter hung on one of the guide lines under the rotary deck. This device measures the angle of inclination of the guide line and converts this information into vessel displacement in percent of water depth. A two channel recorder also records vessel displacement in port, starboard, bow and stern directions.

A second XY plotter indicates pitch and roll. Another two channel recorder records this data on various scales.

Four additional channels are normally used for recording mooring line loads. However, when spotting on location, the four mooring line recorders can be used in conjunction with the two previously mentioned two channel recorders to record all eight mooring line loads. Only the XY plotter then is used to indicate vessel position. ◘

A complete technical-operating article on Shell's submarine completion technique will appear in a forthcoming issue of WORLD OIL.

Shell Demonstrates Oil Drilling Platform That May Permit Open Sea Operations

By a WALL STREET JOURNAL *Staff Reporter*

GRAND ISLE, La.—A new technique which may permit oil exploration and drilling on the open seas was demonstrated yesterday by Shell Oil Co. on a platform in the Gulf of Mexico 41 miles south of Grand Isle.

Drilling in such offshore areas as the Gulf of Mexico off Louisiana, the Pacific Ocean off California, the Persian Gulf off the Middle East and the North Sea off Holland has become the petroleum industry's biggest hope of finding big new oil and gas fields. But high costs and technical problems which increase in deeper water have restricted most of this drilling to close-in areas with water no more than 200 feet deep.

"Oil men can now find and produce petroleum from the open sea, regardless of distance from land or depth of water," said J. E. Clark, executive vice president of Shell, in announcing the technical "breakthrough."

"Semi-Submersible" Rig

Shell's deep water drilling is done from a huge drilling platform known as a "semi-submersible" rig since it floats with 40 feet of its giant tubular structure below the water. This is designed to hold the platform in position over the ocean bottom even in wind and waves of near hurricane force. The rig contrasts sharply with the "ship-type" hulls used on other floating drilling rigs.

Shell also has developed complex new types of drilling equipment which, it says, permit crews to remotely control from the platform completion of oil wells on the ocean bottom without the use of divers.

"Now for the first time an oil company can use the full resources available on land drilling rigs to push ahead with exploration in deep water areas," says Bruce Collipp, Shell engineer with a degree in Naval architecture who designed the rig's unique anchoring system. "Drillers can do anything from this rig that they can do on land."

The Shell project has been one of the most closely guarded secrets in oil industry history. Rival oil companies have been spying on the [illegible]

extends over 1⅓ square miles of ocean. By adjusting tension on cables to the anchors, and by shifting ballast in stabilization tanks, the rig can stay within three to four feet of its required position over the bottom, Mr. Collipp says. The rig has withstood winds of up to 72 miles an hour and waves up to 28 feet high, he says. Shell officials contend the rig will ride out a hurricane, although the crew would be removed in such a storm.

Mr. Collipp says the rig can drill in depths up to about 600 feet of water, and, with conversion, up to 1,000 feet.

Shell's new drilling developments basically enable drillers to use more sizes of "casing," the large diameter pipe through which drilling is done. This makes it possible for them to drill to much greater depths than they could from a floating rig. One of the wells drilled by Blue Water No. 1 went to 13,302 feet below the ocean floor.

Remote Control Equipment

Shell says the new equipment also permits placing of control equipment on the ocean floor where it is operated by remote electro-hydraulic controls. Re-entry into the hole by the drilling bit is facilitated by a system of guide lines, the company says.

Drillers observe operations on the bottom through a television camera. "Cost of drilling the initial hole with the new equipment runs about the same as with conventional equipment, but large potential savings are possible by completing wells on the bottom of the ocean instead of building costly production platforms," says J. W. Pittman, production manager of Shells New Orleans exploration and production area. A study of underwater production and storage problems is being made, he added.

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Remoulade

Offshore Rig Tour Was an Eye-Opener

By HOWARD JACOBS

THIS CORNER made like an oil scout the other day on an inspection trip to the Shell Oil Company's fantastic Blue Water drilling rig off of Grand Isle. Shell sponsored the tour for visiting newsmen via two amphibious planes—a Grumman Goose and a Royal Gull—from New Orleans airport (lakefront). At the controls was Carl Stone, a veteran pilot for Pan Air Corp. with whom we once had the pleasure of jousting at poker.

After some 25 minutes aloft Stone set the plane down at Grand Isle. The plane skimmed into the tranquil offshore waters and raced at some 60 mph toward the landing ramp, churning the water into white foam. A school of porpoises gamboled lazily nearby.

After taxiing up the ramp onto dry land, we alighted and were transported by car to a nearby helicopter base, accompanied by Shell engineers R. W. Carter and B. G. Collipp. Soon we were aboard the giant whirlybird and soaring over the Gulf. Whereas inland we had viewed little but serpentine waterways and inhospitable marshland, here was a vast expanse of blue water, flecked by an occasional whitecap. A flight of some 20 minutes brought us to our destination, and we landed on the heliport of the gigantic floating rig, which is over an acre in area.

On a tour of the rig, the engineers explained how oil operations were conducted by remote control in some 300 feet of water.

The rig, almost as stable as a dry-land structure, has four stabilizing columns—one at each corner—resembling monstrous milk bottles. The 100-foot high columns are hollow, and contain water ballast that can be raised or lowered at will.

A five-columned structure, resembling flaring organ pipes, is used in guiding the underwater equipment to its place at the bottom. This is first lowered and locked to casing embedded in the Gulf bottom. Each of the five fluted columns has a guide line extending to the drilling platform. Three lines are to run equipment to the bottom, and the other two are used to run an underwater TV camera. In a huge circle around the rig float a series of buoys, each attached to an 11-ton anchor. Cables from buoys to the stabilizing column add to the rigidity of the rig. The derrick, soaring 140 feet from the Texas (upper) deck, brought to 227 feet the distance from the top of the structure to the waterline.

We were enormously impressed with the massiveness of the winches, the grotesque cranes and the huge quantities of pipe and packaged additives for drilling. On the upper deck several drillers in silvery helmets prepared to lower a blowout preventer into the water. Helmeted welders operated blowtorches in the blazing sun.

An amiable driller named Fines Martin conducted us into the spacious, air-conditioned galley, where messmen were slicing filets from a 250-pound fish. "He floated to the surface when we dynamited," explained Martin. We dined sumptuously on steak and potatoes, then repaired to the control room, whose wilderness of instrumentation suggested something out of Buck Rogers.

From marine operating quarters we were taken to the shipshape crewmen's quarters, one of which featured a flock of sultry pin-up girls. In the dining area we espied a sign: YOU DON'T HAVE TO BE CRAZY TO WORK HERE, BUT IT HELPS. The crewmen were rugged specimens, indeed. They work 12 hours on, 12 off, for one week. Then a week off.