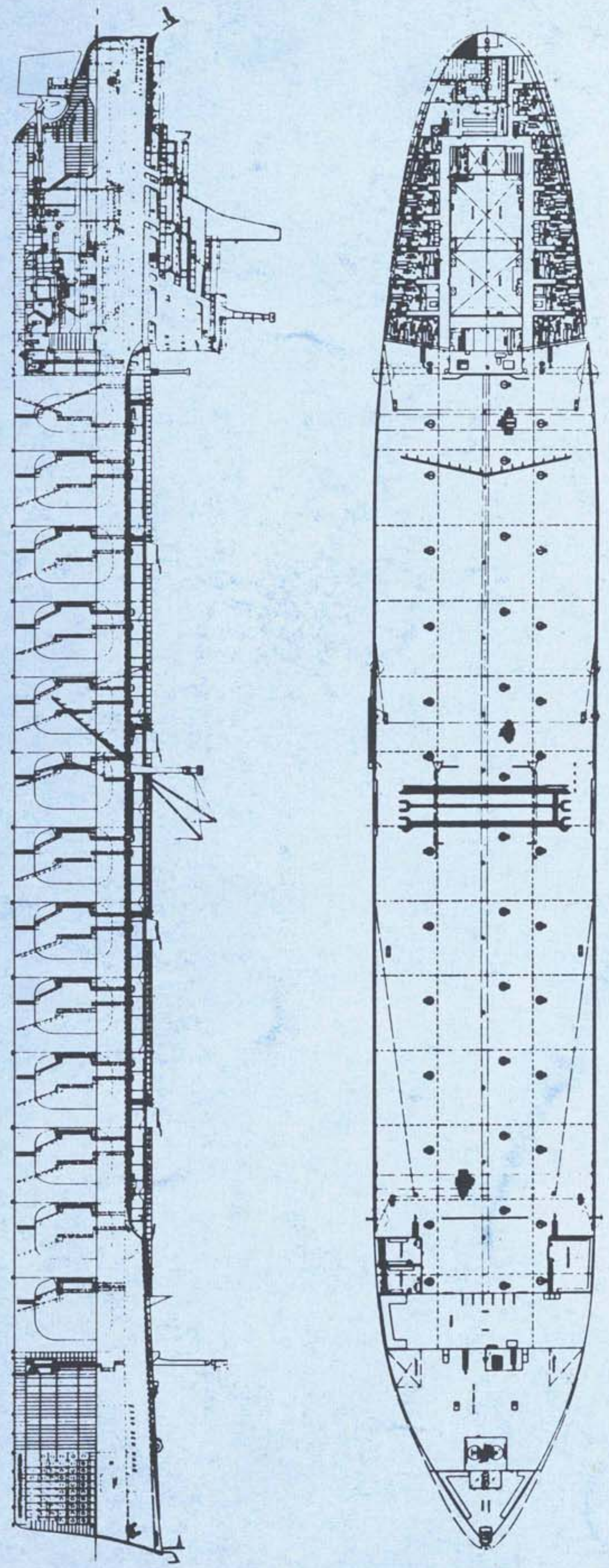

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TANKERS: A SPECIAL ISSUE

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TANKERS: A Special Issue

Written by Paul F. Hoye
Editor, Aramco World

Photographed by Burnett H. Moody
Chief Photographer, Aramco

Cover: Against a pale blue sky over a deep blue sea, the Esso Den Haag, a 90,000-deadweight ton Dutch oil tanker, steams westward toward the Atlantic, its weathered decks a subtle background for the vivid reds of the foam monitors and the soft green of the hatch covers that open into the Den Haag's cavernous tanks.

TANKERS: A SPECIAL ISSUE

Written by Paul F. Hoye/Photographed by Burnett H. Moody

Anchored off the Trans-Arabian Pipe Line Company's terminal at Sidon, Lebanon the Esso Den Haag loads crude oil. The ship can load some 27 million gallons in about 15 hours.

In a strict sense, Aramco's world is confined to the eastern part of the Kingdom of Saudi Arabia. It is here, on a small section of the huge Arabian Peninsula, that Aramco—the Arabian American Oil Company—performs the three functions for which it exists—finding petroleum, bringing it out of the ground and delivering it in crude or refined form to customers who will market it around the globe.

Across the 125,000 square miles of desert, gravel plains and salty water that make up its concession area, Aramco sends oil explorers seeking geological evidence that there may be petroleum in the earth where they are looking. If their knowledge, experience and complex instruments produce an affirmative answer, Aramco's drilling teams follow. If their drilling bits confirm the existence of oil in commercial quantities, planning begins for developing the field. Eventually the field is linked by pipelines to company facilities for handling the crude oil found there. Some will go to the company's refinery at Ras Tanura to be turned into products for use in Saudi Arabia and elsewhere. Most, however, will be shipped by pipeline to points where customers can pick it up and transport it to destinations in the Far East, Europe and America.

One such terminal point is at Ras Tanura, on the Arabian Gulf, where the oil is delivered to two T-piers and a brand-new sea island offshore. Another is at Qaisumah, near the Saudi Arabia-Iraq-Neutral Zone border, where the Trans-Arabian Pipe Line Company's first pump station sends Aramco's crude oil into a large-diameter pipeline crossing northern Saudi Arabia and ending at Sidon, Lebanon, on the Mediterranean Sea. A third is on the shore near al-Khobar, where twin pipelines dip into the Arabian Gulf and come out 20 miles to the east on Bahrain Island, bringing oil to the refinery there. At these three points Aramco's job ends and as the oil emerges from pipelines and is delivered aboard vessels its owners, Standard Oil Company of California, Standard Oil Company (N.J.), Texaco Inc. and the Mobil Oil Corporation, with their ready-made transportation and marketing facilities, take over.

But if Aramco's operations stop at the water's edge or at a remote desert pump station, the oil does not. The oil moves on. Aboard tankers, supertankers, mammoth tankers and, now, gigantic tankers the oil travels to distant terminals and refineries and then into tank cars and barges and pipelines and tank farms all over the world, eventually to supply the kind of efficient energy needed in modern life everywhere.

In this larger sense, then, Aramco's world knows no boundaries. In this sense the world of finding and producing oil is joined to the world of shipping and selling it.

And the link between these two worlds, the bridge, so to speak, between source and buyer, the span between petroleum's original location and its ultimate user, is the oil tanker—the huge, lumbering, ubiquitous and totally indispensable oil tanker—to which this issue of Aramco World is, with considerable affection, hereby dedicated.

— THE EDITORS —

TANKER TO NORWAY

For most of a day and all of a night the tanker had been loading petroleum.

Hour after hour, from the great steel tanks on the hill 6,000 feet away, crude oil from the fields of Saudi Arabia had poured aboard, gurgling quietly through the long green mains into the dark cavities that stretch between bridge and forecastle. Hour after hour the high-riding hull had settled more deeply into the water.

Now, at dawn, it was time to prepare for sea. The rubber loading hoses were uncoupled from the manifold; the steel cables and heavy nylon hawsers were winched in and stowed; the second of two massive bow anchors was dragged dripping from the water. A moment later the ship began to move, the stern pivoting toward shore, the bow toward the open sea. Black smoke belched from the twin stacks on the funnel deck and three shattering blasts from the whistle banged hoarsely against the purple hills of Sidon. The ship, steady on a heading of 277 degrees, steamed west across the Mediterranean. Her name was the *Esso Den Haag*. Her destination was Norway.

There is a definite rhythm to a sea voyage. It begins on a note of excitement, levels off to a placid monotony, rises and falls with the approach of other ships, or with the advent of storms and fog, climbs to a peak in a moment of challenge and then, one evening, or one morning, as the outline of a harbor takes shape on a distant horizon, subsides.

Aboard the *Den Haag* the excitement was short-lived. The crew coiled lines, cleared the clutter from the deck and disappeared, leaving the decks deserted and silent. The Chief Steward, shivering in the numbing zero-degree cold of a galley freezer, chose the meat for the evening meal. The Chief Engineer checked pressure readings of instruments for an indication of some flaw he suspected in the turbine. The Second Officer took over the watch, and Captain Huibert Jansen retired to his cabin to pack his pipe and talk. The sun was warm, the sea blue and all, for the moment, was well.

"It will probably be a calm voyage," said Captain Jansen. "It usually is, this time of the year, and we have made this trip before, many times. But at sea," he shrugged expressively, "at sea, you never know."

He gestured with his pipe toward the starboard side of the ship. "Down there on the poop deck there's a gap in the rail and there's a ladder lashed to the railings nearby. The gap is where the ladder used to be. It is quarter-inch steel, that ladder, but when we started taking green water aboard in the South Atlantic one day it tore like a strip of cardboard."

The captain's words were a gentle reminder that if oil is the central fact aboard a tanker, it is not the only fact. A tanker is also a ship and Captain Jansen made it abundantly clear that once the last hose was disconnected and the last valve was closed, it was to the ship and the long voyage ahead that he would give his full and undivided attention.

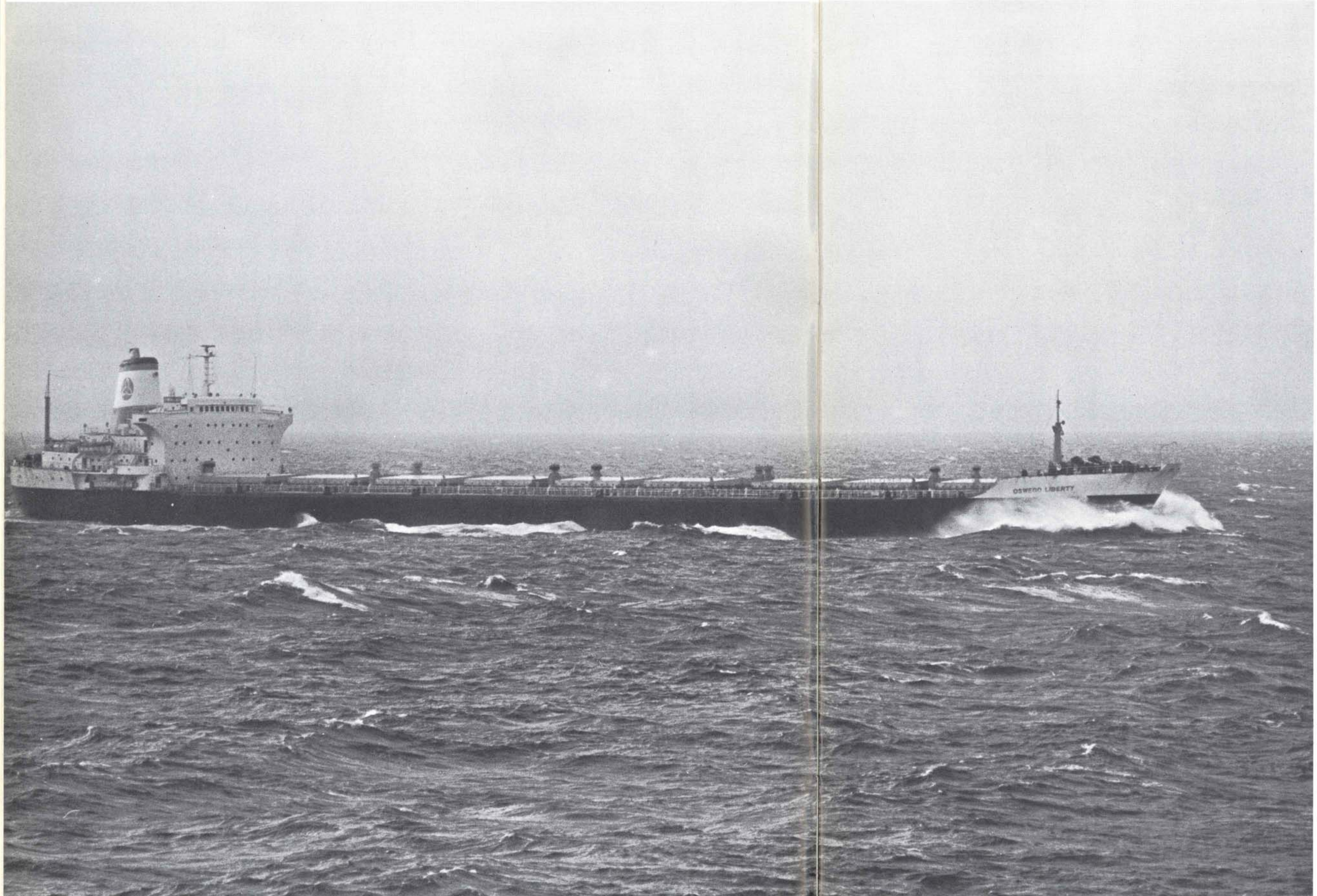
West from Sidon sailed the DEN HAAG — on the first leg of a 4,000-mile voyage to the coast of Norway.

Steaming west across the Mediterranean the Den Haag, steady on a heading of 277 degrees, plows through brisk seas on the first leg of a trip of almost 4,000 nautical miles.

En route to Norway the Den Haag slips past the Channel Islands just off the coast of Normandy in France and plunges into the Strait of Dover where, officers say, "the fog is as thick as plaster".

An officer's face is reflected on the screen as he checks the radar.

Marking the junction of the Mediterranean Sea with the Atlantic Ocean is the famous "Rock," historic Gibraltar.



The drowsy tranquility of the first two days at sea gives way at Cape Bon to brisk and purposeful activity as ships of all sizes and types from around the world appear on the horizon: freighters, fishing trawlers, passenger liners, cruise ships and, of course, oil tankers like Liberia's 44,000-DWT Oswego Liberty.

From Sidon, huddled against the Lebanese coast at the eastern end of the Mediterranean, to Slagen, tucked behind the wooded headland of a fiord in Norway, stretch nearly 4,000 nautical miles of sea. For a ship that at that point had already traveled nearly 240,000 miles it was not a remarkable voyage in any way. Yet the course that Captain Jansen had begun to lay out on the large numbered charts in the chartroom was to take the *Den Haag* through some of the most historic, the most beautiful and, on occasions, the most dangerous seas, oceans, straits, bays and inlets in the world. And first was the Mediterranean.

In all the world there is no waterway to compare with the Mediterranean Sea. Along her shores have risen two of the world's great religions and most of the ancient civilizations: Egyptian, Greek, Roman, Arab, Byzantine, Ottoman. On her waters have sailed the men, great and near-great, legendary and starkly real, who have created, altered or inspired much of the history, philosophy, poetry and literature of both Eastern and Western worlds. It was on the Mediterranean that Ulysses saw his "rosy finger'd dawn" and lashed himself to the mast to defy alluring Circe. It was across the same sea that Paris fled with Helen to spark the Trojan Wars; that Jonas sailed to find his whale and St. Paul, braving tempests and shipwrecks, to preach the new gospel. Columbus set sail here in search of a new route to the Indies. So did Napoleon, to meet the Mamelukes in Egypt and Lord Nelson, to trap him there. Many years after came Dwight David Eisenhower to lead American and British troops into the first Allied counterattack of World War II. Across the Mediterranean sailed Phoenicians, Egyptians and Romans. Later came Arab raiders, streaking out from rocky inlets to seize and plunder unwary merchantmen lumbering toward teeming Venice, or Spanish galleons bringing gold from the New World. And still later came English men-of-war, German U-boats and cruisers, Russian submarines and American aircraft carriers.

None of this, to be sure, was visible from the deck of the *Den Haag* that warm October day. There was only the quiet and empty sea as blue as a baby's eyes and as beautiful. But as the days went by it seemed that in the dim light of the radar screen the entire story of the past—the myths, the gospels, the history—was unreeling chapter by chapter. First came Crete, where noble Theseus of Athens killed the fabled Minotaur in the hidden labyrinth beneath the palace of Knossos; tiny Gavdos, where St. Paul took refuge from a tempest on his way to Antioch; Tripoli, where an intrepid Stephen Decatur first defied the fierce Barbary pirates. Later there was Malta, where the Knights of the same name held their little domain against the Turks for centuries; Pantelleria, to whose volcanic shores came the agents of doomed Carthage; Cape Bon in Tunisia, where, in 1943, Germany's North African armies surrendered to the Allies.

At Cape Bon the drowsy tranquility of the first two days at sea began to give way to brisk and purposeful activity. On the evening of the second day and at dawn on the third, ships from all over the world began to appear: the *Mimje Taru*, a freighter out of Tokyo, the *Olympic Chivalry*, a tanker from the fleet of Greek multimillionnaire Aristotle Onassis, a Russian steamer, the hammer and sickle bright against the funnel, the *Sine Maersk*, a 43,000-deadweight ton tanker, its hull painted in Denmark's traditional bright blue. All that evening and next morning they paraded by, steaming straight for the cape and then peeling off to port or starboard, according to their destination, and vanishing.

It was at Cape Bon that Captain Jansen began to use his radar for more than brief explorations of conditions ahead. Normally—when traffic and weather permit—he prefers that young officers stick as closely as is practicable to the visual sightings and manual plottings that have guided mariners for centuries. This is no fetish. It is grounded in an eminently practical belief that although officers ought to cherish the instrumentation available to them on all modern ships, they ought first to perfect the seamanship that no storm or power failure or mechanical error can affect.

"The captain feels that instruments should help us with our jobs, not do them for us," one officer said.

"Of course," he added after a moment's reflection, "they are a considerable help."

He went on to say that because of

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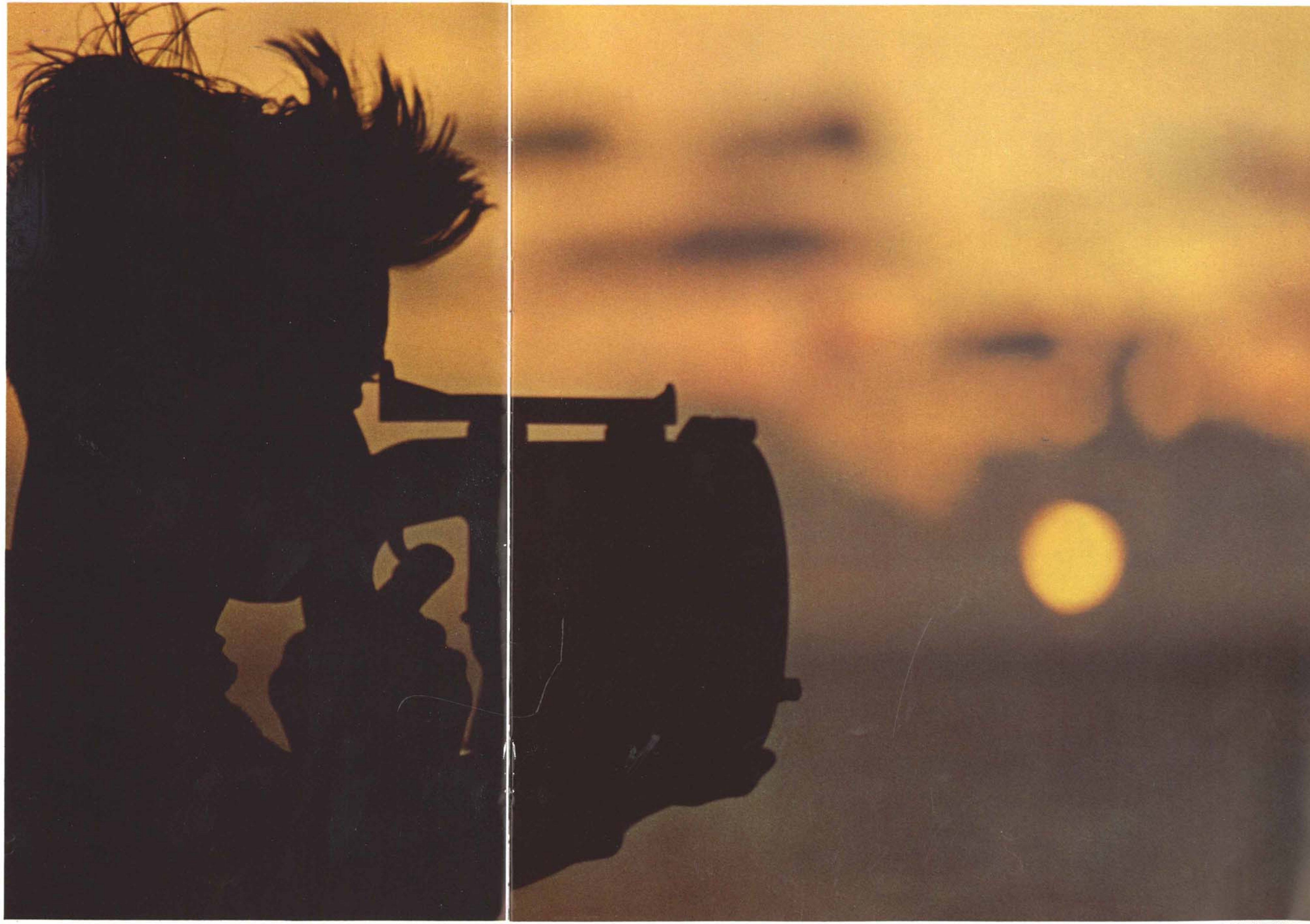


Against a spectacular sunset the Den Haag's Fourth Officer "talks" by flashing light to another ship several miles away.

Although the tanker Den Haag carries the most modern instruments officers must still master and use all traditional methods of signalling, from semaphore to signal flags and flashing light.

Fire precautions on the Den Haag include eight foam monitors that resemble antiaircraft guns and are positioned so crewmen can spread a canopy of foam and water over the entire main deck area.

THE CENTRAL FACT

On a tanker, "the cargo is the point of everything."

Aboard the *Esso Den Haag*, oil is the central fact.

You don't realize it right away. You are too busy gaping at the sheer size of the deck, a vast stretch of steel plating scrubbed and weathered to the color of old brick, and at the high clean white superstructure rising out of the stern like the side of a glacier. Besides, what strikes you is not the presence of oil, but the absence. How could there be oil, you wonder, on a vessel so well-ordered that the officers greet you in pressed plaid sport shirts and creased slacks? Could there possibly be a mistake? Could they be carrying something else this voyage?

It is not until later—after you have adjusted to the fact that to get to the bridge you take a five-story elevator and realized that really *was* a swimming pool you saw on the funnel deck—it is not until then that you begin to sense the presence of oil. It is not until then that you realize that somewhere beneath your feet, somewhere deep down under the main deck, are stored nearly 27 million gallons of crude oil and that this cargo, sloshing about silently in the dark there, dominates the lives of the men aboard, controls their work and time off and has dictated the size and shape of the ship to which they are assigned. As the First Officer put it, "The cargo is the point of everything."

It comes on you slowly, this realization. One day, by a sighting port, you see a small stain of oil on the deck. The next day you catch a faint sour smell on the wind, a mere whiff gone as quickly as it came. The third day you notice a seaman unreeling a measuring tape and you learn that he is checking the distance between the top of the hatch and the surface of the oil and that the distance is just five feet. And then comes the day when the First Officer hands you a set of limp cotton overalls and slips into another pair himself. "We're going to tour the ship," he tells you, "and learn something about tankers."

Before I boarded the *Den Haag*, I had no real idea of what a tanker was like. I couldn't have distinguished the manifold from the foremast. But having boarded the ship and having stowed my gear in the alloted space, I almost immediately came across a set of anodized aluminum plates bolted to the bulkhead of a lower deck companionway. On the plates, stamped in sharp black lines, were complete scale drawings of the *Den Haag*—so clear and detailed that the most obtuse novice could at least grasp the general layout. Thus, when the First Officer led me down the companionway on the first leg of the inspection, I had in mind a clear if very general idea of the ship's basic plan.

The *Den Haag* is divided into three sections. Huddled up forward is the forecastle with, above deck, a clutter of winches, stanchions and bollards just forward of a stubby foremast and, below deck, a warren of fuel and ballast tanks, shops, storage lockers and various compartments and spaces in which are crammed such miscellany as an emergency diesel pump, anchor chains piled in awkward heaps of rusted, salt-crusted shackles, the big Suez Canal searchlight, hoses and special nozzles for washing down the tanks, liquid foam for lighting fires, and sacks of sawdust to sop up oil spillage.

Aft, crowded onto the stern, is the superstructure crowned by the radar scanner perpetually circling while the ship is underway, and the twin stacks leaning against the wind. In the aftership superstructure, arranged in descending order, are the bridge, chartroom and wheelhouse, the quarters for the deck officers, engineers and crew, the galley, dining salon, the lounges, the lifeboats, the stern anchor and, eight decks below, the engine room, ablaze with an eerie, bluish light and vibrant with noise.

And in between is the oil.

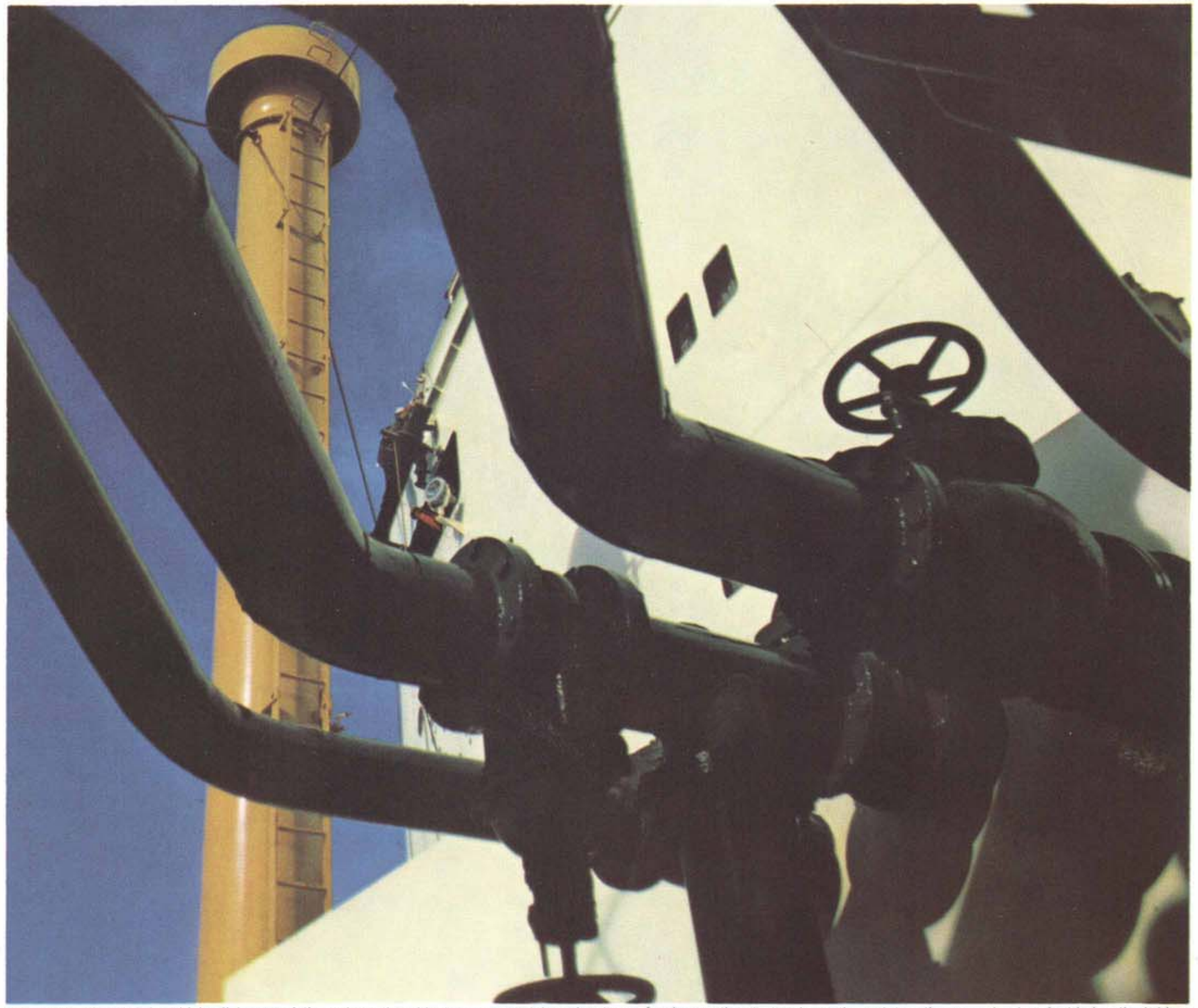
The division of the *Den Haag* into these sections gives the ship we were riding her distinctive look. But the engine room, bridge and living spaces are all located in the stern for reasons of safety and economy, not appearance. On tankers the engine room has always been placed aft rather than midships thus eliminating the need for a tunnel running half the length of the ship to house the propeller shaft. This not only saves valuable cargo space but does away with the danger that the cargo might ignite because of an overheated bearing. Concentrating the bridge and the living quarters at the stern also puts 680 feet of steel and all the cargo between the men and what would probably be the point of impact should a collision occur. This design also assures that the greatest number of the ship's company, on duty and off, would be on that part of the vessel most likely to survive and float even in the unlikely event that she should break in two. Furthermore, the designers of the *Den Haag* eliminated a hazard common to freighters which have the bridge and quarters amidships: the possibility that a rare spark from somewhere would land on the cargo area; on the stern such sparks are simply blown overboard into the water.

All this the First Officer discussed as he led the way along the narrow catwalk bisecting the main deck from bridge to forecastle, the start of what he said was an essential tour. "If you are to write about this ship," he said, "you must see all of it, and right here is a good place to begin."

"Right here" was a dim compartment high up in the forepeak near the bow, with an open manhole in the deck. We slipped through it and began to descend the rungs of a narrow ladder. It was hot and the smell of oil was strong. The rungs were slippery. Except where the First Officer's gastight flashlight threw a dim beam the place was pitch black.

"This is called the 'forepeak tank,' " my guide explained. "It measures 68 feet from top to bottom, and has a capacity of 100,000 cubic feet. There are also four deep tanks in the foreship having a total capacity of 266,567 cubic feet of fuel oil or ballast water."

For a moment there was silence. Then I heard, faintly, the sound of the open sea washing against the sides of the ship. I suddenly realized two things: that we were standing about 48 feet below the



Framed by oil mains in which oil is moved throughout the ship two seamen take advantage of calm weather to touch up the paint on the superstructure just below the bridge.

surface of the water outside and that right about here was probably the most vulnerable point of the whole vessel. Right here, the structural strength of the curved bulbous bow and the force of the throbbing turbine aft were pitted against the enormous pressures of the deep and the stunning power of angry waves. I was beginning to wonder how any ship could stand up against these conflicting elements when, in the beam of his flashlight, the First Officer showed me the answer: the entire bow was braced with heavy steel I-beams. There were nine layers of them almost seven feet apart and they formed an interlocked structure so rigid and unyielding that it was hard to conceive of even the worst seas damaging the forward section of the ship in the slightest.

Climbing up to the open deck and proceeding to the forecastle we continued the tour, stopping here and there while the First Officer described the workings of the nozzles which can be dropped down into the tanks to hose them off, or explained that tons of sawdust are carried to sop up spilled oil.

He talked with the enthusiasm and clarity of an officer who knows where each bolt in the ship is and what part of the ship it is supposed to hold together. In an hour's time he pointed out every locker, chamber and compartment in the forecastle, explained the functions and capacities of each, and seemed able to go on indefinitely. Finally, though, he stopped. "Now I must go and inspect a pump. We'll talk more later."

Which we certainly did. All that week, as the *Den Haag* steamed west through the golden sunshine of the Mediterranean, we—as well as Captain Jansen, the Second Officer, the Third Officer and the Fourth Officer—walked around the *Den Haag* and climbed up, down and through the *Den Haag*, and, constantly, unendingly, talked about the *Den Haag* .....

"See that red instrument there near the catwalk? The one that looks like an antiaircraft gun? It's a foam monitor for fighting fires. We have to handle it manually and there are eight of them working off what we call a foam-proportioning pump that sends a solution of foam and water through foam lines into the nozzles at high pressure. They're positioned so that we can provide a canopy of foam over the whole cargo area when necessary, and also so that we can handle them from behind the shelters on the fore and aft gangways ..... This, of course is in addition to the diesel pump up forward that supplies sea water and or foam from a separate tank—250 tons an hour, by the way—and a battery of steel CO_2 bottles. One simple pull at a handle directs CO_2 gas to the engine or boiler room. For extra safety an alarm is first sounded to enable all men present there to leave before the gas is released.....

"The anchor? It's hauled aboard with a steam winch and a system of gearing that has a special shut-off valve in case anything sticks down below. We don't want to snap the chain, eh?....

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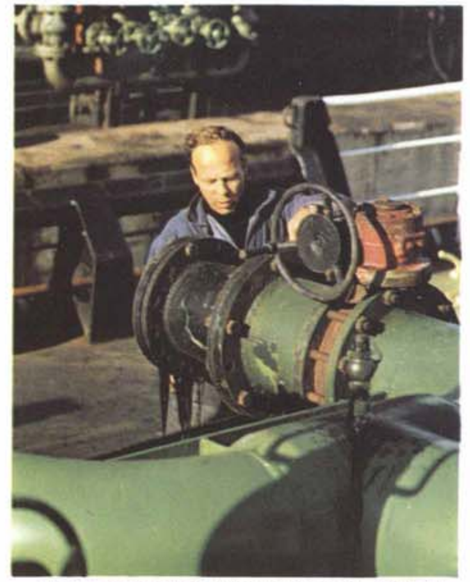
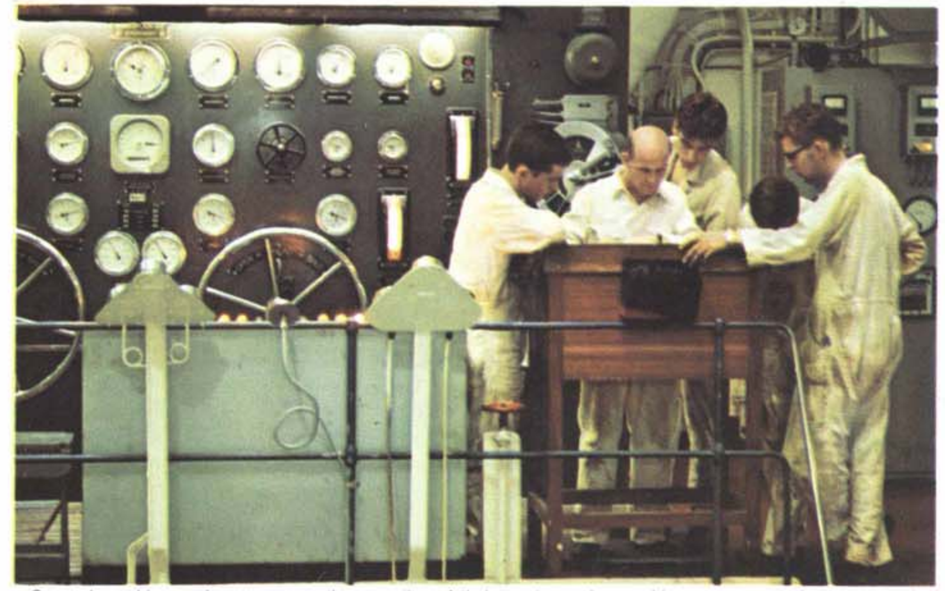


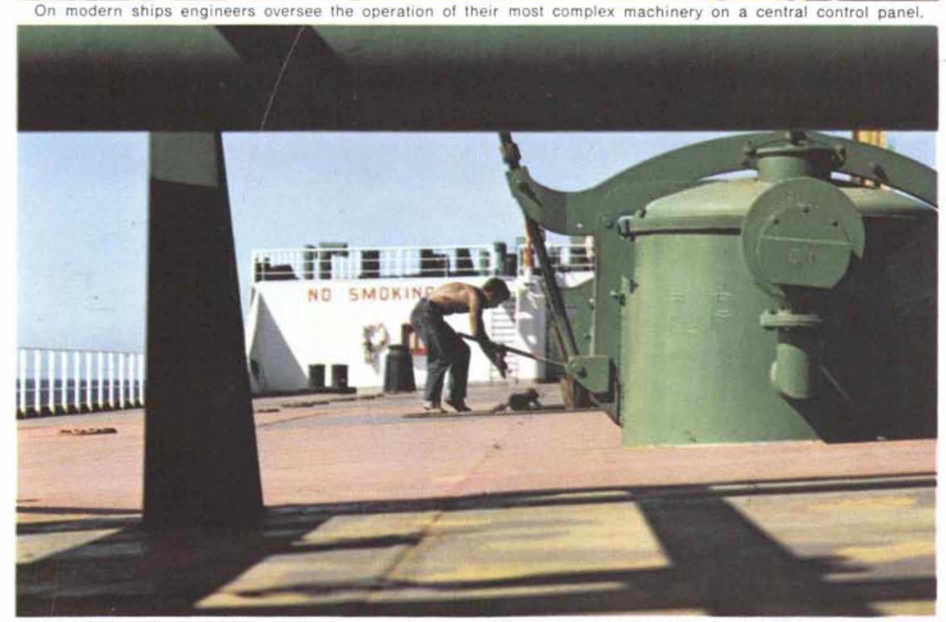
A bosun coupling off-loading hose to the manifold.

On a tanker the manifold is a battery of pipes through which oil flows aboard and is routed into the tanks.

Crewmen adjust fitting on hatch leading into tank below.



On modern ships engineers oversee the operation of their most complex machinery on a central control panel.



For safety, each of 39 hatch covers is screwed firmly in place by means of a long hatch cover control screw.

BIG-BIGGER-BIGGEST?

The recent trend toward industrialization in emerging nations notwithstanding, it is a fact that much of the world's oil exists in regions where its consumption happens to be small. Conversely, the greatest oil requirements are still to be found in such areas as Western Europe, where supplies are relatively low. And since an estimated half of the world's energy is derived from petroleum, the job of moving that oil from source to user takes an immense importance. Ever since someone discovered a practical way to make the hull of a ship double as a container for oil, tankers have largely dominated liquid fuel transportation—and their role in the field is becoming more vital all the time.

On January 1, 1966, according to the British tanker brokerage house of John I. Jacobs & Company Limited, there were in the world 3,484 tankers of 2,000 deadweight tons and over. (Deadweight tonnage represents the weight of the cargo, stores, water bunkers, the fuel carried to drive the ship, which that ship can lift, expressed in tons of 2,240 lbs.) Only five years earlier, when tankers already were accounting for one-third of all merchant shipping in the world, the Economist's industrial editor, J.E. Hartshorn, placed total tanker tonnage at some 67 million, which even then was a three-fold increase over 1939's and 25 times that of 1914. On March 30 last year there were 227 tankers under construction in various parts of the world, representing 43 per cent of all ships being built everywhere. Hartshorn notes that "over the last generation in particular, tanker tonnage has been by far the most rapidly growing element in world shipping."

Not only are tankers becoming more numerous, they are also getting bigger and faster, for, as one writer put it quite simply, "The general rule is that a large fast ship is more economical than a small slow one."

During a long period ending in 1939 the size of tankers gradually rose to between 10,000 and 12,000 deadweight tons, and seemed to stay there. It took military hostilities on a global scale, with an accompanying need for fuel, to break the tonnage "sound barrier." World War II brought the famed T-2's, rated at a standard 16,000 deadweight tons. In the last three years of the war American shipyards turned out, assembly-line fashion, 500 of them.

The astonishing postwar demand for oil began to exert its influence. Europe and Japan went to work rebuilding their shattered economies and the momentum of U.S. business activity, already shoved into high gear by the war, accelerated. Oil fields in the Middle East went into full production. New refineries were located near markets rather than sources of the oil which feed them. Oilmen studied the economics of larger tankers to meet the need, and increase in size won out.

Adopting the old boxing rule that a good big man can beat a good small man any time, the oil industry experimented with tankers of 28,000-32,000-deadweight-ton range and found, as expected, that they cost less per ton of capacity than smaller ones to build and operate. So swift was the growth of the supertanker that by 1959 more than 37 per cent of the world fleet consisted of ships over 25,000 deadweight tons and 16 per cent were rated at more than 35,000 tons—and the end was nowhere in sight.

In 1964 one-fifth of the world's tankers had capacities of 30,000 deadweight tons and up. By the beginning of this year 15 tankers of at least 100,000 deadweight tons were plying the seas, according to John I. Jacobs & Company Limited and the Petroleum Press Service. In February of this year, the new 1,006-foot Tokyo Maru docked at Ras Tanura and took aboard more than a million barrels of crude oil. The Tokyo Maru with a capacity of 150,000 tons, will reign as the world's largest oil tanker only until six vessels of 165,000, five of 175,800, one of 191,300 and another, the Idemitsu Maru, of a staggering 205,000 deadweight tons, all now on order, have been delivered.

Pre-World War II tankers had operating speeds of 11-12 knots. The T-2 standard tanker of the early 1940's was able to push through the water at between 14 and 16 knots. Powerful 33,000-horsepower steam turbine engines will enable the 1,120-foot Idemitsu Maru to cruise at a service speed of $16\frac{1}{2}$ knots, fast enough to get her from Japan to the Arabian Gulf and back eight times a year when she is commissioned some time in 1967.

So the universal demand for petroleum is only part of the reason behind the ever-increasing size and speeds of oil tankers. A glance at a world map further explains these two trends: with oil requirements growing apace often far from major areas of production, tankers now have to travel longer distances to supply those demands. It makes good business sense for them to carry large loads between source and destination in the shortest possible time.

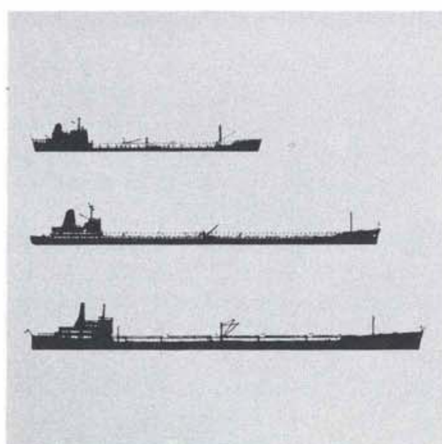
Besides taking into account capacity, speed and areas of trade when figuring cost-earnings ratios, tanker men note that capital investments do not rise proportionally with each increase in vessel size. Hartshorn expresses the idea another way when he says, "It takes less labor, steel and shipyard design to build a tanker to carry 60,000 tons of crude oil than it does to build two to carry 30,000 tons each."

The same principle applies to operating costs. Up to a point the expense for insurance per ton of cargo falls as size increases. Very few more officers and men are needed to run a large ship than a comparatively small one, and automation, now being fully applied to tanker operations, helps hold down the size of ships' complements. Modes of propulsion (motor vs. steam) and fuel types (diesel vs. fuel oil) are being carefully studied for economy's sake. And even though the new giant tankers' capacities are huge, their expensive in-port stays are constantly being reduced by improved pumping systems, which shorten loading and discharging periods.

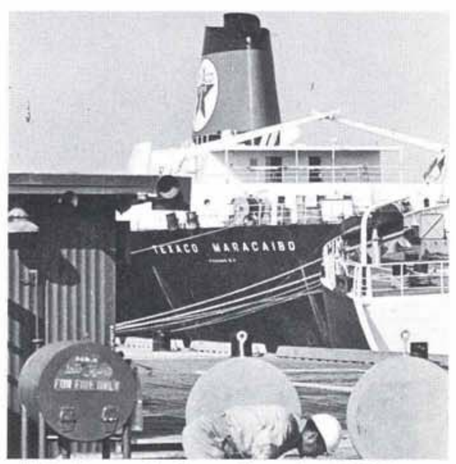
There will of course always be a need for the small and medium-sized tankers able to get into the smaller and out-of-the-way ports. Oil-carrying ships of more modest deadweight tonnage are especially useful for carrying petroleum products to destinations where the giant cargoes could not possibly be absorbed in one load ashore. Flexibility is another useful factor in oil transportation, but the overriding characteristic of the ships used for this vital work is still their enormous—and growing—capacities.

Where will the size of tankers stop? At which point will their bigness no longer pay off in the highly competitive petroleum market place? No one really knows, of course, but one thing is certain: the growing numbers of large tankers is further complicating the already complex oil business. No tanker makes money unless it is working steadily, transporting a full load of crude or products to a customer, so the big ones must be routed with great care to make them pay.

Linked to this challenge is the problem of loading and discharging facilities necessary to accommodate the new breed of giants. Revolutionary concepts in marine terminal design must be worked out on or near the world's shorelines if the growth of oil tankers continues at its present rate. The seagoing mammoths also need correspondingly big dry docks for necessary maintenance and repairs, and these, like the new terminals, will of necessity be very costly. It is apparent that the bigger future oil tankers become, the sharper will have to be the imaginations—and pencils—of the men who design them.



Tanker growth: 19,000 tons; 62,000 tons; 90,000 tons.



At Ras Tanura, the Texaco Maracaibo, 82,000 tons...

The Mobil Energy from London, a ship of 48,000 tons...

... and the enormous new 150,000-ton giant, Tokyo Maru.

"Yes, the bridge, living quarters and lounges are air conditioned. It sounds expensive but the *Den Haag* is almost always assigned to semitropical regions and there it can get quite uncomfortable, even at sea. Besides, tests have shown that if you air-condition the ship the corrosion is less and the overall maintenance easier. That saves more than the air conditioning costs....

"There are pumps everywhere. The most important, of course, are the cargo pumps and each is driven by a 1,300-horsepower turbine and each can handle 11,000 gallons—U.S. gallons—per minute. The stripping pumps—they're to get what the cargo pumps leave—have a capacity of 1,400 gallons per minute. There is also a clean-ballast pump rated at 9,200 gallons per minute. There are steam pumps, a diesel pump, hydraulic pumps, bilge pumps, main and auxiliary circulation pumps, main feed pumps, lubricating oil pumps, fuel oil transfer pumps, washwater pumps, sanitary pumps ..... well, as I said, all sorts of pumps ..... The fore and aft pump rooms have been equipped with explosionproof ventilators that can change the volume of air many times an hour .....

"Look at it this way. If the tanks are the belly of the ship, the manifold is the mouth. All it is, as you can see, is a battery of large pipelines running almost all the way across the deck in about the middle of the ship. When we are loading or discharging cargo we couple hoses to the manifold on one side or the other and either open up the valves—if we're loading—or turn on the pumps—if we're discharging—and the oil starts moving in or out. The valves are located at the very bottom of the tanks and they are opened or closed hydraulically or by hand via a long rod that extends from the deck, all the way down. In either case, the oil is routed through three systems of pipelines: 20-inch main lines, 16-inch main branch lines for pumping the oil aboard and 18-inch lines for discharging it. You can see those lines there under the fore and aft gangway, the ones going into the deck. That other line there, the one covered with rust, is not a cargo line; that carries steam forward ....

"During the voyage we must keep constant check on what we call 'ullage.' That's the distance between the surface of the oil and the top of the hatch. Oil, you see, is unlike other cargoes. It expands and contracts and you have to keep this in mind while you're loading. One time, the ship's records show, the oil was loaded when the outside temperature was 105 degrees Fahrenheit. When they finished loading, the ullage was four feet. But when the oil was discharged some 10 days later the temperature was 80 degrees and the ullage was four feet nine inches. That's quite a difference.

"Here in the boiler room is where you can see one good example of mechanization. To maneuver a ship—slow down, speed up, back up, turn, and so forth—requires a constant adjustment in the flow of steam. That's because—I'm simplifying, of course—the pressure of the steam is what turns the turbine fans and, in turn, the shaft and the propeller. Now to regulate the steam—reduce it to slow down or increase it to speed up—means that the burners which generate the steam have to be extinguished and relighted at a fairly rapid pace and this in turn requires that the burners be pulled out or pushed into the combustion chamber. This whole process used to be done by hand. Today, one man standing at a control panel in the engine room can regulate the steam flow, extinguish or ignite the burners and pull the burners out of the combustion chamber or push them in. With this kind of an arrangement, the whole ship can actually be run in a pinch by just two men—one on the bridge, one in the engine room.

"After a cargo has been discharged there is always a mixture of gas and air left in the tanks and pumping system which is potentially dangerous and must be removed. We call it 'gas-freeing.' It is done by pumping sea water through the system, then using gas ejectors to force the gas up through special pipes and discharge them into the air and next circulating fresh air throughout the tank. Until a tank has been gas-freed no one can go in without wearing a gas mask and special shoes. There is always a chance that there is gas left or that a nail in a man's shoe strikes a spark if he slips...

"Now about the tanks. First of all, there are tanks everywhere. It's a tanker after all, eh? Aft there are two fuel oil tanks holding 60,575 cubic feet of bunker fuels; four deep tanks forward with a total capacity of 266,567 cubic feet for fuel oil or water ballast, two fuel oil settling tanks with a capacity of 22,891 cubic feet, two after fuel bunker tanks, plus tanks for water. And naturally there are the cargo tanks. But we'll have to talk more about the cargo tanks, much more."

Like most people, I suppose, I had imagined that the interior of a tanker must be some sort of huge bin amidships. I also had assumed that filling this bin would be rather like turning on the faucet in a large bath tub. I couldn't have been more mistaken.

"First of all," the First Officer said, "we must talk about the arrangement of the tanks. The interior looks rather like an ice-cube tray in a refrigerator, the kind with a metal separator. It is divided into compartments, first to prevent surging and second to permit a tanker to carry more than one grade of petroleum.

"Imagine this ice-cube tray without the separator in it. If you fill it full of water and walk with the tray in your hand the water will splash back and forth or across. And each surge will be a bit stronger than the one before, until it spills. That's surging. In a ship the force of the oil splashing back and forth as the ship rolls and pitches might turn her over. Now put the separator in your tray and look at each compartment as you walk. The water does not splash so much, eh? That's because the free surface is limited.

"The other reason for these divisions is that tankers used to carry different grades of oil that shouldn't be mixed. I say 'used to' because this practice is on its way out. While the *Den Haag* was being built in 1963 it was decided to assign her exclusively to the transport of crude oil. This meant that except to prevent surging, all that compartmentation—there are 39 separate tanks—was unnecessary. And since the ship was almost finished, it meant that for the next 15 or 20 years the *Den Haag* would carry a substantial tonnage of unnecessary steel around the world with her. So they cut holes through the compartments, making double tanks, and reducing the weight of the bulkheads...

"On the *Den Haag*, by the way, all steel surfaces in the cargo tanks are protected by an epoxy paint coating, a tremendous job that was carried out during construction and took about 80 tons of high quality paint to cover the total area of over 17 million square feet of steel, and every square foot had to be inspected."

The First Officer then turned to the problem of loading and unloading.

"Loading is the most difficult part of the job. You may think the *Den Haag* looks very strong, but in port if you make a false move in loading, it is entirely possible to snap her in two, like a match.

"As you know, the *Den Haag* is a very long ship. She has to be to provide the desired capacity. But precisely because she is long this ship is vulnerable to the stresses we call 'sagging' and 'hogging.'

Holding up a long yellow pencil, the First Officer pressed down with his thumbs on the center. The center bent downward and the eraser and the point bent upward and the pencil broke in two.

"That's sagging," he said.

He picked up another pencil, pressed up with his thumbs and down with his fingers. That pencil broke, too, but in an upward direction.

"And that's hogging.

"The bottom of a ship always sags where the pressure is applied. For example, if the oil we loaded at Sidon were put into all the wing and center tanks at the middle of the ship, the bottom of the ship would sag in the same way the pencil did when I pressed on the middle. Keep putting the pressure there, tank by tank, and the center would go down as the bow and stern came up. Finally the whole ship—beam, hull, deck—would simply break in two. It is unlikely but it could happen.

"Hogging is just the opposite. If we loaded cargo into all the tanks at the bow and the stern, the center would rise and the bow and stern would sink. But the strain would be the same. The ship can break either way.

"In smaller ships," he went on, "sagging and hogging are less serious because the longer the ship, the greater the danger. The sag would be two inches in a fully loaded ship of 25,000 tons, for example, four inches in a ship of 35,000 tons but 12 inches in a 90,000-ton-ship like the *Den Haag*."

The problem has been solved, of course—*is* solved each time the *Den Haag* loads another cargo—by simply filling all

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QUEEN OF THE FLEET

The Den Haag is not nearly as big as the Empire State building. She is not even as big as the Eiffel Tower. But you wouldn't mistake her for a rowboat either. She is just 176 feet short of the majestic Queen Elizabeth. There is enough room between her bridge and her bow to line up 10 regulation bowling alleys or install 24 tennis courts. If she carried water instead of oil she could supply an American town of 3,000 people for a year. Fully loaded she can't get through the Suez Canal or into any harbor on the East Coast of the United States including New York. And when her officers or crew have to go forward they usually ride bicycles.

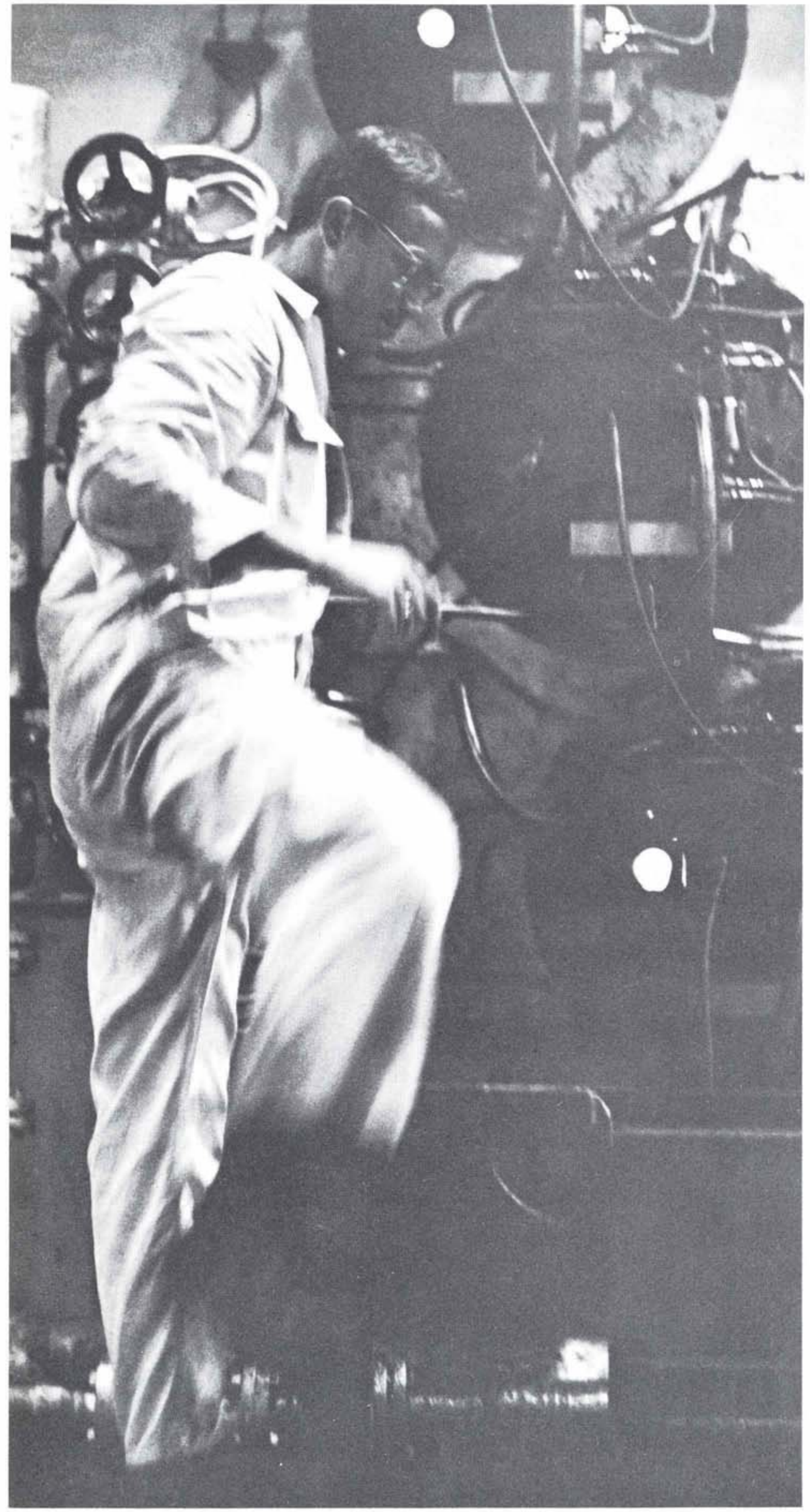
This last fact impresses visitors to the Den Haag more than statistics do. The sight of a weathered bosun or a dignified ship's master phlegmatically pedaling along the deck of a ship in mid-ocean is not only astonishing and amusing but conveys in a most graphic manner the size of today's tankers.

The Den Haag — that's Dutch meaning "The Hague" — was constructed by the Verolme United Shipyards in Rotterdam, at a cost of $18 million. Launched July 4, 1963, at a christening presided over by Princess Beatrix, the Den Haag, as the largest Dutch vessel afloat, was promptly crowned queen of the Dutch merchant fleet.

It is true, of course, that the new giant tankers being constructed will soon dwarf the Den Haag as the Den Haag now dwarfs the once huge T-2's of World War II. Yet the Den Haag is still a very large ship and her dimensions show why: length 855 feet, 10 inches; beam, 125 feet; draft 847 feet, six inches; capacity, 670,000 barrels; top speed 19 knots.

Her three cargo pumps can lift 11,000 gallons a minute. Her stripping pumps can drain her bilges at 1,400 gallons a minute. In case of fire her diesel pumps can pick up and throw 250 tons of sea water an hour. She carries three anchors each weighing 11 tons. The surface of the rudder totals 660 square feet and the rudder assembly weighs about 90 tons. In the engine room, behind walls of two-inch steel, two boilers generate 95,000 pounds of steam per hour—and can go to 150,000 pounds—at temperatures up to 860 degrees Fahrenheit. The turbine can produce up to 26,500 shaft horse power (SHP)—enough to spin a two-feet-thick and 67-feet-long propeller shaft and a 33-ton, 25-foot-bronze propeller at 108 rotations per minute, and enough to keep her going 11 miles after you shut off her steam.

Clustered beneath the fore and aft gangway, the ship's main cargo pipes and steam and water lines stretch from superstructure to forecastle, accenting the ship's already impressive length.



Engineers say that if the manifold is a tanker's mouth and the tanks her belly, the engine room is her heart.

the tanks in the center of the ship first, leaving the wing tanks empty. By opening all the valves in the center tanks simultaneously the First Officer keeps an even amount of oil in the bow and stern and amidships all the time and so minimizes sagging. After the center tanks are filled the flow is routed into the wing tanks. Thus the stresses are balanced one against the other and excess sagging and hogging are avoided.

It would seem logical that once this was done, future loading could follow the same pattern. But this ignores an important aspect of oil. Different products have sharply different specific gravities and so, also, have different kinds of crude oil. Since this changes the stress patterns significantly each shipment must be calculated separately—now, fortunately, with the help of an instrument called the "loadicator" which indicates the proper sequence to follow once it has been fed the basic information. Furthermore, the First Officer must take into his calculations another factor: the "trim" of the ship, or how she sits in the water with reference to a level horizontal plane.

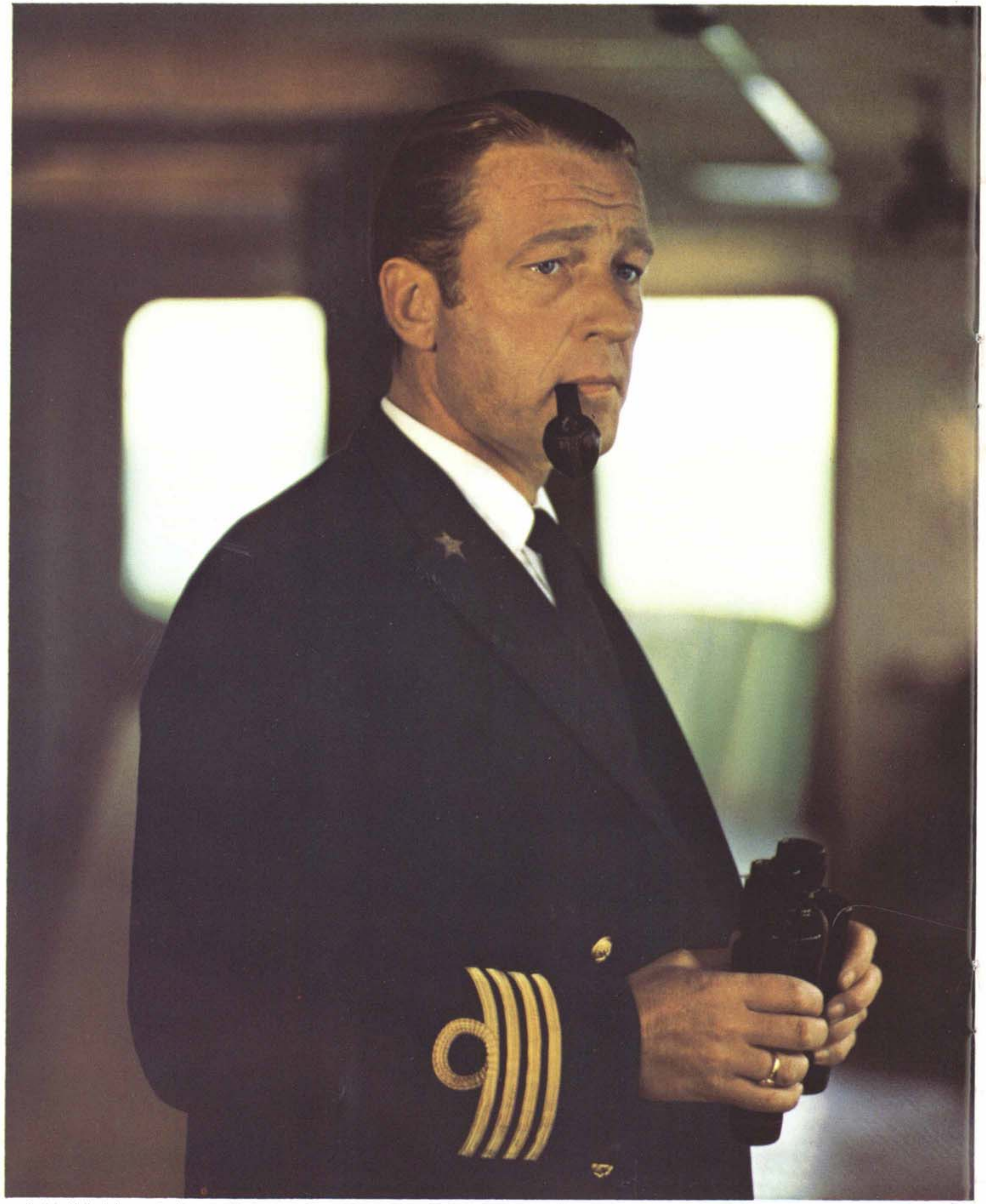
As the hours went by the First Officer ranged over a seemingly endless number of factors concerning tanks, listing their capacities and limitations and problems, and tossing out statistics and measurements with the speed of a computer.

And then, he smiled and said, "I think we've covered everything—except.."

"Except what?"

"Except that you cannot possibly know a tanker until you have gone into the tanks."

He was right, of course. You may listen to all the explanations and read all the statistics, but the central fact does not strike you until the moment you scramble through a hatch that looks no bigger than a dinner plate, climb carefully down an endless ladder and stand in the blackness and silence. Above, nearly seven stories over your head, is the hatch, now the size of a dime. Below are the bilges. And all around is an enormous empty space—the space, you realize, that they fill with oil, submerging frames, webs, girders, everything around you including the very ladder you climbed down just before.



Captain Huibert Jansen, "a big man with broad shoulders, hair the color of brass, a lopsided grin, a lively wit... and a gift for running a taut ship with a minimum of effort."

CAPTAIN JANSEN AND HIS MEN

In the haze of the English Channel one night, a young officer named Huibert Jansen was standing his watch on a Dutch merchant vessel when he noted a huge liner bearing down on him. He flashed a warning, added a request for identification and received, from the bridge of England's biggest ship, the haughty reply, "The *Queen Elizabeth.*" Unabashed, young Mr. Jansen flashed back: "What nationality?"

That story, told with a shout of delight on the bridge of the *Den Haag* one evening last fall, typifies not only the man who told it—Captain Huibert Jansen, master of Holland's biggest ship—but also the officers and men who serve on the *Den Haag* and ships like her.

It is an odd paradox of industrial growth that although mechanization and automation do reduce the numbers of men essential to an operation, those who survive are more essential than ever. On the *Den Haag*, for example, just 32 officers and men load and unload her, operate the boilers and turbines and all the interlocking and intricate system of machinery, navigate her around the world and see to all the traditional tasks of provisioning, cooking, washing, cleaning. Quite clearly they could not accomplish it all efficiently without a high degree of mechanization. But neither could they accomplish it if they themselves were not experienced experts—men like Captain Jansen and his First Officer, Gerard Alkema.

Captain Jansen is a big man with broad shoulders, hair the color of brass, a lopsided grin, a lively wit, a taste for strong tobacco and Dutch gin and a gift for running a taut ship with a minimum of effort. As one officer put it, "There's a line between informality and carelessness and he marks it plainly." Still in his forties, Captain Jansen won his master's ticket at the age of 29 and has been handling tankers for most of his career since, a fact that was doubtedlessly considered when he was chosen last year to help design the new Esso 150,000 and 170,000 deadweight ton-class vessels now under construction in Germany and France; he will eventually command one of these two ships.

Equally typical of the breed is the First Officer, a youngish Dutchman who already holds his master's ticket—the chief officer's and the master's tickets are the same in the Netherlands—and will soon, no doubt, have his own command. A serious, dedicated professional, the First Officer is proud not only of his ability to carry out his main job—handling the cargo—but also of his acquired skills in filling other roles aboard, being the ship's doctor, for instance, a duty which traditionally goes to the second in command. This assignment can be a grave responsibility at sea, and the First Officer accepts it in just that spirit. Instead of taking only the basic medical courses required of all Dutch deck officers, he went on to read and study on his own. He plans to go for a brief internship in the accident room of a hospital ashore. Several Dutch merchant officers do this to get more practice. It is encouraged by nautical colleges and the shipowners.

Not all men aboard the *Den Haag*, certainly, are as dedicated. One member of the ship's company, son of a merchant seaman, remembers his loneliness as a child when his father was away for months on end and wonders whether he ought to subject his own son to the same thing. Another related ruefully that the day after his wedding he was summoned to his ship, which was going around Africa. He was permitted to stay ashore "a bit longer" after he explained the circumstances, but not all ship's masters would be so considerate. And, as the Chief Steward pointed out with dry understatement, life at sea has its uncertainties. One night, he said, he was hard at work in the galley baking a very special cake for a festive occasion aboard a passenger liner when, without warning, there was a collision. A serious collision? Well, rather. The liner was the *Andrea Doria.*

It is not often, of course, that discomfort at sea has such dramatic

On duty there are no coffee breaks—just coffee.

Second Officer Van der Velden standing his watch.

Norway—and the end of the voyage—is in sight.

First Officer Gerard J. Alkema plots ship's position.

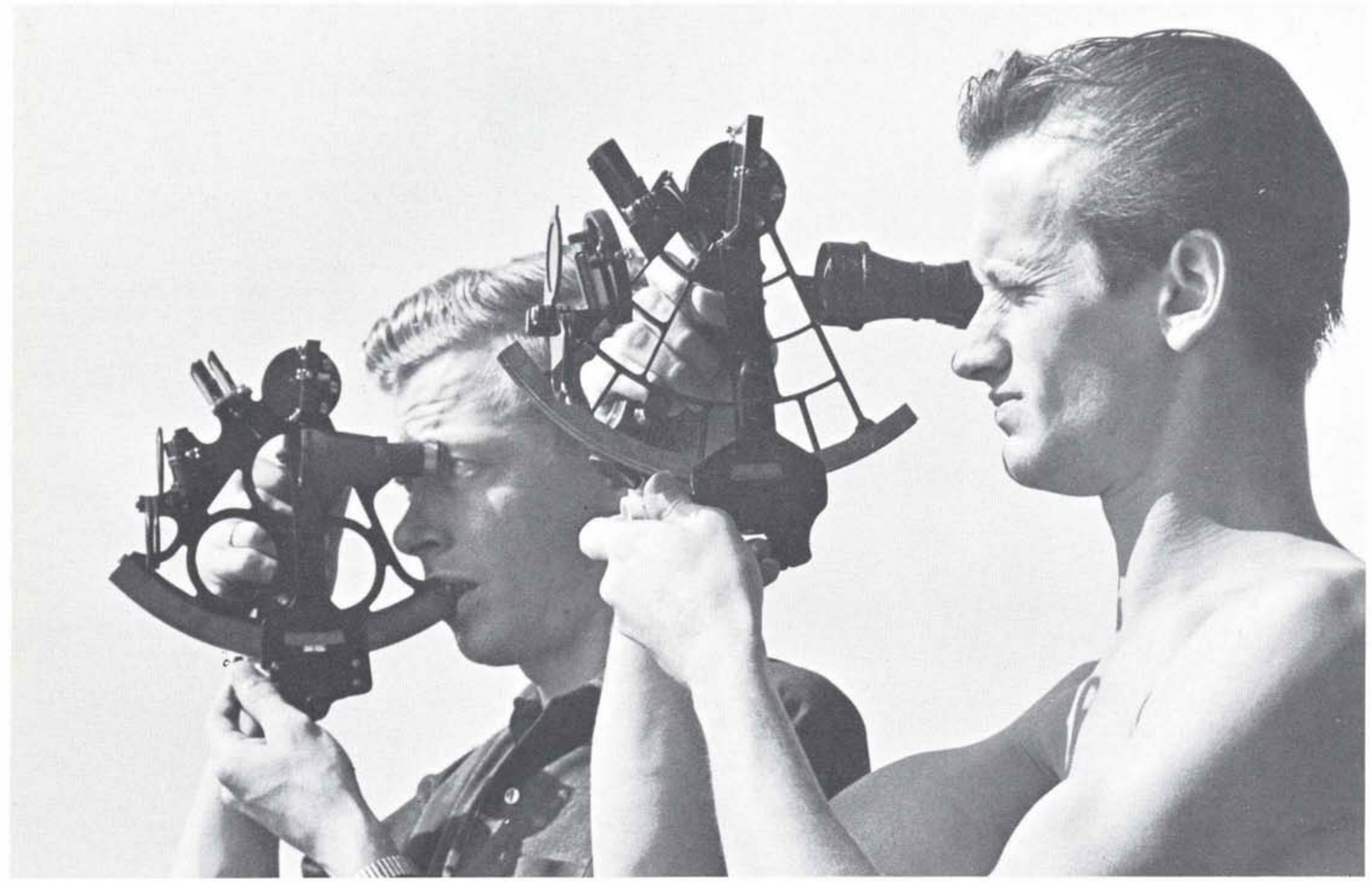
intensity. Most complaints are far more routine. Loneliness is unavoidable. Even the Captain, who may bring his wife on two cruises a year, and the First Officer, who can have his wife aboard for one cruise, admit that for the younger men with families the constant separation can cause hardships. But they also point out that a sailor's life has plus factors which should be weighed, too. Wages are an example. For young men of comparable educational background and experience the pay for shore jobs is often considerably lower than that for a ship's officer. Also, the steady comfortable routine of work ashore might seem attractive to a man standing a lonely watch at midnight in the Arabian Gulf, but seem hopelessly dull while actually engaged in it in an office on a Thursday afternoon in Amsterdam.

Those who follow the sea as a profession often share a dilemma experienced by wage earners who never leave the shore. Even if they wanted to they cannot switch careers because all the time and study expended to qualify for their present one would make it impractical to start all over again. And the training of a deck officer in the Dutch merchant service does indeed take time and study.

Under the Dutch law on nautical certification, all deck officers must be graduates of one of the Netherlands' eight nautical colleges, where they spend up to two years studying navigation, seamanship, geometry, trigonometry, stereometry, physics and communications. After they have received a certificate from a school they must spend a year at sea as an apprentice, return to nautical school for three to six months and then take the examination for Third Officer. If successful they have to go back to sea for two more years before trying for the Second Officer's ticket (license), and two more years at sea after that they go for their First Officer's ticket—the final step, since in the Netherlands a First Officer is qualified to command any ship; no separate Master's ticket is issued.

It is a long, hard and expensive apprenticeship, but out of it come sailors of the caliber that has always written proud records in Dutch maritime history—the kind of officers who may never throw down the gauntlet to the *Queen Elizabeth* but who one day will most likely salute her from the bridge of their own ships.

Third Officer A.G. Engels talks to nearby ship on VHF telephone as Fourth Officer M. Broek watches it on radar.



To ascertain the tanker's exact position the Third Officer and Fourth Officer practise "shooting the sun" with their sextants, still the navigator's single most important instrument.

Despite the most modern instrumentation Captain Jansen prefers that his officers, when possible, rely on visual sightings and other more traditional, means of navigation.

LIFE ABOARD THE DEN HAAG

On a modern oil tanker life may be earnest and it is certainly real, but it is also extraordinarily pleasant.

If conditions on merchant vessels were ever as bad as popular opinion believes, today they have changed for the better. Today not only have working hours been reduced to normal levels, but a ship is considered a man's home and is designed accordingly.

On the Den Haag, for example, every member of the crew, from able-bodied seaman to captain, has his own cabin and every two crew men have their own shower. Each cabin is furnished with a desk, an easy chair, a reading lamp, a commodious clothes locker and a wide, soft berth. With books on the desks and family photographs on the wall, some of the cabins could be mistaken for a room in a college dormitory—except that they are bigger.

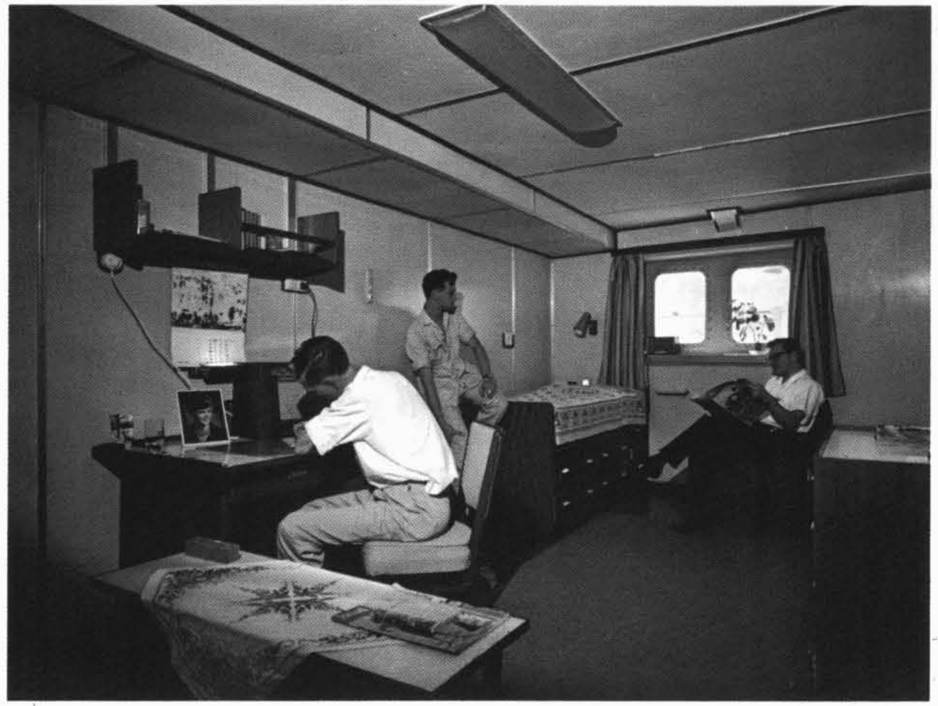
Then there is recreation. Once upon a time, they say, sailors who had time off used to splice lines, whittle and play chanties on harmonicas and concertinas. Today they can go to the movies, play table tennis, develop and print photographs in the ship's darkroom, have a swim in the swimming pool, sun bathe in a deck chair, play cards in the chintz-curtained lounge or curl up with a good book and a cold beer from their own "Café Old City."

No sailor, of course, is ever entirely satisfied with the food he gets and those on the Den Haag are no exception, but her crew will grudgingly admit that there is a good variety and that the cook does have a way with home-made bread, gravy and an occasional Italian specialty.

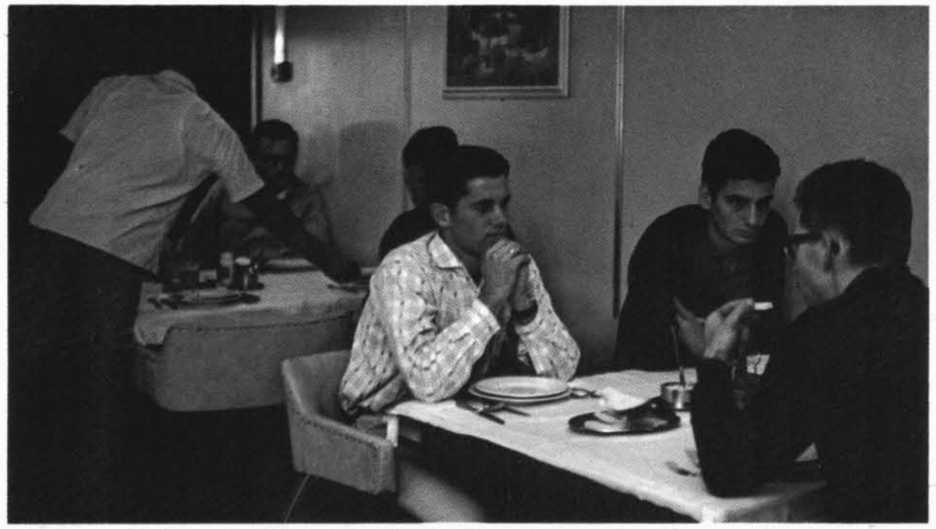
In providing for the welfare of the officers and crew the designers of the Den Haag have forgotten very little. There is a three-bed sick bay, or hospital. There are three refrigerated lockers for various kinds of food. There are rubber tile floorings to eliminate the strain of standing and walking on steel decks. There is a news bulletin composed of items from Radio Holland that is mimeographed and distributed every day.

There are even moments on the Den Haag when it is hard to remember that you are aboard a ship. Daily, at precisely 12:20 by the ship's clock the off-duty deck officers and the engine room officers make their way aft for a mid-day meeting over a convivial glass of beer or a thimble of Dutch "jenever" (gin). The curtains are drawn and a string of dim, colored lights over the bar are turned on and except on Sunday, each officer takes his turn buying and serving the refreshments. Sunday is the Captain's day.

This custom has grown out of a company policy of trying to ease the almost traditional frictions between deck officers and engine room officers, and it works. Each day for a half hour or more the Captain and the Chief Engineer, the First Officer and the Second Engineer and all the others sit, talk, drink and argue and then have lunch together. In such an atmosphere the ancient rivalries almost inevitably give way to a spirit of cooperation and friendship that is a trademark of the oil tanker.

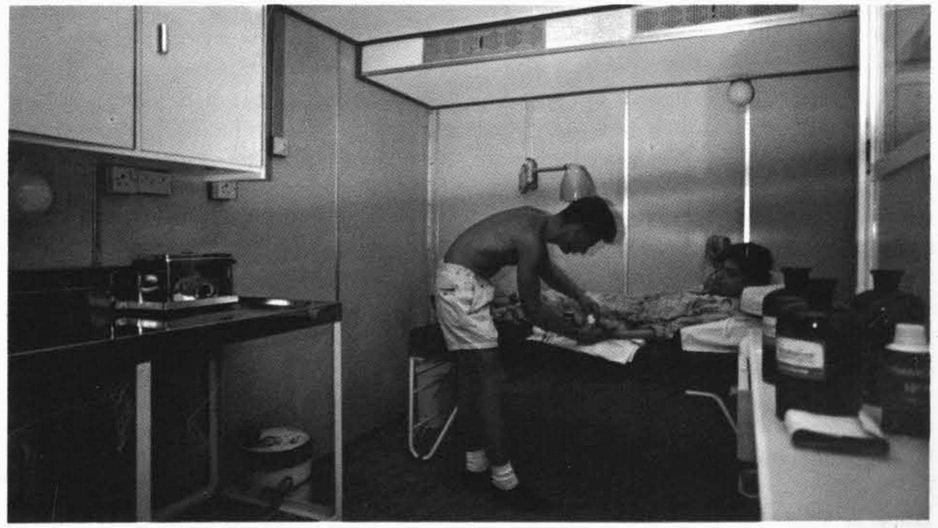


On today's tankers every member of the crew has a cabin of his own and every two crewmen have their own shower.



In décor and in the quality of its food the officer's mess compares favorably with many restaurants on shore.

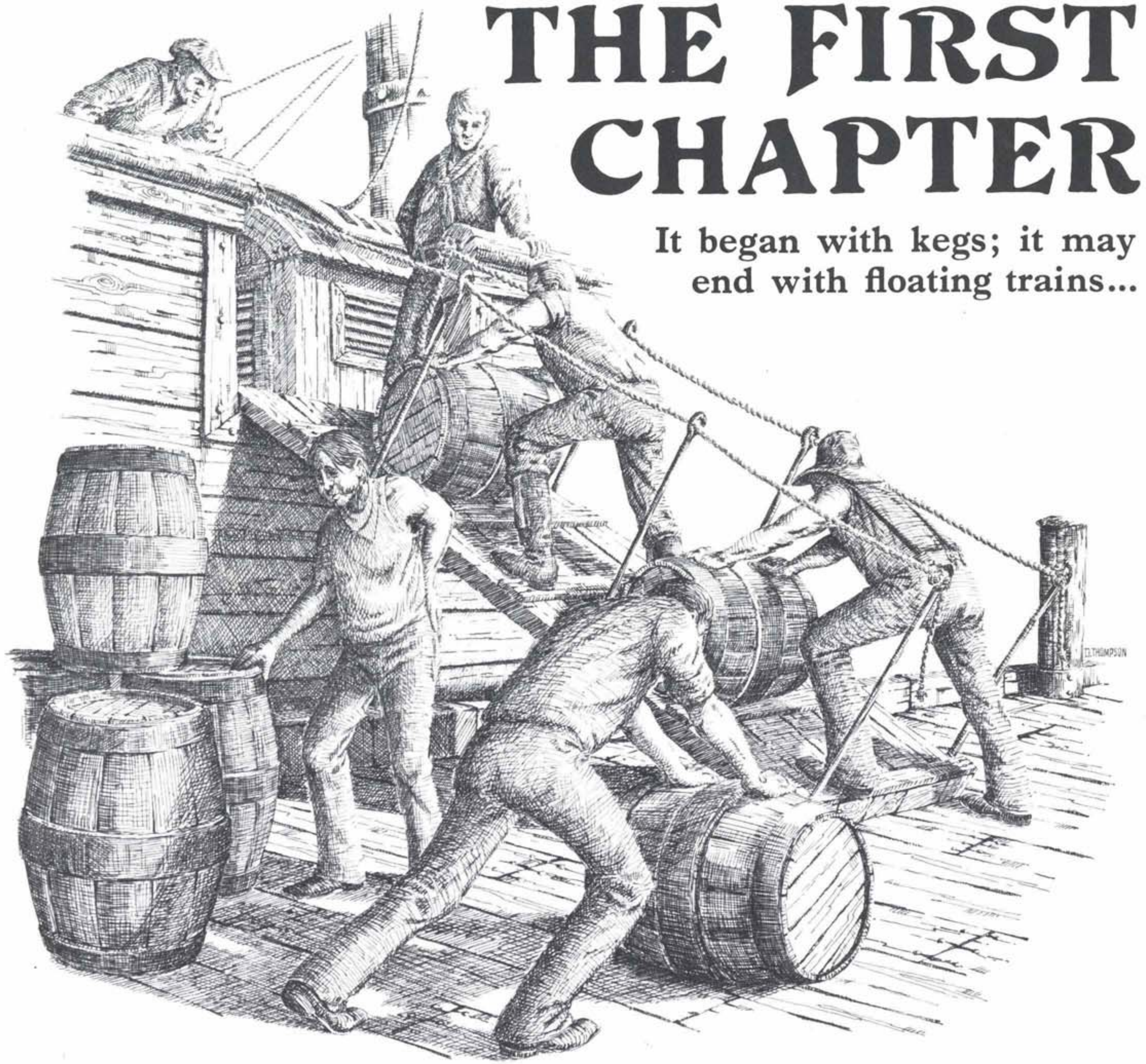
For the officers of the Den Haag, as for the officers of most oil tankers today, off-duty hours mean a chance to read, play bridge, swim, or, as these men have chosen to do, sop up the warm sunshine of the eastern Mediterranean.



Men at sea weeks at a time find a ship's hospital and officers' medical training important health safeguards.

THE FIRST CHAPTER

It began with kegs; it may end with floating trains...



Late in 1861, in a dim office somewhere in Philadelphia, an anonymous clerk dipped his pen in ink and, quite unknowingly, wrote the first chapter in the history of oil tankers. The brig *Elizabeth Watts*, he wrote, had recently sailed for England carrying 224 tons of a substance called petroleum.

Not much is known about the *Elizabeth Watts*. She carried the world's first really substantial cargo of oil and arrived safely in England 45 days later. Beyond that the records are blank—except to note that the ship's master had considerable difficulty in recruiting a crew. Sailors, not unreasonably, balked at signing on with a ship that was quite likely to explode and burn to the waterline halfway down the Delaware River. The master of the brig had to take drastic measures. He canvassed the inns, plied the sailors with grog and gently guided their staggering steps up the gangway. By the time they woke the ship was scudding into the Atlantic under full sail.

From the vantage point of 1966 such tactics undoubtedly seem extreme. Yet they suggest the kind of problems that were to confront shipowners as, in the last half of the 19th century, they began, with considerable uneasiness, to cope with this new, unpredictable and often deadly cargo. The brig's voyage, after all, was undertaken only 27 months after Colonel Edward Laurentine Drake drilled America's first producing oil well; petroleum was still a relatively new substance whose properties and characteristics were dimly understood. Furthermore, with technology at a relatively simple stage, the methods of shipping liquids were decidedly limited. The early history of the tanker, in fact, was primarily a struggle to find safe, quick and economical ways of loading, storing and unloading a valuable but volatile liquid on the inflammable and unstable brigs, schooners and clippers that sped the commerce of the world across the oceans in the 1860's.

In those days there was only one way to transport liquids: in kegs. Since the kegs were quite undependable because they leaked, and since they not only wasted precious space but had to be loaded and unloaded slowly by hand and since it was apparent that petroleum was to be a cargo of considerable volume (one year after the first trip Philadelphia shipped nearly 239,000 barrels), shipowners were soon experimenting with new, often ingenious, sometimes bizarre methods of handling and controlling the cargo. Some fitted square upright iron tanks into the hold. Some tried tin boxes encased in wood. Some, realizing at once that if the hull itself could serve as the container, ships could carry more and weigh less, tried to oilproof the wood hulls with clever, but usually ineffective, combinations of planking, felt and cement.

But leakage was only one of the problems. In warm weather oil expanded; in cold it contracted. Carry too much, it spilled; carry too little, it sloshed about with enough force to capsize the ship. There were gases to worry about too, with their deadly vapors settling silently into double bottoms to lurk in wait for the unwary lantern, the heedless candle or the forbidden pipeful of Virginia tobacco.

The solution to most of the problems, of course, was the iron ship, with its nonabsorbent, leakproof hulls, its compartmentation and its relative resistance to fire. But technology hadn't quite caught up to theory in the 1860's and although an iron sailing ship expressly designed for oil—the *Atlantic*—was built as early as 1863, and although the Nobel brothers in Sweden launched a steam-propelled tanker in 1878, the level of iron work was such that there was still considerable leakage and loss. With the introduction of steam the problem got worse. Shipowners had to face the hair-raising hazards implicit in keeping huge coal fires burning constantly just a few feet from poorly-constructed, usually leaky tanks of petroleum.

As the century waned, however, technology improved. In 1884 farsighted British shipbuilders, finally realizing that one key to better ships was simply closer riveting, launched the 300-ton *Glückauf*, an iron tanker propelled by steam in which the oil was carried—safely—against the hull. The modern tanker had arrived.

For the next 34 years changes in tankers were generally no more than improvements in the basic idea. Then, in 1920, Sir Joseph Isherwood introduced a new system of combined transverse and longitudinal framing which strengthened the ship, reduced its weight and substantially expanded its capacity. About the same time significant improvements were made in the arrangement of the compartments, in the number and kind of pumps and in sizes of mains. And not long after, in astonishing succession, came breakthrough after breakthrough in physics, chemistry and engineering, each adding impetus to the feverish technological development of those hectic years when the world was recovering from one war and preparing for another.

Most tanker shipments consist of crude oil, but when crude is refined into products that are marketed across the water from where the refinery itself is located, they too must be shipped. Such familiar products as gasoline and fuel oil need no special care except the usual safety precautions while being loaded, carried and discharged. The newer and less well-known products in the petroleum spectrum, however, require exceptional handling, and some now even call for specially-designed tankers in which to transport them.

One example of the latter is bitumen, a semisolid at normal temperatures. This particular end product of crude oil must be heated to temperatures ranging from 250 to 350 degrees Fahrenheit while being loaded. Steam heating coils in the cargo departments of bitumen ships maintain the cargo in a pumpable state in transit. Petroleum gases, on the other hand, are liquefied by cooling—to 31°F for butane down to -259°F for methane—so they can be shipped at atmospheric pressure, and giant containers built on the principle of a Thermos bottle hold these liquefied gases at their required low temperatures aboard ship.

Concurrently with these developments there have been many innovations introduced ashore and along coastlines to keep pace with the larger and specialized modern tanker. Larger-diameter pipelines are being laid, bigger-than-ever storage tanks built and deeper harbors dredged. Longer jetties are being constructed, too, some so long that pier workers and seamen from tankers use cars to get to shore. A new approach to loading is the "sea island," an offshore installation connected by pipelines to the shore being built in water deep enough to admit the gigantic tankers still in the planning stage. Maintenance and repair facilities are growing with and sometimes ahead of the biggest tankers. *Petroleum Press Service* reported in February that a dry dock capable of handling tankers of 250,000 deadweight tons is being planned in Japan to be in service by October 1967.

Communications are posing their own challenges in the new tanker era. As more and faster oil ships take to the sea lanes the petroleum industry has had to develop highly complex and carefully balanced routing systems and, to make them work, vastly complicated systems of radio, radiotelephone, Teletype and telegraph services.

To some forward planners the progress tankers have made up to now represents only a beginning. Ahead, they say, are such innovations as submarine tankers, nuclear-powered tankers, hovercraft tankers—tankers that travel over the water on cushions of air—and such startling possibilities as floating tanks magnetically coupled to a sort of floating locomotive, and floating inflatable plastic containers linked together like freight cars.

Some of these ideas are already the subject of study; all will be seriously considered and many will undoubtedly be in use by the end of the century. If the history of tanker development has demonstrated anything it is that there are few limits to what can be done and what will be accomplished.

TANKER TO NORWAY

continued from page 8

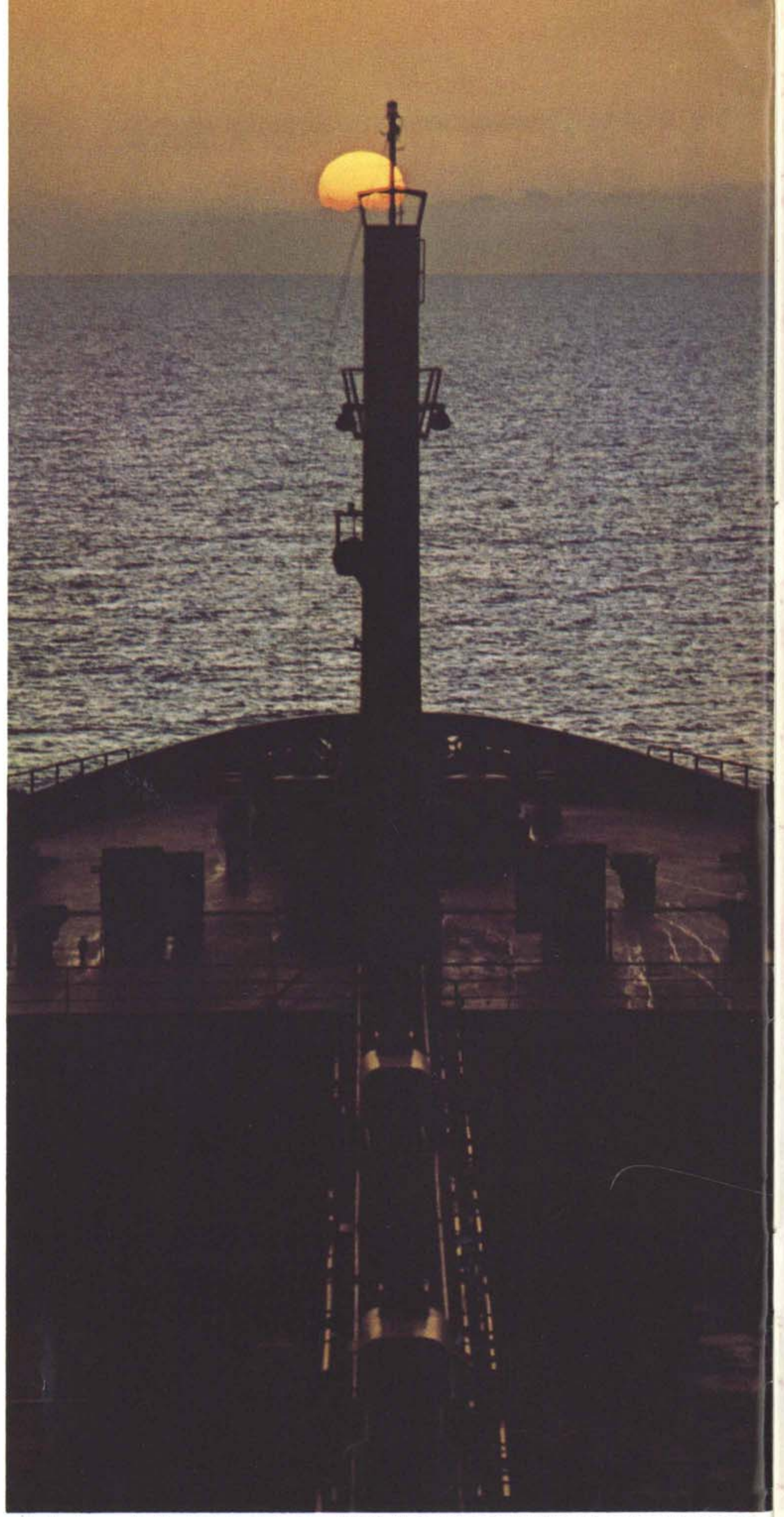
improved instruments on the modern tanker, one officer alone can handle the ship and its operations in situations that would send a Yankee shipmaster or a Captain Bligh galloping to his lifeboats. A good example, he said, was the console.

The console is a large gray steel cabinet slanted like a drafting board and looking rather like an IBM computer, studded with switches, dials and lights. With the console an officer on duty can, without budging, note the direction and force of the wind, scan the horizon with the radar for a distance of 48 miles, sketch a charcoal profile of the bottom to a depth of 720 fathoms, instantly check shallow water down to 30 feet, telephone to anyone on the ship, and—via VHF radio telephone—to ships up to 30 miles away. At the console he also can switch on a 3,000-candlepower searchlight as big as a cannon, sound the steam and air whistles and the ship's alarm bells, operate the loud hail and the public address systems, and —if he should have a moment or two to remember it—regulate the volume of the tape-recorded music that plays steadily all day long throughout the ship.

And the console contains only part of the instrumented aids available. There is the automatic pilot that locks the ship on a prescribed course. There is a 60-mile radar unit. There is the Decca Navigator, a special receiver that picks up a prearranged pattern of radio impulses that are coordinated with markings on charts of certain waterways and enable navigators to check their position almost foot by foot, second by second.

The operation of the more sophisticated instruments, especially at night, is at once eerie and comforting. It is eerie because the soft flashes of the radar scanner circling the screen, the metronomic beat of the echo sounder drawing its jagged profile on the steadily unwinding roll of recording paper, and the nervous flicker of the shallow-depth finder, bouncing on the panel like bright green quicksilver in a tube, are like sights and sounds from science fiction. It is comforting because, paradoxically, its inhuman efficiency seems to promise an infallible security.

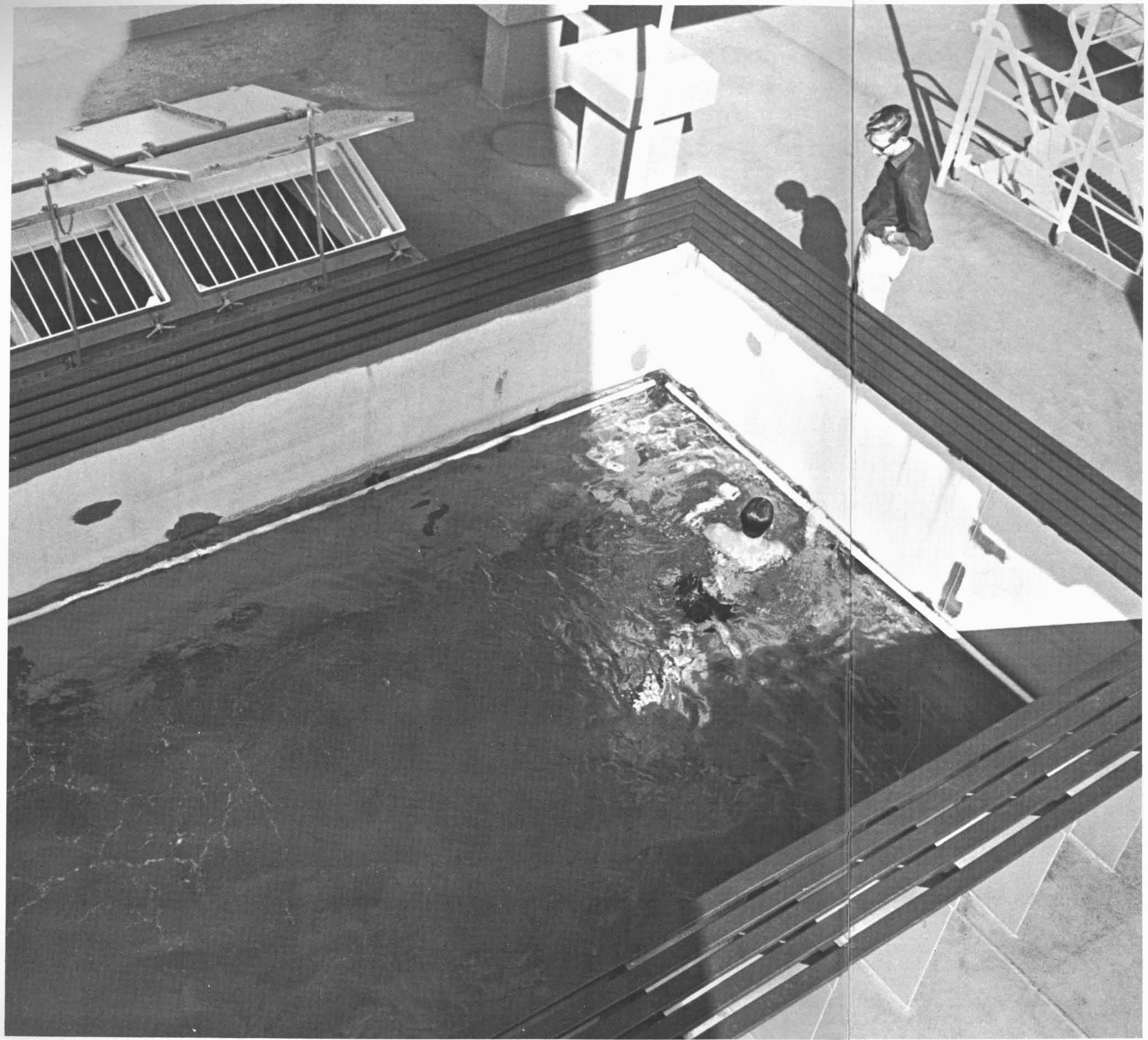
It would be hard to think of a situation that such instruments could not either warn the officers about or help them face. Radar is a good example. There are two



For five days, as the Den Haag moved steadily toward the Atlantic, the sun set in a blaze of magnificent orange hues.

On a scaffolding high on the sheer side of the superstructure seamen ignore the spectacular view as they turn to the never-ending task of the sailor: scraping and repainting corroded metal.

At sea where there are few events to disturb the monotonous passage toward deserted horizons, the approach of a passing ship provides a moment of interest for the most seasoned officer.



In the old days, according to legend, life at sea was an almost unremitting cycle of hard work, bad weather, poor food low pay and harsh treatment. In modern ships, obviously, conditions have improved continually and considerably.

radar sets on the *Den Haag*, one set flush in the face of the console like a great orange eye, the other mounted in a curtained booth that looks like a take-it-yourself photo booth at an amusement park. The console radar is a "relative" radar—which means that any object "seen" is seen only in relation to the ship's heading. In the exact center of the screen is a pinpoint of light with a lighted line sweeping around and around like a ray of light from a lighthouse. The dot is the ship and the lighted line, the "sweep," is the radar scanner that is spinning in unison with the signal line on the radar screen. When the scanner senses something—a ship, an island, a bank of low clouds, or sometimes even a high wave—there is a flicker on the screen along the line at the point where the object is located and the shape of it is momentarily outlined—rather like the dark areas on a photographic negative.

The radar in the booth is "true motion" radar and the difference is that this radar works like a television camera. It simply scans a given area and projects a picture on the screen showing the *Den Haag*'s actual position and movement in an area with a radius of 60 miles.

"It is really invaluable," said the officer, "but we prefer to use it only in fog or rain or when traffic is heavy, or when we're in a tight spot like the Strait of Dover or the Strait of Gibraltar. Incidentally, we'll be stopping at Gibraltar tomorrow morning."

The *Den Haag* at that point had been at sea five days, steadily pushing west toward the Atlantic. The original course did not call for a stop at Gibraltar but word came from the Netherlands that an engineer from England was flying out to meet the ship and conduct some tests on the turbine during the rest of the trip. So, on the sixth day of the trip the *Den Haag* eased her long hull into Outer Harbor at the foot of the great limestone cliff into which England, 262 years ago, carved the world's most famous fortifications.

It was a short halt—two hours at the most—and soon, the engine room telegraph clicking from slow astern to half speed ahead, the tanker executed a smart pivot, steamed into the Atlantic and headed north along the coast of Portugal.

For the next few days the *Den Haag* seemed to speed through the sea with new vigor as if the fresh Atlantic winds had roused her from a leisurely nap. Past flashed Cape St. Vincent, where Lord Nelson trapped the Spanish Fleet; the Cape of Trafalgar, where he issued his famous "England expects that every man will do his duty," and then died; the Bay of Biscay, where Atlantic swells roll landward to foam against the sea walls of San Sebastian and Biarritz; and finally past a line of white cliffs called Beachy Head and into the English Channel.

On every voyage it seems, there is one place that ships approach warily. For some it may be the Cape of Good Hope or the Strait of Magellan. For the *Den Haag* it was the English Channel and the Strait of Dover, that narrow gap of crowded water linking the Channel to the North Sea and dividing France from England. All the way through the Mediterranean and up the coasts of Portugal and Spain the officers of the *Den Haag* had spoken about the Strait of Dover. In the Strait, they said, the fog is as thick as plaster. In the Strait, they said, the ships are as numerous as bees in a hive.

There were reasons for those warnings—the knowledge of experience in an area where the fog is dense, the currents are strong and the sea lanes are busy. And so, as darkness fell one night and the *Den Haag* steamed into the notorious Strait, it was no surprise when Captain Jansen quietly took over the conn, when his officers began to drift restlessly into the chartroom for a word with the officer on duty or a glance at the chart, or when two lookouts instead of one reported to their stations. It was no surprise either that suddenly, for the first time, there was on the *Den Haag* a very real, very urgent sense of concern.

To get through the Strait Captain Jansen had chosen to take the *Den Haag* between two shallow banks called the Varne and the Ridge where, less than a mile from the ship's flanks, the depth of the water was less than nine feet. It was dark by the time the *Den Haag* approached this channel and all around were the lights of other ships, freighters, liners, ferries and trawlers, all jockeying for position, plotting courses, changing speeds and direction. Beyond, on the coast of England, headlights flashed on coastal roads. Across the water there was France.

The minutes ticked by. Standing by

In the cold clear air of Norway tugs from the Slagen oil refinery speed to the Den Haag to begin the job of nudging her ashore.

the chartroom table, his pipe forgotten, his face calm in the subdued cone of light beamed at the chart, Captain Jansen measured an angle, walked his dividers along the penciled line that led alarmingly close to the shallows, and x'd in a position. From time to time he walked over to glance at the Decca Navigator twitching and clicking in the light of a dim lamp, or strode outside to sweep the coast with his rubber-cased binoculars, or stopped to have a word with the officer on duty. Occasionally he would point to this beacon or that light and once he stopped to sip a cup of coffee and meditate on his latest entry, made in the ship's log.

All at once he said, "We should be seeing that lightship about now; about two points off the port bow. Ah, there, you see? Now we're through!"

And that was all. In minutes the tanker was gliding past Dover, past the Sandettie banks to starboard and South Falls to port, past the dim beacon at Calais. Later there was the glitter of the Thames Estuary and the glow of London. Then, England was astern and the *Den Haag*, with a regretful glance toward Rotterdam, her home port, plunged into the darkness of the North Sea.

After that the end of the voyage came rapidly. By dawn of the next day Norway was in sight, a jagged spire of rock poking from a cold gray sea, an old stone lighthouse as red as a Vermont barn, and woods as crisp and colorful as New Hampshire in the fall. By mid-morning the pilot was guiding the ship toward a finger of land in the fiord where green pipes stood tall on the shore and four tugboats were casting off lines. Minutes later the tugs made for the *Den Haag* like hounds circling a bear, nipping at her quarters, nudging and tugging at her bow and stern and hooking the ends of heavy hawsers out of the water and pulling the ship to shore. There, on a pier angling out from a slope where storage tanks waited, the huge Chiksan loading arms were already dropping toward the manifold. On the forecastle the steam from the winch hissed into the air, the hawsers tightened, sagged, and tightened for good. Then the ship brushed the pier, seasoned workers coupled the arms to the manifold and the cargo pumps coughed and caught. Across the decks came a cold breeze and into the now-deserted wheelhouse poured the pale sunlight of autumn. The voyage was over.

The ship touched the pier, seasoned workers coupled the Chiksan arms to the manifold and the oil began to flow. So, ten and a half days later, the Den Haag ended her voyage.