MARCH 1974

Ocean Industry

ENGINEERING, CONSTRUCTION AND OPERATIONS

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plus...

Bounce dive may save millions

Seminar on million-ton tankers

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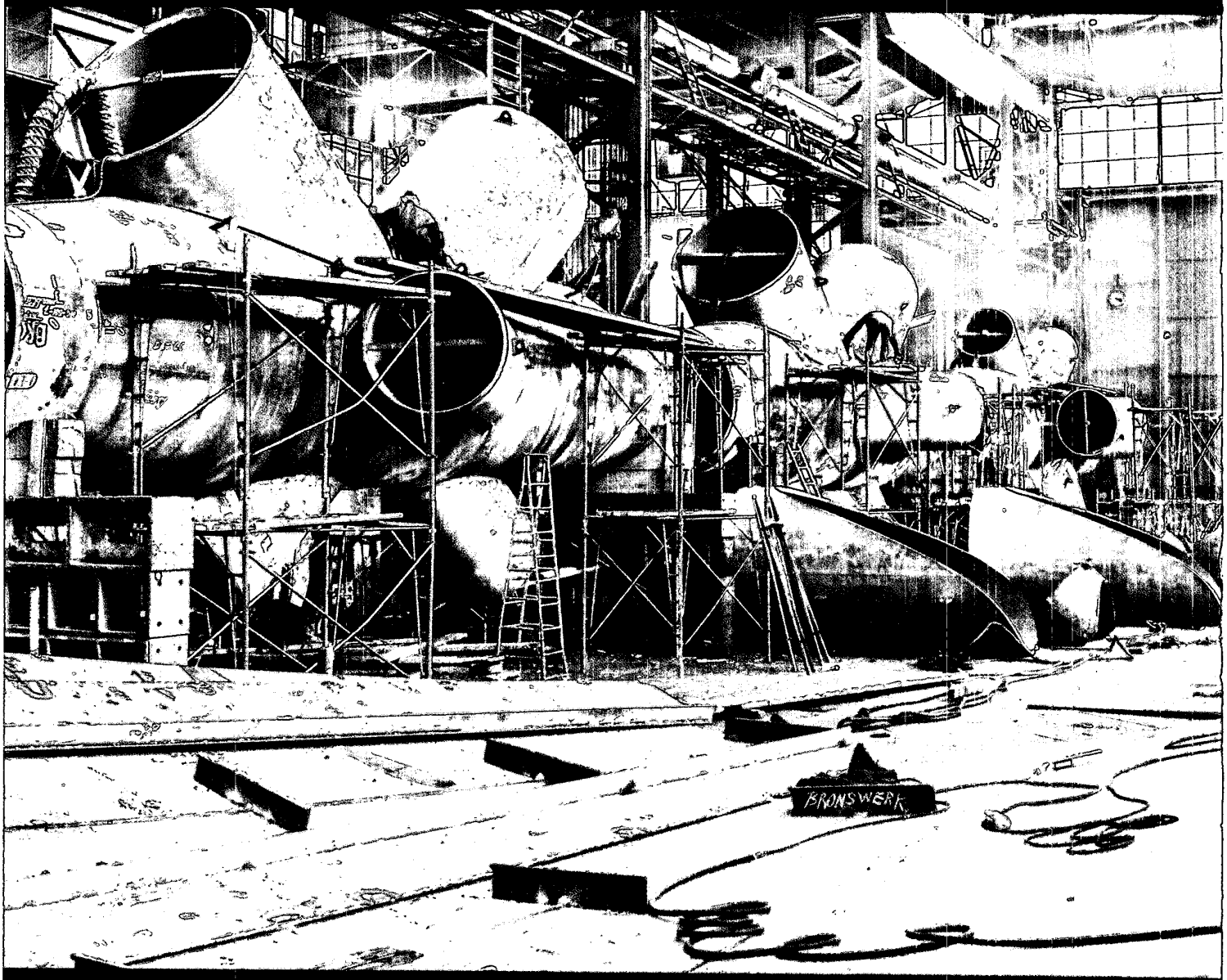

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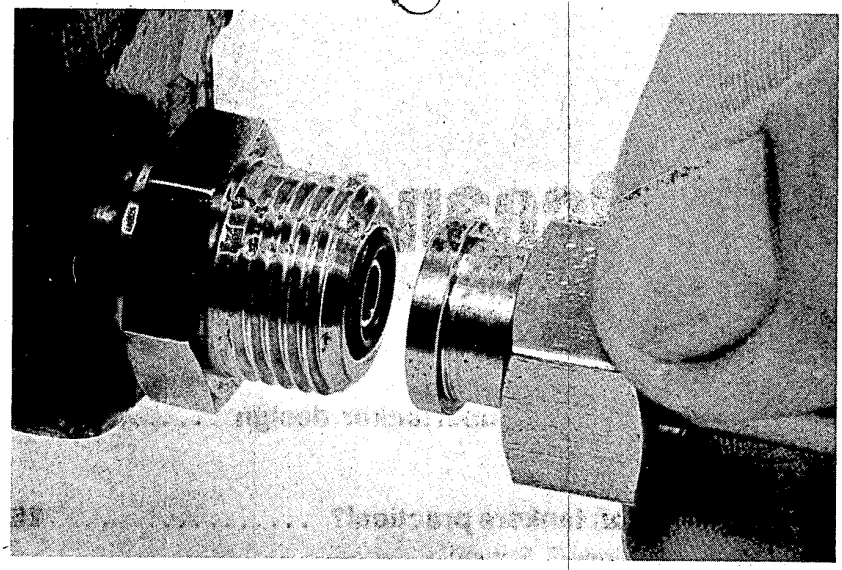

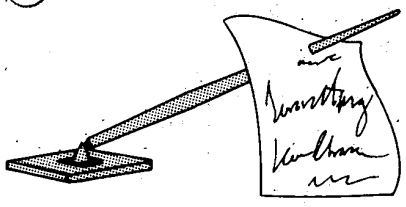

meetings to make

MARCH

20-22 **"Artificial Reefs,"** Astroworld Hotel, Houston. Sponsored by Texas Coastal and Marine Council, Center for Marine Resources, Texas A&M University, and the National Marine Fisheries Service. (Write Artificial Reef Conference, Box 13407, Austin, Texas 78711.)

APRIL

4 **SEASCAPE '74**—"Energy from the Depths—the Engineering Implications:" Henderson Hall, Newcastle-on-Tyne, England. Sponsored by the Junior Section, Northeast Coast Institution of Engineers and Shipbuilders. (Write Seascape Conference, 3rd Floor Clayton House, Regent Center, Newcastle-on-Tyne, NE 3HW, England.)

23-25 **Floating Breakwater Conference,** Sheraton Islander Inn, Newport, R.I. Sponsored by the University of Rhode Island and the University of Washington Sea Grant Programs. (Write Walter J. Gray, Univ. of Rhode Island Marine Advisory Service, Narragansett, R.I. 02882.)

29 **"Cost Effectiveness in the Environmental Sciences."** Three-day annual meeting of the Institute of Environmental Sciences. Shoreham Hotel, Washington, D.C. (Write Betty L. Peterson, Institute of Environmental Sciences, 940 East Northwest Highway, Mount Prospect, Ill. 60056.)

MAY

6-8 **Sixth Annual Offshore Technology Conference,** Astrohall, Houston. (Write Sherry Anderson, OTC, 6200 North Central Expressway, Dallas, Texas 75206.)

13-16 **Hovercraft and Hydrofoil Exhibition,** Metropole Exhibition Center, Brighton, England. (Write Hovercraft and Hydrofoils Exhibitions Ltd., 51 Welbeck St., London W1M 7HE, England.)

21-22 **ASTM Symposium on "Properties of Materials for Liquid Natural Gas Tankage."** Statler Hilton Hotel, Boston, Mass. Sponsored by the Low Temperature Panel of the ASTM-ASME-MPC Joint Committee on the Effect of Temperature on the Properties of Metals. (Write Hank Hamilton, P.R. Director, 1916 Race St., Philadelphia, Pa. 19103.)

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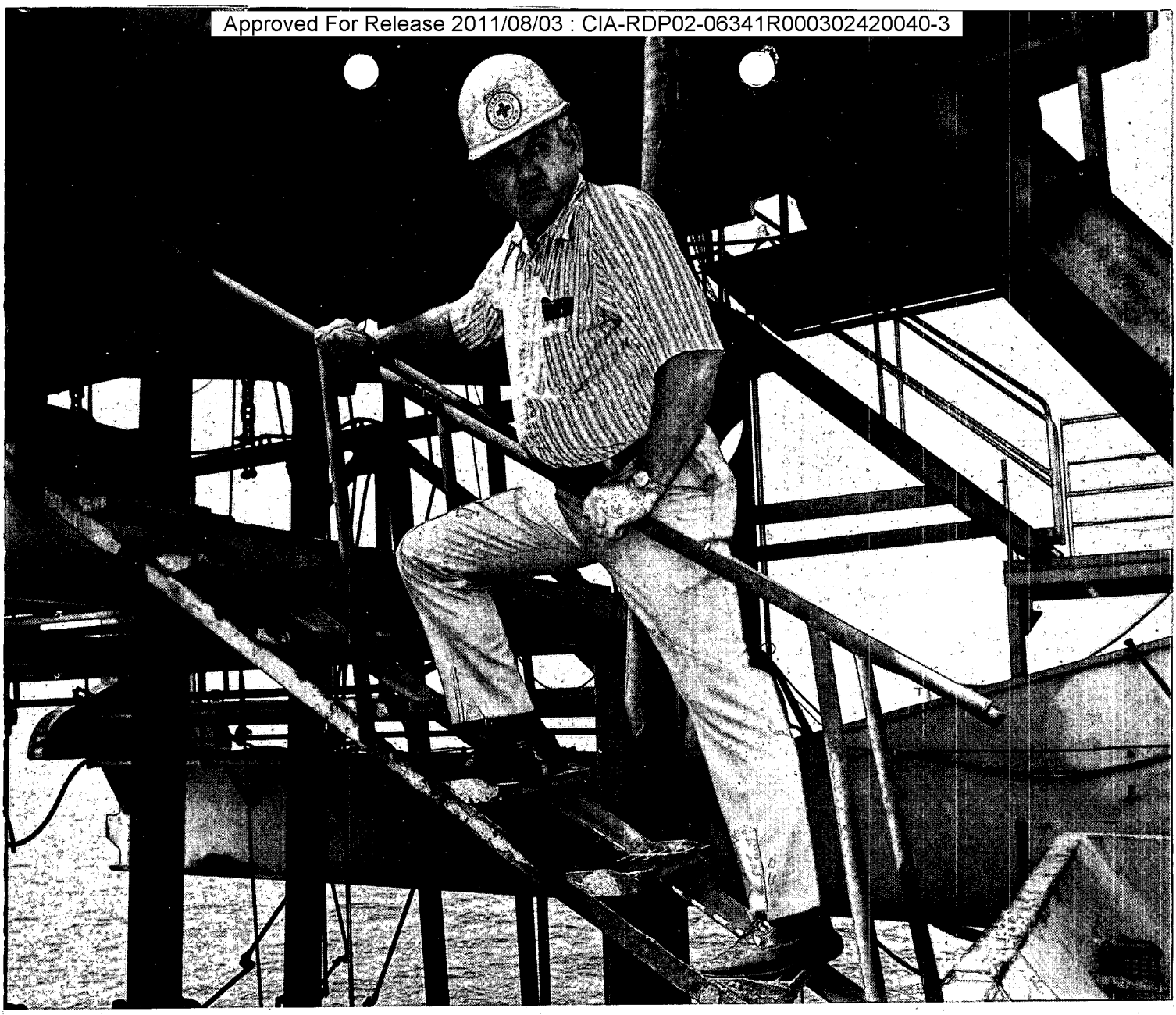

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"I used to think all diesel engine starters were pretty much the same . . . until I tried StartMaster," says John Moore, Drilling Superintendent for the Walker Huthnance Offshore Company.

John is directly responsible for 6 offshore rigs and more than 60 diesel engines. He's been in the business for years and he's tried them all.

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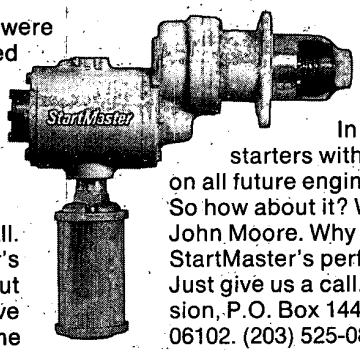

John summed it up . . . "I guess I really am a StartMaster believer. In fact, I'm replacing all my other starters with StartMaster and specifying it on all future engine purchases."

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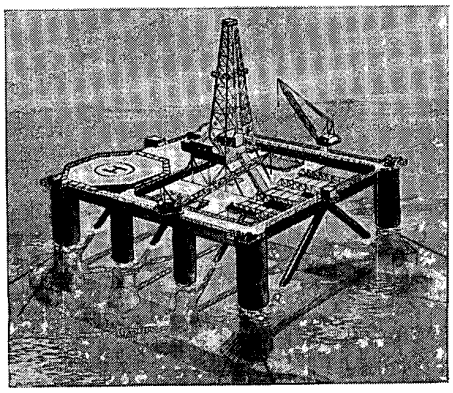

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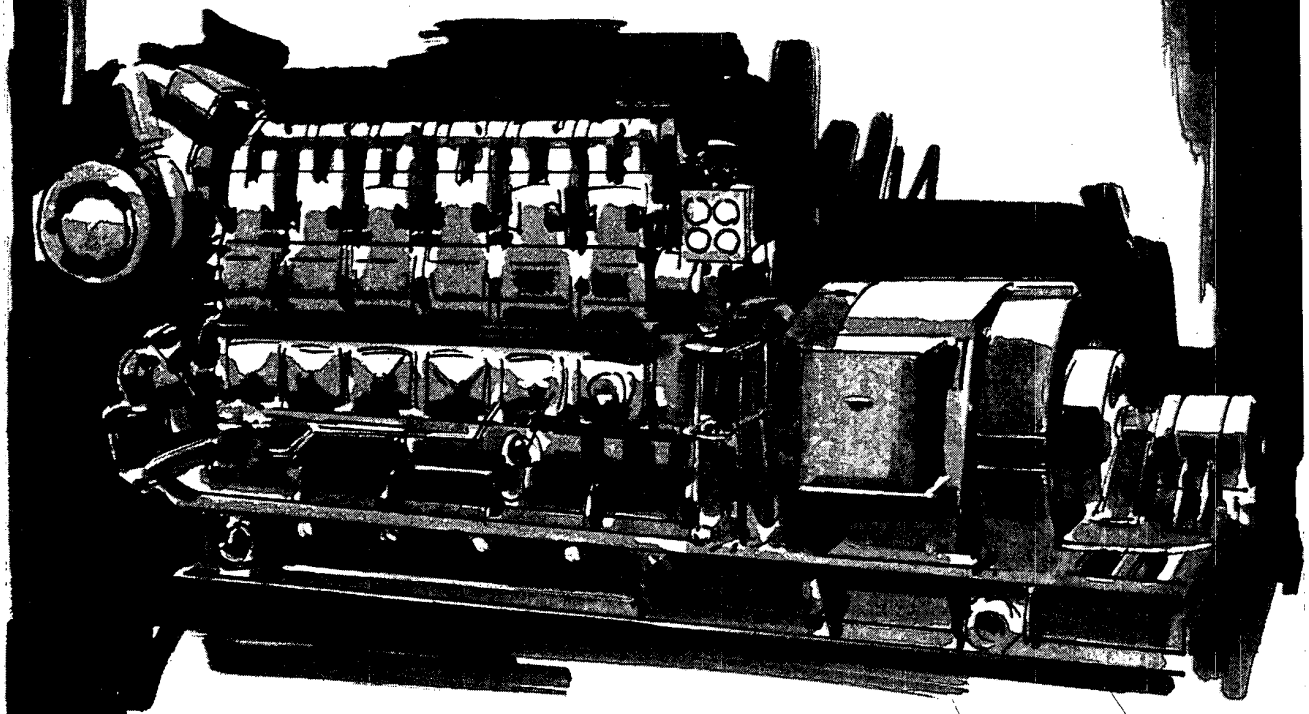

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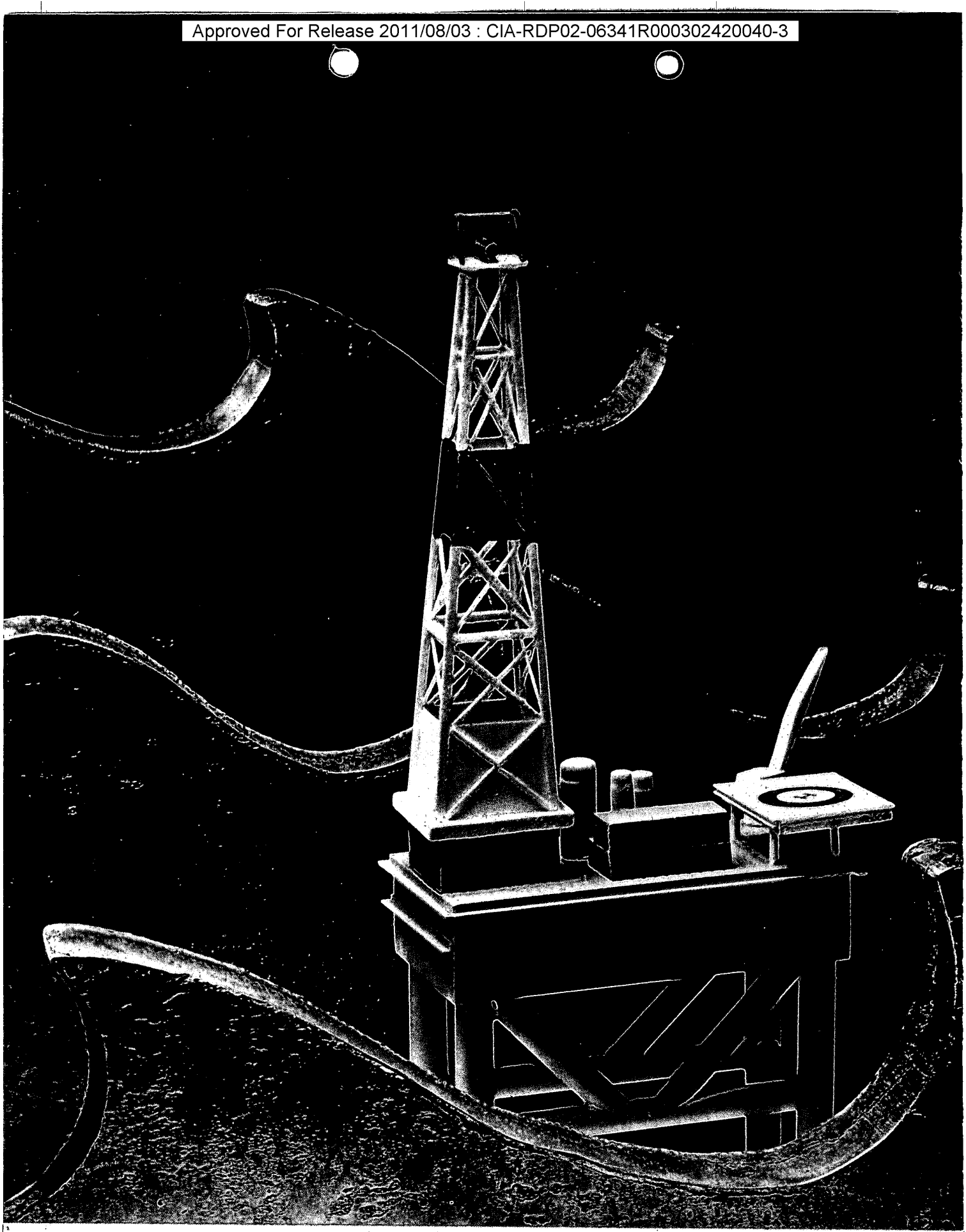

Creative steelpower. Helping offshore oil recovery stand up to Mother Nature at her worst.

In the search for tomorrow's energy, oil companies must now reckon with the awesome powers of nature. Much of our future oil supply depends on the ability to design and build the innovative machinery that can be planted on the ocean floor. And these offshore platforms must be able at times to withstand angry elements, like the 100 foot waves and extreme temperatures of the North Sea. To solve these problems, engineers are turning to the creative steelpower of Lukens.

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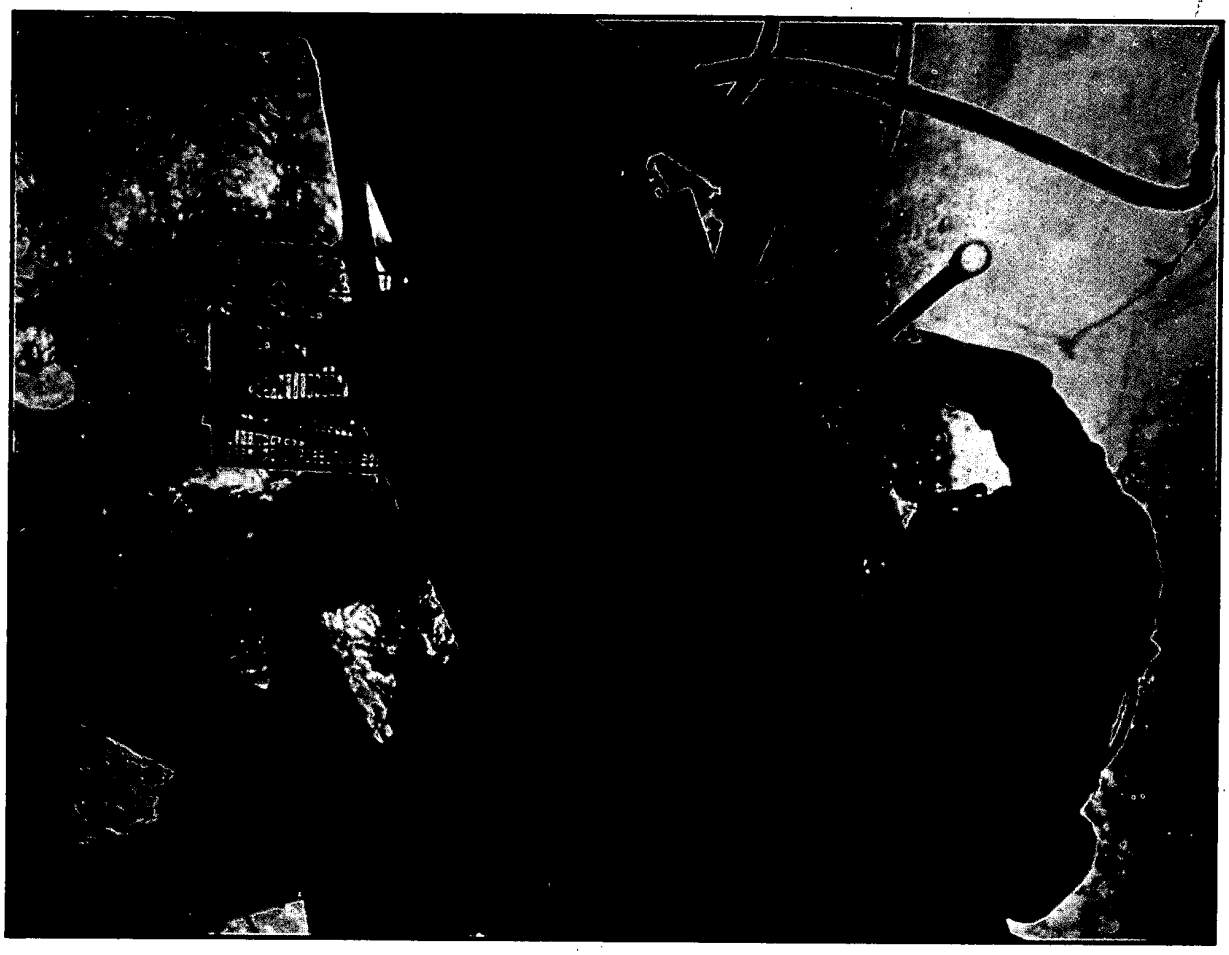

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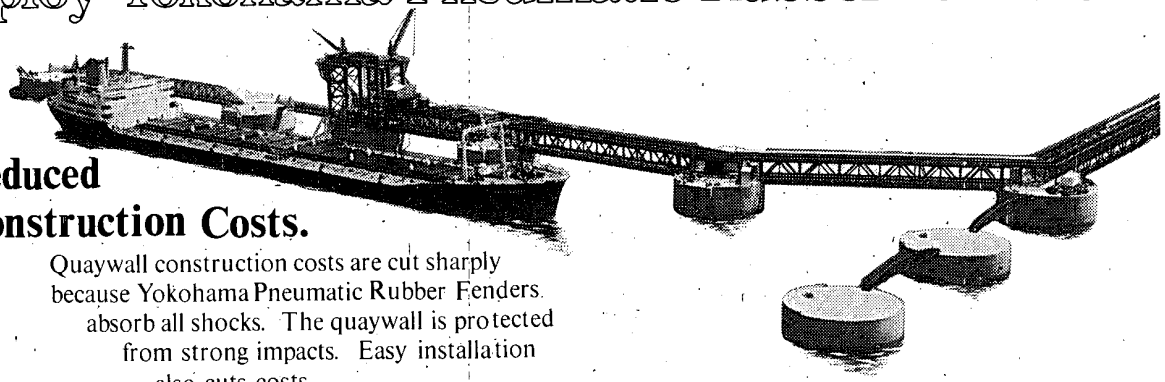

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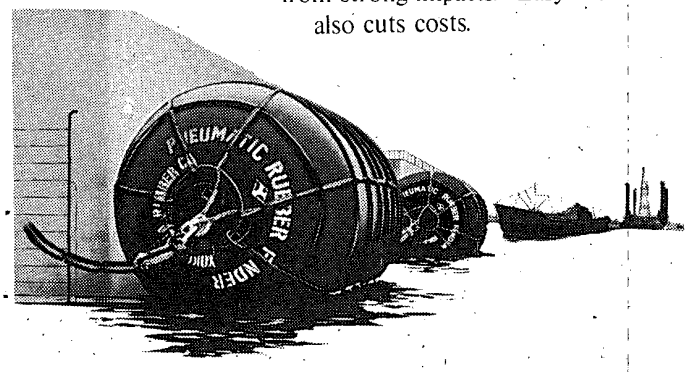
Quaywall construction costs are cut sharply because Yokohama Pneumatic Rubber Fenders absorb all shocks. The quaywall is protected from strong impacts. Easy installation also cuts costs.



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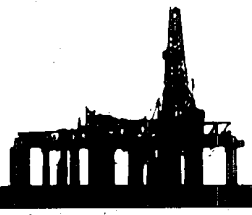

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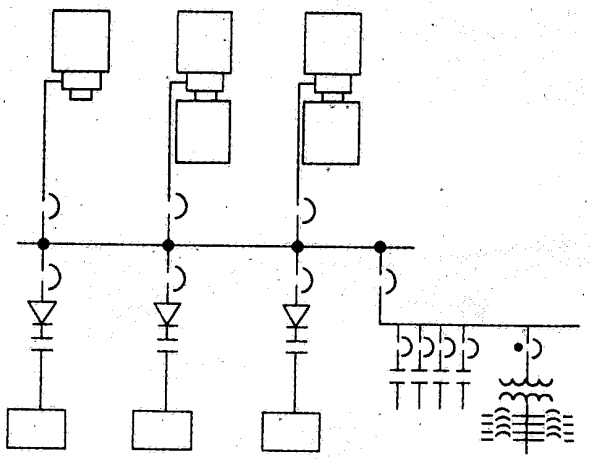
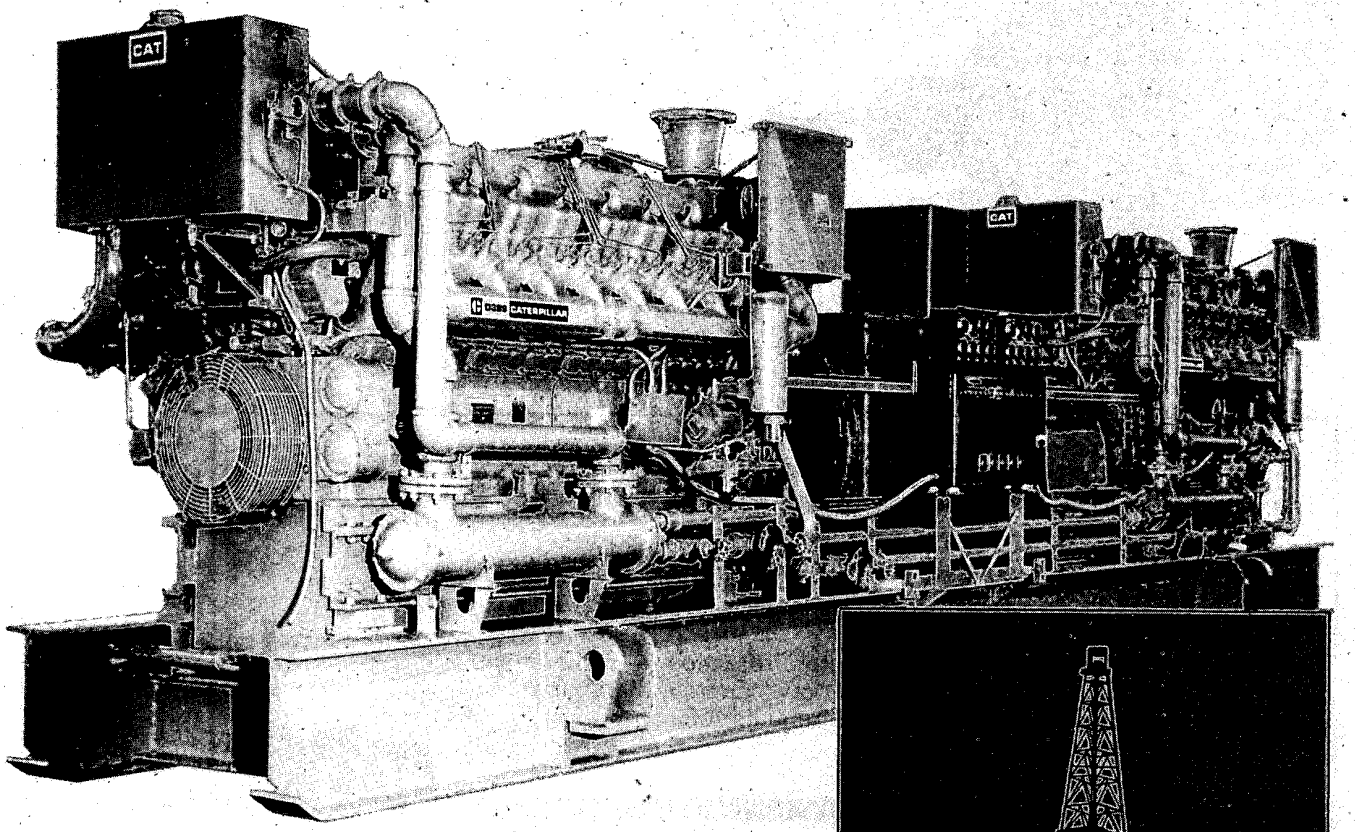
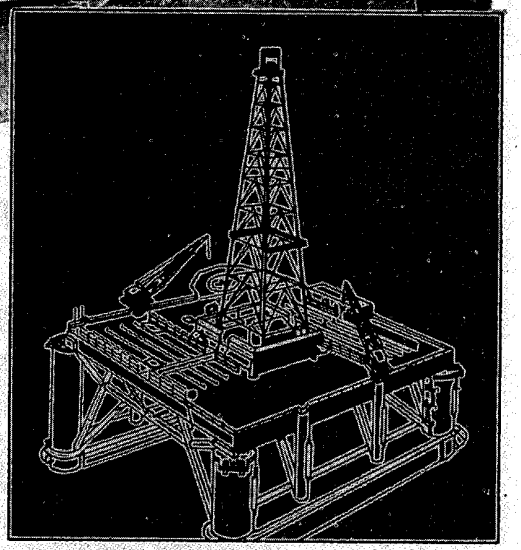




Cat Tandem D399's with generator between, capable of 1850 kW (hoisting). Cat-designed base, incorporating three-point suspension, retains factory alignment without deflection.



Atwood Oceanics' semi-submersible *Margie*. Built by Marathon-LeTourneau in Singapore. Capable of drilling in 600′ (185 m) water to a depth of 20,000′ (6100 m). Two D399 Tandems plus a fifth D399 furnish prime power.

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See the Cat Tandem D399 unit on display at the Offshore Technology Conference, Houston Astrohall, May 5-8, 1974.

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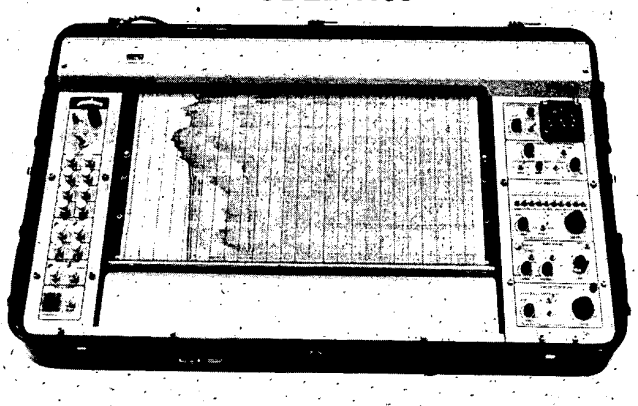
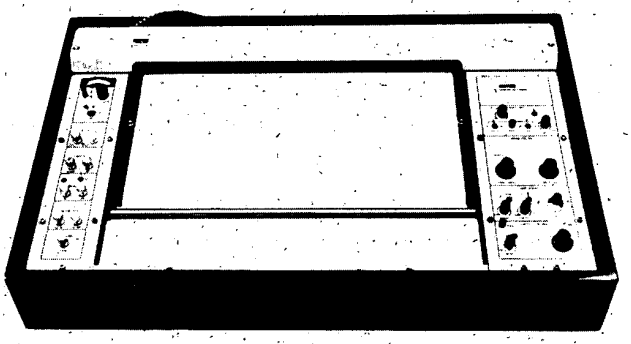


MODEL 4600



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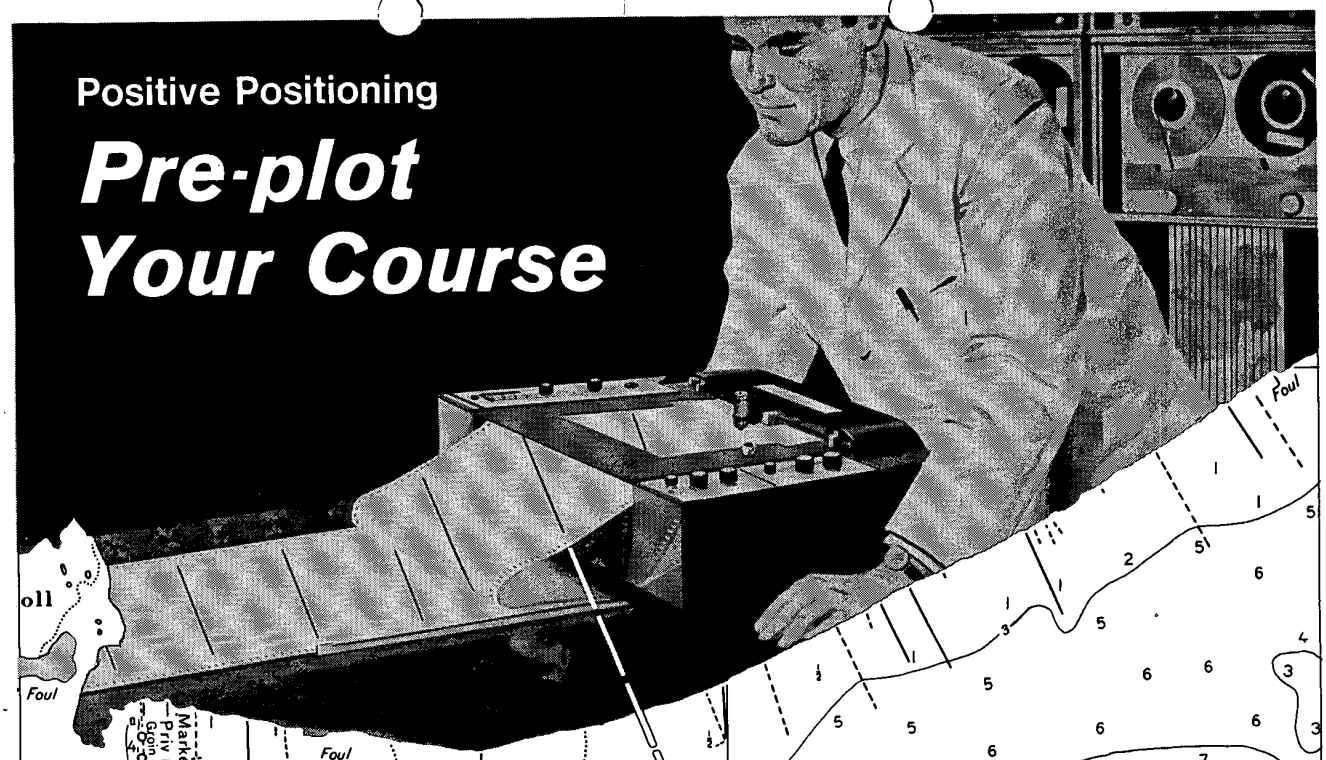

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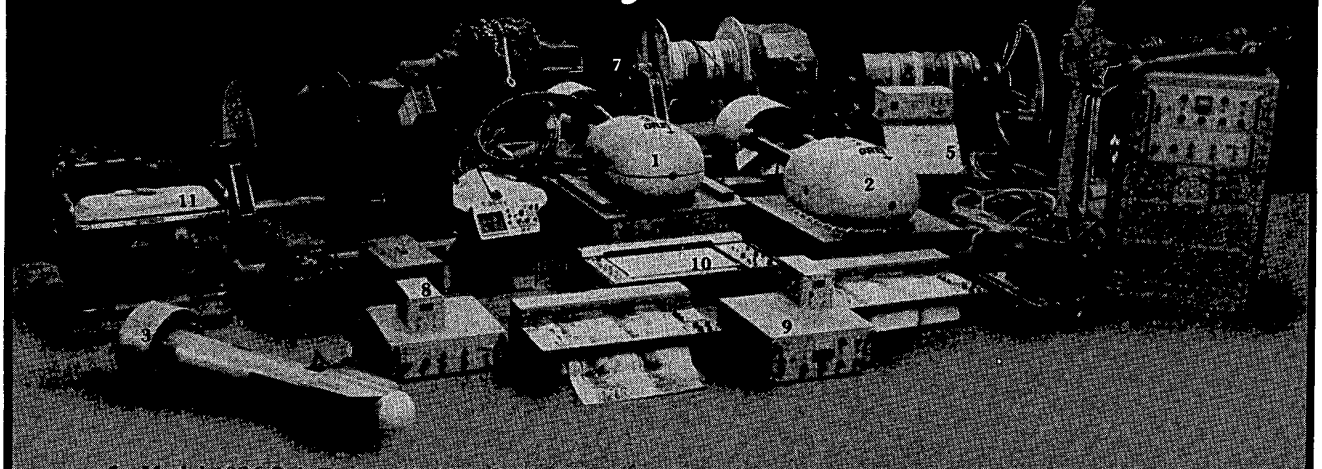

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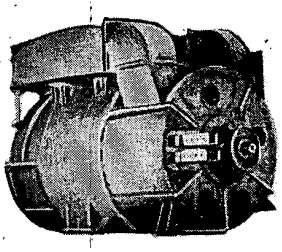

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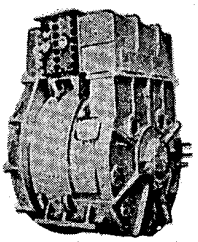

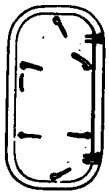

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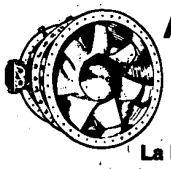

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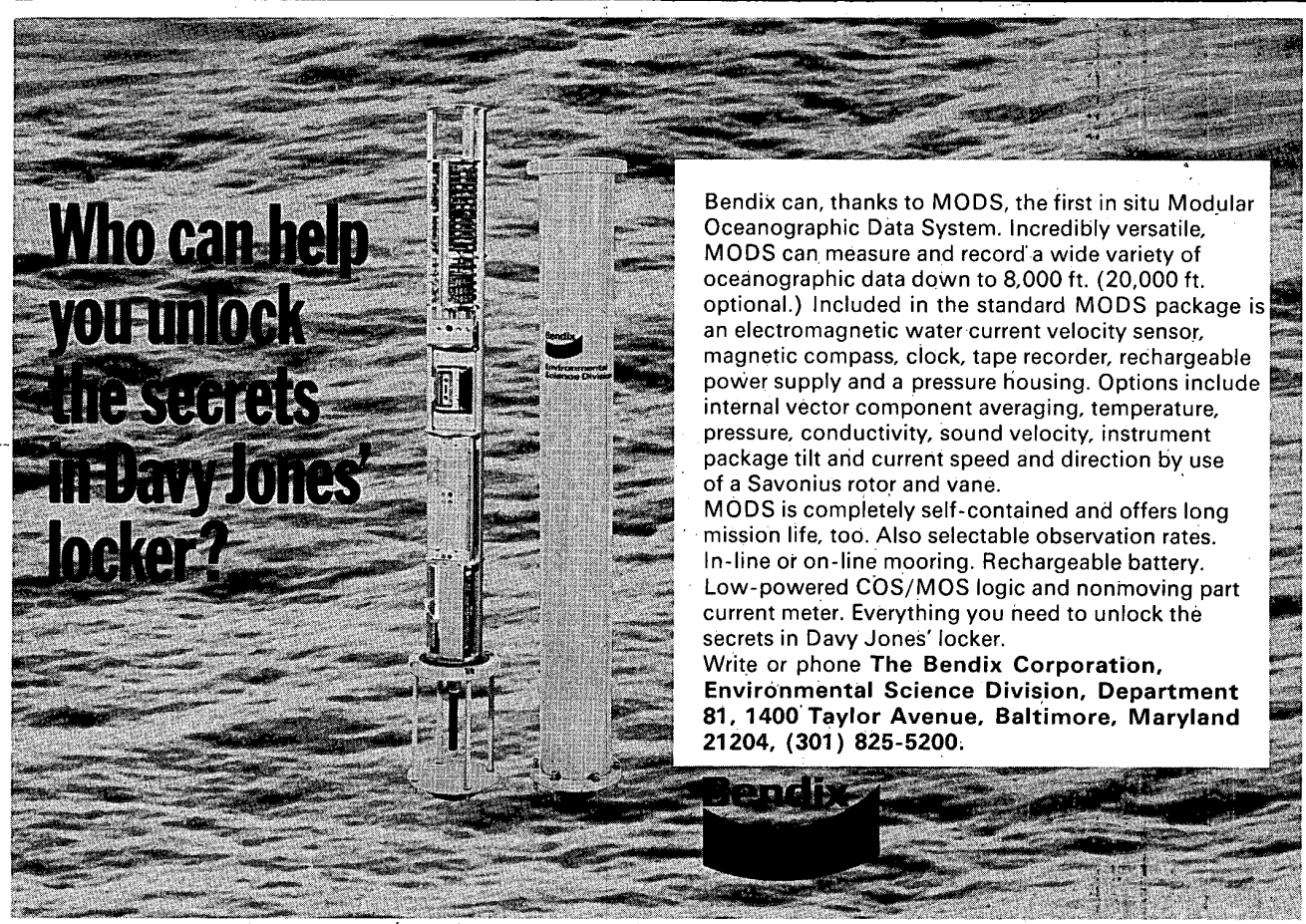

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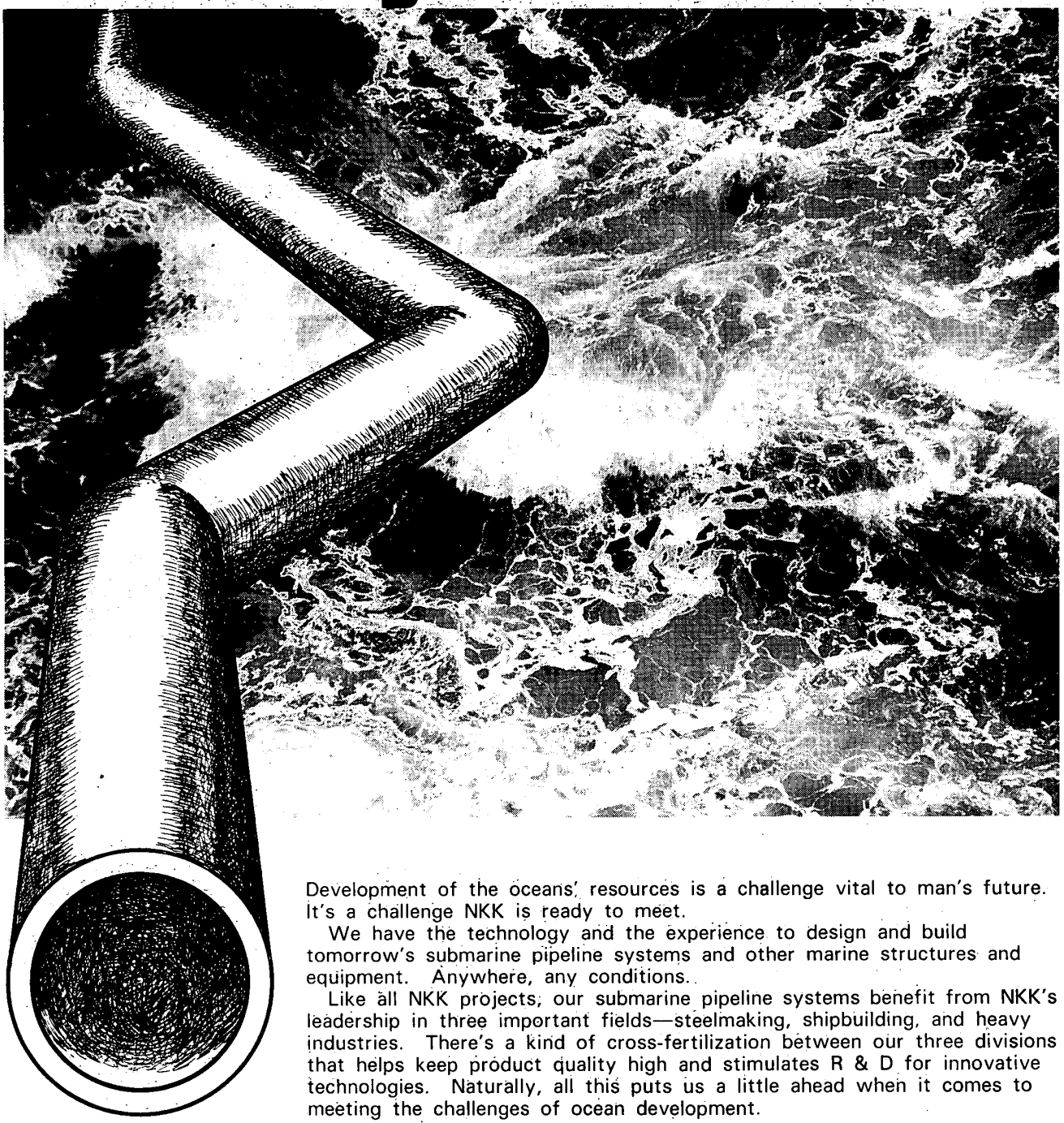

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MILLION-TON TANKERS

A new approach to supertanker design

A stalemate between economic and ecologic interests in the movement of crude oil between supply and demand points has been developing over the last few years. To the present, the ship designer has played a minor role in effecting a rational compromise. While the new approach to supertanker design suggested here is obviously not a panacea for all problems that have arisen, it does address itself to a number of the ecologic differences that exist.

Robert Taggart, Robert Taggart Inc., Fairfax, Va.

In months the ecological acceptability of very large crude carriers used for energy fuel transport has been seriously challenged. It is contended that, in coastal waters, these large ships have neither the low-speed maneuverability nor the structural integrity to permit them to operate without undue hazard to the environment. Furthermore, during operations associated with the discharge of ballast water, the amount of oil pumped into the oceans of the world has created a major pollution problem.

There have been suggested a number of minor design changes that purport to make these vessels ecologically acceptable. Unfortunately, the cost of these changes is so great that the economics of the transportation system is unbalanced to the extent that tanker operators are unwilling to incorporate them. It appears that there is an impending stalemate between environmentalists, on one hand, and large tanker operators, on the other hand, as to what should be done to provide a supply of much needed energy fuel, at a reasonable cost, with a low probability of environmental desecration.

Perhaps it is time to take a hard look at all of the factors involved to see whether a new design concept might provide a solution which is both ecologically acceptable and economically viable. To do this, it is in order to examine the fundamentals of the problem from the point of view of both the environmentalist and the operator.

Tanker Operating Economics

The total economic picture of transport of crude oil by sea from source of supply to point of demand is extremely complex. However, for the purposes of this discussion, a simplistic view of the total picture will suffice. Of specific interest is the transportation cost of moving a unit of cargo across a given span of ocean. This can be expressed in dollars per thousand dwt-miles.

The unit transportation cost is made up of a number of elements. It includes amortization of the construction cost over the life of the ship, insurance, operating and maintenance costs, and profit to the operator. The sum of these costs divided by the product of the ship deadweight and the miles it travels to transport a ton of cargo gives the unit transportation cost. As shown in Fig. 1, this cost is reduced significantly as the size of the tanker increases.

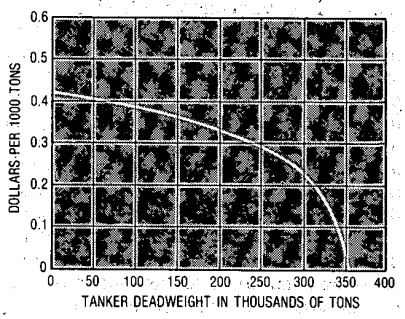

Fig. 1—Unit transportation cost for crude oil.

The reasons for this are fairly obvious. A larger container costs less to build per unit of capacity. The size of crew to operate a large ship is no greater than that to operate a small ship and propulsive power per ton of displacement decreases with increasing size for the same sea speed. Thus both the initial cost and operating cost per ton of cargo is less for the large tanker than for the small tanker.

It is in the best interest of both the operator and ultimate consumer to keep these transportation costs to a minimum. The operator is concerned with obtaining the maximum possible return on his investment; the consumer is concerned with obtaining the maximum amount of energy fuel at the least cost. Anything that is done to the ship design which will increase initial cost, increase operating cost, or reduce the carrying capacity, will be objectionable both to the operator and to the ultimate consumer.

HAZARDS TO ENVIRONMENT

Environmental hazards associated with tanker operations fall into two general categories. One category is related to conventional methods of tanker operation; the other category is related to the probability of a catastrophe that may result in the dumping of cargo into the water.

Movement of energy fuel is almost universally a one-way operation over great distances. The supply and demand points are widely separated geographically and the supplier has no requirement for any cargo that can be returned to him in the same type of vessel used to transport the energy fuel to the point of demand. The result is that a tanker carries cargo in one direction and returns devoid of cargo.

For reasons that will be discussed later, current tanker designs are such that the return trip is made in a ballasted condition. Cargo oil tanks are filled with sea water up to 45% capacity for the return voyage. This sea water must then be discharged before the tanks can be again filled with cargo oil. The hazard to the environment is that a residue of crude oil may be mixed with the discharged sea water.

This hazard has been reduced somewhat in recent years by the load-on-top technique. The new cargo is pumped in at

the top of the cargo tank which forces the sea water out at the bottom. The oil, being of lesser density, floats on top of the water but there is some mixing at the interface and also some oil from the previous cargo is mixed with the ballast water. The water discharge can be carefully monitored and, when traces of oil are apparent, the discharge can be stopped or rerouted to separation tanks. Although this technique has helped, the problem is not satisfactorily solved. From the environmentalist viewpoint, nothing but zero discharge of oil will be acceptable.

The other category of environmental hazard, that of accidental oil spills, is equally critical. Any rupture of a cargo oil tank can have a disastrous effect on the ocean environment. A Coast Guard study[1] of world-wide tanker casualties in 1969-1970 showed that of a total of 926 tanker casualties involving rammings, collisions, and groundings there were 175 incidents of environmental pollution. Of these casualties, approximately 94% occurred during inshore operations as shown in Fig. 2 and 97% of the polluting incidents occurred in inshore waters. The percentage distribution of location of polluting incidents is very similar to the distribution of all casualties. Other Coast Guard statistics[2] indicate that, on the average, every tanker is likely to be involved in an accident once every nine years in its lifetime and that one out of every six of these casualties is likely to result in a polluting incident.

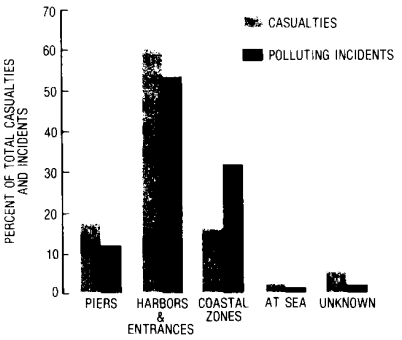

Fig. 2—Tanker casualties and polluting incidents involving rammings, collisions and groundings.

When these statistics are examined, there is little wonder why environmentalists wish to restrict tanker operations to those areas where they are the least accident prone—in other words well away from any coastline. This concern applies to all tankers, not just supertankers, since the major quantity of pollutants has been spilled by tankers of less than 10,000 dwt. Their contention is that either the polluting casualty probability must be significantly reduced or that some means must be found to import energy fuel without the hazard of ships operating in inshore or coastal waters.

CHANGES IN THE TRANSPORTATION SYSTEM

The increasing size of tankers used to transport crude oil has dictated a number of changes in the methods used to transfer the cargo from seagoing vessels to shore storage facilities. This applies particularly to the coasts of the United States where no existing harbors can accommodate the larger tankers now being constructed. Several alternative means are under active consideration to adapt the transportation system to this geophysical situation.

The most obvious alternative is to dredge existing harbors and their approaches to a depth sufficient to accommodate deep draft tankers. This would permit these large vessels to move to within hose transfer range of existing shore storage facilities. The time and cost of the required dredging operations is in most cases exorbitant. One compromise, currently being investigated, is to alter tanker designs to a large beam, shallow draft configuration that will reduce dredging costs to a realistic figure.

A second alternative is to construct offshore transfer stations, in waters deep enough for supertanker operations, where large vessels can tie up to discharge their cargo through pipe line to shore demand points. Under this alternative are included fixed superports with storage and service facilities as well as single point moors connected by flexible hose to the transfer pipe line.

A third alternative is to develop transfer stations that are located on or near the shores of islands, outside the continental limits of the United States, where deep water is available close to shore. Potential sites currently being considered or developed are offshore of Nova Scotia, Grand Bahama, Puerto Rico, and Trinidad. From these stations, the crude oil will be transported by feeder tankers to East and Gulf Coast ports of the United States. This type of system, serving Northern European ports, has been in operation for a few years in Bantry Bay, Ireland.

The fourth alternative is the cargo oil sea transfer system where the transfer of crude oil from supertanker to feeder tanker is carried out with the vessels under way at sea. This system avoids the high cost of offshore terminals or island transfer stations but does involve the use of feeder tankers that must make their way into existing shore terminals. However, as a part of the system, the feeder tankers are equipped with a high degree of maneuvering control capability.

CURRENTLY PROPOSED SOLUTIONS

To combat the problem of discharging oily ballast water, the load-on-top technique already mentioned is a partial, albeit unsatisfactory, solution. Some improvement in this system can be anticipated due to recent developments in sensors to detect the presence of oil in water and in more efficient methods of separating oil and water. However, these developments are either not considered sufficiently promising or they are projected to be inordinately expensive. In either case, the consensus is that the procedure of overboard discharge of ballast water that has been exposed to cargo oil contamination will not be tolerated in the foreseeable future.

One alternative is the use of segregated ballast tanks. These are separate tanks used for ballast water on the return trip wherein the ballast water is never exposed to oil contamination. Such a system is certainly feasible and unquestionably would solve the environmental problems that fall into this category. Unfortunately, this solution is unacceptable from the economic standpoint. The incorporation of segregated ballast tanks in the design of a ship means that the cargo oil carrying capacity, for a given size of ship, will be correspondingly reduced. This has the effect of increasing the unit transportation cost in proportion to the amount of cargo deleted to make room for segregated ballast tank capacity. The requirement for segregated ballast tanks could involve up to an 80% increase in the unit transportation cost. This is acceptable neither to the operator nor to the consumer.

Under the other category of environmental hazard, that of tanker casualties occurring in coastal or inshore areas, the proposed solutions have been both more numerous and, in some cases, even more expensive. The solutions that are applicable to a particular transportation system depend upon the specific characteristics of that system with regard to exposure to potential casualty situations and the types of ships involved. These systems, described earlier, cover:

- Large beam supertankers brought to existing shore facilities through dredged channels.
- Supertankers tying up to offshore transfer stations with cargo oil being piped ashore.
- Supertankers delivering cargo to island-based transfer stations with feeder tankers used to move the oil to existing continental bases.
- Supertankers transferring cargo oil at sea to feeder tankers which in turn bring the cargo into existing shore facilities.

The most hazardous of these operations is that of running large beam vessels into existing terminals through restricted and heavily trafficked waters. At low speeds, **a very large vessel of conventional design is virtually incapable of controlling its own maneuvers. In waters of restricted depth, this capability is further degraded,** to the point where the operation becomes exceedingly dangerous. Proposed solutions include fitting this type of ship with powerful maneuvering propulsion devices and developing tug systems with integrated control to maneuver these large vessels in and out of port. From an economic standpoint, when harbor improvement costs are added to the costs of ship modification and tug system development, this operation appears to hold only marginal promise as a viable transportation system.

When supertankers are required to tie up to a pipe line-connected offshore terminal, the environmental hazard is reduced considerably. These terminals can be located away from congested traffic areas thus reducing the probability of ship collisions. The terminals can be designed to minimize the chance of rupture of ship tanks due to collisions between ships and fixed structures, and the water depth should be ample to avoid groundings. With techniques currently available it should easily be possible to augment tanker maneuvering capability and to provide tug services adequate to reduce the probabili-

ty of oil spills from tankers to near zero with this type of operation.

Both the environmental threat and the economic problems of a system utilizing offshore terminals relate more to the terminal and its shore connection lines than to the ship operation aspects. The terminals and pipe lines will be subjected to sea forces that may cause massive oil spills. The cost of offshore terminals and of laying pipe of adequate size is extremely high. Thus, although there seems to be no insurmountable problem in adapting ships for this type of transportation system, **the economic and ecological acceptability of the required facility installation is open to question.** For this type of system, there is being considered the installation of special wave barriers to mitigate the sea action both to protect the fixed installations and to extend the periods during which ships can tie up. Specially designed heavy weather tug systems are also being considered to aid in mooring and docking operations. However, the remote offshore location of a deepwater terminal will undoubtedly result in a system that will have a considerable amount of down time due to weather and sea action.

Many of the problems of an offshore deepwater terminal are overcome when transfer stations are provided at sites where deep water is found close to a protective shoreline. This route is being followed by a number of large oil companies as the most economic means of bringing oil to continental demand points. The Gulf Oil installation in Bantry Bay has already been cited. In addition, Texaco is constructing such a station in Trinidad and Burmah Oil is planning to expand the present facilities on Grand Bahama Island. The main problem with this form of transportation system is that feeder tankers are required to transfer the cargo oil from the island stations to continental demand points. In other words, the same total quantity of cargo will be brought into continental ports by ship.

One can conclude that the use of feeder tankers is economical since the major oil companies are investing heavily in island transfer stations. It does not, however, solve the problem posed by the environmentalist. Although feeder tankers are somewhat more maneuverable than supertankers, the probability of polluting casualties occurring in inshore waters is not reduced significantly. It is increasingly evident that drastic changes in tanker design will be required to render this transportation system ecologically acceptable.

The latest contender for consideration as a crude oil transportation system is the cargo oil sea transfer system.[3] This system has both economic and ecological advantages over the other systems discussed. From the economic standpoint, the cost of expensive fixed installations is avoided and turnaround time can be considerably reduced. From the ecological standpoint, the transfer between supertanker and feeder tanker will take place at sea, well away from marine traffic, with both ships underway so as to retain their full maneuvering capability. The feeder tankers are equipped with a powerful maneuvering propulsion device and sensors and control elements for precise positioning during mating operations. **This high degree of maneuvering capability can be exercised when the feeder tankers enter port so that the probability of polluting casualties from these vessels will be minimized.**

Except for the last system discussed, no major changes in the design of either supertankers or feeder tankers are evidently contemplated to improve the ecological acceptability of these crude oil transportation systems. Consideration has been given to using segregated ballast tanks, double-bottoms for increased protection, and a variety of improvements in maneuvering and control systems. But, in most cases, the concessions to the environmentalists have been minimal and usually do not involve a major imbalance in the operating economics. The question is whether there is any possibility of altering tanker designs to meet the economic requirements of operators and consumers while also satisfying the legitimate demands of those concerned with the environment.

DERIVATION OF DESIGN REQUIREMENTS

The economic disadvantages of segregated ballast tanks are in direct conflict with the demand for zero discharge of oily ballast water. The operating technique of ballasting down for return voyages should be examined in some detail to see if there is a likely prospect for resolving this conflict. As an initial step, consider the reasons for running a large tanker in ballast. These are:

- To obtain sufficient propeller submergence for adequate propulsion and maneuvering capability without intolerable vibration.
- To reduce freeboard at the bow by an amount necessary to retain control of heading.
- To reduce structural loads due to imbalanced weight distribution and dynamic effects of seaway action.

In order to maintain reasonable propulsive efficiency, without excessive cavitation or vibration, the tips of a screw propeller should be submerged approximately 25% of the propeller diameter. For a 300,000 dwt supertanker, with a propeller diameter of 30 ft, this would call for a draft at the stern on the order of 37.5 ft. With cargo and ballast tanks completely empty, the stern draft of a typical ship of this size might be on the order of 20 ft, which would hardly be adequate. Furthermore, only about half of the rudder area would be effective in meeting coursekeeping and maneuvering requirements.

Under the same unballasted conditions the forefoot might be almost completely out of water, with a freeboard of 80 to 90 ft exposed to wind action. The lack of submerged forebody, coupled with the high freeboard and reduced rudder effectiveness would render the ship almost totally uncontrollable at sea.

Structurally, the ship should be capable of withstanding the bending loads imposed by this condition in still water. In a seaway, however, the slamming loads and torsional bending moments imposed might easily prove too much for the structure to withstand. Therefore, a conventional supertanker without either cargo or ballast could not be considered a seaworthy vessel.

The excessive trim of a supertanker in the light condition is due primarily to the fact that the machinery, fuel oil, and house structure are located aft. In current supertanker designs this is done for a very good reason. With the main propulsion and maneuvering devices installed at the stern it is essential that propulsion machinery and steering engine be juxtaposed so that connecting shafting lengths be minimized. For efficient operation, the engine room personnel should be housed near the machinery spaces and it is also logical that all of the machinery required for hotel services and for ship operation be located in the same general area. Similarly, deck personnel and ship control areas have been located in proximity to other operating personnel and near the basic services required. This results in the after location of all personnel, all primary operating functions of the ship, and the consequent concentration of light ship weight at the stern.

Although there is justification for locating ship control functions at the stern, this is not necessarily the best location for optimum ship handling. With ships exceeding 1,000 ft in length, control from the stern becomes exceedingly difficult due to the distance between the bridge and critical parts of the ship. It may be noted that, in the past, tankers were usually designed with the navigating bridge amidships and Great Lakes freighters, that have many similar characteristics, are controlled from a bridge at the bow.

If the necessity for running a supertanker in ballast was eliminated, the need to use segregated ballast tanks to avoid discharging polluted ballast into the ocean would disappear. It is of interest to see what would be involved in removing the ballast mode from tanker operating procedures.

The first requirement is to devise a propulsion system that will have adequate submergence for efficient propulsion at greatly reduced ship drafts. Concurrently, the maneuvering control system must also perform effectively at these reduced drafts. The second requirement is to alter the light ship weight distribution to get the bow down and the ship on even keel. This will serve both to improve course keeping ability and to reduce structural stress caused by seaway action. The transverse metacentric height must also be adequate to ensure ample static stability under this operating condition.

The above design requirements are those that relate specifically to economic and safe ship operation without the potential environmental hazard of discharging oily ballast into the ocean. There is an additional requirement to improve significantly the low speed maneuvering capability of both supertankers and feeder tankers. This includes the ability to stop in a lesser distance, to turn more rapidly, to be able to sidle against wind and current, and to retain complete ship control while backing. In a recent study conducted for the Maritime Administration,[4] these maneuvering requirements for a supertanker were summarized as follows:

- The ship shall be capable of maintaining complete maneuvering control under all conditions of operation.
- The safe approach speed toward a

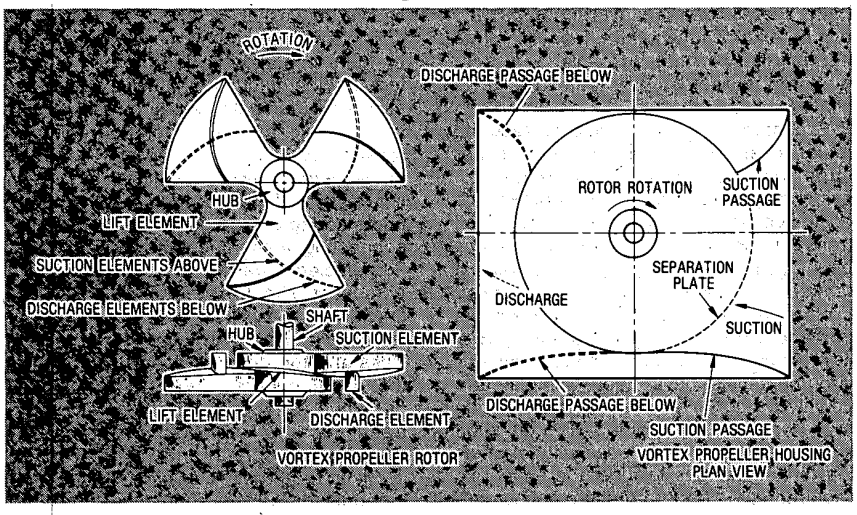

Fig. 3—Scheme of the Vortex propeller.

fixed structure ahead shall be at least 30% greater than for an unimproved ship.

- Without the aid of tugs or shore lines the ballasted ship shall be capable of holding itself stationary against a beam wind of 35 knots.
- The loaded ship shall be capable of holding itself stationary against a beam current of one knot in water depths of three times the draft of the ship.
- The loaded ship shall be capable of rotating about its midsection at a constant rate not less than 12 degrees per minute.
- The ship shall be capable of self-propulsion in the event of failure of main propulsion components.

These requirements were derived for a supertanker that might be called upon to offload at a continental port, at an offshore transfer station, or at an island transfer station. They apply equally well to a supertanker that operates in restricted waters anywhere in the world and to a feeder tanker that enters any heavily trafficked port.

CONCEPTUAL DESIGN OF A SHIP TO MEET THE FOREGOING REQUIREMENTS

For a supertanker or feeder tanker to make a one-way ocean voyage without ballast it is fairly obvious that, in light ship condition plus personnel, fuel, and stores, the ship must ride on even keel. This means that all machinery, equipment, and structures associated with ship propulsion and control and cargo loading and discharge, as well as those associated with life support of personnel, must either be located amidships or equally distributed fore and aft. This may appear to be a radical deviation from current designs but has many advantages from the standpoint of ship control and of structural design.

Assume, for the moment, that a supertanker is designed with its main propulsion prime movers amidships together with all cargo pumps and auxiliary hotel load machinery. Also assume that the personnel accommodations are in a mishipsh house structure as are the navigation spaces and bridge. This would preserve the need for close juxtaposition of all ship and crew operating functions and at the same time permit the design of a ship that would ride on even keel under either light or loaded operating conditions.

It would be convenient, in meeting the design requirements, if the propulsion units and maneuvering control devices could also be located amidships. This, of course, is impractical from the standpoint of propulsive efficiency using any known propulsive devices. The alternative is to install propellers fore and aft at the extremeties of the ship. Since it is not feasible to run drive shafting from a midships prime mover to these locations, it is necessary to use either electric or hydraulic motor drives for each propeller connected by cable or piping to midship prime movers.

To meet the design requirements, the propellers must be totally submerged at the light ship draft. For the 300,000-ton ship cited previously, this light draft might be in the order of 10 to 12 ft. Also, it is desirable that the propellers not extend below the keel of the vessel. If conventional screw propellers are used, the allowable diameter would be in the order of 8 feet, which is much less than that required for efficient propulsion. In fact, to provide adequate propulsive thrust, it is mandatory that a vertical-axis propeller be used in order to fit within the allowable dimensions. This is essentially a propeller, such as a paddle-wheel, that delivers thrust with the rotational axis disposed in a generally vertical direction.

There are a number of existing propeller designs which meet this criterion. They can generally be classified under the category of rotating-blade propellers. **The blades are spade-shaped hydrofoils extending downward from a circular plate.** The blade axes are parallel to the rotational axis and, as the mounting plate turns, the blades change pitch angle with respect to their orbital path of motion. The pattern of pitch change varies for different types of rotating-blade propellers; they may be identified as sinusoidal, cycloidal, or Pi-pitch propellers or by manufacturers/inventors names such as Voith-Schneider or Kirsten-Boeing.

Although rotating-blade vertical-axis propellers could be used at the bow and stern of a supertanker, it is believed that a recently invented device called a Vortex Propeller would be more practical. **The Vortex Propeller has no moving parts other than the rotating impeller unit and can be designed with the ruggedness and reliability that are essential for long term use in tanker service.** This device consists of a rotor fitted with multiple blades that turns in a specially configured housing. The propeller is capable of delivering propulsive thrust in any selected direction perpendicular to the axis of rotation and developing a concomitant lift force along the line of the axis of rotation. The proportion of lift to thrust is a function of the design of the rotating blades. The direction of thrust is a function of the housing configuration and its alignment relative to the rotor.

Each rotor blade comprises three elements: a suction element, a lift element, and a discharge element as shown in Fig. 3. The suction element is a cambered hydrofoil which acts to draw fluid from the periphery of the rotor and to move the fluid radially inward toward the axis of the rotor. The lift element is also a hydrofoil which resembles a blade of a screw propeller; it may have pitch as well as camber and serves to move the fluid axially from the suction region to the discharge region of the propeller. The discharge element of the rotor blade is also a cambered hydrofoil which acts to move the fluid radially outward from the rotor axis to the periphery.

A simplified housing configuration is illustrated. For convenience in describing the forces developed by the propeller, the rotor axis is shown vertical. Flow through the propeller is from right to left and downward. The resulting thrust force is to the right and the developed lift force is upward. The housing is divided into upper and lower chambers by a separation plate which has the same thickness as the lift elements of the rotor blades; it has a circular cut-out concentric with the rotor and equal to the rotor diameter plus a slight clearance. Above the separation plate is the suction chamber and below is the discharge chamber. Small clearances are also provided between the suction elements and the top of the suction chamber and between the discharge elements and the bottom of the discharge chamber. The suction chamber is open to the surrounding fluid on the right, or suction side of the housing with the remainder of the rotor periphery sealed-off to contain the fluid within the rotor diameter. Similarly, the discharge chamber is open to the surrounding fluid on the left, or discharge side of the housing with the remainder of the periphery sealed off to contain the fluid within the rotor diameter. Thus, the fluid is drawn into the rotor through the suction opening, directed downward from the suction to the discharge chamber, and then is forced outward through the discharge opening. Propulsive thrust to the right is developed by the acceleration of fluid from right to left; upward lift is developed by the downward acceleration of the fluid as it moves from the upper suction chamber to the lower discharge chamber.

For a 300,000-ton supertanker, four Vortex propellers would be required, each of about 20 ft in diameter and requiring approximately 10,000-hp drive units. These

four propellers can be located near the extremities of the vessel, well outboard of the centerline, as illustrated in Fig. 4. The total rotor axial dimension is on the order of 4 to 5 ft so that the propeller can fit above the keel and below the light ship waterline.

Fig. 4—Plan view of Vortex propeller locations at bow and stern.

The housing configurations for the two forward propellers can be arranged so that the suction is taken from directly ahead and the discharge follows the hull lines downward and outward. Similarly, the after pair of propeller housings can be arranged to take suction from below and outboard with discharge directly astern. In this way the flow through the propellers will follow the general path of flow around the hull as it moves downward and outward at the bow and inward and upward at the stern. Thus, the propeller action will be tailored to adapt the propulsion system to the hull form. Although propeller efficiency may be less than that of a screw propeller, the total propulsive efficiency should be a considerable improvement over what could be anticipated for a single-screw propulsion system at the stern.

It may be noted that no rudders or other devices for maneuvering control are indicated. If the four propellers are driven with individually controllable speed and direction, this vessel can achieve a maneuvering capability far exceeding that of any conventional tanker. In fact, it can exceed the maneuvering requirements cited earlier, both underway and during mooring and docking maneuvers. Underway, maneuvering control is exercised by varying individual propeller rpm to alter the flow around the hull, as shown in Fig. 5. The increased flow velocity on one side of the bow, with a corresponding decrease on the other side, alters the position of the stagnation point at the bow causing a pressure increase on the lower velocity side and a pressure decrease on the higher velocity side. This pressure difference causes the bow to move in the direction of reduced pressure. A similar situation occurs at the stern when the relative propeller speed is changed. With the proper rpm control the ship can be made to sidle to either side or to rotate about its center.

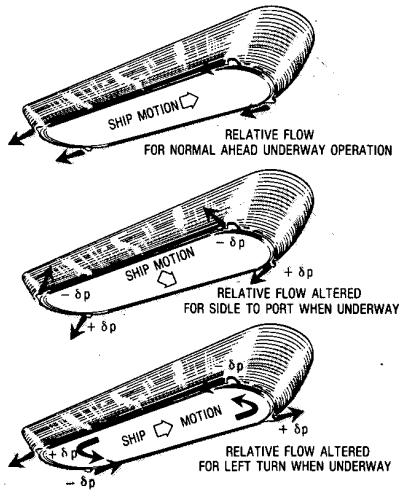

Fig. 5—Effect of varying individual propeller RPM when underway.

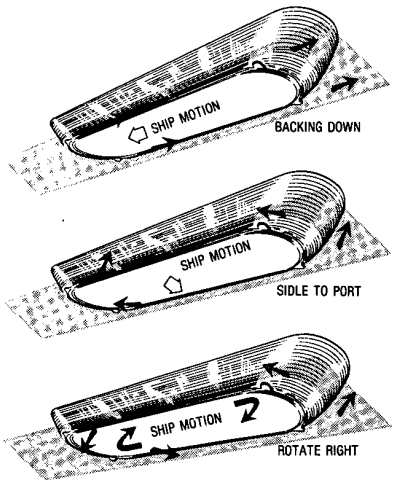

Fig. 6—Control of propeller rotation for low speed maneuvers.

Fig. 6 illustrates a few combinations of propeller speed and direction changes that can be used during low speed maneuvering to cause the ship to translate or rotate in any selected direction at a desired velocity. With proper sensors and control system this vessel is quite capable of being dynamically positioned, that is, holding itself in a selected position and attitude on the ocean surface. Therefore, it has no requirement for tug services at either end of its run. Furthermore, the requirements for deck winches and anchoring systems are drastically reduced; these items of deck equipment and tug services will be needed only for emergency operations.

COST FACTORS

The elimination of rudder and steering engine plus a reduction in deck machinery and tug services will result in a significant saving over the cost of construction and operation of a conventional ship. The magnitude of these and other cost factors are difficult to analyze and are beyond the scope of this paper. However, a few elements of the cost equation are given here to illustrate the differences that may be anticipated.

The installation of four propellers, rather than one or two, will obviously increase the construction cost. Also, an electric or hydraulic drive system calls for additional machinery that is both more expensive to procure and install and has a lower overall mechanical efficiency and thus a higher fuel consumption. However, it has the advantage of being easier to control during maneuvering operations and is more adaptable to the different propeller loadings that will be applied when the ship is fully loaded and when it is in light condition.

There will be a significant reduction in operating cost brought about by running the ship in light condition as opposed to running it in a ballast condition. Due to the lower resistance, the return trip can be made at a higher speed, or the fuel consumption at the same speed will be considerably less.

From a volume standpoint, it is expected that there will be a definite increase in carrying capacity for a given length, beam, and depth. With the form of propulsion recommended, the stern can be filled out to give a higher block coefficient. There will be no requirement for segregated ballast tanks or for oil-water separation tanks. Also, the greatly improved maneuvering capability, with the accompanying reduction in casualty probability, may obviate the need for double bottom tanks. The midship location of main machinery spaces and house structure should make possible a more efficient arrangement design that also conserves space within the hull.

It is not expected that the structural weight and cost should differ markedly from conventional designs. However, the distribution of structure will change considerably due to the differences in hull form, support requirements for the midship house and fore and aft propulsion units, the need for a lower center of gravity, and a heavier bottom girder structure to reduce bending stresses when operating in the light condition.

All of these cost factors must be carefully considered to determine whether such a radical design change is feasible. In evaluating the merit of this concept, both acquisition costs and operating costs must be analyzed to see what the net effect will be on the unit transportation cost of crude oil. Only if this unit cost is equal to or less than the current cost can the concept be considered economically acceptable.

About the author

Robert Taggart, a graduate of the Webb Institute of Naval Architecture, has been engaged for 30 years in research and development related to the design, construction, and operation of marine vehicles. He is a recognized authority on ship propulsion and maneuvering control; he conceived, designed, built, and operated the first dynamic positioning system used on an ocean drilling vessel. Taggart is a member of the Society of Naval Architects, Marine Engineers and the American Society of Naval Engineers. He is a licensed professional engineer in Virginia and in the District of Columbia.

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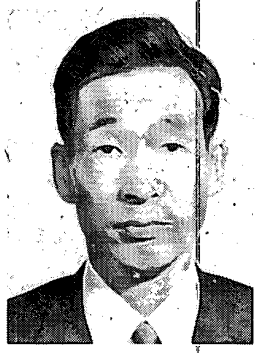
Are million-ton tankers practical?

YES

says

Andrew G. Spyrou
Onassis Group of Companies



NOT YET

says

Dr. Tsunco Kuniyasu
Ishikawajima-Harima Heavy Industries Co., Ltd. Tokyo

The oil industry, which is constantly investigating ways and means to maintain a reasonable cost of transporting oil, has found no substitute for the conventional tanker; and the economics of transportation has proved that the bigger the tanker, the smaller the transportation cost. The question is—how large should a tanker be to transport the required amounts? The magic figure of one million tons deadweight has often been mentioned.[1]

Are we ready to build a ship of this size, and therefore create the million-ton tanker fleet? The answer to this intriguing question is a qualified "yes," for the following reasons:

Since IMCO recommendations have been made known, shipyards in Japan and Europe with the capability to build very large tankers set out to put the final touches to the design for the million tonner. The main constraint on use will necessarily be the routes and port facilities which can accommodate these ships. The routes of these fleets must ultimately be defined by their reception facilities.

Because of its large draft (about 100 ft), the million tonner would be excluded from certain routes to Northwestern Europe. It will not be able to enter the North Sea through the English Channel. It may, however, enter the Mediterranean and approach Europe via the south. This would leave three choices open to European countries: either create another Bantry Bay to supply NW Europe or make Fos-sur-Mer in France, or Genoa in Italy, what Rotterdam is to NW Europe today. For Japan, the million tonners will have to use Lombok Straits. For the United States, there are no limitations around the Cape of Good Hope. There are indications that port authorities, as well as oil companies, will improve port facilities the next few years to take advantage of the economics of the million-ton tanker. When it is not feasible to dredge to sufficient depths, the use of a single-point mooring system and transshipment terminals will permit the use of those large carriers.

PROBLEM AREAS

Design

Because of its size, the ship must be designed as far as possible to be independent of outside assistance when away from terminal ports. For this reason, the question of control, reliability and duplication of essential components is of prime importance. Maneuverability at low speeds is also very important.

Thus great emphasis must be placed on safety and reliability, and the ship's equipment must be chosen from designs already available and proved. Further, the final product must be entirely viable in the hands of the operating personnel.

It is doubtful whether an owner of the million-ton tanker will

With the world's crude oil consumption expected to total some 4,100-million tons by 1980, and the distance between the oil-rich nations of the Mid- and Near-East, Venezuela, North Africa and Alaska and the oil-consuming countries, mammothizing tankers is greatly needed to carry large volumes of crude oil economically.[1] Improved and amplified port and harbor facilities have been developed in oil-producing nations, while oil-consuming countries have made great strides in developing central terminal station (CTS) systems, utilizing off-shore terminals at ample water depths. The more the ships increased in size *(Fig. 1)*, the lower became their cost per dwt, reducing transportation cost per dwt and raising their economic aspect.

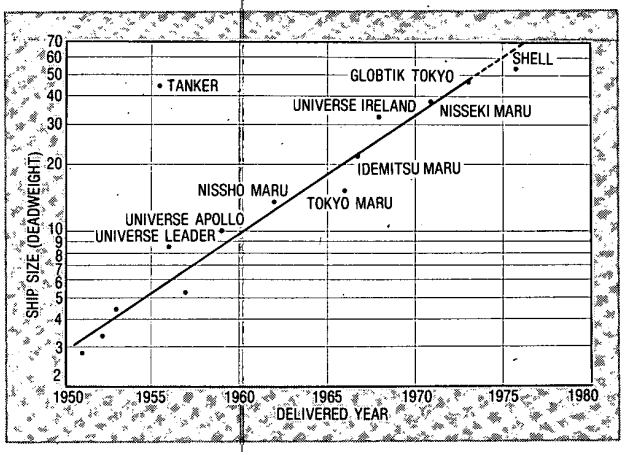


Fig. 1—Historical transition of tanker size.

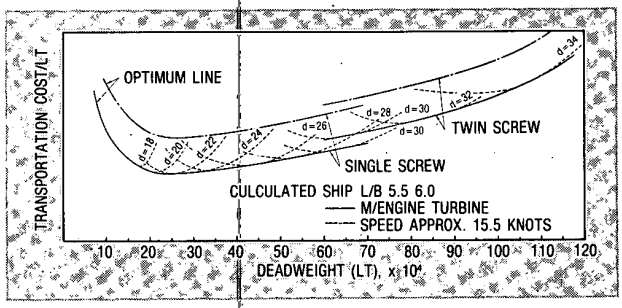


Fig. 2—Tendency of hull steel weight.

YES

have the facilities to carry out calculations necessary to determine the scantlings for this size ship. It is essential that the shipyard, the owner and the Classification Society work together on such problems throughout the design and building stages.

Because of deficiencies in the knowledge of structural analysis and of material behavior, the structural design of a ship of this size is rapidly acquiring a more theoretical basis. The importance of the experience factor, however, must not be overlooked when formulating standards employed to verify a design. Where shipbuilding is concerned, there is a lapse of many months between the time a design is finalized and until service experience has been gained. By that time, several ships of a particular design will have been completed and a fault in the design will have been repeated several times. In terms of money, this could be a very formidable sum. In terms of oil pollution, whether operational or accidental, it could mean a disaster of tremendous magnitude.

In the past few years there has been a tendency to produce designs which, in order to make them competitive, building time and labor involvement was reduced to a minimum. There is nothing wrong in such efforts, because it is considered progress and I fully agree with the idea of cost reduction. What I would not agree with, however, is the adoption of a design with a construction method which could compromise the efficiency of operation of the ship whether at sea or in port.

Some of the important problems which still require intensive study and careful consideration for this size ship are: corrosion control, mooring and anchoring, stern tube seals, steering and emergency stopping.

Construction

Ship construction is an assembly industry, and the method of construction and organization of the shipyard has a large bearing on the yard's competitive position. There are shipyards in Japan and Western Europe capable of building the million-ton tanker.

Today, however, all these yards are geared to build tankers up to 500,000 dwt. This means that present production methods will contribute to somewhat higher cost per dwt for a million-ton tanker than for VLCCs or ULCCs.

Propulsion machinery

To provide power needed for the million tonner, a single low-speed diesel engine with direct drive would require large dimensions. If a group of medium-speed diesel engines is arranged to develop the required power and transmit it through reduction gears to the propeller, the problem of power developed from one single engine is simplified, and has the advantage of allowing three choices of propeller revolutions and, in case of engine trouble, the ship can sail at reduced speed with one engine disconnected for repairs or maintenance.

Against these advantages are important disadvantages: the use of boiler fuel is still a borderline case; because there are many parts to be overhauled, more maintenance will be necessary; and because such an installation, with all its auxiliaries, will be much more complicated and less suited to automation.

A gas turbine installation would appear to be an ideal prime mover because it is mechanically much simpler than the diesel, and when compared with the steam turbine, the problems of feed water or condenser do not exist. An important disadvantage is the need to use properly treated fuels. Also, a first cost comparison shows the gas turbine plant is more expensive than the equivalent steam turbine plant.

Steam turbine propulsion machinery has been used almost exclusively by the VLCCs now in service. Although it has a lower thermal efficiency than either the diesel engine or gas turbine, the power output for marine propulsion has never been a problem.

Since we first gave serious consideration to a nuclear propulsion plant in 1957, great advances have been made in reactor technology, particularly in the United States, and the view prevails that nuclear-powered ships can now be built and operated safely and effectively. There are some very important questions still to be resolved, such as international agreement on safety, licensing and regulation, responsibility, third party liability, and indemnification limits, among others.

NOT YET

Problems: Hull Steel Weight v. Price

One of the most influential factors on a ship's price is the hull steel weight. Fig. 2 shows the changes in hull steel weight per dwt with increased ship's size. **First,** there is a dwt zone which minimizes the unit hull steel weight per dwt in every draft. **Second,** the unit hull steel weight goes down with the increase in hull size, reaching a minimum around 250,000 dwt, then turning up from that point. **Third,** the propulsion power required by a megalotanker exceeding 800,000 dwt becomes in excess of 70,000 hp which, from a technical point of view, should be propelled by twin screws, aggravating the unit hull steel weight per dwt. In the case of the one-million dwt tanker, this would be as bad as that for tankers below 100,000 tons.

This means large vessels over 250,000 tons, considering hull weight, are very much subject to a rise in cost per dwt.

The relationship between increased hull size and ship's price per dwt is shown in Fig. 3.

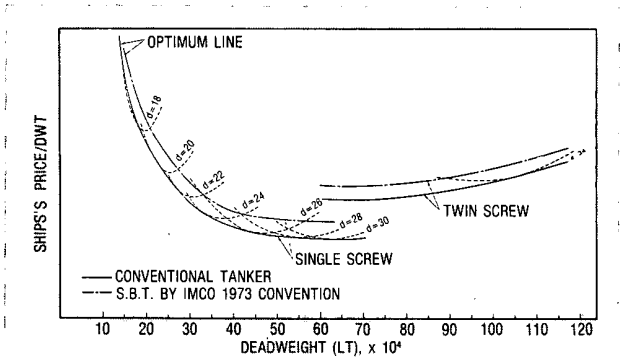


Fig. 3—Trend of ships' price.

First, there is dwt zone giving a minimum ship's cost per dwt in every draft.

Second, although the ship's price per dwt sharply declines with increased hull size, price reduction effects of hull size are no longer expected if the hull size exceeds some 400,000 dwt.

Third, ship's price per dwt attains a minimum at 600,000 to 700,000 dwt, and increases if the hull is made larger than 700,000 tons.

Fourth, those vessels over 800,000 tons will necessarily use twin screw propulsion, and the price per dwt will go back to the 250,000 to 300,000-ton class level.

In summary, the scale merit on ship's price is limited to no more than 400,000 or 450,000 tons, compared with the value 250,000 tons justified by the unit hull steel weight per dwt (Fig. 2). One of the reasons is the larger the hull size, the less the hp per dwt, if hull speed is fixed.

Results of estimating transportation cost per dwt of various sizes are indicated in Fig. 4. **First,** there is a dwt zone which gives a minimum transportation cost per ton in every draft. **Second,** the transportation cost per ton gradually descends with the increase in ship's size so far as tonnage is limited to about 600,000 tons; in the 600,000 to 800,000 ton range, its decrement becomes smaller. Exceeding 800,000 tons, the cost per ton is almost flat. **Third,** ships exceeding 800,000 tons may have to be driven by twin screws, and eventually can only compete with a single screw for 400,000-ton tanker in payability, unless their insurance credit is considered.

I believe, therefore, that the largest single-screw ship technically feasible could attain the minimum transportation cost per ton.

Since IMCO enacted regulations to prevent world-wide marine pollution, tankers over 70,000 tons delivered in 1980 and onward are required to be segregated ballast tankers (SBT), unavoidably pushing up building costs. The average increments according to IMCO's new requirements have been computed, and the results

YES

Automation

We must accept the fact that machinery surveillance should become the province of instrumentation which can be superior to human sensory perception. Today and in the immediate future, owners are able to select reliable and durable equipment as a result of the technologies of the aerospace and nuclear engineering industries, which have produced materials and techniques to manufacture components which last for many years and require little or no maintenance. The same factors should determine the selection of navigational aids.

Survey and drydocking

To illustrate the enormity of the structure, and the effort involved for proper examination of the structure and cargo tank testing of a VLCC, it has been estimated a surveyor must travel a vertical distance equivalent to climbing Mount Everest, with still one more mile to go!

Consequently, it is not only prudent but essential to provide for safe and rapid accessibility to inspect tanks during the design development. Underwater survey by movie or high-resolution TV could be considered for outside examination of hull and survey work in drydock.

By the end of 1976, at least four drydocking facilities will be available to accommodate this size ship. By the end of this decade, three more drydocks for repairs of million tonners will also be in service. Another way to carry out repairs could be in the "afloat" condition, a successful method we used for two of our tankers, the *Olympic Runner* and the *Olympic Rider* in 1966. This successful ship surgery simultaneously increased depth and length of the ships, and they continue to operate satisfactorily today. Thus, I feel confident the ship repair industry will also make its contribution to the development and operation of the new super tankers.

Experience justifies optimism

Looking back, my optimism for the rapid development of the VLCC and the facilities to service them has been justified. I view the development of service facilities for the million tonners with the same feeling of optimism.

As we move towards the realization of building the million-ton tanker, it has become more urgent for the Classification Societies to revise their requirements for drydocking these very large ships. Serious consideration must be given to extend the period between drydocking from two to—say—four or five years, with an afloat survey in between to reduce the lay-up periods to a minimum. A universally agreed pattern of hull markings should be arranged for ready identification by a diver or camera crew. And the Classification Societies should consider extending their services to survey repair work carried out while a vessel is under way at sea.

In summary, I remain optimistic about the construction of these million tonners so long as it is approached in a rational and receptive manner.

The shipping industry is constantly faced with problems of real, technological and economic challenge. The prospect of the million tonner is part of that constant challenge.

I feel we are ready for it.

About the author

Andrew G. Spyrou, technical director of A.S. Onassis' Group of Companies, graduated from Strathclyde University, Scotland, in 1945 with a B.Sc. degree in naval architecture. He is a member of the Technical Committee of the American Bureau of Shipping and Lloyd's Register of Shipping. Also, Spyrou is a director of Govan Shipbuilders Ltd. and Scotstourn Marine Co. of Glasgow.

NOT YET

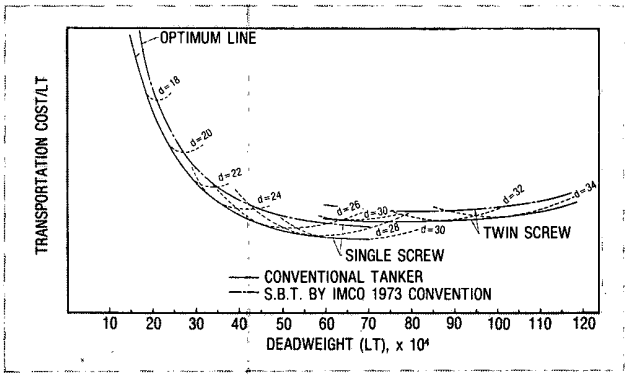


Fig. 4—Analysis of transportation cost/LT.

indicated by broken lines of Figs. 2 through 4.

Thus, ships of 400,000 dwt will be increased in price per dwt by some 6%; transportation cost per dwt will increase by some 5%, if the staggered ballast system is used.

Elements accelerating enlargement

With the economy of the world expanding, there are some factors promoting the enlargement of hull size. The scale merit as viewed from the ship's price is limited to around 400,000 to 450,000 tons, but when viewed from the transportation cost per ton, the scale merit is shifted for larger sizes. Therefore, economics indicate enlargement of hull size can still be expected. Another factor is that by reducing the number of vessels by increasing their size, the problem of crew shortages can be resolved, and operating costs can be reduced by the resultant labor saving despite high wages.

Elements restricting enlargement

Preventing the mammothization of ships are these factors: Most shipbuilding facilities are designed to best meet the production of 250,000 to 400,000-ton class ships, and due to limitation in facilities and equipment, the construction of large ships in the 500,000 to 1-million-ton tanker is accompanied by inefficiency. Speaking of earning efficiency of the building berth, it is not profitable for a shipyard building a 500,000-tonner if the rate of profit is the same as that of the 250,000-tonner.

Public voices for increased levels of safety standards for large vessels and requirements for enhanced performance of ship's outfittings such as cargo handling facilities and navigational instruments seem to have become more and more noticeable with the consequence of high grade ships, all combining to increase the cost.

To summarize, it is unlikely for us to see one-million-ton tankers in the immediate future. But it is evident the transportation by sea of crude oil will mostly be undertaken by CTS systems constructed apart from populated areas for economics, pollution control and safety.

ACKNOWLEDGMENT

'Abstract based on a presentation made at the Super Ocean Carrier Conference held in New York City, Jan. 16-18, 1974. Proceedings of this conference may be purchased from SOCCO, P.O. Box 269, San Pedro, Calif. 90733.

About the author

Dr. Tsuneo Kuniyasu received degrees in naval architecture and marine engineering from Tokyo University in 1946. Thereafter, he joined Harima Shipbuilding and Engineering Co., Ltd., and later took an assignment with Kure Shipbuilding and Engineering Co., Ltd. Since 1969, when Ishikawajima-Harima Heavy Industries Co., Ltd. merged with Kure Shipbuilding and Engineering Co., he has been manager of the Initial Design Department of Ishikawajima-Harima Heavy Industries Co.

Constructing an artificial island off Brazil

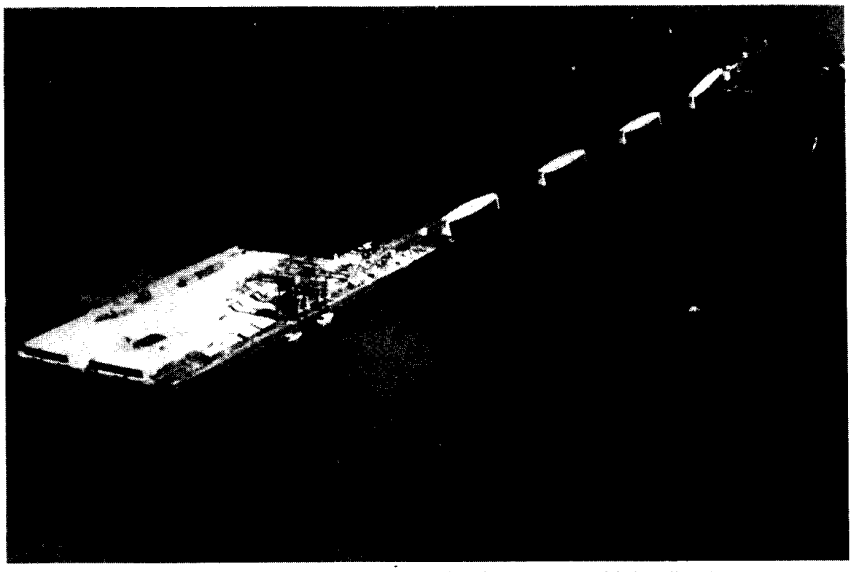
Offshore trans-shipping terminal is located in open sea

Luiz de Lima Cardoso and **Leandro Mendes Sabino,** Termisa, Rio Grande do Norte S/A, and **Bela Koman,** Soros Associates International

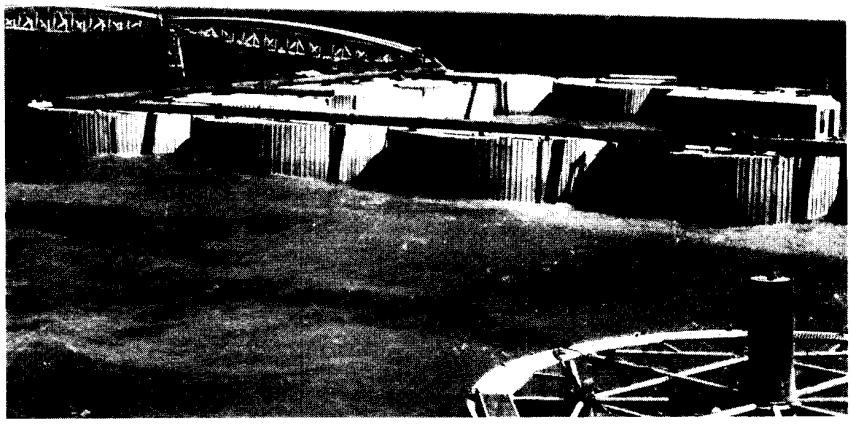
An artificial-island type of terminal was recently built 8 miles (14 km) off the coast of Brazil, near Areia Branca in the state of Rio Grande do Norte. It is intended for the trans-shipment of solar salt, and possibly other bulk commodities, destined for southern Brazilian ports and for export.

The Brazilian government, through Termisa—*Terminais Salineiros do Rio Grande do Norte S/A,* a mixed economy enterprise attached to the Ministry of Transport through the National Department of Ports and Navigable Waterways, had the terminal built after a detailed study of the region's salt producing industry, its markets and the traditional methods of handling and transporting the product. The new terminal with its modern material-handling system replaces the antiquated method of hoisting hand-filled buckets from barges to ships anchored in the open sea. Before the selection of the artificial-island system as the optimum solution for the terminal, Soros Associates International Inc., the consulting engineers for the project from concept to completion, investigated several alternative systems, including self-unloading barges, floating storage facilities, long-distance conveyors and aerial cableways.

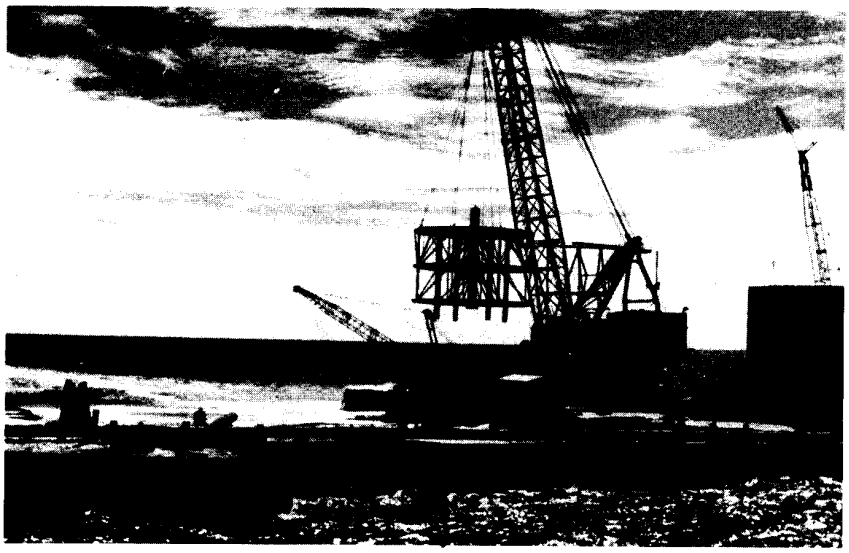
The feasibility of building and maintaining an artificial island in this part of the Atlantic Ocean was established after careful investigation of the wind and wave data, tidal movements,



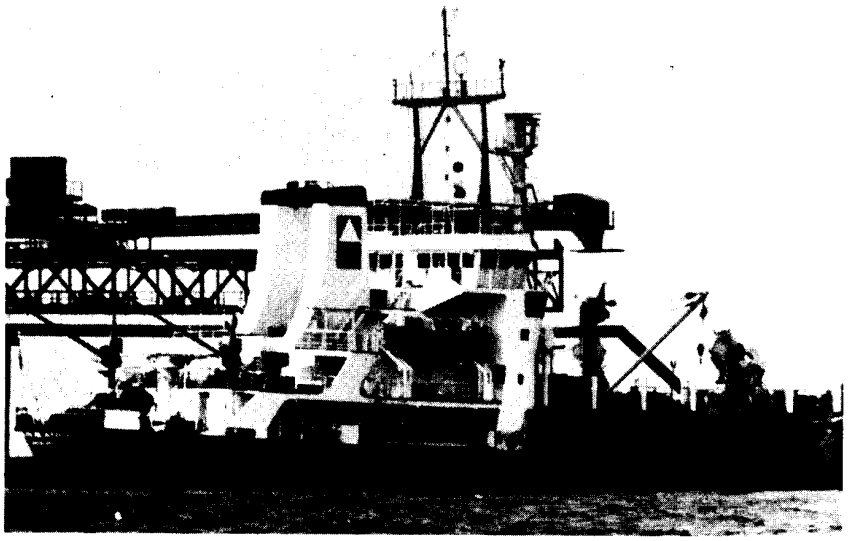
Trans-shipping Terminal consists of artificial island, open-sea shiploading berth and connecting conveyor trestle. Island includes barge unloading wharf, storage area and auxiliary facilities.



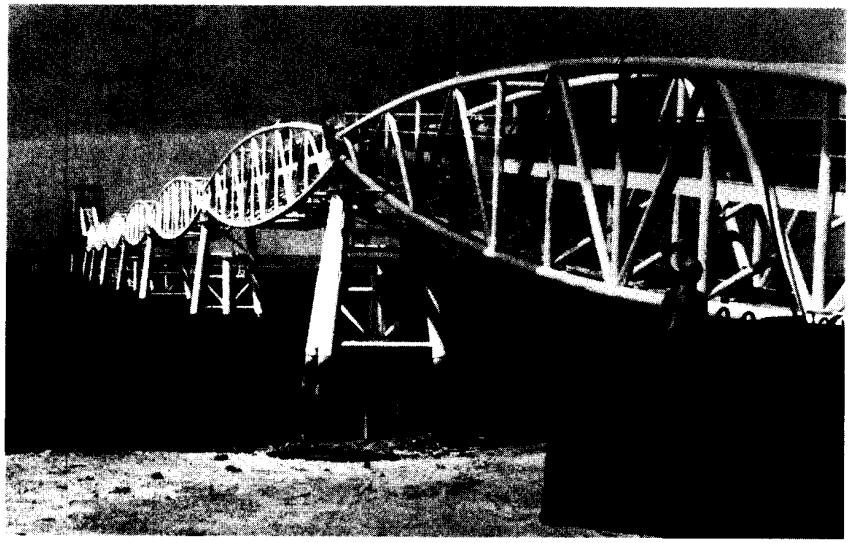
Circular sheetpile cells form the perimeter of the island.



As sheet-pile cells are completed, the template is removed. Contractor was J. Ray McDermott, Inc.



Seagoing dredge docks at shiploading pier to pump its cargo to the island.



Conveyor trestle supports temporary pipe line carrying a mixture of sand and water.

ocean currents and sea bottom conditions. Geophysical surveys and soil borings carried out before final design led to the most suitable location of the island and of the adjacent pile-supported structures for the barge unloading and shiploading facilities.

Several alternative methods were considered for the construction of the island perimeter, including a rubble-mound breakwater, rectangular caissons on top of a rubble base, cylindrical caissons jetted into the sea bottom, a flat beach with revetement and seawall, and sheet-pile bulkheads. The method adopted consists of steel sheet-pile circular cells topped with a reinforced concrete seawall. Rip-rap protection is applied in front of the cells to prevent scour of the sea bottom and to serve as a filter blanket.

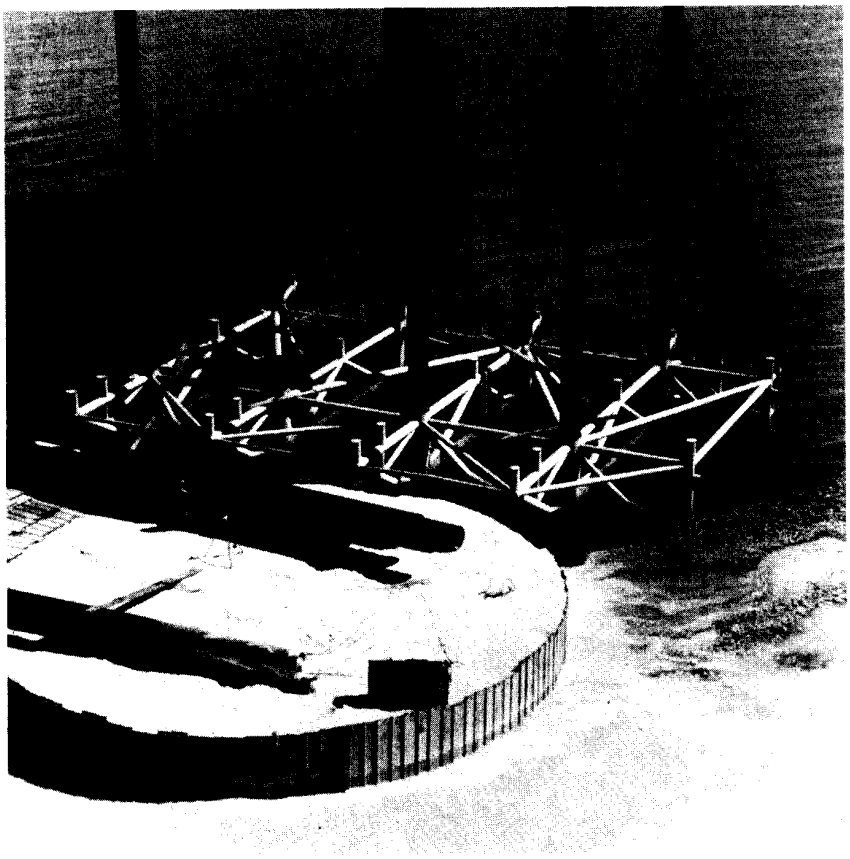
The construction of sheet-pile cells in the open sea presented many initial problems, mostly related to the selection of construction equipment. However, once these were surmounted, the basic island was completed in less than four months.

How the island was constructed

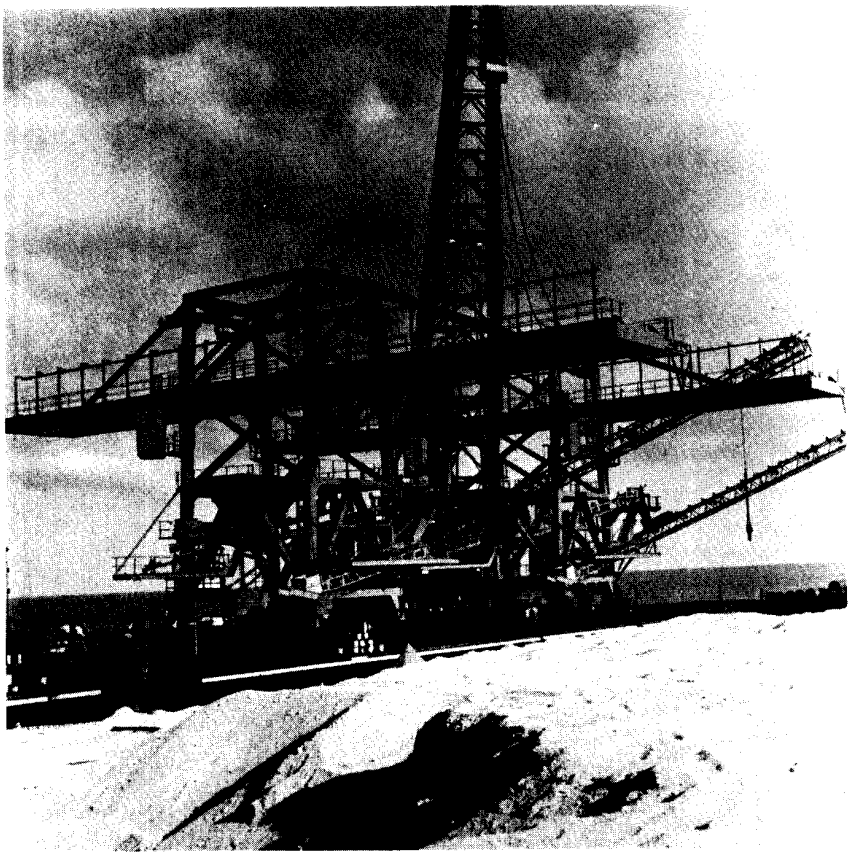
The marine engineer-contractor, the Oceanic Division of J. Ray McDermott Inc., used a fleet of vessels including a derrick-boat of 500-ton lifting capacity. Each of the 24 cells was preassembled around circular template on the deck of the derrick-boat. The 58-ft (17.5-m) diameter assembly was then lifted by the derrick boom, swung into position and lowered to the sea-bottom over guide piles. A pile-driving hammer was used to drive the sheet-piles to a penetration of approximately 15 ft (5 m) into the fine granular soil. As soon as each cell was driven, it was filled with selected material dredged from the sea-bottom some 9 miles (16 km) from the terminal. The template was removed progressively with cell filling.

Dredging. The dredging and filling operations were carried out by a seagoing trailing-suction type hopper dredge which filled the cells and cell closures as well as the enclosed body of the island. The discharge pipe line of the dredge was supported on the approach trestle between the island and the shiploader.

The shiploader, dolphin, trestle and supports are steel structures supported on pipe piles of 24-in. (60 cm) diameter penetrating up to 120 ft (37 m) into the sea bottom. Permanent, braced jackets were used to position and guide the piles during driving. The depth of the water at low tide varies from 23 ft (7 m) near the island to 50 ft (15 m) at the shiploading berth.



Barge wharf utilized a pre-fabricated template.



Barge unloaders were assembled on shore, transferred to a barge and towed to the island for positioning by the derrick-boat.

equipment

The shiploader, designed by Soros Associates and detailed by Pohlig-Heckel, is of the slewing-bridge type capable of loading up to 25,000-dwt bulk carriers without having to move the ship while at berth. Larger ships can be loaded by moving them fore and aft under the loader so that the boom may reach the extreme hatchways.

The shiploader was towed, pre-assembled, from the construction yard on the bank of the Mossoró River via barge to the terminal. Upon arrival at its final location, it was lifted into position by the derrick-boat. The completed shiploader, including slewing bridge, shuttle carriage, boom, mast and conveyor equipment, has a total weight of 320 tons. The shiploader as well as the rest of the materials handling machinery was furnished by Pohlig-Heckel AG and Pohlig-Heckel do Brasil S/A.

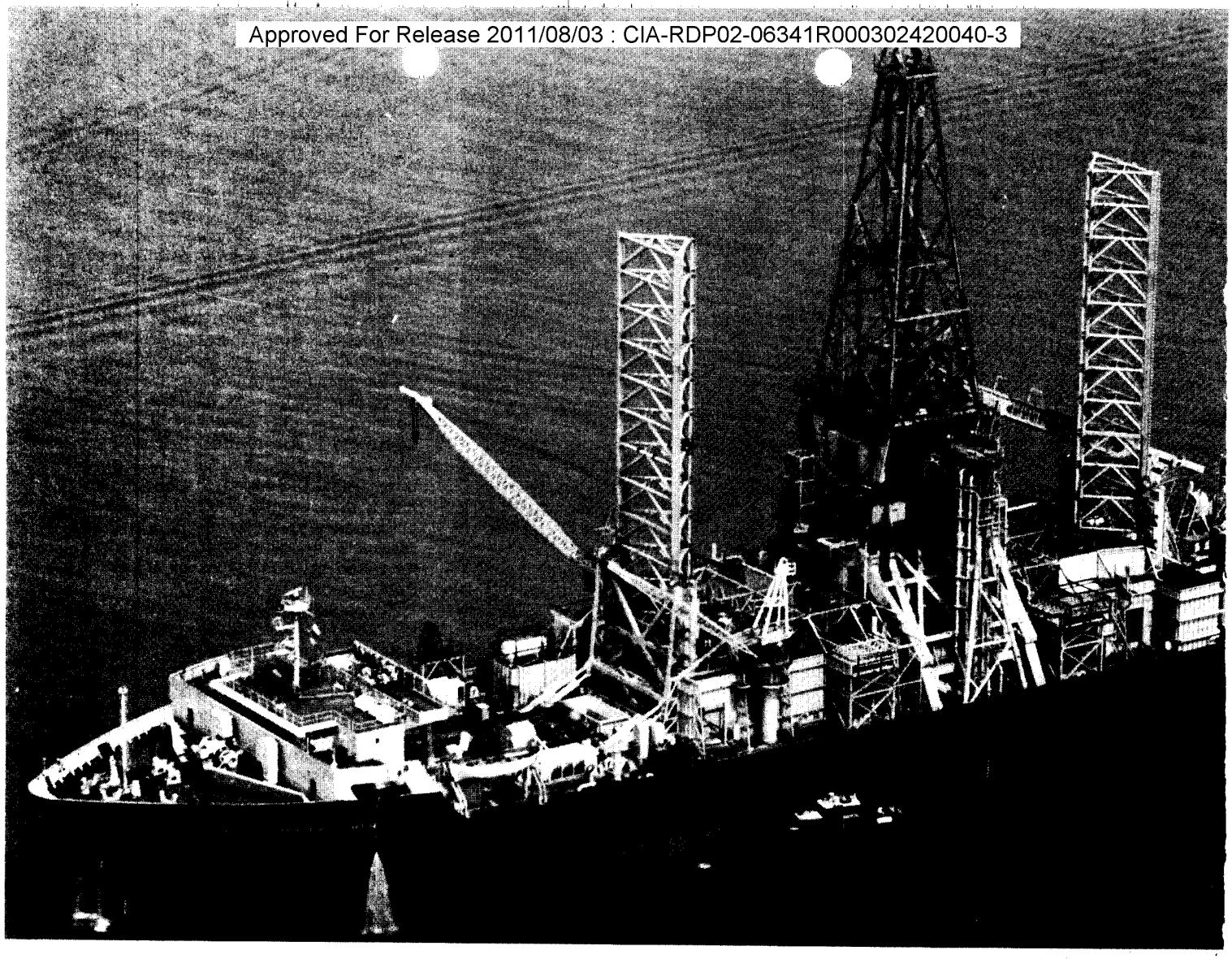
Barge unloaders. The western or lee side of the rectangular island is naturally protected from the prevailing easterly waves. A pile-supported wharf was built along this side to accommodate two barge unloaders capable of traveling longitudinally over the length of the wharf. Each unloader weighs 353 tons including counterweight and machinery. The two machines were pre-assembled in the construction yard on shore, transferred to a barge and towed to the terminal. The derrick-boat lifted each unloader and placed it on the wharf track.

Each unloader is equipped with a grab-type bucket and has a capacity to unload salt from barges at the nominal rate of 350 tons per hour. The reclaiming and shiploading system, using 42-in. (1,070-mm) and 36-in. (920-mm) belt conveyors, can load ships at the nominal rate of 1,500 tons per hour. Up to 100,000 tons of salt can safely be stockpiled on the island.

Along the three exposed sides of the island a reinforced concrete seawall was built on top of the sheet-pile cells. This seawall protects the island against wave action. Records indicate a maximum wave height of approximately 8 ft (2.5 m).

The open-sea structures were designed to resist 20 ft (6 m) waves as a safety measure. Recorded waves are sufficiently small to permit the docking and loading of ships on a regular basis.

The completion of the Termisa terminal is considered a milestone in the relatively short history of offshore terminals for bulk materials. The successful solution of the technical problems encountered during its planning and construction should provide useful guidance for what will probably be an increasing number of installations of this type in the future.

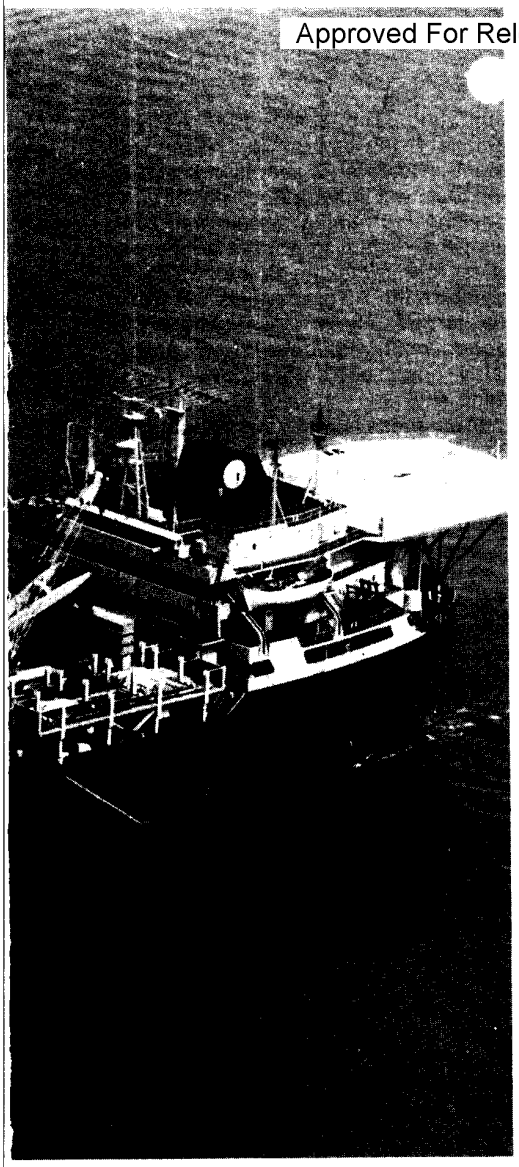


'Hughes Glomar Explorer' begins sea tests of mining systems

Though little heralded, an event of world-wide importance occurred at 8:30 a.m. on February 15, when the *Hughes Glomar Explorer* sailed from Long Beach, Calif., to begin tests at sea of manganese nodule mining systems. The outcome of these year-long tests could materially affect every nation on this planet. For if successful, this prototype mining vessel could open up vast new resources of hard minerals locked in the trillions of tons of potato-like nodules that lie scattered on the surface of deep ocean sediments throughout the world.

In the Pacific alone, there are an estimated 1.6 trillion metric tons of nodules, and 6 million more tons are forming each year. If it were possible to gather all of these nodules and economically process them, world production of nickel, cobalt and manganese could be sustained at present rates for tens of thousands of years. And we would have enough copper to last the world for several thousand years.

But it's not a good idea to count nodules before they're harvested. They are widely scattered over the vast reaches of the oceans, and the first step in the establishment of a mining venture is to locate a large concentration of nodules—say an average of about 2 lbs of nodules per sq ft extending over an area of several thousand square miles. To make matters more difficult, these sites



World's first deep-ocean mining ship, the 36,000-ton *Hughes Glomar Explorer.* The rugged derrick and substructure will handle the heavy mining vehicle and the casing used to raise and lower the vehicle to the sea bed.

have to be searched out in 12,000 to 20,000 ft of water because this is where nodules with the most favorable mineral assays are to be found.

Surprisingly, these initial difficulties have been largely overcome by at least eight modern-day sea-going prospectors. This includes five privately financed U.S. companies (or groups): Deepsea Ventures, Inc.; Howard Hughes' Summa Corp. (owner of the *Hughes Glomar Explorer*); Kennecott Copper Corp.; Ocean Resources, Inc., and International Nickel Co. of Canada. Three other government funded groups are Japan's Sumitomo—MITI (Ministry of Trade and Industry) group; France's CNEXO—Societe Le Nickel group; and a German combine of Metallgesellschaft AG, Preussag AG and Salzgitter AG (AMR Group). Apparently all of these companies and combinations of companies have located mine sites through highly sophisticated survey methods.

Several of the companies have even developed methods of extracting the metals from the nodules. (Please see June 1971 *Ocean Industry*, pages 27-28). But the biggest problem facing miners is skimming the nodules off the seafloor in 2 to 4 mile-deep-water and raising them to the surface, economically and efficiently.

The first to develop a full scale prototype mining system was Howard Hughes' Summa Corp. The major components of the system are the 36,000-ton mining ship, *Hughes Glomar Explorer* and a seafloor mining vehicle which is connected to the ship by a string of pipe and an umbilical cable that supply electric power and control circuits.

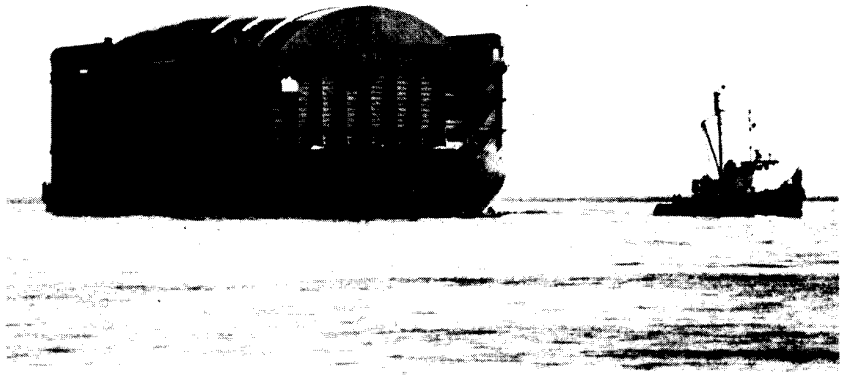
A large submersible dry dock, designed by Lockheed Missiles and Space Co. Inc. and constructed by National Steel and Shipbuilding Co. in San Diego, Calif., plays a key role in the system. The mining vehicle, which was also developed by Lockheed, is too large and heavy to be handled by the ship's gear in a conventional manner and must be installed from beneath the ship. The unit is loaded onto the submersible dry dock which rendezvous with the ship in calm waters of specified depth. There, the dry dock submerges and the ship moves over the drydock. The docking legs engage the mining vehicle, lift it clear of the drydock and the ship moves off. The drydock then surfaces and returns to its base. It will subsequently be used to service the mining vehicle when it requires undocking for maintenance or repairs, etc.

As shown in the accompanying illustration, the mining ship has a heavy-duty dynamic derrick and substructure. This unit handles the large diameter pipe which links the mining vehicle with the ship and, of course, supports it on its transit to and from bottom.

Characteristics of the ship. The fundamental engineering concepts for the new mining ship were supplied by Global Marine Development, Inc. which will also test and operate the vessel for Summa. The unit is 618 ft long, with a 115½-ft beam and an assigned navigational draft of 46 ft.

Construction was carried out under Global's supervision in Sun Shipbuilding and Dry Dock Co.'s Chester, Pa., yard. Because of the large beam, the vessel had to sail around Cape Horn to reach Long Beach where outfitting was completed.

The vessel is propelled by five Nordberg diesel-driven main generators which supply power through an SCR system to six propulsion motors capable of delivering a combined total of 12,000 bp to the ship's two shafts. The deep ocean mining ship is capable of operating at very slow



Submersible drydock which is used to transfer the mining vehicle to (or from) the *Hughes Glomar Explorer.* The mining vehicle is placed in the drydock, which submerges. The ship moves over the submerged drydock and docks with mining vehicle, and sails off. The submersible drydock then surfaces and returns to its base.

Some of the key men involved in the development of the mining system. In the top row from left to right are George Sheary, Summa's technical coordinator; Manfred Krutein of Global Marine Development Co.; Paul Reeve, Summa's project manager. In the foreground are David Pasho, Global Marine geologist, and Conrad Welling of Lockheed Missiles & Space Co.'s Ocean Mining organization. The men are standing in the nodule analysis laboratory on board the *Hughes Glomar Explorer*.

speeds during mining operations or at speeds up to 12 knots.

Features of the *Hughes Glomar Explorer* include automation permitting control of engine speed, direction and position from either of the ship's two complete bridges. Under normal operating conditions the ship will be conned from the forward bridge while under way and from the after bridge while mining.

Positioning system. The vessel has dynamic positioning system supplied by Honeywell that allows it to move slowly and precisely during mining operations. There is also a highly sophisticated navigation system which enables the operators to determine the location of the vessel with almost pinpoint precision.

On-board assays. The ship is equipped with a laboratory which can run assays to determine the mineral content of the nodules.

Quarters. Because the *Hughes Glomar Explorer* is an experimental vessel with new and untried systems, the number of accommodations for personnel were extended to 125. This will take care of the operating crew, as well as the technicians who will inhabit the vessel during the testing and "debugging."

Test program. Summa is reluctant to divulge technical details of the new vessel and its systems because of the highly competitive nature of the operation. The same goes for the details of the tests which began last month. However, it seems logical that the tests will include docking and undocking the mining system and running the system to bottom in shallow water before taking it into water of great depth. Also, the tests will likely be carried out in waters where the bottom configuration is known, and in fairly rough seas before moving into a mine site.

From these tests Summa should be able to approximate the number of working days per year from the mining vessel. This, of course, will have a strong bearing on the economics of the operation.

One thing is certain. The tests will *not* be carried out in one of the mine sites Summa has located. These are carefully guarded secrets, and at the present time, no proprietary claim could be exerted because there is as yet no legal mechanism for regulation of deep ocean mining.

One of the supplemental but highly important activities that will be a necessary part of the shakedown will be a study of the impact of deep ocean mining on the environment. Preliminary tests made by independent researchers, however, indicate that deep ocean mining will have a minimal effect. But this will have to be thoroughly demonstrated and documented in the early stages of deep sea mining, if the fledging industry is to operate without hampering lawsuits and needless delays.

Paul G. Reeve, Summa's project manager, has stated on a number of occasions that the project is primarily experimental and that the objective is not to establish commercial mining operations by any set date. Most of the systems are new and many may have to be modified or even replaced before full-scale mining operations can be commenced.

But as matters stand today, it's a safe bet that Summa will solve the technical problems before the U.N. solves all of the legal problems relating to deep ocean basin regulation.

When the U.N. Conference on Law of the Sea gets under way in Caracas, Venezuela, in April, the subject of deep sea mining will undoubtedly be near the top of the agenda, because the presence of the *Hughes Glomar Explorer* in the Pacific will serve as a strong reminder that technology will not wait for another decade of debate and procrastination.

If the regulations which ultimately will grow out of this and other conferences on law of the sea, are such that they encourage the venture capital and pioneering efforts, the world may realize the benefits of this new source of raw material.

Lad Handelman and Mike Hughes of Oceaneering International inspect preparations for the dives.

Bounce diving in 450-600-ft water depths and deeper

A new breathing mix could save up to $300,000 per year on rigs operating in this depth range

Donald M. Taylor, Editor

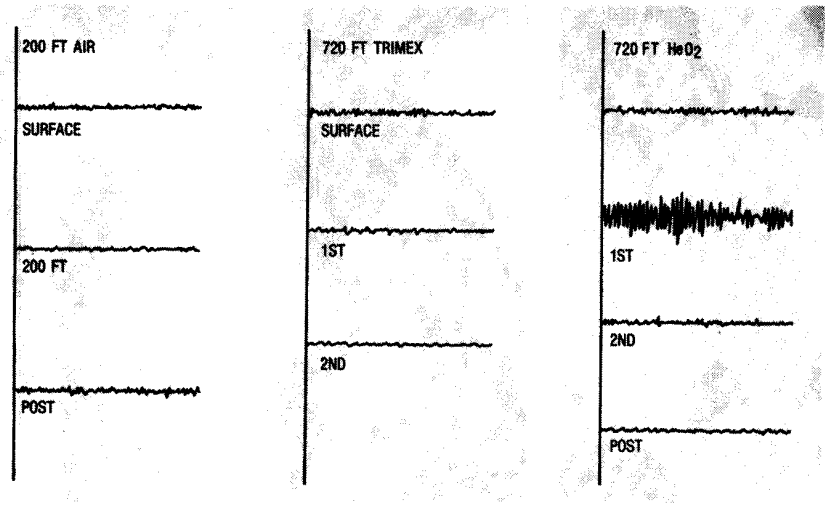
Recently, four divers in a hyperbaric chamber at Duke University made a simulated dive to 1,000 ft in only 33 minutes.

The men were breathing a new mixture of helium, oxygen and nitrogen. They arrived at the simulated depth with none of the usual losses of mental or physical capacity that afflicts divers breathing the traditional helium-oxygen mixture. They returned to the simulated surface pressure in 96 hours.

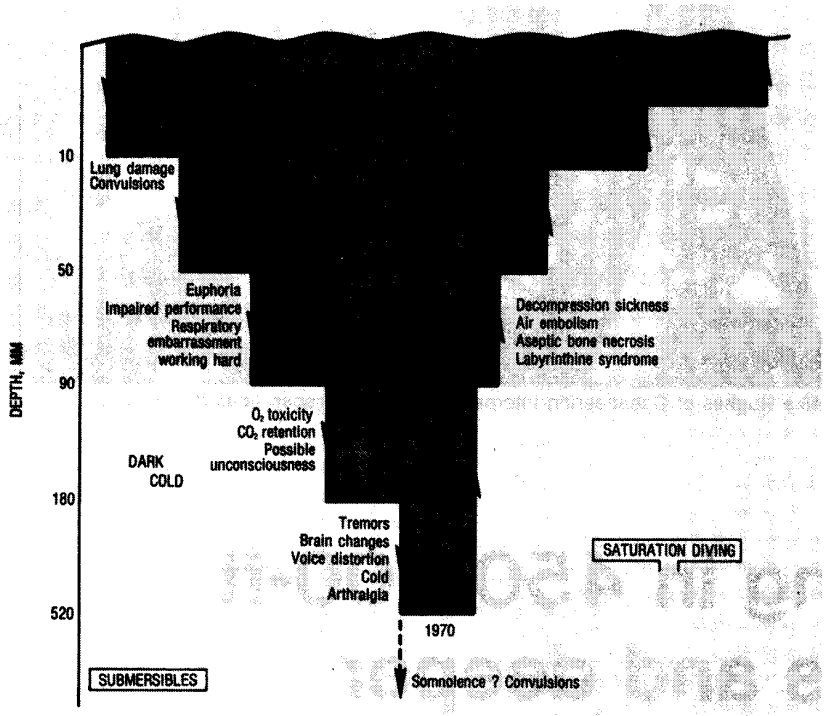
By way of comparison, the normal time for compression in 1,000 ft is 24 hours; and the decompression period now used by the U. S. Navy for a similar dive is 11 days. This amounts to a reduction of 7 days in total elapsed diving time. At lesser depths, the percentage reduction in time runs even higher.

What will this mean to the offshore oil industry? It could mean plenty. Officials of Oceaneering International, Inc., one of the participants in the Duke experiments, say the new technique could extend non-saturated diving beyond its present depth limit of 600 ft to as much as 1,000 ft. And this could reduce diving costs by almost $300,000 per year for rigs operating within this range.

The basis for this reduction in costs can be found in current diving practices. To begin with, the time required on bottom for actual work is usually quite



Recording of tremors during dives. First column shows suppression of tremor during a 200-ft air dive. The second column indicates no increase in tremor after reaching bottom following rapid compression to 720 ft breathing special gas mixtures. Third column indicates severe tremor occurring following same compression rate while breathing conventional helium/oxygen mixtures.



Physiological problems of diving.

short. "An analysis of 4,000 drilling rig dives showed the average time spent on bottom was only 17 minutes," says D. Michael Hughes, Oceaneering's chairman. "The expense of diving then, is almost entirely a function of the time, effort and materials expended in going to and from bottom. This is why non-saturated or bounce dives hold such promise in the 400 to 600-ft depths."

The time required for a bounce dive may run as little as 10% of that for a saturated dive. In the bounce dive, the diver is compressed to bottom pressures in a matter of minutes, quickly does his work, and usually starts decompression within the first hour. Because of the short exposure to high pressures his body does not become saturated with the breathing gas, and the period of decompression runs only a fraction of the time that would have been required had he stayed longer under high pressure.

Why, then, aren't all dives bounce dives? Hughes, a tall affable man in his mid-30s who started as a diver in the Gulf of Mexico, explains, "Primarily, it's because we lack precise knowledge about short-duration diving beyond 400 ft. Although a large number of short duration dives have been made in the 500 to 600-ft range, most of them produced an unacceptable incidence of bends. The ones which were not successful pointed up a need for further work if these dives are to become a commercial service."

One of the most difficult problems starts with the compression cycle. In depths below 430 ft, high speed compression in the helium-oxygen mixture can produce high pressure nervous syndrome (HPNS) which is characterized by nausea, dizziness and tremors. The symptoms become more severe with increasing depth, eventually resulting in somnolence or convulsions. Even if the diver's mind is clear, he may be physically incapable of working or even of saving himself.

To Dr. Peter B . Bennett, professor of anesthesiology at Duke University Medical Center, this represented a challenge. Animal experiments had previously indicated that the effects of HPNS could be negated by adding a certain amount of anesthetic or narcotic gas such as nitrogen to the helium-oxygen diving mixture. Experiments had also shown that the effects of nitrogen narcosis, which would then result, could be relieved with increasing pressure.

In August, Bennett, who is an international authority on the physiology of diving, began a series of simulated human dives designed to see whether just the right balance could be found between helium and nitrogen so that narcosis and HPNS might both be negated. Four divers participated in the dives, three from Harbor Branch Foundation and one, Erik Geerts, from Oceaneering.

Surprisingly, success came early. During a dive to 720 ft in August, using the three gas mixture, the four divers showed no signs of HPNS but did complain of slight narcosis.

In the 1,000-ft dives that followed later in the year, the nitrogen content was decreased. "This greatly reduced the narcosis they had experienced without causing any of the symptoms of HPNS to come back," Bennett said. "The divers had no tremors, giddiness or sickness and felt no pain in their joints."

ADVANTAGES OF NEW MIXTURE

Everybody involved considered the experiments a nearly perfect success. Lad Handelman, Oceaneering's president was particularly happy with the possible time saving because his company has a contract to provide diving services in water depths to 1,000 ft. If divers can be compressed to 1,000 ft in 20 to 30 minutes, then spend 20 minutes working on bottom, they can be decompressed in a fraction of the 11 days normally required. Because divers would not be tied up for such long periods in the decompression chambers, the size of the diving

Control console at Duke University Medical Center Hyperbaric Research Facility.

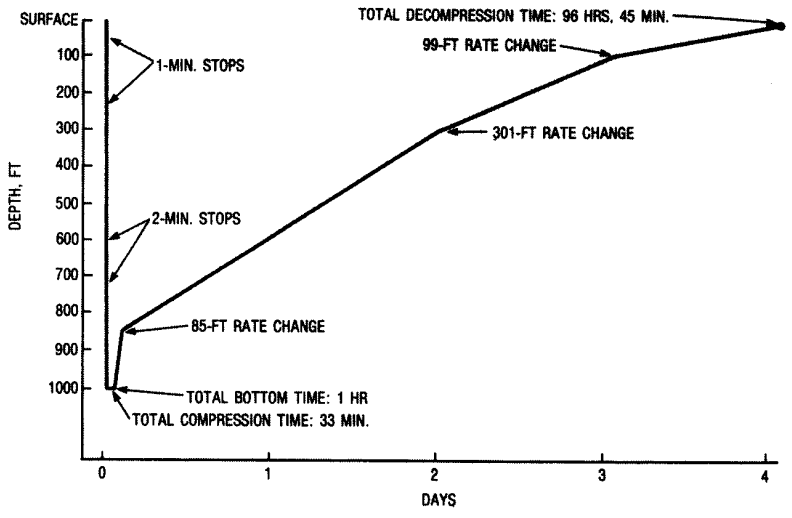
crews could be reduced by, say, 25%. This is a much needed savings which can be passed along to the customer.

Another savings comes from the speed of response to emergencies. "It costs $40,000 to $50,000 a day for a drilling rig to operate in the North Sea," Handelman said. "If it typically takes a diver 24 hours to compress to 1,000 ft, that's a waste of a day right there."

Oceaneering believes the new technique can lead to still another saving. A non-saturated dive to 600 ft would require only half the charging gas and no replenishment gas during decompression. A 60% reduction in consumption of expensive gases is possible using bounce diving rather than saturation dive technique. At two dives per month, this new technique could effect a major yearly savings.

The divers, too, prefer the non-saturated for obvious reasons. Following a bounce to 600 ft, the diver will need only about 15 hours in the decompression chamber. A saturated dive at the same depth will require a stay of about 6 days.

And this brings up another factor of keen interest to Mike Hughes. That is the matter of diver safety. "Long periods under pressure increase the diver's exposure to possible rig catastrophes such as fire or blowout," says Hughes. "Can you imagine the feelings of a diver if a fire breaks out when he has eight more days to go in the decompression chamber!"



Graph of 1,000-ft dive showing rapid compression and decompression.

The new diving mixture takes on still greater importance in light of the oil industry's expansion into deeper water. As Dr. Bennett put it, "One thousand ft has been the limit of man's working capacity in water, but even this has not been practical commercially because the divers had to go down and come back so slowly they lost much of their functional ability at that depth."

But this depth limit has been set by the combined effects of helium and pressure, he says, and no one yet knows how far man can dive with the helium/pressure effect eliminated by the use of the three gas mixture. It could be considerably deeper. More research is needed to complete studies of rapid compression before this technique can be considered safe for field use, but the potential savings could be tremendous.

Vessels supporting North Sea drilling

It was about 26 years ago that the first offshore well was drilled on a federal lease in the Gulf of Mexico. In the formative years that followed, shrimp boats and flat bottom barges were used to support the offshore drilling and production effort.

In 1955, some 19 years ago, the first boat specifically designed for offshore support operations was built. This was Tidewater Marine's *Ebb Tide*.

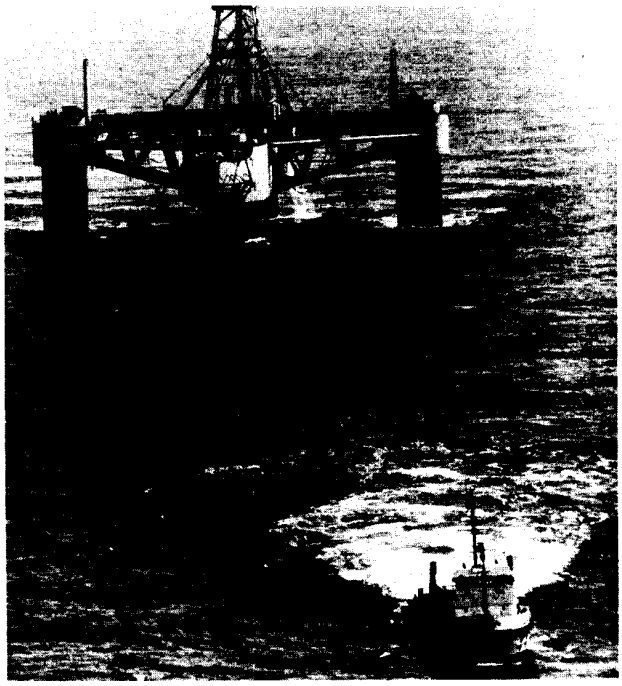
From this point the marine transportation industry has evolved to a fleet of over 2,700 vessels with a replacement value in excess of $4 billion. No longer can these vessels be classed as "boats." One of the most recent North Sea designs, for example, is Tidewater's *Mammoth Tide*. She is 220 ft in length and rated the largest towing/supply ship in operation. This 10,500-bhp vessel has a bollard pull in excess of 250,000 lbs.

Note the contrast in the two Tidewater vessels, *Ebb Tide* and *Mammoth Tide*, shown in photos accompanying this table.

Other sophisticated towing/supply ships include Offshore Logistics Inc.'s *Ranger*. This vessel is depicted towing the *Waage Drill I* from New Orleans, La., to Stavanger, Norway. The *Ranger* is one of six such units being built for and operated by Offshore Logistics from its Aberdeen, Scotland, base. It is 200 ft in length and has a continuous rating of 7,040 bhp.

These and other vessels have been designed by naval architects and marine engineers to meet the growing demand to serve the industry in the North Sea.

As indicated in the chart below, vessels are being used in support operations of some mobile drilling units. However, this is not an indication of the actual number of vessels operating in the North Sea. Spot charters, pipe hauls and countless other duties are being performed by these and other vessels.*



Wassertor, owned by Offshore Supply Association Ltd., is shown here towing the ***Transworld 61*** off Stavanger. The vessel is currently under contract to Shell.

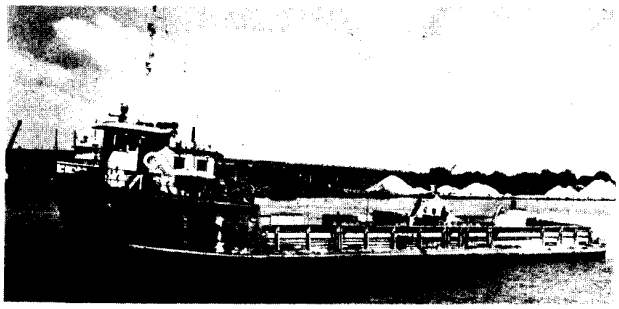
MARINE TRANSPORTATION COMPANY

Vessel name	Horsepower (BHP)	Length (ft)	Drilling unit	Contract	Comment
AquaMarine Inc.					
AquaMarine 502	5,400	180	*Ocean Victory*	Occidental	(Scheduled to begin work with platforms in Piper field and assist in support operations of the *Ocean Victory*.)
AquaMarine 503	5,400	180			
AquaMarine 504	5,400	180			
Acadian Marine Service Inc.					
Acadian Freedom	3,100	170	--	Brown & Root	Pipe haul contract. Also doing rig work on sport charter with Sun, Union, Santa Fe and other companies.
Acadian Victory	3,100	170	--		
American Offshore Inc.					
Polar 901	9,000	225	*Sedco 702*	Conoco	
Polar 902	9,000	225			
International Offshore Services Ltd. (I.O.S.)					
Lady Joyce	--	--	*Sea Quest*	British Petroleum	All vessels listed are servicing these rigs. Also, two Ocean Inchcape vessels are servicing these units. Currently drydocked due to grounding.
Lady Elizabeth	--	--	*Sedco K*	British Petroleum	
Lady Vivienne	--	--			
Lady Jean	--	--			

**Ocean Industry's* June issue will feature a complete report on the marine transportation industry. This will include complete data on vessels in operation, under construction and planned as well as cost figures, etc.

MARINE TRANSPORTATION COMPANY

Vessel name	Horsepower	Length	Drilling Unit	Contract	Comment
Lady Alexandra	--	--			Allocation subject to change as rigs move to new locations.
Lady Jean	--	--	*Sedco 703*	British Petroleum	These vessels will be re-allocated to service the *Sedco 703* in April 1974.
Lady Vivienne					
Lady Alexandra					
Arthur Levy Boat Service Inc.					
Celtic Seahorse	6,000	192	*Sedneth 701*	Ranger/Texaco	
Arctic Seahorse	6,000	192	*Zephyr I*	Texaco	
North Seahorse	6,000	192			
Brown & Root-Wimpey Ltd.					
WimBrown 2	--	--	*Ocean Tide*	Petroland	
WimBrown 3					
Maersk Supply Service (A.P. Moller)					
Maersk Fighter	1,932	52.66 m	*Transocean II*	Shell	
Maersk Shipper	3,800	53.34 m	*Gulf Tide*	Phillips-Norge	
Ocean Inchcape Ltd.					
Oil Venturer	--	--	*Sea Quest*	British Petroleum	These rigs are also being
Oil Discoverer	--	--	*Sedco K*	British Petroleum	serviced by I.O.S.
Oil Driller	--	--	*Ocean Kokuei*	BOC	
Oil Mariner	--	--			
Offshore Logistics, Inc.					
Ranger	7,040	200	*Waage Drill I*	Mobil	
Enterprise	7,040	200			
Offshore Marine Ltd.					
Norfolk Shore	1,600	159	*Britannia*	ARCO UK	
Arctic Shore	2,400	177	*Sedneth I*	Shell	Offshore Marine Ltd. withdrew from the OSA consortium as of Jan. 1974.
Pacific Shore	2,400	177			
Suffolk Shore	1,600	171	*Sedco 135F*	Shell	
Dogger Shore	5,600	176			
Orkney Shore	4,000	175	*Sedco 135G*	Shell	
Dogger Shore	5,600	176			
Shetland Shore	4,000	175			
Tropic Shore	2,400	167	*Pentagone 81 (Neptune 7)*	Elf Norge	
Channel Shore					
Ocean Shore	4,000	182	*Sedco 702*	Conoco	
Viking Shore	5,600	195			
Kent Shore	1,600	176	*Ocean Rover*	Phillips	
Offshore Supply Association Ltd. (OSA)					
Marientor	4,060 IHP	178	*Grand Isle*	ARCO	
Holstentor	2,580 IHP	173	*Zapata Explorer*	Phillips	
Martiniturm	4,060 IHP	178	*Pentagone 81*	Elf Norge	
Wassertor	6,240 IHP	185	*Ocean Voyager*	Shell	
Ansgariturm	2,580 IHP	176	*Ocean Viking*	Occidental	
Johannisturm	2,580 IHP	173	*Gulf Tide*	Phillips Norge	These vessels are also being used in platforms work.
Jakobiturm	2,580 IHP	173			
Hohentor	2,580 IHP	173			
Imkenturm	3,620 IHP	173			
Arsterturm	2,590 IHP	173			
Pagenturm	2,620 IHP	173			
Lukasturm	3,850 BHP	185			
Georgturm	6,240 IHP	188	*Deep Sea Driller*	SAGA	This vessel was delivered early this year. It is the first to six such vessels planned for North Sea service.

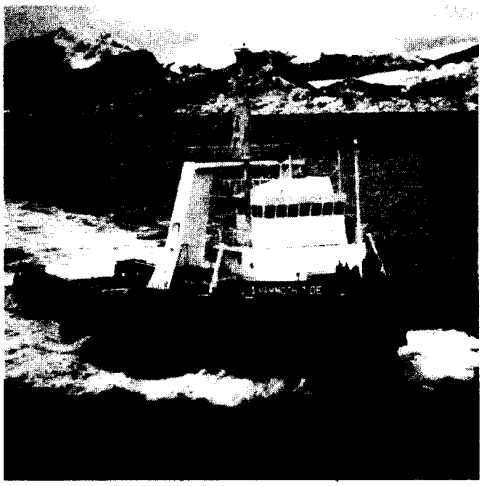


EBB TIDE—The first custom-built cargo boat ever to be constructed to serve the offshore oil industry. This 120-ft vessel pioneered what is now almost a universal trend by having its wheelhouse in a forward position, leaving the entire aftdeck clear for cargo and supplies.

Ranger assists in the tow of ***Waage Drill I*** from New Orleans to Stavanger. The vessel, owned by Offshore Logistics, Inc., is under contract to Hamilton Bros. Oil & Gas Ltd.

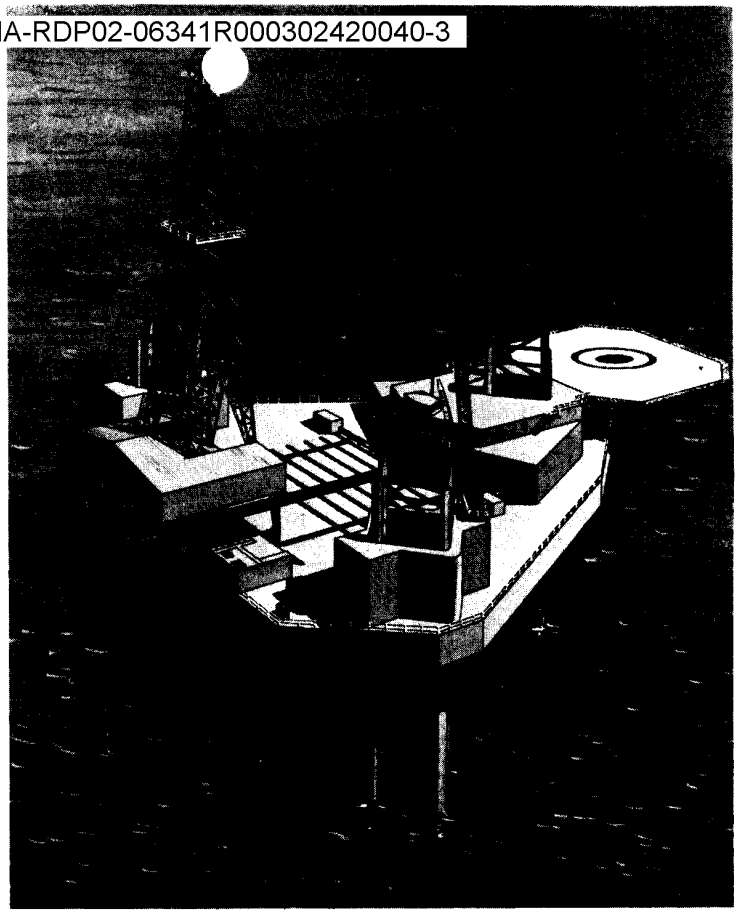
MARINE TRANSPORTATION COMPANY

Vessel name	Horsepower	Length	Drilling Unit	Contract	Comment
Sachesentor	6,240 IHP	188	*Deep Sea Driller*	SAGA	
Wilhaditurm	6,240 IHP	188	*West Venture*	Union	
Pinnastor	2,580 IHP	173	*Chaparral*	Shell	
Kattenturm	2,620 IHP	173			
Seaforth Maritime Ltd.					
Seaforth Hero	5,000	180	*Ocean Rover*	Phillips	Two additional vessels working in the North Sea. Two planned for delivery 4/74 will be placed under exclusive contract to B.P.
Seaforth Challenger	5,000	180	*Pentagone 82*	Conoco	
Peder Smedvig					
I/S Norway Supply Ships					Two new vessels under-construction and committed to Brown & Root for North Sea operations.
West Avocet	4,400	175	--	Mobil	
West Albatross	4,400	175	--	Mobil	
West Eagle	2,100	175	--	Phillips	
Smit-Lloyd N.V.					
Smit-Lloyd 104	7,500	--	*West Venture*	Union	
Smit-Lloyd 109	7,500	--	*Waage Drill II*	ARCO UK	
Smit-Lloyd 107	7,500	--			
Smit-Lloyd 41	4,000	--	*Blue Water No. 3*	Hamilton	
Smit-Lloyd 44	4,000	--			
Smit-Lloyd 43	4,000	--	*Western Pacesetter I*	Sun/Ashland	
Smit-Lloyd 106	7,500	--			
Smit-Lloyd 48	4,000	--	*Drill Master*	Esso	
Smit-Lloyd 105	7,500	--			
Smit-Lloyd 108	7,500	--	*Sedneth 1*	Shell	
			Sedco 135F	Shell	
Smit-Lloyd 2	3,000	--	*Penrod Rig 58*	Placid	
Smit-Lloyd 11	3,000	--	*Zapata Explorer*	Phillips	
Smit-Lloyd 12	3,000	--	*Chaparral*	Shell	
Smit-Lloyd 3	3,000	--	*Offshore Mercury*	Amoco	
Smit-Lloyd 18	3,000	--			
Smit-Lloyd 15	3,000	--	*Transocean I*	Shell	
Smit-Lloyd 16	3,000	--			
Smit-Lloyd 45	4,000	--	*Transworld Rig 58*	Conoco	
Smit-Lloyd 47	4,000	--			
Smit-Lloyd II	3,000	--	*Zapata Nordic*	Phillips	
Tidewater Marine Service Inc.					
Mammoth Tide	10,500	220	--	Conoco	Largest vessel of its kind in operation. A sister ship, *Goliath Tide,* is also scheduled for delivery. One of these units will work with the *Sedco 704* when it is completed later this year.
Wilhelmsen Offshore Services					
Tender Tarpon	5,750	185	*Grand Isle*	ARCO	
			Odin Drill	Home Oil/Bow Valley	
Tender Trout	4,000	185	*Sea Quest*	British Petroleum	
Tender Turbot	5,750	185	*Odin Drill*	Home Oil/Bow Valley	
Zapata Marine Service, Inc.					
Centurion Service	3,600	175	*Transocean II*	British Petroleum	*Signal Service, Victory Service, Viking Service, Hudson Service and Valiant Service* are also working in the North Sea.
Majestic Service	7,040	185	*Ocean Victory*	Occidental	
Monarch Service	7,040	185			
Titan Service	3,600	170	*Orion*	Pennzoil	
Trojan Service	3,600	175			
Saxon Service	5,400	185	*Ocean Rover*	Phillips	
Thor Service	5,400	190			
Baffin Service	6,560	190	*Zapata Ugland*	Total Oil Marine	*Baffin Service* scheduled to begin operations in 5/74.



MAMMOTH TIDE. This 220-ft long towing/supply ship is specifically designed to work in the North Sea. The vessel is a full 100-ft longer than the *Ebb Tide.* It has a 251,370 lb. bollard pull and can attain over 16 knot speeds when fully loaded.

Preview of new drilling rigs



Sedco orders $35 million semi-submersible

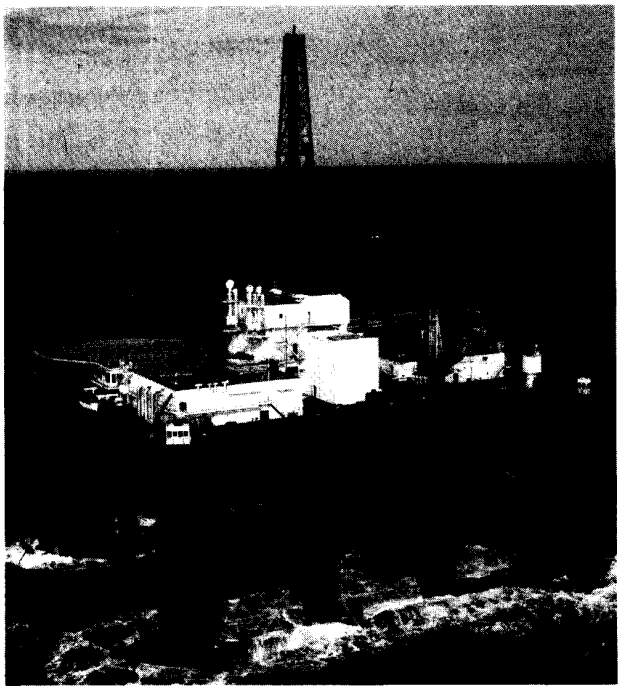
Sedco Inc.'s newest semi-submersible drilling platform will require more than 8,000 tons of steel and cost in excess of $35 million.

The new unit, *Sedco 706*, will be the seventh vessel in the *Sedco 700* series of semi-submersible drilling platforms.

Construction of the new vessel is being carried out by Kaiser Steel Corp. Completion is scheduled in the fall of 1975 at Kaiser Steel's San Francisco Bay area assembly yard.

The twin hull column stabilized semi-submersible will have the same basic design as the other *Sedco 700* series drilling units.

Sedco 706 will be capable of drilling in up to 2,000 ft of water



SEDCO 706 is the seventh vessel in the *Sedco 700* series of semi-submersible drilling platforms. The vessel will be capable of drilling in up to 2,000 ft of water, even in stormy seas.

even in stormy seas. It can maintain its mooring in 80-ft waves, 100-knot winds and 2-knot currents.

The vessel's thruster system is specifically designed to improve performance in rough seas and deep water. Four 1,600-hp thrusters can propel the vessel at 8 knots. This provides power for survival in severe seas while reducing the time and cost of mobilization. But the main function of the azimuthing thrusters is to assist the mooring system when the rig is on location and drilling. (For full technical details on design and system for the *Sedco 700* series, see *Ocean Industry*, May 1973.)

Quarters are provided for 102 persons.

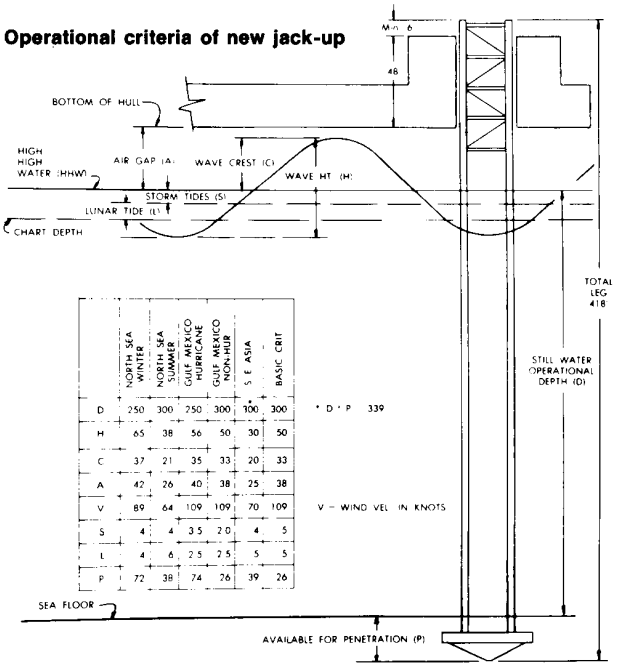
Norwegians order jack-up for 300-ft water

K/S Norway Jackup has placed a construction order with Levingston Shipbuilding Co., Orange, Texas, for a Levingston-designed *Class III* jack-up drilling platform.

This is the first Norwegian firm to contract for a jack-up type unit. K/S Norway Jackup is a three-company joint venture formed by Fearnley & Eger Chartering Co., Ltd., Skips A/S Kim and Odfjell Drilling and Consulting Co. AVA/S. The owners had previously applied for Export-Import financing of the unit.

Delivery is scheduled for September 1976. The total price, in-

Operational criteria of new jack-up



	NORTH SEA WINTER	NORTH SEA SUMMER	GULF MEXICO HURRICANE	GULF MEXICO NON-HUR	S. E. ASIA	BASIC CRIT
D	250	300	250	300	100	300
H	65	38	56	50	30	50
C	37	21	35	33	20	33
A	42	26	40	38	25	38
V	89	64	109	109	70	109
S	4	4	3.5	2.0	4	5
L	4	6	2.5	2.5	5	5
P	72	38	74	26	39	26

cluding machinery and drilling equipment, will exceed $18 million.

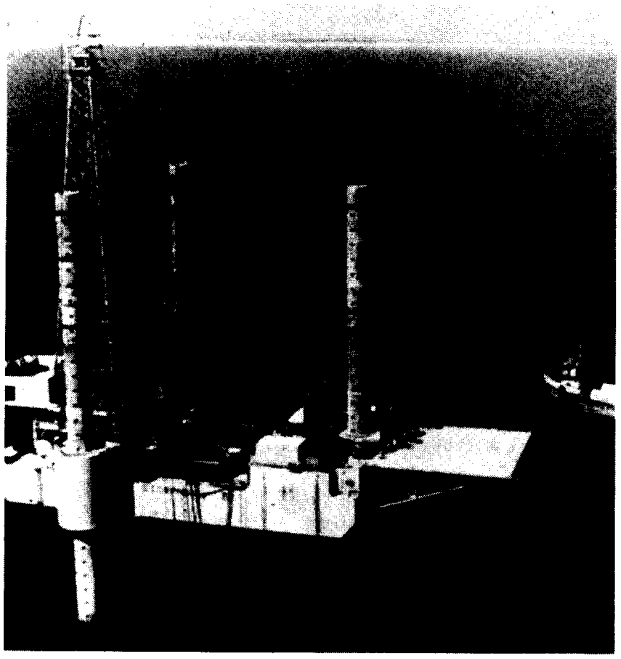
The triangular shaped mobile drilling platform will be capable of drilling 30,000-ft wells in water depths up to 300 ft.

The 418 x 178 x 22-ft platform will be supported by three square truss type legs, each 418 ft long. The 50 x 50-ft drill slot in the stern of the vessel will allow nine well positions to be drilled with the skid-type structure. The derrick substructure can be repositioned over the pipe rack when the rig is under tow.

The hull is equipped with a double-sided rack-and-pinion jacking system furnished by Armco Steel Corp.'s Machinery and Equipment Division, formerly National Supply Division.

The jacking system is electro-mechanical and pinion drive. It is comprised of six gear boxes, two for each leg, with six individual electric gear motors and gear trains terminating at six pinions. The rated jacking capacity for this system is 7,200 short tons at a speed of approximately 1 ft per minute. The controls are a push button type, operated from a single remote control console. Each leg can be operated individually or simultaneously.

Air-conditioned living quarters are provided to accommodate 54 persons.



Storm orders two new jack-ups

Storm Drilling Co. and Storm Drilling S.A. have placed construction contracts for new jack-up drilling units.

These identical mat-supported jack-ups will have a 25,000-ft drilling capability and a 250-ft water depth capability.

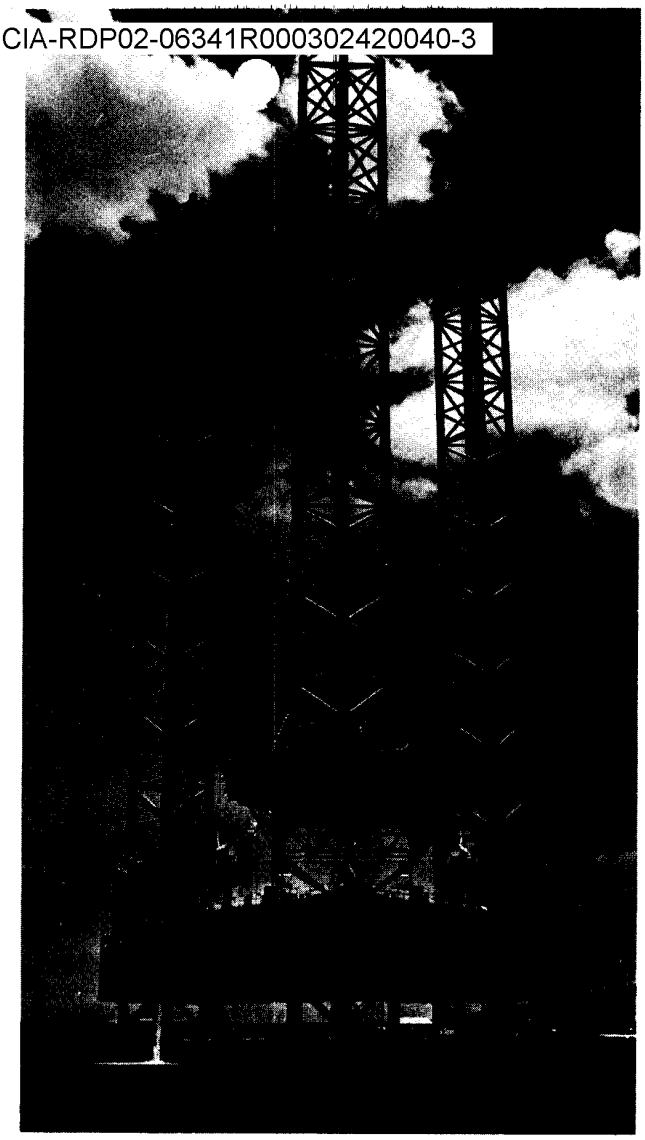
The rigs are hydraulic, self-elevating mobile platforms measuring 166 ft in length, 132 ft wide and 16 ft deep with a 50-ft drill slot.

The mat will be 210 x 170 x 10 ft and its drill slot will be 90 x 87 ft. Each of the three cylindrical columns will be 312 ft long and 12 ft OD.

Both vessels will be capable of storing 6,150 cu ft of bulk mud and cement (3,000 sacks), 1,500 bbls of active mud, 4,324 bbls of drill water, 402 bbls of potable water, 1,796 bbls of fuel oil and 4,027 bbls of salt water.

The Storm Drilling Co. unit is being constructed at Bethlehem Steel Corp.'s Beaumont, Texas, shipyard.

The Storm Drilling S.A. unit will be constructed by Bethlehem Singapore Private Ltd. in Singapore.



THE NEW JACK-UP UNITS are of the same design as the *Diamond M 99*, shown here. The vessels are planned for completion in September 1975 and February 1976.

Diamond M orders three new rigs

Diamond M Drilling Co.'s rig construction program, which began in 1972, now reaches over the $120 million mark with the recent announcement of three new construction contracts for mobile drilling rigs.

Two self-elevating jack-ups and a semi-submersible drilling vessel are planned for construction.

The jack-up units will be of the Levingston design and built by Levingston Shipbuilding Co.'s Orange, Texas yard. These triangular shaped units are designed to work in water up to 300 ft deep and have a rated drilling capability to 30,000 ft.

The 208-ft-long platform with a 178-ft beam and 22-ft deep hull is supported by three truss type legs. A four-point mooring system is provided by four 7,500-lb ships anchors.

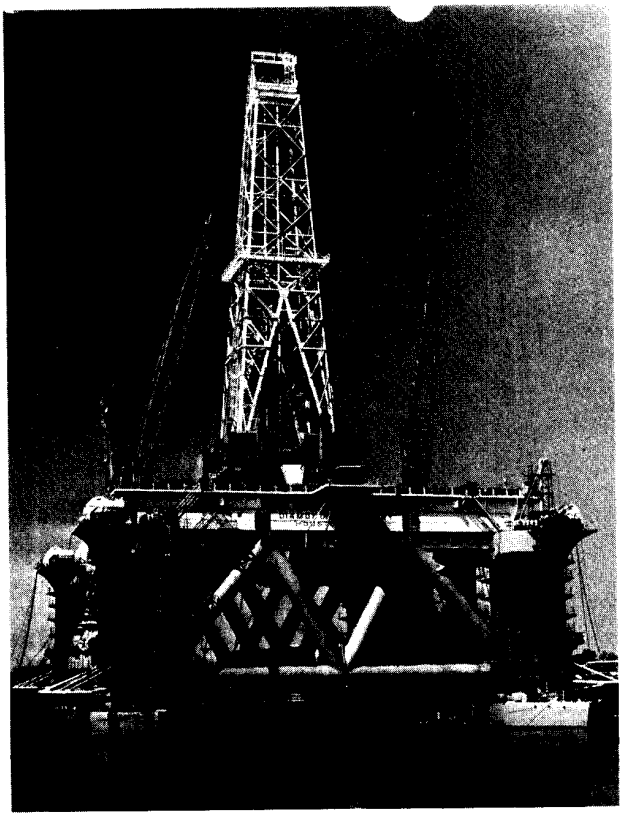
Quarters are provided for 54 persons.

The new jack-ups are scheduled for delivery in September 1975 and February 1976.

The semi-submersible will be constructed at the Alabama Dry Dock and Shipbuilding Co. in Mobile, Ala. This is the third Diamond M/Korkut designed semi-submersible construction contract to be placed with Alabama Dry Dock.

The first unit, *Diamond M Century*, was delivered in November 1973 (see *Ocean Industry*, December 1973, for details). A second unit is planned for delivery in August of this year.

The new twin hull column-stabilized vessel will be completely self-propelled. It will have an over-all length of 290 ft and a



DIAMOND M's NEW SEMI-SUBMERSIBLE will be larger than the company's first self-propelled semi-submersible, *Diamond M Century*. The unit is scheduled for completion in November 1975.

maximum beam of 200 ft. The vessel will be capable of working in water up to 600 ft (with provisions to work in 1,000-ft waters), and to drill up to 30,000-ft wells.

Delivery is scheduled for November 1975.

Diamond M Chairman and Chief Executive Officer Don E. McMahon said the company has executed definitive agreements in connection with the previously announced venture with a group of Norwegian investors with respect to the construction supervision and management of another self-propelled semi-submersible drilling vessel of the Diamond M-Korkut design. This Norwegian rig will also be built at Alabama Dry Dock and delivery is scheduled for July 1975. The rig will be owned by a newly formed Norwegian company in which Diamond M will have a 20% interest.

Rowan plans new semi-submersible

Rowan Companies, Inc., has announced that Rowan Int'l Inc., its 50% owned subsidiary, has placed a construction contract with Levingston Shipbuilding Co., Orange, Texas, for a $26 million semi-submersible.

The unit, *Rowan-Midland*, is designed for operation in 600-ft water depths and has a rated drilling capacity to 25,000 ft.

The platform consists of two parallel lower hulls with four vertical stability columns on each hull with vertical truss system of tubular braces supporting the main deck. The lower hulls are connected by four horizontal braces and four small diagonal braces. The vessel will measure 270 ft in over-all length, 210 ft wide and 100 ft from keel to main deck, with an operating draft of 50 ft.

The rotary table is at the center of the drilling unit above the main deck to minimize motion on the drill floor.

Design and construction drawings for the Rowan design concept were prepared by Earl and Wright, San Francisco.

Delivery is scheduled for the fourth quarter of 1975.

new developments to watch

Maretta Tubb

Homopolar generator shows promise

Revolutionary new unit is expected to achieve a power density greater that 1,000 hp per cubic foot

Westinghouse Electric Corp., under a contract with the Advanced Research Projects Agency (ARPA) of the Defense Department, has developed a novel, high-power density liquid metal current collector that paves the way for completion of a prototype 3,000 hp segmented magnet homopolar generator (SEGMAG). Westinghouse is building the machine for ARPA.

High-power versions of the SEGMAG are expected to achieve a power density greater than 1,000 hp per cubic foot. They will have applications that include ship and vehicle propulsion, high-power pulsing generators, energy storage, and power supplies for electrochemical processes.

Homopolar machines operate on the principle that voltage is generated by a conducting disc rotating in a magnetic field. As generators, these machines are capable of producing large amounts of direct current at relatively low voltage. The prototype, for example, will produce 100,000 amps at 24 volts.

The concept uses a series of small magnets to produce the field, and the conductor is a drum-shaped cage rather than a disc. This arrangement produces only a small field, less than 500 gauss, at the current collection sites in the machine.

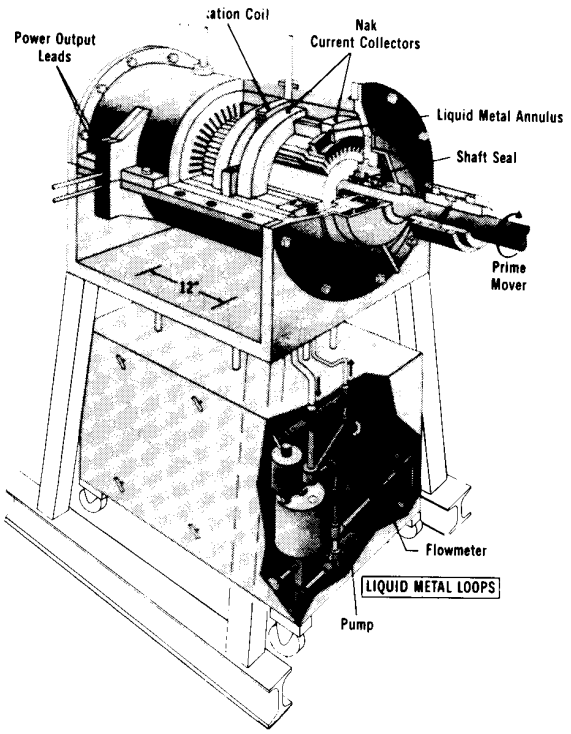
"This has greatly reduced the electrodynamic and magnetohydrodynamic forces that adversely affect the performance of any liquid metal current collector. Fluid dynamic stability problems were the most important design challenges," John Mole, who conceived SEGMAG and manages the over-all program for Westinghouse, said.

Carbon brushes, the current collectors ordinarily used in present-day generators and motors, are inadequate for the high-current densities involved in the SEGMAG—up to 20,000 amps per square inch.

The Westinghouse-ARPA system replaces carbon brushes with a liquid alloy of sodium and potassium metals called "NaK." The liquid makes contact with only a small portion of the rotor surface, rather than over the entire rotor as in most present homopolar designs using liquid metals.

A broad-scoped technology effort was required to support the current collector development. The use of NaK with its unique characteristics of high conductivity, low density, low viscosity and high chemical reactivity presented numerous complex problems associated with materials compatibility, liquid metal technology, cover gas maintenance and seal development.

Major problems overcome in the experimental program include the tendency for the liquid metal to be forced out of the annular collector gap, where it circulates at speeds up to 150 miles per hour, the incomplete filling of the gap by NaK resulting in discontinuous and limited electrical contact, the reactivity of the NaK with water vapor and oxygen contamination in the inert nitrogen cover gas, and the formation of aerosol by the viscous working forces in the NaK.



PROTOTYPE NEARS COMPLETION. This sketch depicts the prototype of a 3,000-hp segmented magnet homopolar generator that is nearing completion at the Westinghouse Research Laboratories.

The program indicates that a loop for circulating and purifying the liquid metal is essential for long-term collector stability.

Also it has shown that a sealing and cover gas system for maintaining the nitrogen purity must be provided, and that constructional materials for the machine which are chemically compatible with the NaK environment must be judiciously selected.

The current collector has been successfully tested over more than 150 hours, including a continuous run of 76 hours, in a full-sized subassembly that duplicates the important operating parameters of a SEGMAG current collector.

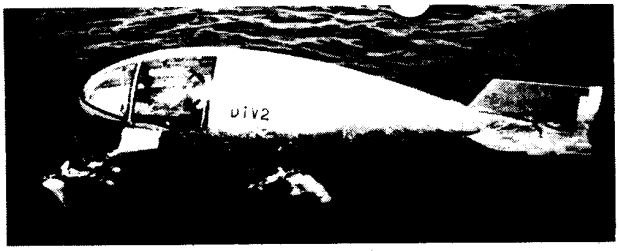
Versatile sub designed for fast long-range performance

A two-man wet submersible with a top speed of over 7 knots and a range of up to 50 miles is claimed by its British manufacturer, Cooke Bros. (Marine Projects) Ltd., to be one of the most advanced craft of its kind.

The *Diver Transport Vehicle (DTV2)* can be accurately trimmed to neutral buoyancy, allowing it to hover at depth, so that work such as the repair of buoy chains and the maintenance of data buoys can be carried out in mid-water. Easily handled and completely stable in operation even in strong currents, it can carry tools and power sources as well as crew support equipment. It features a maximum operating depth of 250 ft.

The *DTV2* is of semi-monocoque construction, with an aluminum frame, GRP shell and an acrylic cockpit which allows distortion-free viewing. A single lever controls the rudder and two 14-in.-square hydroplanes; diving and surfacing are effected by admitting water or compressed air to built-in buoyancy tanks.

Power is provided by either lead-acid or silver-zinc 12-v batteries giving 5 or 10 hours operation, respectively, at a cruis-



ing speed of 5 knots. Speed is infinitely variable, forward and reverse, by means of a simple throttle-type lever.

Being totally enclosed, the crew is protected from cold currents and undersea life, and can undergo decompression while under way. A built-in breathing system is incorporated; oxygen or mixed gas cylinder can be carried to give divers greater mobility and endurance. A full line of optional equipment is available.

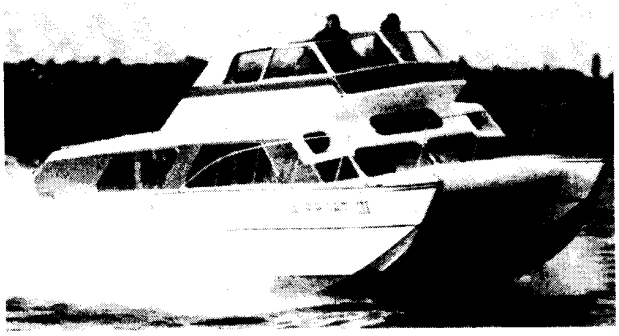
The 18-ft-long craft weighs about 1,800 lbs and can be used in pipe line and archaeological surveys, photogrammetry, geological and marine sampling and numerous other applications.

Airboat in trials on Puget Sound

A 38-ft airboat from the Aircushion Boat Co. Inc. is producing some outstanding performance records during trials on Puget Sound.

The craft has performed in 4-ft ocean chop at speeds of 35 knots with little or no roughness due to waves slapping the hull. The top speed of the vessel is in excess of 40 knots.

In comparison with other high performance type vessels the airboat is said to use about 20% less fuel per mile due to its reduced drag. This is because the hull of the vessel is only slightly submerged during transit. The air cushion supports the 16,000-lb weight of the vessel.



Power is provided by two 330-hp gas powered engines, with a third engine providing power to the air cushion.

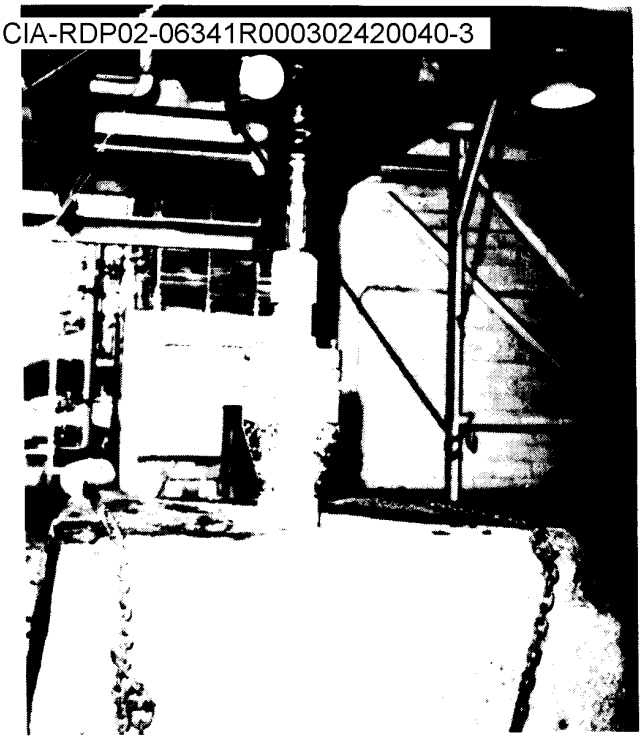
An alternate design is a twin diesel unit, water jet propelled with a 30-knot service speed in 4-ft ocean chop while carrying a 4,000-lb payload. Higher payloads can be achieved with slightly reduced speeds.

The design of the airboat can be adapted to other vessels such as work boats, commercial fishing craft and sport vessels.

Energy conservation strategy study

Braddock, Dunn and McDonald Inc. (BDM) of Vienna, Va., will conduct a technology assessment study on energy conservation for the National Science Foundation.

The $243,691 contract study is expected to take over 18 months and will focus on alternate strategies and methods for conserving energy.



Rock drill bit provides its own thrust

Foster-Miller Associates Inc. has developed a new bit that produces 90% of its own thrust.

The conical-shaped bit has roller cone cutters arranged in such a fashion that the rotating bit acts like a self-tapping screw.

The bit shown here requires less than 10% of the thrust of conventional bits of similar diameters.

Evidence of a hydrothermal field found at the mid-Atlantic ridge

Evidence of a hydrothermal field at the mid-Atlantic ridge has been found in an investigation involving a Texas A&M University scientist.

Dr. Robert Scott participated in the Third Trans-Atlantic Geotraverse cruise that discovered the Atlantic hot springs, located about 2,300 miles east of the Florida Keys.

He said the search for the feature started with one piece of rock dredged up last year.

"It showed strong indications of a circulation of water through the earth's crust," Scott said. The TAMU associate professor of geology said the hydrothermal field covers about 30 square kilometers.

"The water probably circulates in deep fractures associated with small-scale normal step faults parallel to the median valley of the mid-Atlantic ridge," Scott remarked.

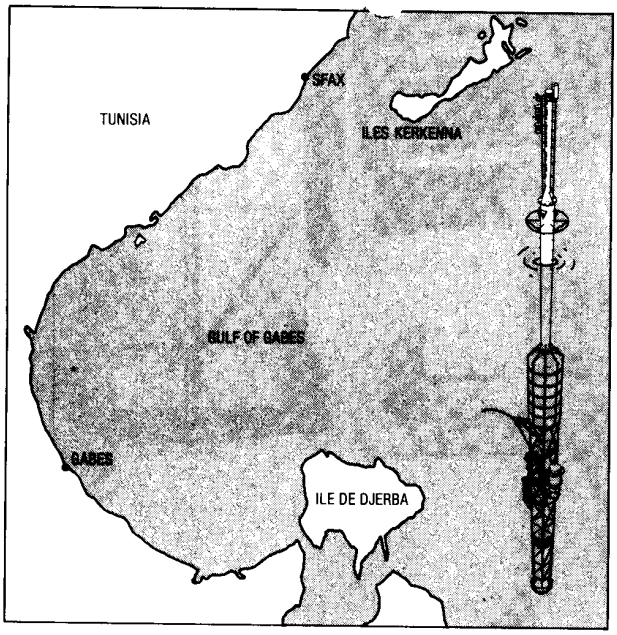
To test the possibility of a hydrothermal field, an integrated system of measurements was made on the November 1973 cruise.

Some of the material collected on the cruise will be sent to scientists in other countries for study. Also, an extensive chemical isotopic and mineralogical study of the sediments and rocks is planned.

Buoy transmits data

Comex Equipement's new meteorological and oceanographic data buoy is moored in the Gulf of Gabes, about 80 kilometers off Sfax, Tunisia. The buoy transmits wind speed and direction, swell amplitude, buoy heave and the voltage level in the battery power supply to a shore-based recording station for 14-minute periods every four hours.

The device uses a spar buoy type structure for its autonomous



measuring station at sea. Basic components are a large float, a small secondary float and a mast which supports the meteorological instruments.

A shore-based recording station, in Sfax, decodes the signals transmitted by the buoy and the various parameters are recorded on a graphic analog recorder.

The system is designed for easy installation and can operate unattended for up to six months. Batteries in the power source have a zero weight in water and can be easily installed by divers.

Private ownership of deepwater ports and refineries studied

The Coastal Plains Regional Commission has signed an agreement with seven oil companies to study the economic and environmental feasibility of privately owned deepwater ports and refinery facilities in North Carolina, South Carolina and Georgia.

Companies participating with the commission include Ashland Oil Inc., Shell Oil Co., Cities Service Oil Co., Exxon Pipeline Co., Mobil Oil Corp., Shell Oil Co. and Tenneco Oil Co.

The $300,000 study cost will be shared by participating companies and the commission.

Selection of a professional study team will be conducted by a Management Committee composed of representatives from the three states. The study will determine the economic and environmental feasibility of deepwater ports and refineries and will also assess the potential economic and land-use impact of such facilities.

The study team will be under the direction of J.K. Schafer, a development planned with the commission. A final report is scheduled for completion within six months.

Underwater laboratory used for coral reef studies

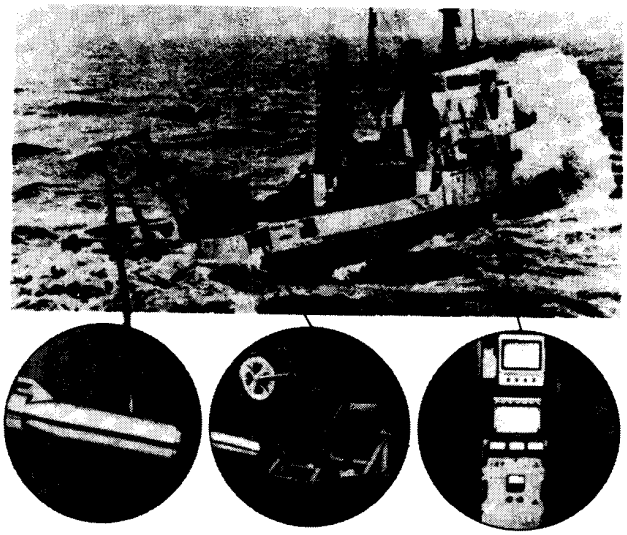
Teams of diver-scientists from France, Germany and the United States are studying environmental factors affecting the health of coral reefs in a series of continuing underwater investigations.

The NOAA-supported projects are being carried out in a 16-ft-long and 8-ft-diameter Hydro-Lab. The facility houses up to four persons for a week. It is operated and supported by the Perry Foundation, Inc., and the Bahama Undersea Research Foundation on a non-profit basis.

Oil and gas seep locator for offshore exploration

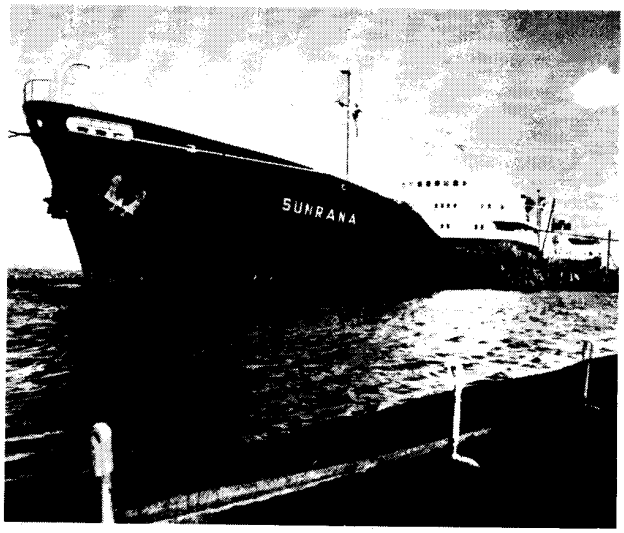
Some of the world's greatest oilfields—on land and offshore—have been discovered as a result of oil seeps.

For this reason the location of oil seeps is an important phase of offshore geophysical exploration.



Now it is possible to lease an oil and gas seep locator to display on a marine seismic survey vessel.

The system, available on a lease basis from InterOcean Systems, Inc., records the data on strip chart analog records as well as digital magnetic tapes.

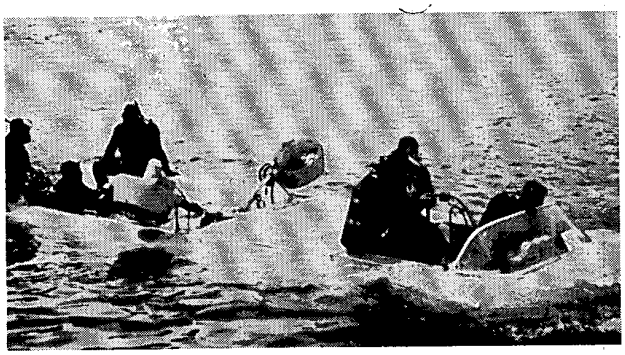


SEABOOM SURROUNDS TANKER. This oil containment apparatus is being used at the Tiverton, R.I., dock to contain any spills or leaks which might occur during oil transfer operations. The apparatus, called Seaboom, rides 12 in. above the water and 24 in. below the water. It was developed by Submarine Engineering Associates with technical assistance from B.F. Goodrich.

Ocean-going car pool

Since this is the only underwater pickup truck in existence, Navy divers have to share transportation to offshore work sites aboard the Construction Assistance Vehicle (CAV).

The revolutionary craft was conceived and developed by the Civil Engineering Laboratory (CEL), Port Hueneme, Calif. After the laboratory completed its program of fabricating, testing and evaluating, the unique craft remained out of service



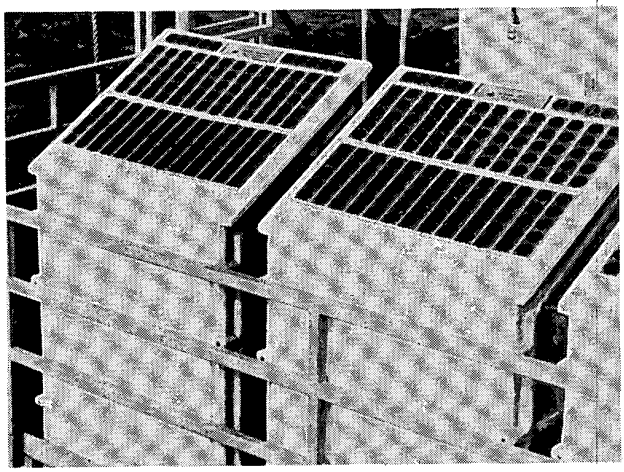
Official U.S. Navy photo

for about two years. But now the CAV is on active duty once again. It is supporting the marine sciences program at Oregon State University.

A catamaran hulled vehicle, the CAV can deliver up to 1,300 lbs of cargo, equipment and divers to and from construction sites to a maximum depth of 120 ft. It weighs 18,000 lbs, has a 10-ft beam, and a top submerged speed of 2.5 knots.

Solar energy supplies power for warning device on platform

Continental Oil Co.'s Marine Division is testing solar panels, similar to those that power Skylab, as a supplemental power source on a production platform off Louisiana. The panels convert the sun's energy into electricity to recharge storage batteries that operate warning devices to alert ships of the platform's position.

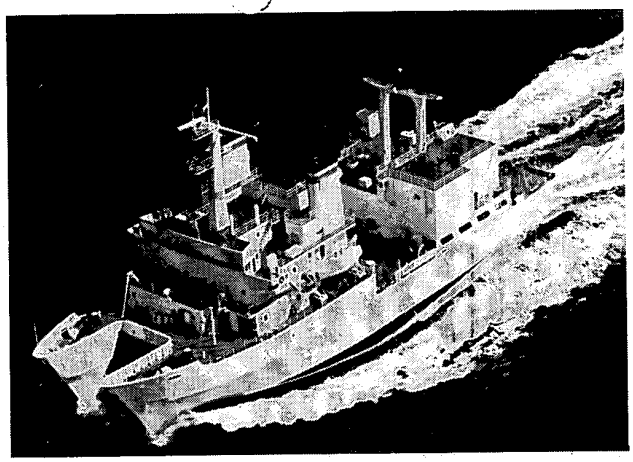


Contract for geophysical data in Gulf of Mexico

The Western Geophysical Co. of Houston has been awarded a $237,930 contract by the U.S. Geological Survey, USGS, Department of the Interior, to provide non-exclusive, proprietary, seismic reflection data in the Gulf of Mexico.

The contract will provide about 10,000 line miles of data between the 600 and 3,000-ft water depth contours on the entire continental slope offshore from Texas.

The contract is part of an accelerated effort by the USGS to evaluate offshore acreage as to its potential for future lease sales. Since this geophysical data acquisition program began in 1969, about $6 million has been awarded through about 50 contracts.



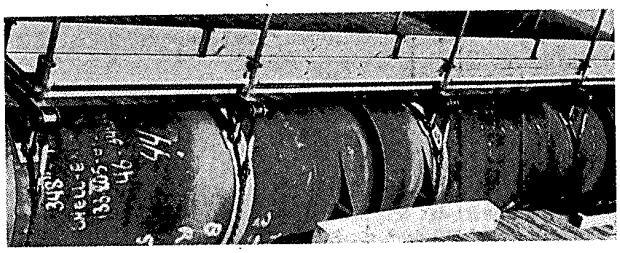
MARINE FOG FORMATION STUDIES. Naval Research Laboratory scientists from Washington, D.C., are conducting studies into marine fog formation in the area of the Galapagos Islands aboard the laboratory's catamaran research vessel *USNS Hayes.*

Access equipment for rig construction

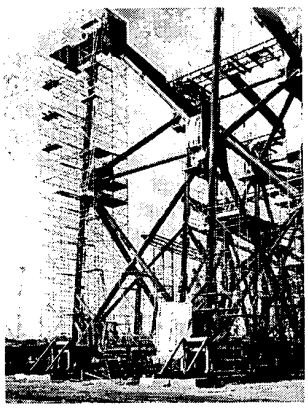
Access equipment for the construction and maintenance of large steel jackets and drilling/production platforms has been developed by Kwikform, Inc.

The equipment includes a specially designed friction clamp (patent pending) which allows mechanical connection of staging to steel structures without the need for temporary welding of attachments. They can also be used for tying access equipment to the main structure.

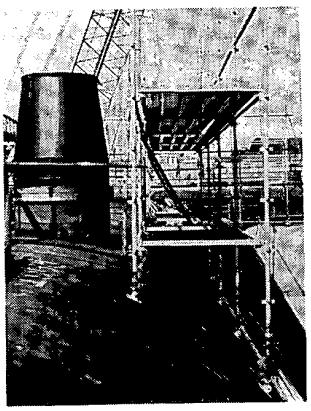
The equipment is being used extensively by Redpath Dorman Long and Laing Pipelines Offshore in the construction of platforms and substructures for both the Auk field and the Forties field.



FRICTION CLAMPS enable contractors to position work platforms above or suspended from a structure without the need for temporary welding operations.

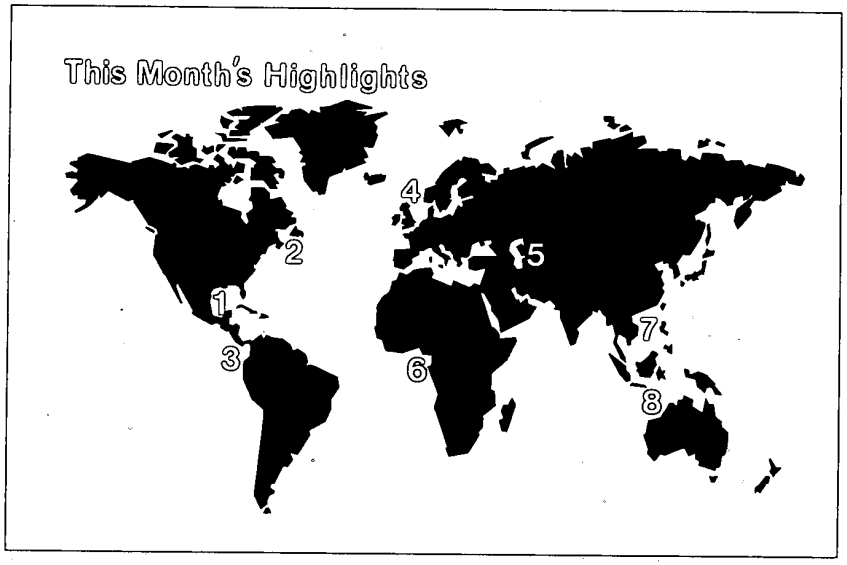


KWIKSTAGE SCAFFOLDING is erected to two end frames at Redpath Dorman Long's facility during the construction of a drilling/production platform.



SWIVEL BASE AND HEAD JACK solve Laing's problem of providing a work platform above floating tank.

GAS & OIL WRAPUP



1. United States

Lease plan draws plaudits

The exploration manager of Exxon Co. USA commended President Nixon for plans to increase U.S. offshore lease offerings from the current 2 to 3 million acres to possibly as much as 10 million in 1975.

R.W. Bybee told an Interior Department hearing in Houston: "We believe the industry for some time to come has the capacity to handle even more acreage than your original five-year program proposed. It will take some time to get tooled up and we'll need state and federal help in tooling for the big job ahead but all the companies need the acreage and your determined effort to maintain a schedule is what we need."

The hearing on a proposed May sale of 1,335,684 acres off the Texas coast was scheduled to last two days, but was completed in one day without opposition to the proposed sale.

Marathon will operate venture

Marathon Oil Co. will succeed Signal Oil & Gas Co. as operator for the SLAM and SLAMT groups off Louisiana, effective April 1.

Marathon said the move, applying to both exploratory and production activities, is designed to more effectively consolidate operations under the direction of one company. Marathon already acts as operator both off Texas and Louisiana on leases owned by certain other companies besides Signal.

Properties involved in the changeover include producing platforms in the Main Pass Block 306, West Delta Block 58 and the East Cameron Block 321 fields, along with associated onshore facilities.

Exploration partnership formed

Texasgulf, Inc., of Houston has assigned three-fourths interest in Tract 101 off Florida to Clark Oil Producing Co., Home Petroleum Corp., Pelto Oil Co. and Tesoro Petroleum.

Pelto and Tesoro each have 25% interest in the tract, Clark has 16⅔% interest and Home 8⅓%.

The tract, covering 5,760 acres, was purchased by Texasgulf in the Dec. 20 federal lease sale for a cash bonus of $4.13 million.

2. Canada

Atlantic potential eyed

Oil discoveries on Sable Island off the Canadian Atlantic Coast may well presage similar discoveries off the U.S. East Coast, according to the American Petroleum Institute.

API says the Sable Island Bank—like George Bank off New England, the Baltimore Canyon Trough east of the Middle Atlantic States, and the Blake Plateau off Georgia and Florida—contains large petroleum deposits.

Oil was found on the small island in 1971, the first oil and gas strike in the Atlantic of North America, and Canadians believe it will prove significant in meeting Canada's growing energy needs.

3. South America

Texaco hits off Colombia

The Colombian Division of Texas Petroleum Co., subsidiary of Texaco Inc., completed a significant extension to the offshore Chuchupá gas field in the Guajira region of northern Colombia. The well, Chuchupa-3, eight miles offshore, tested 8.8 MMcfd of gas. It is 2½ miles south of the field discovery, completed last November.

4. Europe

Japanese aid asked in North Sea

Britain would welcome Japanese help in bringing North Sea oil reserves to shore, according to Britain's industrial development minister.

Christopher Chataway, discussing increased Japanese investment in Britain, said:

"I've made it clear to Japanese industrials that we very much

welcome their participation in North Sea supply, and I pointed to a couple of areas where Japanese industry could be of help to us and speed the flow of North Sea oil."

Boundary agreement expected

An agreement was expected soon, as *Ocean Industry* went to press, establishing the boundary in the Bay of Biscay for Spain and France. The boundary also would fix the limits of certain acreage held by Exxon Corp. in the Spanish sector of the bay.

Lone Star joins Greece venture

Lone Star Gas Co. has agreed to participate in its first Mediterranean exploration venture when two wells are drilled off Greece this year.

The operator, with 75% interest, is Anschutz Corp. of Denver, Col. A Lone Star subsidiary, LSG Greece, has the remaining 25%.

Two wells will be drilled on two separate concessions of about 1.4 million and 600,000 acres. Both are near the large industrial city of Salonika, bordering the Aegean Sea.

5. U.S.S.R.

Fire destroys platform

The Soviet Union reported that fire destroyed a fixed platform in the Bakhar gas field, the Caspian Sea's most prolific. The fire occurred after separation of 6-in. production string with subsequent rupture of the well's casing.

6. Africa

Tests yield gas off Nigeria

The West German Deminex group found a gas structure between 7,545-8,200 ft in its Bilbari 2 well in Block 79 off Nigeria. The well tested gas at the rate of 16.1 MMcfd with 54-gravity condensate.

Amoco drills for acreage interest

Amoco Tanzania Petroleum Co. will participate in drilling four wells in Tanzania to begin earning a percentage interest in a petroleum exploration license held by the Italian state-owned company Agip. Percentage earned will relate to the amount spent by Amoco, and could reach a full-half interest in 14 million acres on and offshore Tanzania.

Two offshore wells are planned for 1974, with two additional undesignated wells programed for the following year. The initial well was spudded recently west of the island of Zanzibar by the rig *Gatto Selvatico*, belonging to Saipem, Agip's sister company in the ENI group.

Agip is operator for the joint venture program.

7. Far East

Agreement reached on disputed area

The governments of Japan and South Korea have signed an agreement calling for joint exploration and development of oil and gas in a portion of the East China Sea claimed by both countries. The area had been under dispute since 1968 and the agreement has been under negotiation the last two years.

Gulf of Siam test planned

Gulf Oil will use Zapata's drillship *Investigator* to drill a wildcat well in Block 9 of the Gulf of Siam off Thailand. The

vessel has been drilling for BP in the Makassar Strait off East Kalimantan.

BP drills in the Gulf of Siam

British Petroleum has begun a drilling program in the Gulf of Siam off Thailand using Atwood Oceanics' drillship *Gettysburg*. The first well was projected to 4,000 ft, and the rig was to move to the southern Gulf area to spud the 16-B-1.

Woodside-Burmah joins venture

Indonesia's Pertamina has approved an agreement between Australian companies International Oils and Woodside-Burmah providing for Woodside-Burmah to earn up to 65% working interest in International's production sharing contract with Pertamina.

As part of the agreement, Woodside-Burmah will carry out substantial seismic surveys offshore and geological surveys onshore. Two to four wells may be drilled, pending results of the surveys. The acreage comprises some 7,500 sq mi covering the Indonesian islands of Timor, Roti, attendant smaller islands, the Savu Archipelago and adjacent offshore areas to the 100-fathom depth.

Asamera gets Sumatra strike

Asamera Oil, operator for a group, has an oil discovery in northern Sumatra, east of the Tualong field. The strike tested 1,300 bopd from one interval, 1,890 from another. Development drilling is planned.

Acreage interest acquired

Champlin Indonesia Inc., subsidiary of Champlin Petroleum Co., has received government approval to acquire 38.8% interest in a production sharing contract off Irian Java, Indonesia. Champlin agreed to drill an exploratory well by March 1975.

Acquisition was from a group comprised of LVO of Indonesia Inc., Odeco Indonesia Oil Co., White Shield Indonesia Oil Corp. and White Shield Exploration Corp.

Tesoro confirms discovery

Tesoro Petroleum said it has completed a well that confirms a new zone discovery in the Juata field on Tarakan Island, Indonesia. The well tested 845 bopd and is on production to an export terminal. A third well is being drilled, and additional sites are being prepared.

8. Australia

Woodside-Burmah logs gas, oil

Woodside-Burmah logged oil and gas shows at its Lambert 1 wildcat on the Australian Northwest Shelf on a test of a perforated interval between 3,101-3,106 ft. On completion of the well, the drilling vessel *Glomar Tasman* will drill the Depulch-1 wildcat on Permit WA-29-P in the Beagle sub-basin off Western Australia.

Esso-BHP leaves Otway basin

Esso-BHP has withdrawn from the Otway basin off South Australia and returned to the Bass basin near the entrance to Bass Strait. Two dry holes were drilled in Otway basin. The drillship *Glomar Conception* was to move to Toolka 1, Permit T-3P, in the Bass basin.

New type of floating storage for Ashtart Field off Tunis

J.D. Bax and **W. J. van Heijst,** SBM Inc.

Increasing world hydrocarbon consumption is forcing oil companies farther offshore in their search. The problem which invariably crops up after the discovery of oil is how to export it—either by constructing a sealine to shore and utilizing conventional land-based storage and related terminals, or by keeping the crude near the field by installing offshore storage and loading facilities.

The offshore solution is in many cases the optimum one, and floating storage in particular has been used widely. Apart from a few exceptions (in the Gulf of Mexico and at the Fateh field off Dubai) when spread-moored storage has been, or is being used, all these offshore floating storage facilities employ an SBM as the mooring system. The advantage of this type mooring is that it allows the vessel to weathervane around the buoy and assume the position of least resistance to wave, current and wind forces.

One of the first applications was off Qatar, where Shell moored the 38,000-dwt *Zenatia* to an SBM and used it as floating storage for their Idd El Shargi field.

Off-taking tankers moored alongside the *Zenatia* to export the crude. This configuration performed quite well for some years until production justified a pipe line to shore. During this period, storms with 25-ft waves and 70-knot winds were weathered without difficulty.

After this successful pioneering by Shell, other oil companies recognized the merits of using an SBM for mooring a permanent storage tanker, and quite a number of these floating storage systems are, or will soon be onstream (see Table 1).

Although the systems listed perform very well, a closer look at the operating records indicates that from the cost angle, some improvements could be made, especially in view of the following:

- The necessity for careful and frequent maintenance and replacement of nylon mooring ropes and floating hoses.
- The need for operating main engines or bow thrusters in order to prevent the vessel hitting the buoy.

Experience has shown that during

TABLE 1 — Floating storage systems

Company	Location	Capacity	Type
UOAC	Cyrus Field	900,000 bbls	Barge
ARCO*	Java Sea	55,000 dwt	Tanker
ARCO	Java Sea	1,000,000 bbls	Barge
IIAPCO	Java Sea	1,000,000 bbls	Barge
Aramco	Zuluf Field	230,000 dwt	Tanker
Shell	Amposta	240,000 dwt	Tanker

* Replaced in July 1972 by a 1-million-bbl barge.

periods of calm weather the storage vessel has a tendency to "kiss" the buoy, consequently endangering the floating hose system between vessel and buoy.

In addition, there is always the risk that during changes of tide, when the vessel swings around the buoy to take up her new position, the vessel may hit the buoy.

For these reasons, the *Zenatia* off Qatar has always had back propulsion available, while the 900,000-bbl *Pazargad* off Cyrus field is fitted with bow thrusters driven by one of the loading pumps. This requires capital investment and affects operation costs.

It is clear that a floating storage system is developed which bypasses the above problems and at the same time retains the important "weathervane" capability of an SBM system, the economics of offshore floating storage will be significantly improved.

It was for this reason that SBM Inc., a member of the IHC Holland Group, envisaged the idea of incorporating the SBM in the tanker or barge, thus eliminating the floating hoses, nylon ropes and the necessity of back propulsion.

However, following engineering studies backed by tank tests in the Netherlands Ship Model Basin at Wageningen, this concept has somewhat changed. A concept where the tanker is attached to the buoy by a rigid arm was found to be a better configuration.

The degree of freedom of both buoy and vessel connection is limited: the rigid arm can only hinge at the vessel end along a horizontal axis. This arm is rigidly connected to the turntable which rotates on the buoy body.

This concept makes optimum use of the "weathervane" principle, since the rotating point of the system is more than 100 ft in front of the vessel, rendering it more sensitive to the continuously changing wave and wind directions.

When the storage vessel is at medium draft, the buoy lies horizontally. Due, however, to the rigidity of the buoy connection to the arm in the vertical plane, the buoy rolls with the vessel and is forced to tilt in order to accommodate the variations in the draft of the storage vessel.

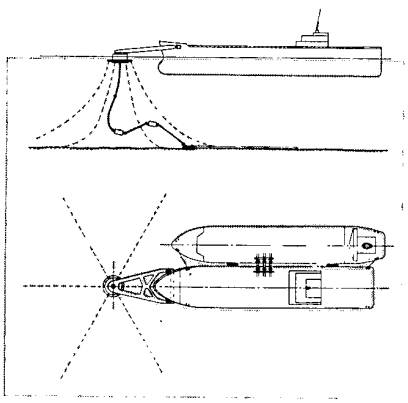
Compared with the size of the tanker and the rigid arm, the buoy dimensions are small and the forces and bending moments necessary to tilt or roll the buoy are therefore limited.

The box construction which combines large bending stiffness with torsional stiffness has been chosen for the rigid arm design.

Extensive model tests on different types of storage vessels in varying water depths and sea conditions (the 100-year storm) have demonstrated that the system is practicable. By optimizing the anchor chain layout, buoy dimensions and rigid arm layout, the mooring forces in the anchor chains and the rigid arm construction were brought below predetermined limits and fully within the bounds of normal shipbuilding practice.

These tests also confirmed that export tankers moored alongside the SBS could continue operation in 14-ft waves without causing excessive mooring stresses.

Single Buoy Moorings Inc. is already in the process of constructing the first SBS for the Societe Nationale de Petroles d'Aquitaine, and the installation of the system in the Gulf of Gabes (Tunis) has been completed. In this particular case, the 70,000-dwt *Torrey Canyon* will be modified to accommodate the mooring arm. By using this existing hull, it is possible to get the SBS onstream within 11 months of the order date.



Mooring of off-tankers alongside the SBS has been tested to determine maximum operating conditions.

ACKNOWLEDGMENT

Based on an article published in the IHC Offshore Division *Oil Report*, Vol. 17.

Research fleet enlarged at Texas A&M facility

Visitors to Texas A&M University's Pelican Island campus of the Moody College of Marine Sciences and Maritime Resources aren't seeing double when they view the dock area of the campus.

The two sparkling new ships tied near the *T/S Texas Clipper* are sister ships, the first of a new class of oceanographic research vessels constructed for the Navy in New Orleans, La.

The *R/V Gyre*, newest addition to the Aggie "Navy," was joined this week by the *R/V Moana Wave* as the Hawaii-bound ship arrived for partial outfitting at Pelican Island.

Dean Letzring, research scientist at the Galveston campus of TAMU, noted that the *Wave* will receive sonar transducers and other navigation and scientific gear while docked at Pelican Island.

"The *Wave* is being delivered to the Institute of Geophysics at the University of Hawaii," Letzring noted. "Some of their technicians have been sent to aid our crew in equipment installation."

He added that equipment manufacturers have been shipping gear to Galveston to be stored by TAMU until the ship arrived. One major unit, a portable laboratory van to be mounted on the ship's working deck, arrived Thursday in duplicate, with one unit being installed on the *Gyre* and the other on the *Wave*.

The new ship will be skippered by Capt. Charles Billings and is scheduled to depart Galveston for Hawaii, via the Panama Canal. Letzring said a full compliment of crew members from Hawaii will be on board.

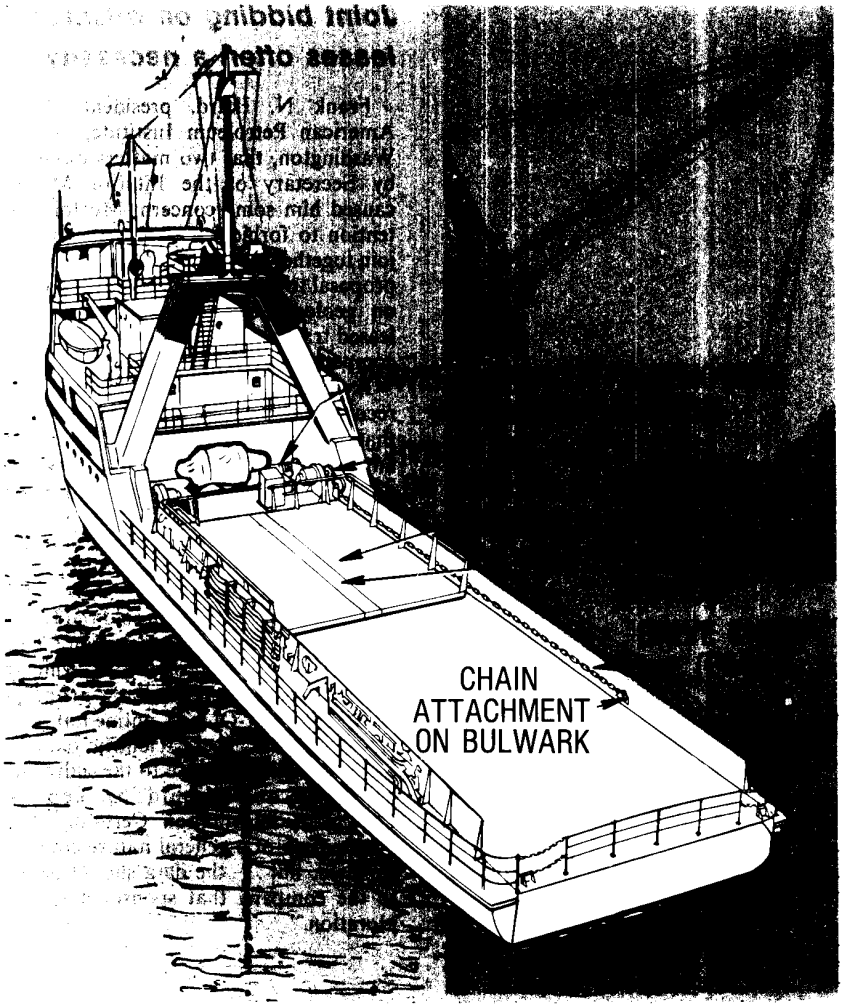
"The *Wave* will undergo shakedown tests enroute to Hawaii," he said. "She will also make some underwater television tests before she arrives in Honolulu."

Both ships were built under Navy contract by Halter Marine Services of New Orleans. They are officially designated as Auxiliary Geological and Oceanographic Research (AGOR) class vessels. The *Gyre* is numbered AGOR 21 and the *Wave* is AGOR 22.

Both ships have duplicate hulls, but the *Wave*'s topside is modified slightly to fit special requirements for oceanographic studies in the Pacific. The *Gyre* will operate primarily in the Gulf of Mexico and the Atlantic Ocean.

The temporary reunion of both vessels, according to Letzring, is probably the last time they will be docked side by side.

The ships, costing $1.8 million each, will accommodate 10-member scientific parties and 11-man crews. The twin-screw, steel-hull ships will cruise at 12 knots with a range of approximately 8,000 miles.



Rolling deck for supply ship designed for work in heavy seas

A rolling platform deck on a supply vessel has been designed to facilitate deck cargo operations to rigs working in heavy seas.

The platform, designed by Central MacGregor Ltd., is comprised of an open steel framework with thick replaceable wood sheathing fitted on top. High side supports retain cargo such as drill pipe, tubular items, etc. The platform rolls on wheels or rollers and is moved by hydraulic winches on the platform, port and starboard, driving on fixed chains.

Hydraulic power is provided by a power pack mounted on the platform structure. The basic design load capacity of the platform is 350 tons distributed over 15 m x 9 m, which can be tailored to suit the individual dual ship's requirements.

The platform is mounted in three sections, making it readily interchangeable between vessels. An extendable center section allows the total platform width to be adjusted to the vessel's beam.

Shipboard connections are kept to a minimum, the only requirement being the traction chain anchorage, platform buffer stops and electric power connection with flexible cable. The hydraulic power pack is completely integral with the platform.

$10 million construction contract awarded for tugs

Equitable Equipment Co., Inc., has been awarded a contract of approximately $10 million by Nolty J. Theriot, Inc., to build four 149-ft, 6-in. twin screw, 8,500-hp ocean-going tugs, with fixed propellers and stainless steel kort propulsion nozzles. They will be built to ABS Maltese Cross A-1, Unlimited Ocean Towing Service, Ice Class C-1, AMS.

The estimated total cost, including owner-furnished equipment of the tugs, exceeds $14 million. The contract for these four tugs and three identical tugs contracted in January 1973 brings to seven the total of such vessels to be built by Equitable for Theriot with an estimated total value of approximately $25 million.

Republic of China orders 12 supply vessels

The Danish shipyard Arhus Flyde dok A/S, which specializes in series production, has received an order for eight supply vessels from the People's Republic of China.

Four additional vessels are on order with Hitachi, according to trade reports.

The supply vessels can be outfitted as seismic research ships before they are put into service to offshore rigs.

Power plant cooling water could boost energy supply

One way to increase the supply of energy might be to explore the possibility of using the warm water which flows from electric power plants.

The water, usually taken from a nearby river, lake or ocean bay, is used to cool the condensers of the power plant. The water is returned to its source several degrees warmer which can be a problem or it can be a resource—a vast one. More research is needed to find constructive uses for waste heat. Experiments and projects now under way may point the way to more efficient energy use in the future.

Among the uses to which warm water has already been put:

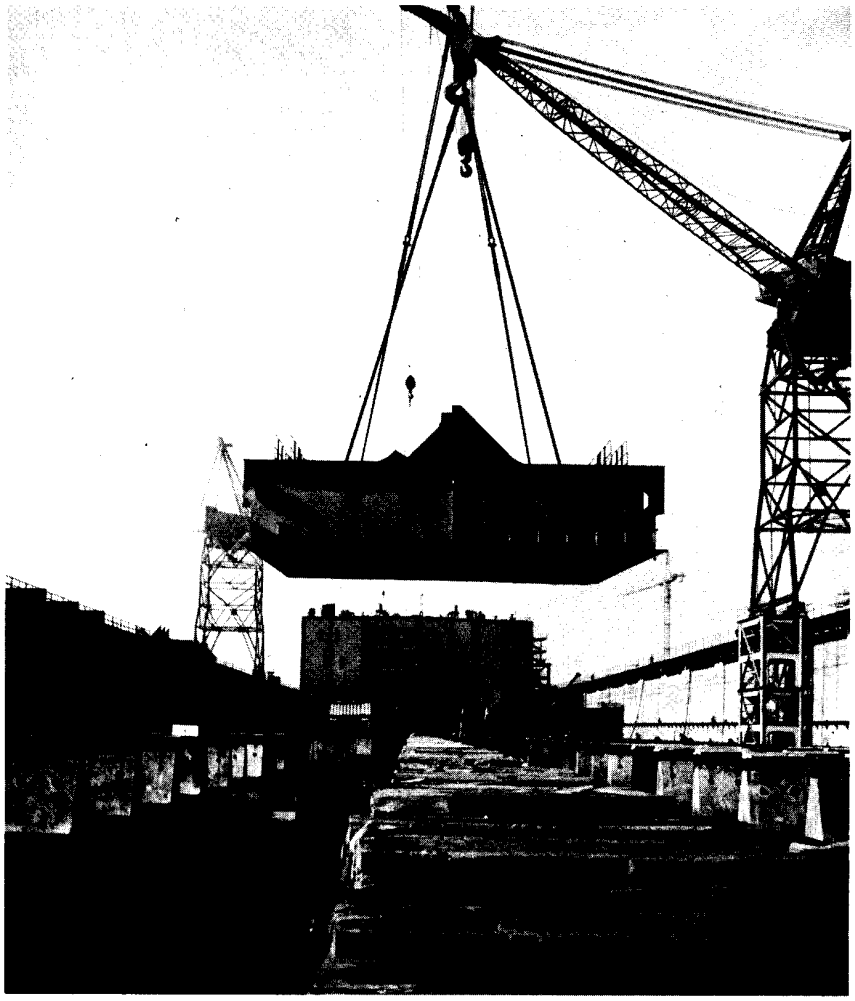
- Heating experimental greenhouses operated by Dr. Merle H. Jensen of the University of Arizona's Environmental Research Lab. Dr. Jensen humidifies, heats and cools his air-inflated greenhouses with waste water channeled through long plastic tubes.

- Controlling the environment in open-field agriculture. In Springfield, Ore., fruit and nut trees sprayed with warm water were not damaged by frost, while half the unsprayed trees were damaged. At Oregon State University, cauliflower and corn yields have been increased by more than 50% by raising root and soil temperatures.

- Raising oysters 12 months a year. The idea was developed when a Long Island power company consulted the New York State Department of Environmental Conservation on the possible effects of warmed sea water on marine life. The result—an oyster hatchery on the discharge lagoon.

Although waste water is a resource of large potential, there are problems which must be overcome, says *Petroleum Today*.

Most power plants are located near cities, while many of the proposed uses (for warm water) are agricultural or aquacultural—far from cities. Low-grade heat has to be used close to its source, otherwise the heat is dissipated during transportation.



The first keel section for the largest vessel ever constructed in an American yard is swung into place at Bethlehem Steel's Sparrows Point, Md., shipyard. The 265,000-dwt tanker is the first of five under contract at the yard. It will be delivered to Boston—VLCC Tankers, Inc. It is being constructed in the yard's 1,200-ft-long building basin which is capable of constructing tankers of over 300,000 dwt.

U.S. gas industry plans $2.3 billion research for five-year period

More than three-quarters of the U.S. natural gas industry's total research budget of $2.3 billion for the next five years should be geared toward development of synthetic natural gas (SNG), according to the American Gas Association (AGA).

"Conversion of coal to SNG represents a major opportunity for the gas industry to increase its gas supply over the coming decades based on enormous available coal resources and existing technology," AGA Chairman Herbert D. Clay said.

A recent report detailed the full technological requirements of the gas industry for the next 25 years in three progressive time frames.

Clay emphasized, "While AGA has for several years pointed to the seriously declining availability of proved reserves and the steps needed to reverse that trend, U.S. potential for new supplies of natural gas from conventional and novel sources is estimated to be in excess of 100 times today's annual rate of consumption."

Over three-quarters of the utilization funding called for in the report should be for continued development of efficient natural gas fuel cells for residential, commercial and industrial markets.

An increase in natural gas supply through the development of improved exploration and production techniques utilizing existing technology will be emphasized over the next five years, according to the report.

Major objectives of the liquefied natural gas program are centered around safety, reducing the possibility of environmental damage, and improved measurement technology.

Joint bidding on offshore leases often a necessity

Frank N. Ikard, president of the American Petroleum Institute, said, in Washington, that two matters discussed by Secretary of the Interior Morton caused him some concern: Morton's intention to forbid large oil companies to join together in bidding on leases; and his proposal to require more rapid disclosure on geologic and geophysical data on leased tracts in order to increase bidding competition.

Ikard's feeling is that "a review of the record over the past 10 years will show that there is already keen competition among bidders. In many instances bidding consortia were the only possible way to raise the huge amounts of capital for the bonus payments, and for the necessary geological exploration and eventual development."

The API president also told the House Subcommittee on Immigration, Citizenship and International Law, which is investigating present and proposed development of Outer Continental Shelf resources, that "these scientific data are gained at great expense to the individual company and should be kept as proprietary information. Certainly some information of a general nature could be supplied, but . . . the data should belong to the company that sponsored the exploration."

Todd signs tanker contracts for $136 million

Todd Shipyards Corp. announced that it had signed contracts for the construction of four 89,700-dwt tankers at approximately $34 million per vessel. Two of the tankers will be built for subsidiaries of Overseas Shipholding Group, Inc., and the other two are to be constructed for affiliates of Seres Shipping, Inc. U.S. government commitments for guarantees under Title XI of the Merchant Marine Act of 1936, as amended, have been issued for each of the four vessels.

The vessels, to be built at Todd's Los Angeles Division, will be 894 ft long, with a beam of 105 ft, 9 in. and a draft of 49 ft. They are of the San Clemente class powered by steam with a shp of 24,500. Delivery of the first vessel will be in March 1977 with the balance at four-month intervals thereafter.

With the award of these contracts, Todd will proceed with the last phase of its program to increase the capability of its Los Angeles Division. Shipbuilding ways are being lengthened and widened to accommodate vessels up to 100,000 dwt. Also included are increased heavy lift capabilities, outfitting and other related production improvements.

Experts from 75 nations will set pollution standards

Experts from 75 nations will meet May 13-17 at the Department of Commerce's National Bureau of Standards (NBS), Gaithersburg, Md., to explore mutual problems and work out guidelines for standardized oil pollution measurement techniques.

The Marine Pollution Monitoring (Petroleum) Symposium and Workshop is co-sponsored by three Department of Commerce agencies—NBS, the NOAA and the Maritime Administration (MarAd). The Symposium and Workshop's working guidelines will be hammered out under a plan developed last August by the joint Intergovernmental Oceanographic Commission/World Meteorological Organization (IOC/WMO) Planning Group for the Integrated Global Ocean Station System (IGOSS). The IOC is a United Nations Educational, Scientific and Cultural Organization (UNESCO) affiliate.

Hotel headquarters for the conference will be at the Shoreham-Americana in Washington, D.C.

Fluor will manage $75 million Java Sea NGL plant

Atlantic Richfield Co. and Fluor Ocean Services, Inc., Houston, have announced the signing of a letter of intent whereby Fluor would carry out project engineering management for a $75 million natural gas liquids (NGL) plant to be built in the Java Sea offshore Indonesia.

As previously announced, construction of the 25,000-bpd complex is expected to begin in mid-year. It will operate with crude oil produced from the Ardjuna field, about 90 miles northeast of Jakarta. The plant will be the world's first totally offshore facility for the recovery, storage and loading of NGL, an Atlantic Richfield spokesman said.

Working on the project with Fluor and responsible for process design will be the Houston Division of Fluor Engineers and Constructors, Inc. Both are subsidiaries of Fluor Corp., California.

Atlantic Richfield Indonesia Inc. is operator for a group of American firms which holds a production sharing contract covering 16,000 square miles in the Java Sea with Pertamina, the Indonesian state-owned oil company. The other participants are Independent Indonesian American Petroleum Co., a subsidiary of Natomas Co.; Carver-Dodge Oil Co., a subsidiary of Reading & Bates Offshore Drilling Co.; and Ramah Properties, a partnership composed of Warrior International Corp. and certain subsidiaries of Tidewater Marine Service, Inc.

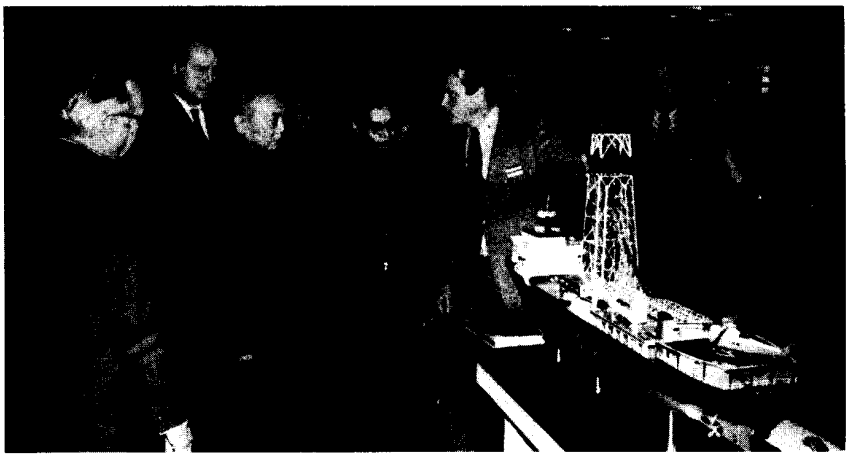
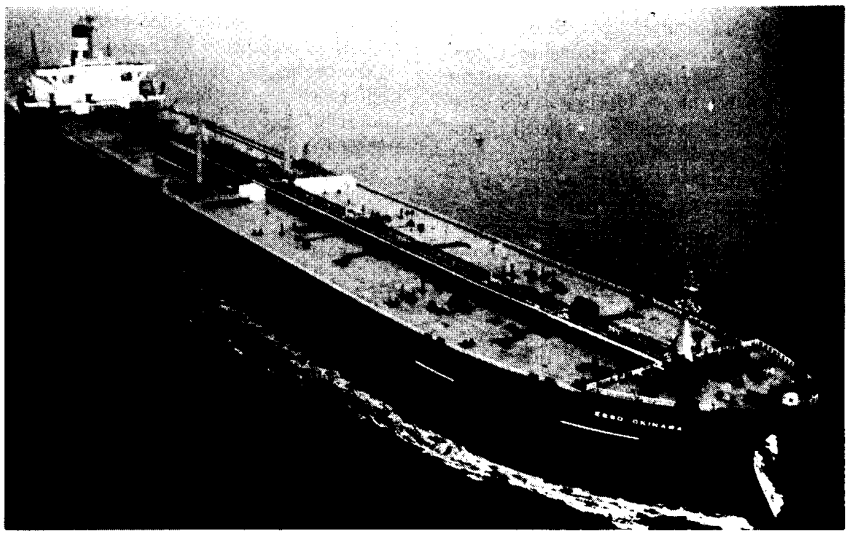


Photo with permission of H.J. Jansen, IHC

Chinese Vice President Hsien-nien, at the IHC Holland stand at the Netherlands Industrial Exhibition in Peking, examines the *D.P. Drillship*, as J.D. Bax of IHC explains its capabilities. The People's Republic of China has 30 dredges on order with the firm at this time.

OIL SUPERVISOR, 105-ton mooring launch is loaded aboard Guinea Gulf Line's *Pegu* for shipment to West Africa for Ocean Inchcape Ltd. (OIL). Three such units will be used by OIL (Nigeria) Ltd. to operate two marine service contracts for the Shell BP Petroleum Co. of Nigeria.



NKK DELIVERS *ESSO OKINAWA.* *Esso Okinawa,* a 255,000-ton supertanker, has been delivered by Nippon Kokan to Esso Tankers, Inc., of Liberia, the first of three such vessels ordered by the firm. The new vessel is 1,109 ft in length, with a beam of 170 ft and a draft of 68.5 ft. It has a service speed of 15.4 knots.

New all-weather lamp for fog penetration shown aboard the Portland, Maine, pilot boat after successful testing by Portland Pilots, Inc. In the group are Air Commander Richard Simonds, USCG marine inspection officer; Capt. Charles C. Dunbar, president of pilot group; Capt. Howard L. Wentworth, Jr., senior pilot, and Loren K. Hitchinson, president of Southworth Machine Co. which will manufacture the lamp for Safemark.

New pulsating light cuts through fog

A pulsating light beam that passes through the empty spaces between fog particles, raindrops, snowflakes or dust particles and can be seen approximately twice the distance of most other lamps has been under test in Portland, Maine.

The tests have been highly successful, according to Charles C. Dunbar, president of Portland Pilots, Inc. Field testing is being conducted by Southworth Machine Co. under a licensing agreement with Safemark Inc., the patent holders of the lamp. Harbor pilots have found the light particularly useful in approaching large ships in foul weather when standard searchlights and radar become relatively ineffective.

It is felt that the new Safemark all-weather lamp holds great promise for the offshore industry as well as the commercial marine field.

Foreign Buyers' Groups program formed

With the 6th annual Offshore Technology Conference, May 6-8, in Houston, as the springboard, the U.S. Department of Commerce is launching a new service to attract foreign buyers to the United States for specific business negotiations.

The new service, called the Foreign Buyers' Groups program, utilizes Commerce facilities both in the United States and overseas to set up direct communications between conference exhibitors and prospective foreign customers, and assist in advance arrangements for business appointments during the conference itself.

As part of the Foreign Buyers' Groups program, Commerce contacted officials of U.S. embassies in 23 foreign countries to determine the level of interest in the conference among businessmen in those countries. Inquiries brought 3,000 requests for conference brochures.

Once the embassies identify businessmen who want to attend the conference, their names and the names of the U.S. exhibitors they want to consult are forwarded to the department in Washington. The information then is relayed to the exhibitors. In turn, exhibitors are invited to contact Commerce if they wish to discuss sales or agency agreements with Conference visitors from specific foreign countries.

Additional information about the Foreign Buyers' Groups program may be obtained from Robert A. Taft, Office of Export Development, Bureau of International Commerce, U.S. Department of Commerce, Washington, D.C. 20230, telephone 202-967-3265.

Orbiting satellites provide positioning for offshore rigs

Magnavox has developed a real-time precise positioning system for offshore drilling vessels. It can automatically provide a position fix day or night, anywhere in the world.

The system receives messages transmitted from five polar orbiting satellites; thus, no signal range limitations or shore stations are required. These satellite messages are processed and a position fix is automatically printed out in latitude, longitude (and height).

Position accuracies of better than 10 m (in three dimensions) can be achieved by automatically obtaining approximately 10 satellite fixes.

A two-dimensional, latitude and longitude, position fix of 100 ft (RMS) can be achieved by computing a single satellite fix. This accuracy is achieved while the vessel is stationary or under way, provided speed and heading are known.

To provide a real-time position fixing capability the dual channel satellite receiver is connected to the computer and the satellite data is processed immediately and a position fix is printed. When a position is required, though not in real-time, a data recorder can be used to store the raw satellite data and a post computation of this data will provide the identical precise position information. The data-recording technique is often used in either inaccessible or highly remote areas for boundary or fixed site positioning.

EXIMBANK interest rate upped to 7%

The board of directors of the Export-Import Bank of the United States announced that the bank has raised its interest rate on loans from 6% to 7% per annum, effective Feb. 4, 1974.

The action of the board in raising the rate followed a recommendation to that effect by the National Advisory Council on International Monetary and Financial Policies.

Outstanding credit authorizations and preliminary commitments will be governed by the interest rate provisions of those authorizations and commitments.

Errata

On the North Sea map, page 20, in the February issue of *Ocean Industry*, the key symbols for drillships and jack-up rigs were switched.

In the February issue of *OIM*, the name of the Graythorp Works was misspelled under the illustrations on pages 25 and 26.

Armco to expand machinery division

A major expansion of domestic manufacturing capacity for oil and gas drilling rigs and their major components has been announced by the Machinery & Equipment Division of Armco Steel Corp.

Robert H. Etnyre, division president and Armco vice president, said the first phase of the multi-million-dollar expansion program will begin soon at the division's Gainesville, Texas, plant. First-stage facilities are expected to be in operation within the year.

"The next phase is planned and will immediately follow this initial expansion as early as possible in the second half of 1974," Etnyre said. "Our division plants are heavily booked well into 1975, and immediate expansion is essential if we're to continue to meet the demands of our customers."

Capacity increase projected. Goal of the expansion, which is scheduled for completion during 1975, is to increase division production of drilling rigs and major replacement components by approximately 50%.

"Our customers indicate that additional drilling rigs and replacement components are urgently needed in their efforts to make the United States self-sufficient in energy supplies," Etnyre said.

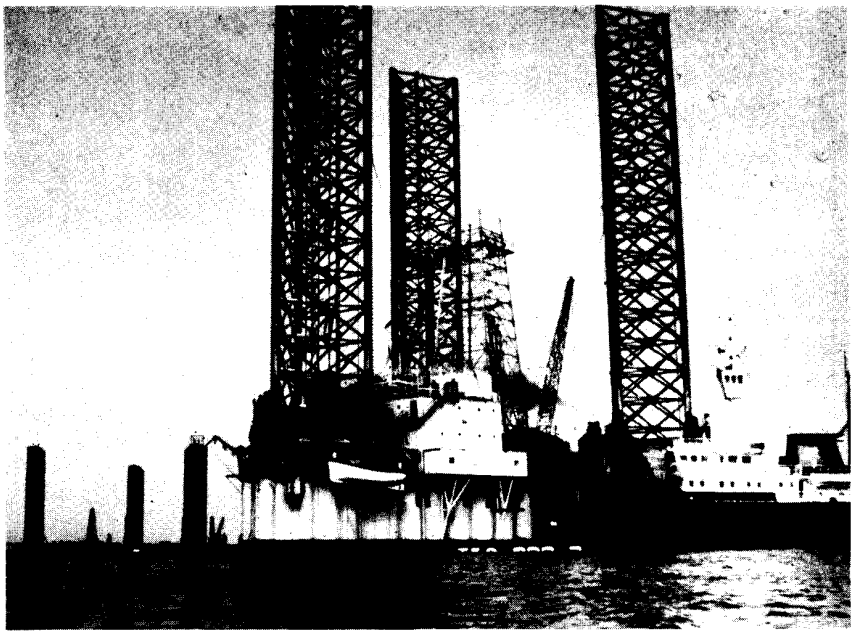
The Gainesville plant produces slush pumps, plunger pumps, torque converters, mooring equipment and pedestal cranes for drilling rigs. First phase of the expansion program will include installation of additional machine tools and heat-treating facilities as well as additions to plant buildings.

Demand for rigs growing. "Our market research indicates there are slightly more than 1,400 operable drilling rigs in the United States right now," Etnyre said, "with nearly 100% utilization. Our most conservative estimates show a need for 250 additional rigs."

He also pointed out that many of the existing rigs are older units, which indicates the probability of heavy demand for replacement components as well as the need for complete new rigs.

Shell orders 3rd deepwater platform for Brent field

Matthew Hall Engineering Ltd. has been awarded a contract by Shell U.K. Exploration and Production Ltd. for the design and engineering of module structures to contain production facilities, plant and equipment for its third deepwater platform. The multi-well drilling and production platform will be located in Shell's Brent field in Block 211/29 in the British sector of the North Sea.



***GATTO SELVATICO* SUPPORTED ON PONTOON.** A 9,900-mile rig tow was completed in 52 towing days. The towing vessel, *Sinader,* can be seen alongside.

Pontoon used to transport rig 9,900 miles in 52-day voyage

A 9,900-mile rig tow performed by the Dutch towage company International Transport Contractors B.V. (ITC) has generated a great deal of interest in both oil and insurance circles.

The operation involved the transport of Saipem's jack-up drilling unit *Gatto Selvatico* from Ravenna, Italy, to Dar-es-Salaam, on the east coast of Africa.

The tow, under the direction of F.J. Jonkman, was headed by an engineering team from ITC. Equipment used in the move included a 7,100-hp tug *Sinader* and an ocean-going pontoon, *Teo 336-3.*

Once on location, the pontoon was submerged and the 4,500-ton jack-up rig was moved into position above the pontoon. The pontoon was then refloated. Once this operation was completed, the *Sinader* took the pontoon in tow and traveled through the Mediterranean, out into the Atlantic and then via the Cape of Good Hope. The entire 9,900-mile trip was completed in 52 towing days at an average speed of 8 knots. During the tow, Force 10 gales were encountered while rounding the Cape. This reduced speeds to 2½ to 3 knots on several occasions.

ITC says the pontoon tow method can be used for moving larger rigs.

Lummus will supply deck modules for Frigg field platforms

Combustion Engineering, Inc.'s subsidiary, C-E Lummus, has received a contract valued at more than $7 million from ELF-Norge for offshore platform deck modules to be used in the exploitation of the Frigg field gas deposits in the North Sea. According to C-E Lummus president, William P. Orr, his company's operating centers in Paris and London will handle project management, process design, detailed engineering, procurement, cost control and scheduling responsibilities.

The Frigg field deposits were discovered by ELF-Norge in 1971 and are scheduled to be operational by 1975. The concessions, in the British and Norwegian North Sea zones, are operated by a French consortium comprised of ELF, Aquitaine and Total—with ELF-Norge assuming full responsibilities for development.

A 345-ft platform, slated for completion later this year, is being constructed by L'Union Industrielle et D'Enterprise (U.I.E.) at the St. Wandrille Yard near Le Havre. C-E Lummus will be responsible for four prefabricated modules to be mounted on the superstructure of the 24-well unit. Included will be drilling and wellheads, scrubber desanders, pig launching equipment and an accommodation module.

At GEC-Elliott we believe that shipping electrical power systems from the States to the North Sea is carrying things a little too far.

An understandable point of view when you realise that we operate from Rugby in England.

A mere 71 miles from the North Sea.

Naturally enough, this has certain advantages. Like when we supply equipment, you pay freight charges from Rugby.

Not Houston.

When our engineers arrive on site, they've had eight hours sleep.

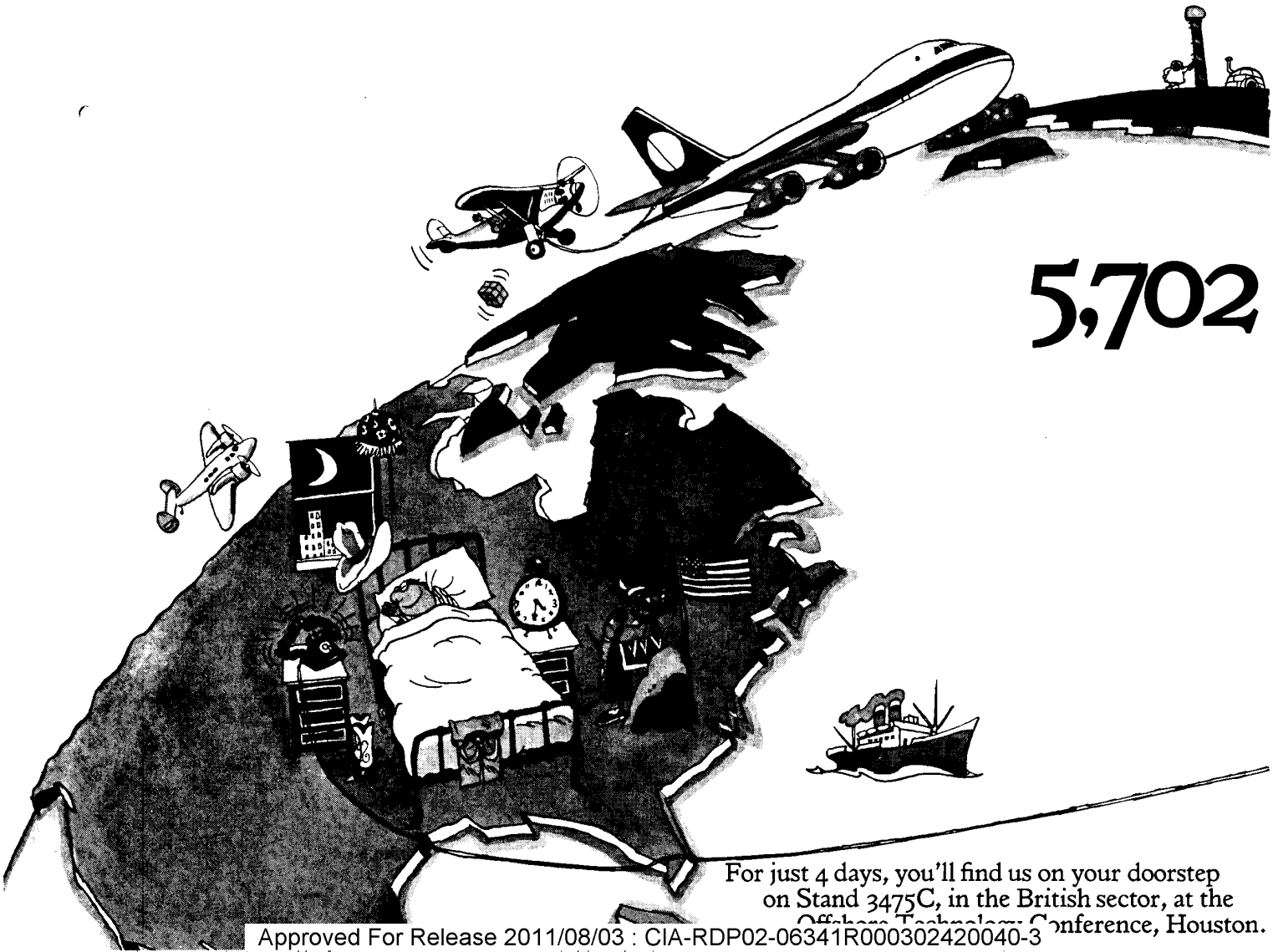
Not an exhausting eight hour, change-at-Washington D.C. flight.

And if we're rung with problems first thing in the morning, we're not five hours behind and tucked up in bed.

But service of this kind isn't much use unless the equipment we make is worth servicing.

So you may like to know that the world's largest drilling and production

American technology a long way to go



For just 4 days, you'll find us on your doorstep on Stand 3475C, in the British sector, at the Offshore Technology Conference, Houston.

platforms, being built for BP, ar eing equipped with our electrical systems and prime movers.

The same goes for two Norwegian rigs being built in Finland.

And we're one of only three companies in the world who have developed dynamic ship positioning.

Whilst North Sea oil is a recent arrival, our capability is based on many years of experience.

We're the l gest electrical manufacturing outfit in the UK.

And the GEC group includes names like Marconi, AEI, English Electric and Ruston.

If you'd like to know more about us, write to this address:

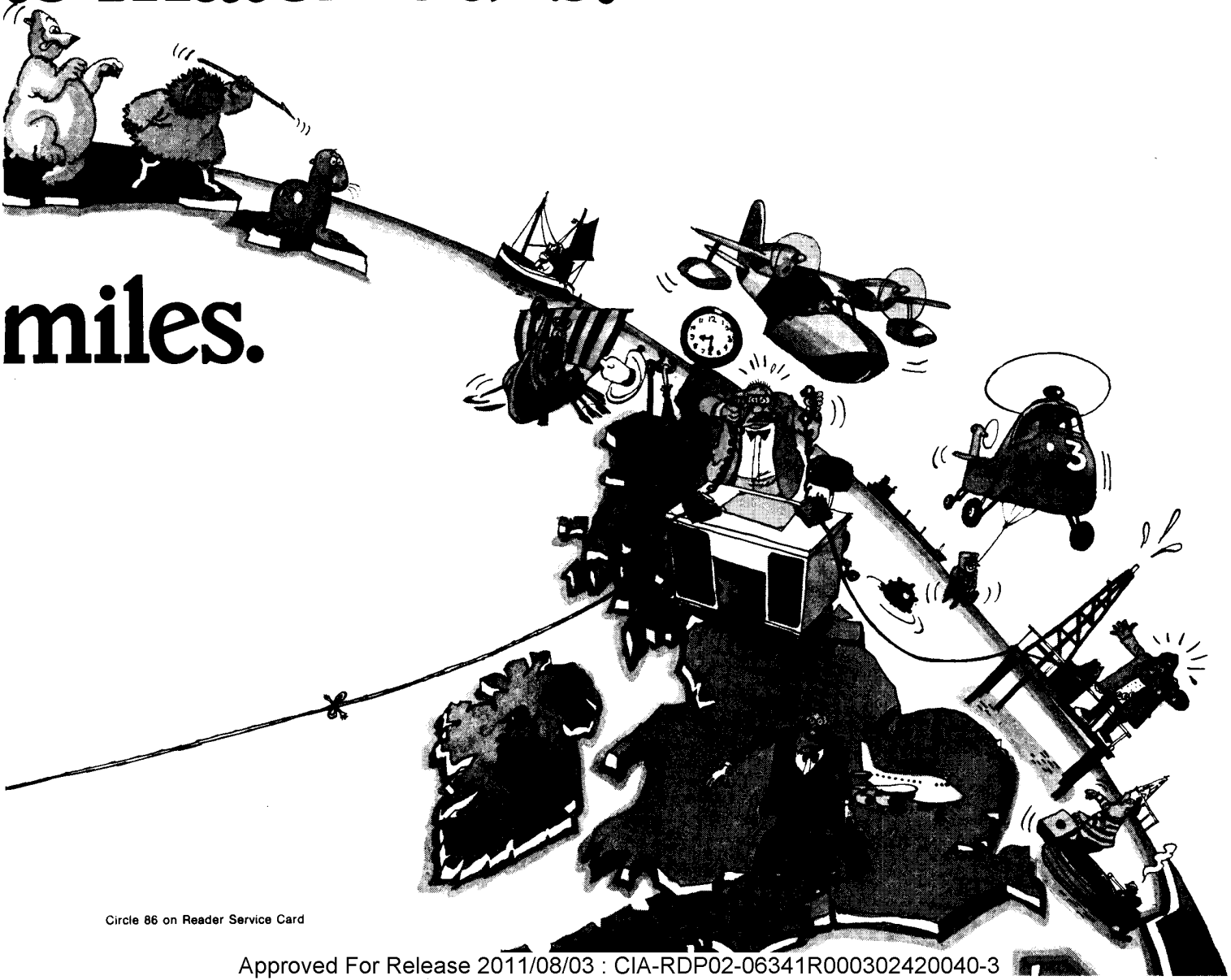
GEC-Elliott Electrical Projects Ltd, Boughton Road, Rugby, Warwickshire, England.

It's 71 miles from the North Sea.

GEC-Elliott Electrical Projects Ltd.
a GEC-Elliott Automation company.

in the North Sea has to match ours.

miles.



Circle 86 on Reader Service Card

North Sea security concerns authorities

The security of gas and oil production platforms in the North Sea is being examined by British defense chiefs.

Admiral Sir Terence Lewis said in Scotland that there was a peace time threat to North Sea gas and oil which was a wide and worrying subject.

He said that the threat of guerrilla or hijack attacks could not be ignored, and that although in peace time the civilian police had jurisdiction on the oil rigs, the Royal Navy stood ready to go to their assistance.

But in times of tension or war, this becomes much more the same problem as protecting merchant shipping and more difficult as the position of the rigs are well known.

Much thought had been given to the problem and he suggested oil companies could help by burying pipe lines in the sand bed in order to make them less vulnerable.

Seaforth orders four tug-supply vessels

Seaforth Maritime has placed an order for £ 7.2 million for two new tug-supply vessels with the Clydeside Shipbuilding Co., Scott-Lithgow and another two vessels of the same class with Drypool Engineering Co. of Hull, which has already built the first eight vessels of the Seaforth fleet.

This brings the Seaforth fleet up to a total of 12 supply ships and the latest vessels now ordered will require very low fuel consumption for free running and they will provide greater power for towing or anchor handling.

The specification will enable these new vessels to support year around drilling programs in the most severe conditions of the North Sea.

Delivery for the four vessels is scheduled for late 1975 or early 1976.

Australian drilling slumps

Preliminary figures for 1973 indicate oil drilling in Australia has slumped to its lowest point in 11 years.

The situation is expected to worsen in 1974, especially with the Australian government's decision to abolish oil drilling subsidies in June.

Figures for 1974 will be further aggravated by Papua New Guinea's independence.

Including Papua New Guinea, about 610,000 ft of exploration, development and service wells were drilled in and around Australia in 1973, a sharp dip from 972,434 ft in 1972.

The last year in which there was less oil drilling in Australia than in 1973 was in 1972, when 408,511 ft of hole were drilled.

Diving Industry—Challenge and goals in '74

D. Michael Hughes, chairman of the board, Oceaneering International

The past year. Rapid development of the offshore oil exploration program in the North Sea and further extension of drilling in Southeast Asia has led the diving industry into much greater diving depths than have been encountered in prior years. There has been talk for years of diving in 400 to 600 ft of water, but very little work done. During 1973 several drilling rigs operated in these water depths and, as a result, a number of support dives have been made.

The result of these dives has been to emphasize the lack of precise knowledge about short-duration diving beyond 400 feet. While the industry had some proprietary decompression schedules, they were never really put to the test. At this time they are being used in the field quite extensively.

Some disagreement exists regarding the actual limits for short duration diving as opposed to saturation diving; nevertheless, a large number of dives in the 500-600-ft range have been made, most of them successful. The ones which were not successful have pointed out the need for further work in "tuning up" the decompression profiles and in establishing new treatment procedures for new problems such as "vestibular bends". In addition, several contracts have been awarded to provide diving services in water depths up to 1,000 ft. To assure safe and efficient performance, a rather extensive research effort has been conducted to establish the adequacy of deep saturation decompression profiles for offshore operations, and to develop and prove the support equipment required to allow divers to work confidently and efficiently. Among these efforts was a 15-day saturation dive to a work depth of 1,000 ft with four days spent at bottom pressure. During this series, a complete test was made of diver life support equipment and communications as well as monitoring a number of important physiological functions.

What's ahead. This year will see a drastic increase in the requirements for diving at depths greater than 400 ft. While an actual working dive has not yet been made to 1,000 ft in the offshore oil fields, it will probably happen during 1974. The significance of this is the increase in proven operational depth of oil field diving from a maximum of 600 - 1,000 ft—an increase of almost 70%.

Also during this year will come commitments by diving contractors to provide services in water depths up to at least 1,500 ft. Requests for these services have already been received from major oil companies.

Deep dives in the Gulf. Even the Gulf of Mexico should see some very deep diving. For example, one major oil company has requested diving services in water depths up to 800 ft and leases are being planned to 1,500 ft.

Research planned for 1974 includes a very extensive program to finalize decompression profiles for short duration dives (up to one hour on bottom) to a maximum of 650 ft. In addition, research is already under way to eliminate the High Pressure Nervous Syndrome (HPNS) which debilitates the diver by producing tremors, dizziness and nausea when they are compressed rapidly to depths greater than 500 ft. If this problem can be overcome, it opens the possibility of "bounce" diving to depths as great as 1,000 ft. For the time being, however, saturation diving will remain the safe and practical way to perform work at depths greater than 650 ft.

Improvements will be made in saturation diving compression to increase the rate of decompression and to provide

safer and more comfortable life support for the divers during their stay in the chambers. Major steps will also be taken to improve gas mixing and conservation.

The pressing requirements of the energy crisis will result in some very rapid increases in diving technology in the next year. It will also place very severe demands upon qualified personnel, and the personnel shortage which already exists will require changes in training techniques. Much more extensive training will have to be given in a "concentrated course" basis rather than the long apprenticeship or "on the job training" which is now used to produce qualified divers.

Urgent action is needed on North Sea oil problems

An urgent plea for greater collaborative efforts by government, industry, universities and research organizations in Britain to solve the major technological problems facing oil companies in the North Sea was made in Edinburgh by Professor Tom Patten, acting director of Heriot-Watt University's Institute of Offshore Engineering.

Speaking at a seminar on "The Future for Submersibles," the last of a series of seminars arranged by his institute on specialized topics relating to the offshore engineering industry, Professor Patten expressed grave concern that unless action was taken now Britain could lose out in the race to develop the new technologies which were so urgently needed.

"No nation has all of this technology at present for the simple reason that the problems being encountered in the North Sea have not been met before. The race to develop this technology is now on. The winner will have a very substantial edge on his competitors—particularly since the current oil supply situation highlights the need in future to look for oil in hostile marine environments.

"These seminars have served to illustrate the range and complexity of the problems facing the oil companies and the sheer magnitude of the cost involved. Both escalate dramatically as we move into deeper waters. I am concerned that the efforts being made by other countries to solve these problems are not matched by similar efforts in the UK. This is an area in which collaboration between government, industry and the universities is in the national interest. If by this collaboration we can lead the world in developing the new technologies we shall have that highly exportable commodity "know how" which has won us such rich rewards in international markets in the past. This technology will assure continued economic growth in Scotland long after the last barrel of oil has been drawn from the North Sea.

"The solution of the technological problem requires massive collaborative effort. My experience at Heriot-Watt University is that such collaboration between university, industry and government does work. ANGUS (the letters stand for A Navigable General-purpose Underwater Surveyor) the university's cable controlled submersible is being developed in our Department of Electrical and Electronic Engineering with the support of the university, the Science Research Council, the Department of Trade and Industry and the Vickers organization who have financed its recent, successful, sea trials. That same department announced only a fortnight ago that with the financial support of Tullis Russell Ltd. they had successfully developed a new one million volt underground cable capable of carrying Scotland's present total power demand at one third of the cost of conventional underground cabling.

"In my own department (Professor Patten is head of the Department of Mechanical Engineering at Heriot-Watt University) we have been working closely with industry on many projects and have

been collaborating closely with Brown Brothers Ltd. on the development of a computer controlled simulator for testing tank stabilizers for ships. Through the university's industrial liaison division, Unilink, we have established a means by which industry can readily gain access to the technological and manpower resources of this university and the Research Park we have established on our new campus at Riccarton provides industry with a convenient research and development base with access to sophisticated university research tools and facilities.

"On the Research Park we are now putting up the first permanent building for our Institute of Offshore Engineering. I am encouraged to believe that the institute—which was set up with a pump priming grant from the Wolfson Foundation—may shortly receive government support from the University Grants Committee. The institute through these seminars has attracted to Edinburgh world authorities on offshore engineering operations.

"The next important stages of North Sea oil development provide great industrial opportunities for countries bordering the North Sea. While in this I see great opportunities for growth in Scotland, I should not be surprised if, by virtue of the expertise of its financiers, its strategic location, its improving communications and its highly specialized manpower, Edinburgh emerges as the nerve centre of the European offshore industry. In this Heriot-Watt University and its Institute of Offshore Engineering have very important roles to play."

Extension to crude loading facility of Kharg Island

Santa Fe Overseas, Inc., has been awarded a contract by Oil Service Co. of Iran for the construction of a two-berth extension to crude oil loading facilities off the coast of Kharg Island.

The project will involve the pulling of two 56-in. crude oil pipe lines from shore to connect with new tanker berths which will be erected approximately one mile off the west coast of Kharg Island in water more than 100 ft deep.

Tankers of up to 500,000 dwt will be able to load at the outer berth. The inner berth is designed to accommodate tankers in the 300,00-dwt class.

The contractor is a subsidiary of Santa Fe International Corp., with headquarters in Orange, Calif. The new berths will be an extension to the two-berth steel island which was constructed in 1972 by a Santa Fe-sponsored joint venture as part of a $30 million expansion of the Kharg terminal.

Work on the project began last month. Steel structures will be fabricated on Kharg Island.

KOCKUMS SHIPYARD recently delivered the 255,000-dwt *Sea Swift* to its owners, Salen Shipping. The VLCC is 1,117 ft long, 170 ft wide, has a 65.9-ft draft, a speed of 15.9 knots and a pump capacity of 70,445.9 gpm.

Why NOIA opposes the establishment of FOG!

The National Ocean Industries Association (NOIA) is strongly opposed to a legislative proposal for the establishment of a Federal Oil and Gas Corp. (FOG) to engage in the exploration, production, transportation, refining and marketing of oil and gas, according to a statement submitted to the Senate Commerce Committee by NOIA President Charles D. Matthews.

The proposal, offered by Sen. Adlai E. Stevenson (D-Ill.) is in the form of an amendment to a bill (S.2506) to amend the Natural Gas Act.

Matthews' statement takes issue with Sen. Stevenson's position that FOG would provide the public with knowledge of the actual cost of producing oil and gas, giving the nation a "yardstick" against which to judge the performance of the private oil companies.

Matthews said, "This so called 'yardstick' argument is as spurious today as it was some 40 years ago when it was also used as a feeble justification for putting the federal government in the electric power business in the form of the Tennessee Valley Authority." He also contends that while yardsticks are useful as important instruments in commerce, they must be checked against standards which are maintained with meticulous care.

Private oil industry and FOG—non-competitive. The NOIA statement says that creation of FOG would be non-competitive between government and private industry because the two parties would not be playing by the same rules.

Noting that the federal government already owns more than one-half of the

WEATHER AVERAGES and SEA STATES FOR

WORLD WEATHER REPORT

This month	Next month	Month after next
Timor Sea	Arabian Sea	Gulf of Mexico
Gulf of Alaska	North Sea	Western Alaska
Argentina	Malaysia	Sea of Japan
Mozambique	Yellow Sea	Adriatic Sea
Canadian Arctic	North Slope	Grand Banks
Caribbean Sea	Bass Strait	Gulf of Guinea

TIMOR SEA (12°26'S, 130°52'E)
Mid April marks the end of the "willy willies" (hurricane) season. These storms form over the Timor Sea and generally move southwestward before recurving to the southeast of Australia.

GULF OF ALASKA (61°10'N, 150°01'W)
The cyclones of the Gulf of Alaska are much less intense during this period, but they are common and bring high winds and high swells. Ice breakup begins in latter part of March.

ARGENTINA (38°44'S, 62°11'W)
Squalls "pamperas" frequently move in from the southwest and bring brief torrential rains, strong winds, and heavy seas.

MOZAMBIQUE (25°55'S, 32°34'E)
Tropical storms pose a threat to this region through about mid-April. However, most of the storms recurve to the east before reaching the mainland.

CANADIAN ARCTIC (74°43'N, 94°59'W)
During this period, the movement of storms through the area will be on the increase.

CARIBBEAN SEA (18°30'N, 77°55'W)
Minor tropical disturbances will cause thundershower activity during this period. Intensification of these disturbances to hurricane strength this early in the year is extremely rare.

		Wind							Sea and Swell													
		Distribution of Winds (all directions), %							Sea Condition (all directions), %					Swell Condition (all directions), %								
Month	Usual wind direction	Calm	1-3 kt.	4-10 kt.	11-21 kt.	22-33 kt.	>33 kt.	Usual sea direction	Calm	<3'	3-8'	>8'	Usual swell direction	No swell	1-6'	6-12'	>12'	Mean Amount	Lowest Month	Highest Month
MAR.	S.W.	4	12	51	28	5	0	E.	12	59	23	6	S.W.	25	75	0	0	11.95	0.81	21.8
APR.	E.	2	6	53	38	1	0	S.	25	75	0	0	E.	50	0	50	0	3.38	0.04	23.7
MAY	E.	1	3	24	48	24	0	S.	0	17	83	0	S.E.	25	38	37	0	0.06	0.00	10.2
MAR.	E.	4	5	31	38	18	4	E.	10	54	31	5	SMALL ICEBERGS AND BERG BITS ARE CONFINED TO COASTAL WATERWAYS					0.51	0.12	1.23
APR.	E.	3	4	34	42	14	3	E.	12	60	26	2						0.43	Trace	1.40
MAY	E.	3	5	42	39	9	2	E.	12	60	26	2						0.51	0.03	1.27
MAR.	N.W.	5	8	31	37	16	3	N.W.	5	63	30	2	E.	29	49	22	0	2.60	0.00	10.7
APR.	W.	3	7	29	36	17	8	N.E.	2	52	46	0	N.	33	52	15	0	2.16	0.00	12.3
MAY	W.	2	6	32	35	17	8	N.W.	5	38	57	0	S.	34	53	4	9	1.65	0.00	5.51
MAR.	S.E.	2	6	38	38	13	3	S.E.	8	63	17	12	S.W.	43	37	11	9	2.84	0.08	22.0
APR.	N.E.	2	6	34	40	15	3	N.E.	8	60	19	13	S.W.	52	33	12	3	2.44	0.12	14.0
MAY	N.	3	7	28	39	19	4	N.	10	58	17	15	S.W.	57	27	14	2	1.06	0.00	5.83
MAR.	W.	5	20	34	25	13	3	NO DATA ICE										0.12	0.00	0.27
APR.	S.W.	6	21	36	24	11	2											0.24	0.04	0.6
MAY	S.W.	6	20	40	23	9	2											0.35	0.04	1.46
MAR.	E.	3	6	38	41	11	1	N.E.	6	62	31	1	E.	23	54	22	1	2.50	0.00	4.55
APR.	E.	2	5	43	40	10	0	E.	2	65	31	2	E.	29	49	20	2	4.32	Trace	8.35
MAY	E.	3	5	43	39	10	0	E.	2	59	38	1	E.	25	52	21	2	6.86	1.61	12.2

Prepared by The Institute for Storm Research, University of St. Thomas, Houston. For annual summaries of stations included in this report or for other world locations, contact Institute for Storm Research, 4104 Mount Vernon; Houston 77006; or phone (713) 529-4891.

*Swan Island NA - Not available

U.S. lands considered most likely to be productive in the search for petroleum, Matthews points out unfair advantages FOG would have over the private oil industry:

(1) FOG would be allowed to take first choice of 20% of the most promising federal lands offered for lease.

(2) Three offshore lease sales between December 1972 and December 1973 brought about $5 billion in bonus bids into the general fund of the Treasury, which eased the burden on the taxpayer. (FOG would not be required to pay bonus bids.)

(3) FOG would pay no royalties.

(4) FOG would be financed under appropriations on which it would not be required to earn any rate of return.

(5) FOG would be able to borrow funds at a lesser rate than private companies because of the federal government guarantee of its obligations.

(6) FOG would not be required to pay federal taxes, while the federal government levies heavy taxes against its business enterprise competitors.

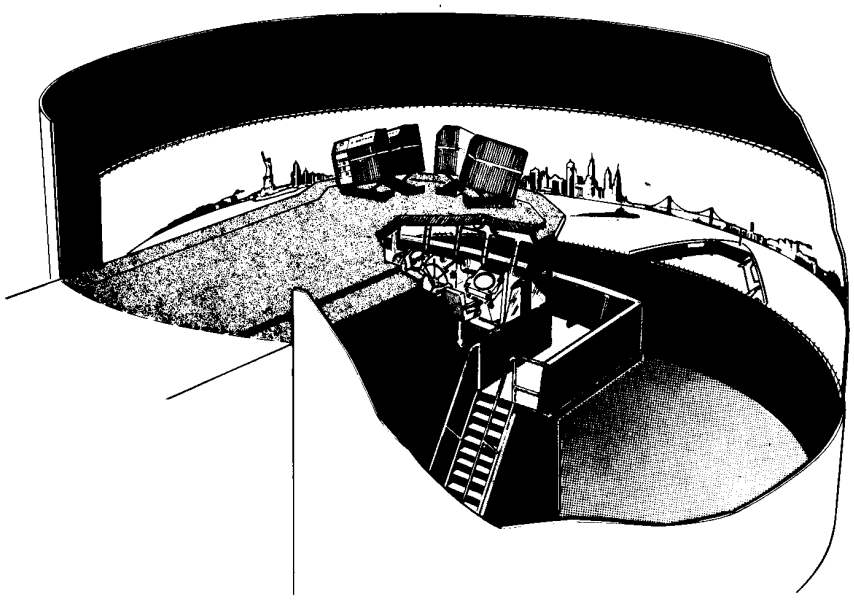
Allocation of fuel supplies. As to the legislative sponsors' claim that the corporation would contribute additional fuel supplies which the federal government could effectively allocate to essential public needs "including national defense," Matthews states, "There is no more justification for FOG being established to contribute fuel supplies to the national defense and for the federal government to own and operate the steel mills, aircraft factories, shipyards, and other businesss enterprises which contribute significantly to 'essential' national defense." He called attention to the fact that, as far as allocating fuel supplies to "essential public needs," the Federal Power Commission had already adopted allocation plans for natural gas to ensure available supplies for such purposes, and the Federal Energy Office, with its Petroleum Allocation Regulations, has made ample provision for allocation of fuel supplies to go to essential public needs in accordance with the Emergency Petroleum Allocation Act of 1973.

Increased offshore lease sales urged. While agreeing with Sen. Stevenson's statement that "only about 2% of the federal lands under which oil and gas may be found have been leased for exploratory and developmental purposes to private oil and gas companies, Matthews says that this can in no way be construed as being an indictment of petroleum companies, but rather a severe indictment of the federal government for not making more acreage available for lease sales. "If the petroleum industry was willing to spend almost $5 billion in lease bonuses in the 12-month period from December 1972 until December 1973, just for the right to look for petroleum on the Outer Continental Shelf of the Gulf of Mexico, it must surely be considered as being ready, willing, and able to meet the current challenges." All the industry seeks is to be allowed to do so by the federal government in circumstances which will allow the expectation of a reasonable return on the very large investment necessary to satisfy the nation's energy needs. NOIA takes the position that the federal government can make a significant contribution to increasing fuel supply sources if it moves with dispatch to require the leasing of offshore tracts for exploration and production along the Atlantic Coast, the Gulf of Alaska, and the offshore areas of California.

NOIA is the only national trade association organized to serve as the legislative and administrative spokesman at the federal level for all facets of the nation's offshore and ocean-oriented industries. It represents over 210 companies from 20 states and the District of Columbia, from Alaska, the West Coast, Gulf of Mexico and the Atlantic Coast. The membership engages in activities closely related to petroleum supply from the Outer Continental Shelf, particularly air and marine transportation, drilling, equipment manufacture and supply, gas transmission, geophysical contracting, offshore construction, mineral production, shipyards, service, etc.

SELECTED OFFSHORE AREAS

Precipitation				Temperature, °F						Tide and Current					Fog/Cloud	
		1973					1973									
w/precip.	% days w/snow	Amount	Departure	Mean	Coldest Month	Hottest Month	Mean	Departure	Mean sea sfc. temp.	Maximum tide range (ft.)	Date of maximum	Mean current speed (kt.)	Max. tidal current (kt.)	Reference point	% time ∨ 5 miles visibility	% time 80% cloud cover or more
0	0	NA		82.2	79.2	87.2	NA		83	22.7	10/11	0.8	1.2	DARWIN AIRPORT	<5	19
8	0	1.22	−2.16	81.8	79.5	87.3	83.8	+2.0	83	22.9	9	0.8	1.2		<5	13
2	0	NA		79.8	77.4	84.7	NA		81	23.0	24	0.6	0.9		<5	13
6	10	.67	+.16	24.6	12.6	35.4	24.3	−0.3	<32	35.7	9	2.8	NA	ANCHORAGE	15	60
5	3	.31	−.12	36.9	26.8	39.4	30.9	−6.0	35	34.4	7	2.8	NA		15	60
5	1	.16	−.35	47.5	41.5	49.6	43.5	−4.0	38	35.1	23	2.7	NA		15	62
6	0	3.43	+.83	65.3	62.4	72.5	68.0	+2.7	63	13.7	15/16	0.8	NA	BAHIA BLANCA	6	18
9	0	3.07	+.91	59.7	55.0	64.0	56.1	−3.6	62	13.5	13/14	0.8	NA		8	25
9	0	NA		52.2	48.2	58.1	NA		57	13.0	12/13	0.8	NA		8	25
6	0	2.76	−0.08	77.0	73.8	81.0	79.7	+2.7	80	13.8	8/9	0.8	1.2	LORENCO MARQUES	<5	12
4	0	2.05	−0.39	73.2	71.2	74.8	72.3	−0.9	79	12.2	7/8	1.0	1.5		<5	8
6	0	NA		69.3	66.9	73.4	NA		76	11.3	22/23	1.2	1.8		<5	8
6	NA	.04	−.08	−24.3	−33.5	-16.2	−30.3	−6.0	<32	6.4	7/8	0.4	NA	RESOLUTE	NA	NA
0	NA	.04	−.20	−8.9	−17.9	5.7	−13.7	−4.8	<32	6.3	23/24	0.4	NA		NA	NA
2	NA	NA		13.5	5.5	23.4	NA		<32	6.8	22	0.4	NA		NA	NA
5	0	*0		76.9	76.0	78.6	*81.3		78	1.3	3/4	0.8	NA	MONTEGO BAY	1	<20
0	0	*15.63		78.1	76.3	80.6	*82.4		80	1.4	24/25	0.8	NA		1	<20
3	0	NA		79.0	77.2	81.0	NA		81	1.5	22/23	0.8	NA		1	20



Computer model simulates view from ship's bridge

National Maritime Research Center will use $3.5-million unit for training and research on ships

An unusual computer-generated color video display that will be used to present a realistic view of seascapes as seen from a ship's bridge is being built by Philco-Ford Corp. The Image Generation and Display Subsystem (IGADS) is being built under a $3.5-million contract awarded to Philco-Ford's Western Development Laboratories (WDL) Division by Sperry Rand Corp.

The huge subsystem is part of the Computer Aided Operations Research Facility (CAORF) being engineered by Sperry Systems Management Division in Great Neck, N.Y., for the U.S. Maritime Administration. It will be installed in the National Maritime Research Center at Kings Point, N.Y.

When completed, the facility will be used to improve the efficiency and competitive position of the U.S. Flag Merchant Fleet, to evaluate port and terminal concepts, assist in increasing safety at sea, substantiate environmental impact evaluations, and to establish maritime industry standards through improved technology and operational procedures.

CAORF's simulated ship's bridge will make it possible to analyze ship operations through a wide range of environments, including simulated hazardous conditions at sea and in harbors, harbor approaches and channels.

The facility will consist of a full-scale model of a ship's bridge which looks out on IGADS, a cylindrical display 12 ft high by 120 ft long that covers a 240-degree field of view from the bridge.

According to John C. Keyes, Philco-Ford vice president and WDL general manager, IGADS is unique in that images will be in full color and, unlike most

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2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77	82	87	92	97	102	107	112	117	122	127	132	137	142
3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133	138	143
4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94	99	104	109	114	119	124	129	134	139	144
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	

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computer-generated scenes, "hidden" lines will be removed to provide three-dimensional realism. (Hidden lines are ones normally present in computer graphics that define shapes of sections of an object, such as its backside, which would not be visible to someone looking at the real object from the front or, in this case, from the bridge of a ship.)

The CAORF ship's bridge will be equipped with steering gear, engine room telegraph, radar consoles, communications and other standard instrumentation, all connected to a central computer that simulates ship dynamics and environmental factors. The central computer will also feed information to the IGADS computer on sun position, fog conditions, ship position and heading, and similar data for up to six other ships "moving" in the research ship's area.

The IGADS computer will combine this information with data it stores on objects located in various harbors, channels and approaches. It will then generate a changing scene on the display that duplicates what a pilot or bridge officer would see from the bridge of a real ship actually under way.

Delivery of the IGADS equipment and software to Sperry is scheduled for early 1975.

VLCC terminal site study complete

Dames & Moore has completed a six-month site and geological evaluation at a proposed location for Standard Oil of California's West Coast deep water marine terminal.

The environmental and applied earth science consulting firm has now assisted in studies for three of the four known Very Large Crude Carrier (VLCC) terminals actively planned for the United States. Dames & Moore is also participating in environmental work for the LOOP and SEADOCK projects in the Gulf of Mexico.

The SOCAL terminal will consist of a single point mooring system designed to receive and unload deep draft tankers with capacities of up to 400,000 dwt.

While D&M evaluated offshore geological conditions for one potential VLCC terminal site in Estero Bay (midway between San Francisco and Los Angeles), SOCAL is still looking at every potential and feasible site on the West Coast that could be an alternative to Estero Bay. The consulting firm also evaluated geotechnical design considerations along the proposed pipe line route from Estero Bay to a SOCAL refinery in Richmond, Calif.

The Estero Bay site is in water about 150 ft deep, about 1,400 ft from shore. A minimum water depth of 90 ft is required to accommodate VLCCs.

Rail to barge river port terminal announced

American Commercial Barge Line Co. (ACBL) has announced selection of a Mississippi River-Missouri River industrial area in St. Louis County, Missouri, as the site for a major rail to barge river port terminal that, at capacity, will handle more than 20 million tons of western coal each year.

Floyd H. Blaske, president of ACBL, part of the Inland Waterways Services Division of Texas Gas Transmission Corp., said that the transfer facility will be owned and operated by an affiliate within the division.

Low-sulfur coal from mines in Wyoming and Montana will be transferred at the terminal site from unit trains of Burlington Northern Inc. to ACBL barges for continued transportation to steam generating plants on the Mississippi and Ohio River systems. This intermodal transportation system is being developed to move the western coal, which meets current environmental requirements, for new coal-fired plants in the midwestern and southern states.

"This will be the largest coal barge-loading terminal on the Mississippi-Ohio system, and when the volume reaches its peak, 2½ barge tows of 15 barges each will be required each day to handle it," says Blaske, who also is chairman of the Inland Waterways Services Division of Texas Gas. Towboats in the fleet of ACBL will move the barges to their destinations.

"Although the lead time required for the construction of the terminal facility will prevent any immediate impact on the current energy problems, the project represents a significant step in responding to the challenge to make the United States energy self-sufficient by 1980," Blaske added.

The site for the terminal, Blaske said, is an industrially zoned area known as Columbia Bottom, bounded by the Mississippi and Missouri rivers. Acquisition of the site is under way.

Terminal facilities will include high-speed rotary dump railcar equipment that will empty the coal gondolas Burlington Northern will deliver to the site in 100-car unit trains. Each train will carry 10,000 tons of coal produced from several Wyoming and Montana surface mines.

The 10,000 tons of coal to be delivered to the terminal sites by each unit train will be transferred by conveyor belts to barges on the river. Each tow of barges will have capacity of 24,000 tons or more. The terminal site will include storage capacity for up to a million tons of coal.

The river-rail terminal facility, which is expected to commence operation in 1976, is being designed to withstand the highest floods on record. It will feature the latest improvements in dust and water pollution-control equipment and techniques.

Total capital investment in the terminal facility will be approximately $20 million, according to Blaske.

American Commercial Barge Line Co. is operator of one of the largest towboat-and-barge fleets on the inland waterways. ACBL will, however, find need to add materially to its number of both towboats and barges in order to handle the new business that will come through the St. Louis terminal. The ACBL current level of business on over 8,000 miles of inland waterways already is keeping its more than 40 towboats and over 1,100 barges busy, Blaske said.

The number of new towboats and barges to be required has not been fully determined, he added.

Jeffboat, Inc., the shipyard affiliate of ACBL in the Inland Waterways Services Division of Texas Gas, will build the new equipment. Located in Jeffersonville, Ind., Jeffboat is the largest such inland facility in the nation.

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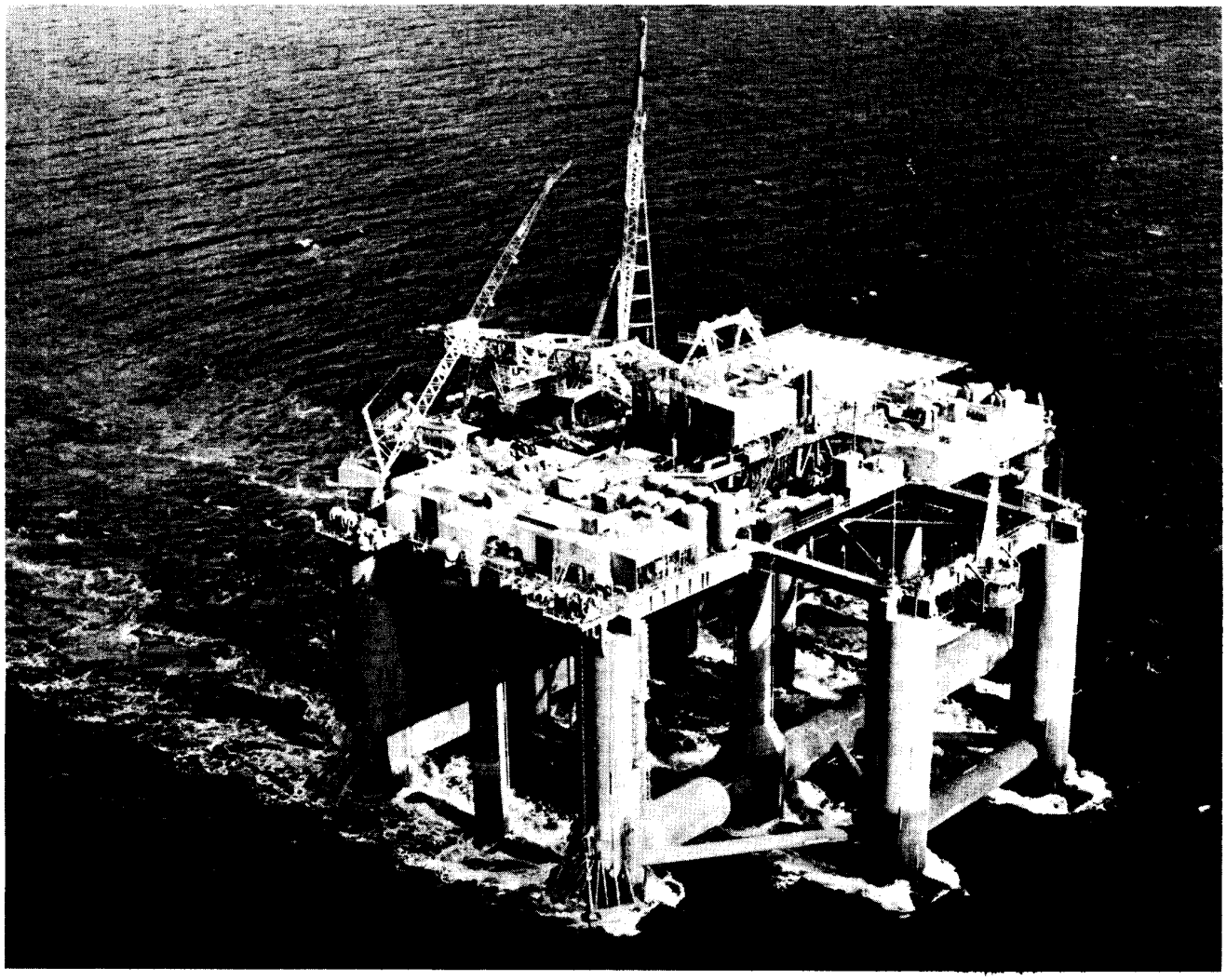
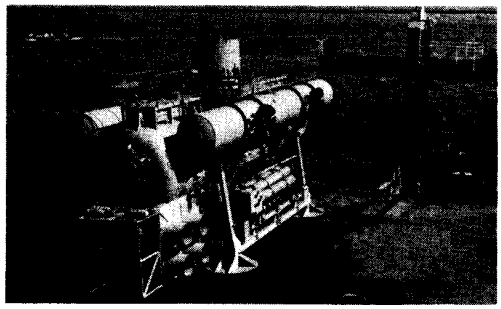


This huge rig, "Ocean Prospector", has 4 submerged pontoons under a total of 16 columns supporting the work deck. The two inner pontoons each carries a propeller driven by a DC motor housed in the pontoon. Power for cruising and drilling comes from eight 1600-KW DC generators coupled to 4 opposed-piston diesel engines.

The "Prospector", sized 344 by 263½ ft, drills to 25,000 ft, holding itself steady in heavy weather by its sophisticated mooring and ballasting systems. Test cruise revealed 7 knots ahead, 3 knots astern. Steering is by twin nozzle type rudders.



MHI-developed undersea habitat "SEATOPIA", supporting the life of 4 aquanauts 300 ft below for one month straight.

Built by MITSUBISHI HEAVY INDUSTRIES to the designs of Ocean Drilling and Exploration Company, the "Propector" sailed out of MHI's Hiroshima Shipyard in January last for its first assignment and is now drilling in the Sea of Japan. MHI can go for truly big and complex things in offshore equipment.

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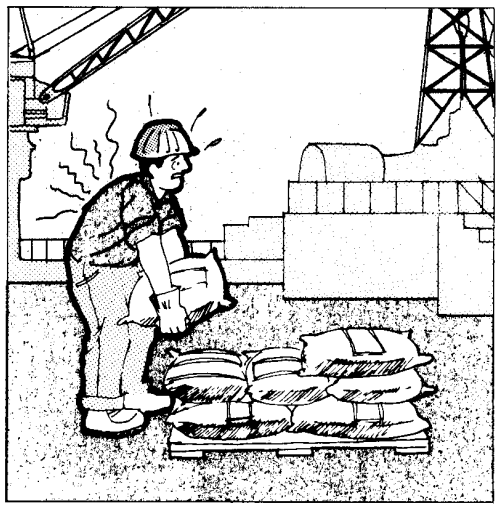

OFFSHORE ACCIDENTS:
When a roustabout is injured while unloading a supply boat, is the boatowner or drilling company liable?

The Story: Remember the story of the roustabout who broke his back sloshing in mud from broken sacks to be delivered from supply boat to drilling rig? (OFFSHORE ACCIDENTS in the July 1972 issue of *The Ocean Law Letter.*) The seas were high, the weather was rough—too rough for the delivery to take place. The boat could hardly be tied up.

But the captain went ahead—and the roustabout suffered the broken back. His employer was Jade Drilling Co., the owner of the boat and supplier of the mud was Geroid Division of PB National, and Conch Oil Co. was the owner of the well who had ordered the mud and had contracted Jade Drilling.

In court, all the blame was pinned on Geroid for unsafe operation of and improper loading of the boat—a blatant example of unseaworthiness. But Geroid appealed the decision, claiming that although the boat captain was responsible for instructing his deckhands, the roustabout pusher aboard the rig was responsible for instructing the roustabout crew.

"The roustabout reluctantly followed Jade's orders, not ours," Geroid contended, claiming indemnity from the drilling company. "The Supreme Court has ruled that a stevedoring company entering into a service agreement with a shipowner is liable to indemnify the owner for damages sustained as a result of its improper stowage of cargo," Geroid continued. "Jade may be compared to the stevedore in this instance."

The Result: The Court of Appeals agreed with Geroid, reversing the district court's prior decision and holding the drilling company liable. Relying on the principle that "liability should fall on the party best situated to adopt preventive measures and thereby reduce the likelihood of injury," the court ordered the drilling company to reimburse the boatowner and to pay any legal costs the oil company had originally paid in its defense.

Holding to the comparison between drilling company and stevedore in this situation, the court said:

> *It is clear . . . that the warranty of workmanlike service demands that a stevedore must not continue to work its crew in the face of an unsafe or unseaworthy condition. Rather it must remedy the situation itself, have the shipowner remedy it, or stop the operation.* (477 F.2d 211)

"Once again, we go down to the sea in drilling rigs," the judge presiding over this case remarked. Once again, the laws governing shipping are applied to oil operations offshore. Here the recent reforms effected by Congress concerning the indemnification of shipowners were applied to the drilling company.

The reforms provide that the liability of shipowners to "longshoremen and others who perform work on a vessel that is traditionally performed by seamen" must be based on negligence rather than on the no-fault concept of seaworthiness. Thus, the shipowner is no longer strictly liable to such seamen for injuries which are really the fault of the stevedore or another's negligence—such as the drilling company in this case.

NOTE: Company and individual names are fictitious. Cases are taken from *The Ocean Law Letter.* For specific details related to this incident, or about the *Law Letter,* contact William Priest, president, or Ava Stern, editor, *The Ocean Law Letter,* P.O. Box 415, New York, N.Y. 10023.

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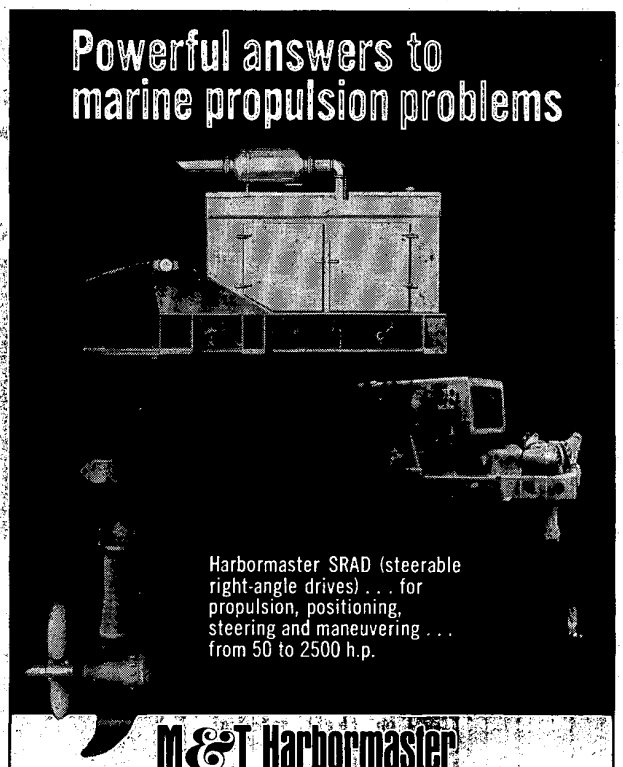

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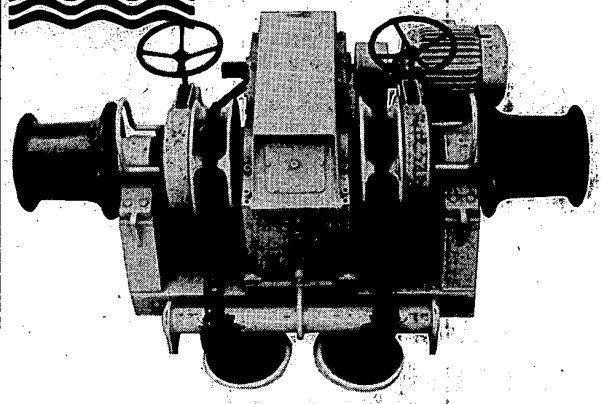

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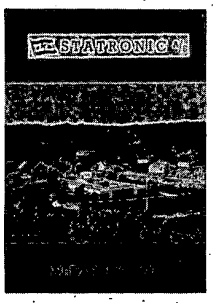
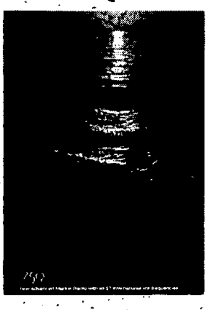
HULL SURVEILLANCE SYSTEM



WEDAR, a system developed by Det Norske Veritas and Statronic A/S, monitors the effect of different weather conditions on a ship's hull. WEDAR measures dynamic stress and motion in the hull, gives warning of hull overload, indicates optimum speed, and predicts wave loads.

Circle 1 on Reader Service Card

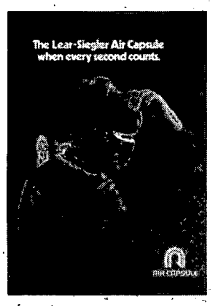
57 FREQUENCY MARINE RADIO



Bulow International Inc. distributes the AP 759, which is described in a seven-page folio. This marine radiotelephone has a data-controlled channel selection of 57 international frequencies, with an option for 10 additional private channels. A remote control unit is also available.

Circle 2 on Reader Service Card

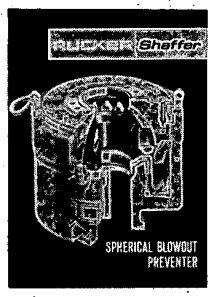
EMERGENCY AIR CAPSULE



Lear Siegler describes their "Air Capsule" in an eight-page brochure. The self-contained breathing apparatus for emergency escape can be donned in 10 seconds, and provides five minutes of breathing air. A transparent hood protects the head. Weighs 4½ lbs.

Circle 3 on Reader Service Card

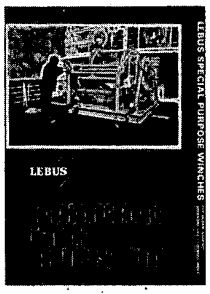
SPHERICAL BOP STACKS



Rucker Shaffer has a 17-page catalog on their spherical blowout preventers which includes performance data, parts lists, and maintenance instructions. The units are long lived, can be serviced on the job, are low in height and can be changed with pipe in the hole.

Circle 4 on Reader Service Card

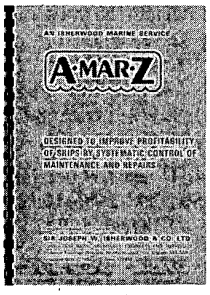
OCEAN GOING WINCHES



LeBus International Ltd. describes 10 winches for ocean industry use in a six-page brochure. Included are: deep-water oceanographic, instrument towing, hydrographic survey, multiple duty oceanographic portable towing/coring, diving bell systems and other applications.

Circle 5 on Reader Service Card

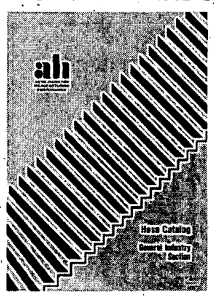
REDUCE OPERATING COST



A system to reduce VLCC operating costs has been developed by Sir Joseph W. Isherwood Co. Ltd. The A-Mar-Z system provides owners with a planned, integrated, all-embracing range of maintenance, repair, and spares management services which reduces drydock time.

Circle 6 on Reader Service Card

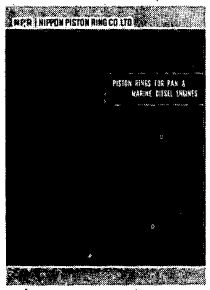
GENERAL INDUSTRY HOSES



A 32-page illustrated catalog describing more than 60 different hoses for a wide range of application is available from Acme - Hamilton Manufacturing Corp. Hose types are categorized under seven classifications.

Circle 7 on Reader Service Card

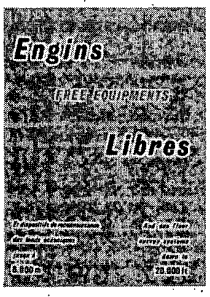
PISTON RINGS



A 22-page illustrated brochure lists piston rings for marine and general uses, built of Nippon Piston Ring Co. Ltd. wear-resistant materials and with surface treatment techniques. The booklet includes tables of shapes and special applications, and material on trouble shootings.

Circle 8 on Reader Service Card

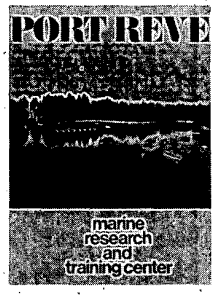
MARINE PROSPECTING TOOLS



An illustrated 20-page brochure on equipment for prospecting the seafloor offered by the National Center for Exploitation of the Seas and the Nickel Society. Independent units: sampler assembly; immersible camera assembly; flashing beacon, radio beacon and weights.

Circle 9 on Reader Service Card

LEARN SAFER SHIPHANDLING



A seven-page brochure on the Port Revel Marine Research Training Center, Grenoble France, describes a one-week training course for pilots and captains. Safe ship-handling in mooring, berthing, use of bow and stern thrusters, and hawser loads taught in labs, model ships, basins.

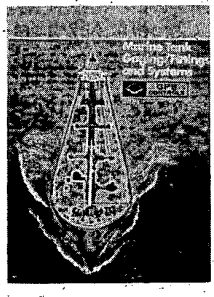
Circle 10 on Reader Service Card

PIPE CUTTING PROBLEMS?

Portatools' four-page brochure shows their Generation II Porta-Cutters Mark II, III and IV, with cutting time and specification tables. The units will cut and bevel cold pipe in a flameless, spark-free operation. For use on platforms, pipe lines, underwater construction.

Circle 11 on Reader Service Card

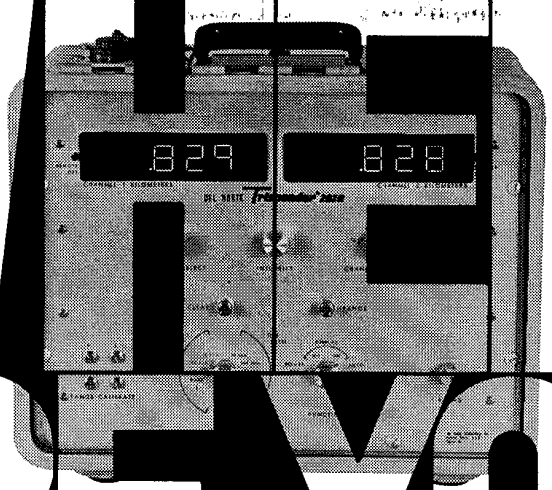
LIQUID CARGO CONTROL



GPE Controls' brochure describes Shand and Jurs marine controls capabilities for barges and VLCCs. Systems provide constant visual display of vessel's trim, and flow of liquid cargo during loading, transport and discharging. Operators can correct deviations instaneously.

Circle 12 on Reader Service Card

WHERE ARE YOU?



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Trisponder systems provide range-range information to accurately determine your position. Digital displays give you the distance to fixed points with BCD data available for automatic recording.

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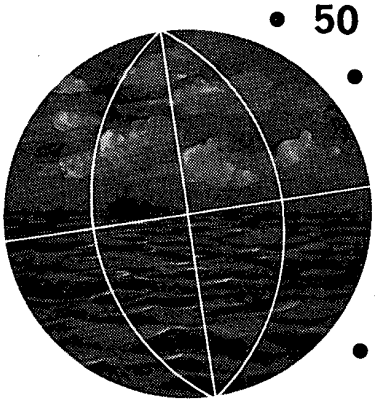

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del norte technology, inc.

1100 PAMELA DRIVE P.O. BOX 696 EULESS, TEXAS 76039 (817) 267-3541

New Equipment

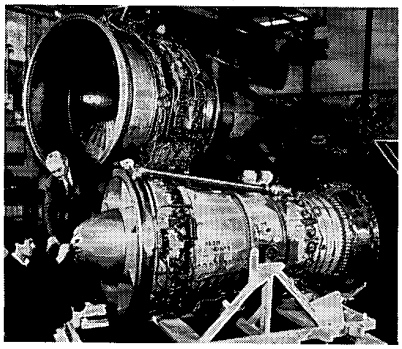
Rolls Royce's new pipe line turbine

Rolls Royce is testing its first industrial version of the RB 211 aero engine, designed to have a much lower fuel consumption than similar units. The industrial gas turbine, rated at 26,400 bhp, is intended initially for oil and gas pipe lines.

Other advantages, according to the company, are the high efficiency and easier maintenance capabilities.

Following initial tests, a second unit will be sent to Canada for installation in a gas compressor station on the Trans-Canada Pipeline in late 1974.

Rolls Royce and Kawasaki Heavy Industries are now studying a marine version of RB 211 for powering bulk carriers, containerships and LNG carriers.

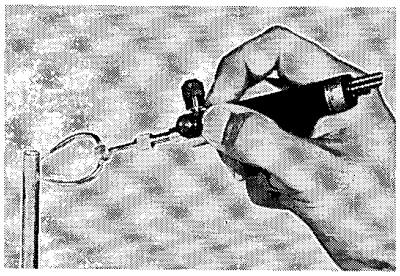


Circle 13 on Reader Service Card

Miniature welding torch

The "Little Torch" manufactured by Tescom Corp. was designed to do precision small scale work, concentrating heat in very constricted areas without damage to heat-sensitive surfaces, such as heating and soldering individual posts within the confined areas of terminal clusters.

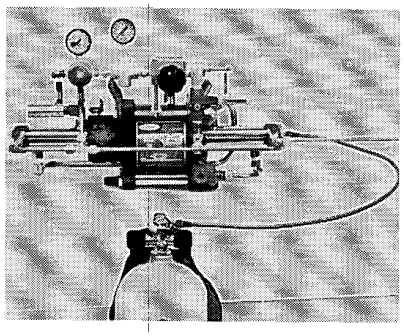
"Little Torch" can produce a flame as high as 6,300°F and small enough to go through the eye of a needle. Interchangeable tips allow the tool to weld 0.002-in. wire or 16 gage steel.



Circle 14 on Reader Service Card

Rapid dive tank fills

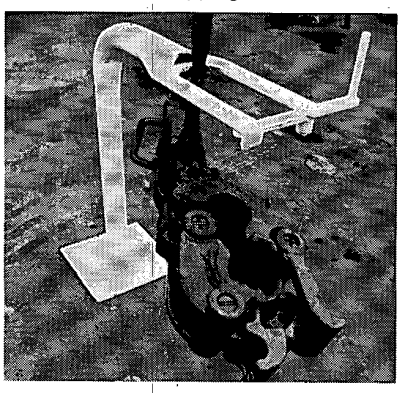
Haskel Engineering & Supply Co. has a self-contained air-driven air pressure amplifier for use with any existing air pressure system, which will provide rapid dive tank fills to pressures up to 4,500 psi. It is a quick way for scuba divers to top off the new 3,000-psi dive tanks from existing 1,500-2,500-psi high pressure air systems.



Circle 15 on Reader Service Card

Keep rig tongs out of the way

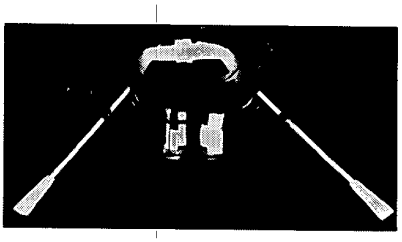
A spring-loaded device which provides positive locking protection for most sizes of rig tongs, including power tongs, has been developed by Lamb Industries Inc. The TONG LOCK is easily operated and protects against slipping.



Circle 16 on Reader Service Card

Reflective material aids sea search and rescue

SCOTCHLITE, a highly reflective material containing millions of tiny glass beads, has been developed for use in nighttime search and rescue at sea. According to the 3M Co. which produces the material, it will not crack, blister or break. The pressure sensitive type used on inflatable material can expand and contract without losing its adhesiveness.

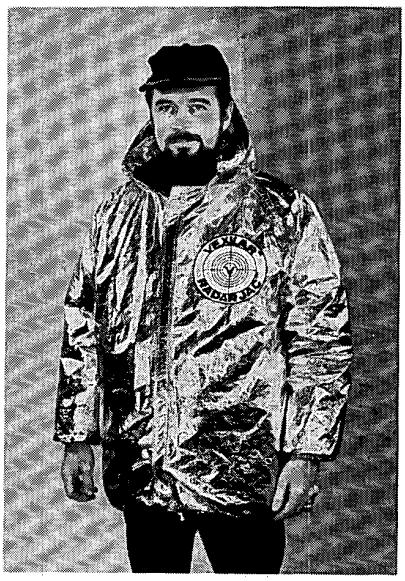


Circle 17 on Reader Service Card

Radar reflective jacket can save lives

Needless deaths occur when search planes are unable to locate disaster victims at sea in plastic or rubber life rafts. These materials as well as the human body are transparent to radar. The life jacket shown here solves the problem. It is highly reflective to radar search beams, and is also optically reflective.

The RADARJAC was developed by Vexilar Inc. Its thermal properties protect against wind, rain and sun, while maintaining body warmth.

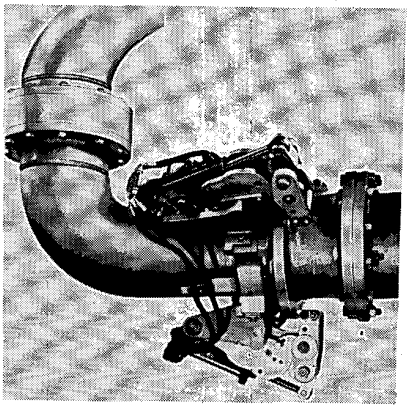


Circle 18 on Reader Service Card

Coupling reduces weight of marine loading arm

Swivel and cryogenic couplings for use on marine loading arms can reduce the weight of the loading arm and save money in total arm construction. The new couplings are produced by Speed Seal.

As shown, hydraulic ram-operated hooks, which run on a small power pack, provide a positive clamping action. A positive mechanical lock, independent of the power supply, maintains the connection of the couplings to their mating flanges.



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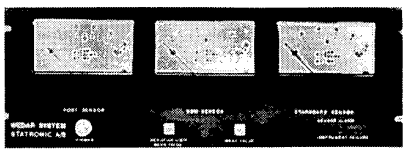
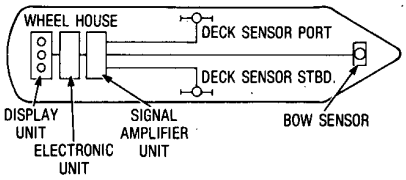
New Instruments



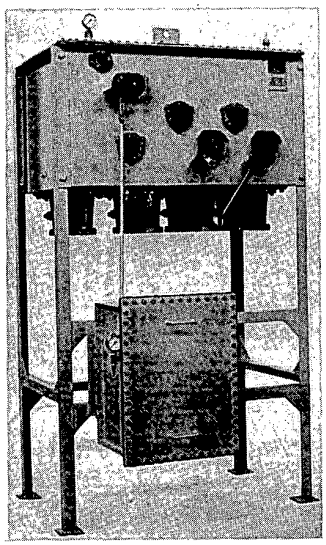


Monitor stresses in ship's hull

Now it is possible to monitor the stress loading on a ship's hull while the vessel is under way—even in a storm. This is important because as ships get larger the skipper and helmsman have less "feel" for the ship's behavior in severe seas. With accelerators and strain gages located at strategic points the captain can determine the optimum procedure. The WEDAR system, developed for the Hull Surveillance I study undertaken by Det Norske Veritas, is now being used on project ships. Statronics A/S, the manufacturer, and Det Norske hope to have established realistic warning levels by 1976 for a wide range of ship types.

Illustrations show general assembly and console.

Circle 20 on Reader Service Card

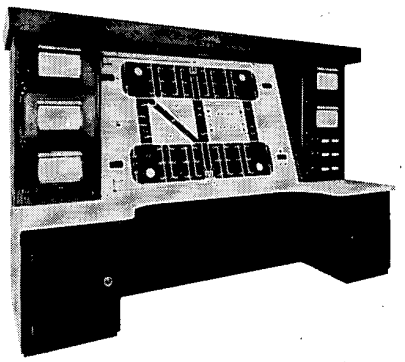


Automatic transfer device prevents loss of power

An automatic transfer device, which protects critical loads against loss of power by transferring the load to an alternate power source, has been produced by Nelson Electric (division of Sola Basic Industries). It will operate on a complete line of load break oil switches.

The mechanism requires no maintenance or adjustment. Transfer power is provided by a simple, powerful gear motor.

Circle 21 on Reader Service Card



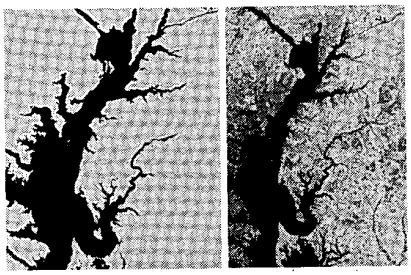
System monitors, controls offshore drilling rig

A marine control and instrumentation system which monitors six vessel functions has been developed by the Baylor Co. The Baytrim Ballast Control System gages the ballast, fuel, potable water and sewage tanks. It controls ballast and measures the vessel's draft in feet/meters.

Draft and hydrostatic pressure of each tank is measured in inches/centimeters. Added features are the shaping circuits for specific tanks, which allow a digital readout of contents in tons/kilograms for circular or odd shaped tanks.

Coordinated ballast control enables precise vessel draft to be maintained, and keeps the vessel trim required by the master or drilling superintendent.

Circle 22 on Reader Service Card



Satellite photos aid pollution studies

Photographs made via the ERTS-1 satellite from 550 miles up are helping Westinghouse Ocean Research and Engineering scientists make a detailed survey of the contaminants in upper Chesapeake Bay for the state of Maryland.

The photo at left was made by infrared sensor; the one at right by an optical sensor. Comparative studies make it possible to determine the degree and nature of pollution.

Circle 23 on Reader Service Card

Ocean Industry professional directory

CLASSIFIED

EMPLOYMENT OPPORTUNITIES

Experienced Marine Engine Sales Person. Gulf Coast Territory. An Equal Opportunity Employer. Send resume to Dept. 403A, Ocean Industry, Box 2608, Houston, Tx. 77001.

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GET ACTION — USE OCEAN INDUSTRY CLASSIFIED ADS

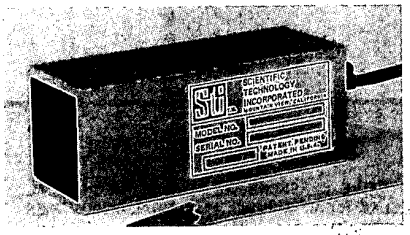
NEW INSTRUMENTS

High sensitivity non-contact sensor

A self-contained system component for detecting, monitoring and controlling almost any kind or quality of material that the eye can see, whether solid, liquid or gas, has been introduced by Scientific Technology Inc.

The sensitivity adjustment of the new sensor allows it to see, or see through a transparent surface. It will signal color and texture change and read codes.

Operation of the Sti 3093 OMNIPROX sensor is not affected by ambient light, bright sun or environmental contaminants.



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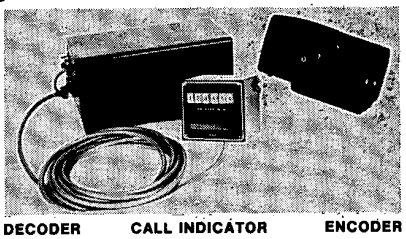


DECODER CALL INDICATOR ENCODER

Dial direct to your fleet tugboat or port authority

A selective calling system puts marine radiotelephone calls through promptly and directly. The shore operator selects the 5-digit code for the vessel on the Lorain Encoder and pushes the transmit button.

Aboard ship at sea the call channel lights on the Call Indicator and an audible signal sounds. The call is completed without voice monitoring. The calls are also visually displayed on the Indicator, and remain so until cancelled. As many as six calls can be stored on the Call Indicator until completed.

The Lorain Encoder/Decoder is produced by Lorain Electronics Corp.

Circle 25 on Reader Service Card

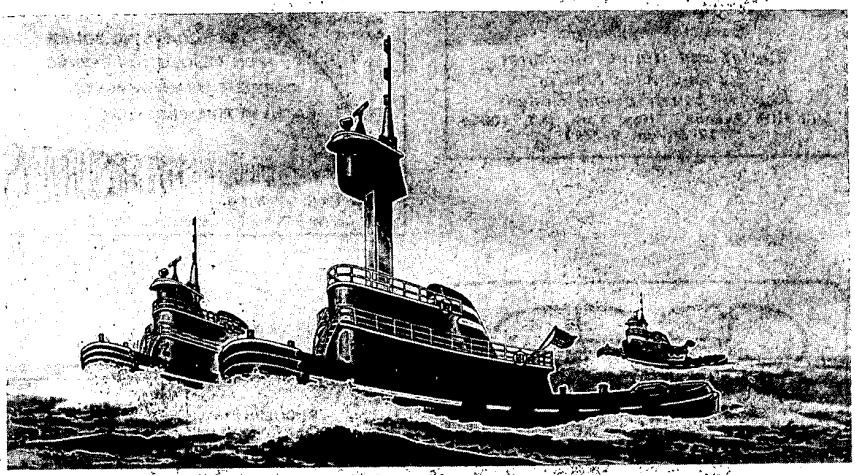
Bookshelf

Abyssal Environment and Ecology of the World's Oceans. Robert J. Menzies, Robert Y. George and Gilbert T. Rowe, John Wiley & Sons Inc., 305 Third Ave., New York, N.Y. 10016. $24.95. 488 pp. Three eminent oceanographers have collaborated in this study of the animal life in the benthic realm and on the sea floors of the Northwest Atlantic, Southeast Pacific, Arctic and Antarctic oceans.

Beginning with the research in this field, they bring the reader to the latest developments in pollution control of the oceans and international law of the sea.

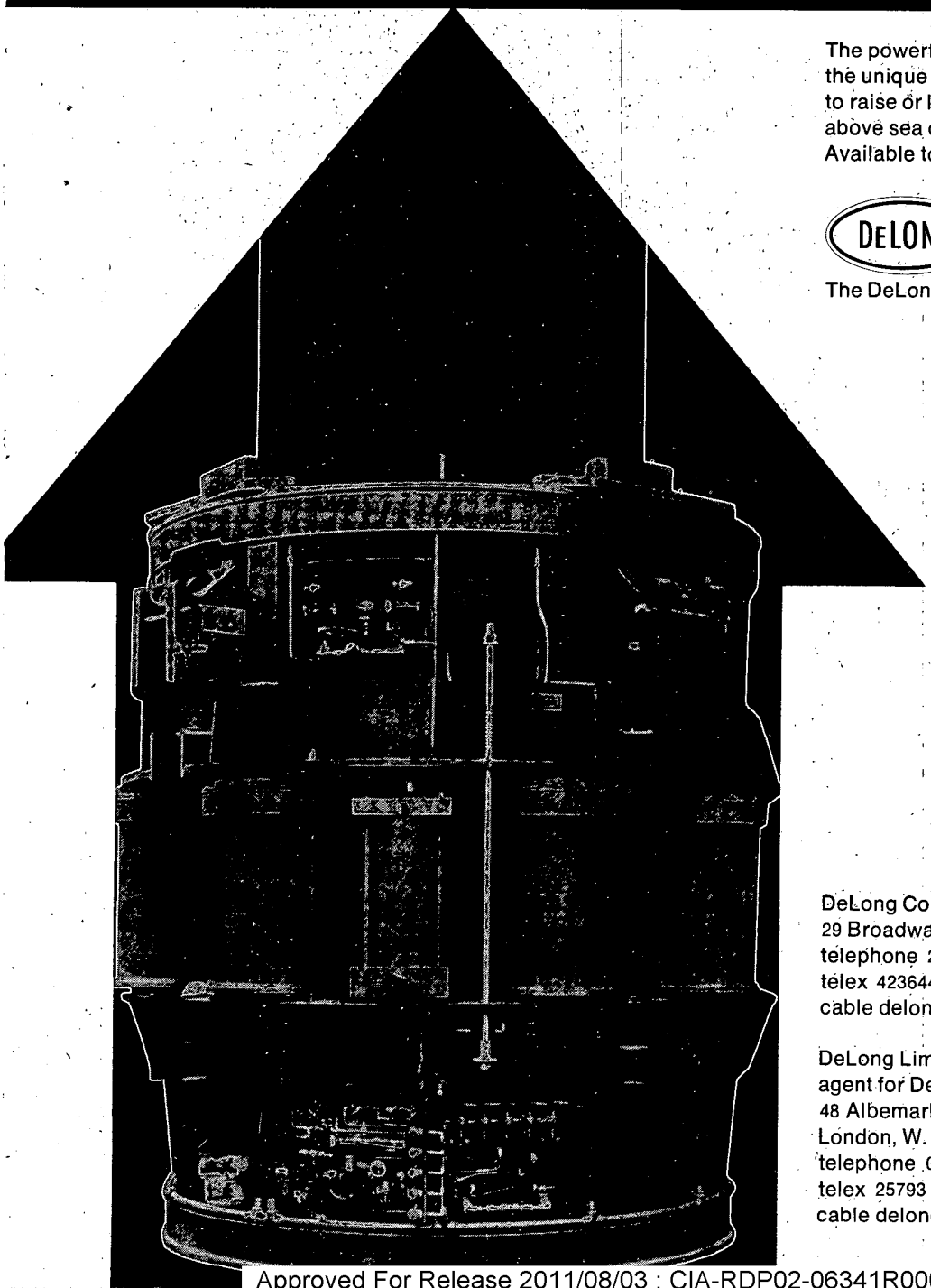
The sections on the Archibentho Zone of transition, and the evolution of deep-sea marine sediment and marine climate are particularly interesting.

The text is a blending of paleogeography, ecology, adaptation, migration and zoning of abyssal fauna, fully illustrated and tabulated. A scholarly contribution to the extensive research and bibliography from which it developed.



THREE NEW 4,290-HP TUGS are being built by Main Iron Works, Houma, La., for McAllister Brothers Inc. The elevating pilot house on the vessel is designed to provide greater visibility when handling new super-barges in and around harbors. The vessels are scheduled for delivery later this year.

This is the jack that DeLong built



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telex 25793
cable delongdock london

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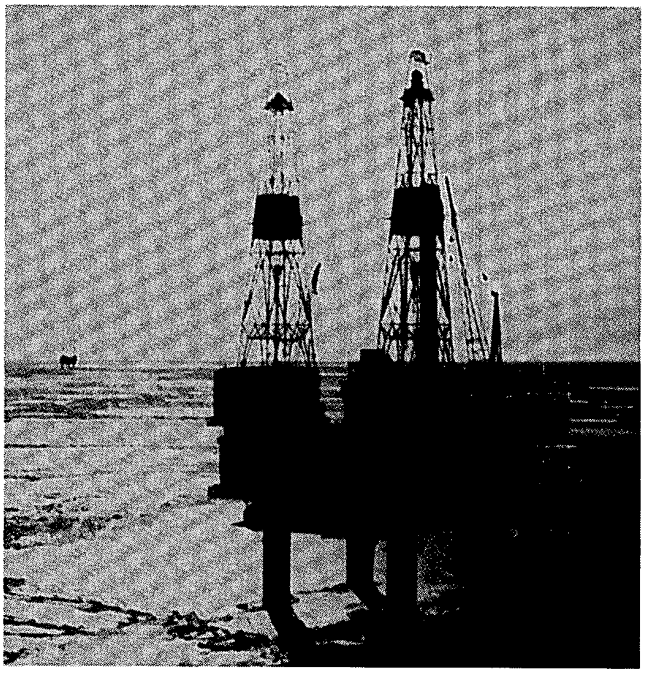

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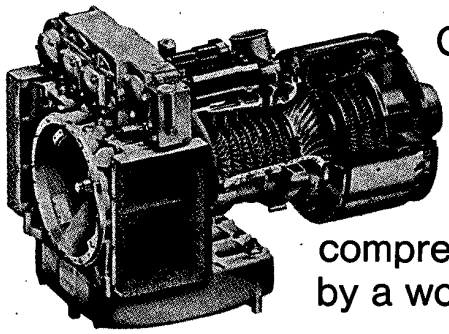

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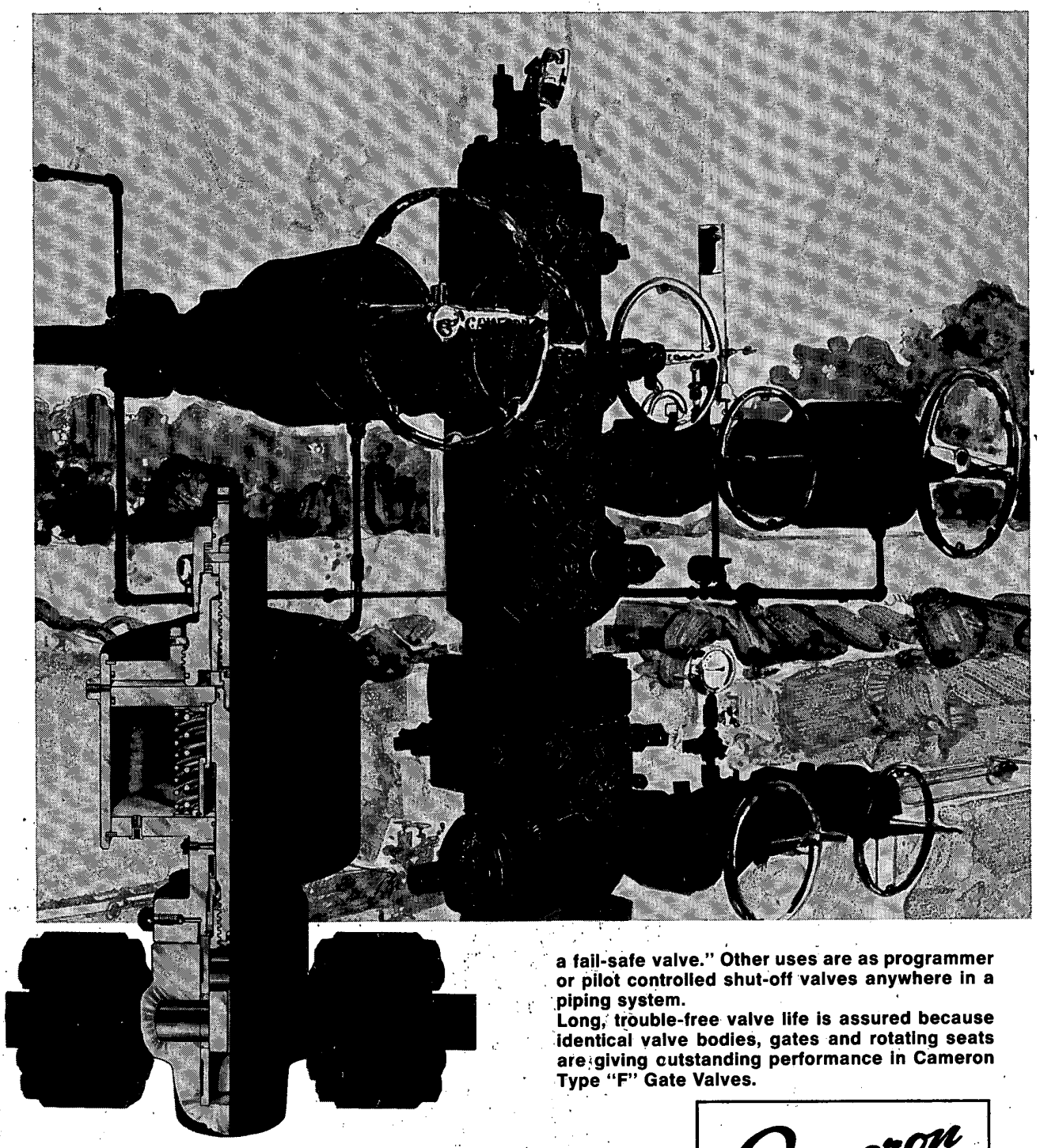

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