ARAMCO WORLD
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Mrs. David Carlson
62 Grove St.
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CSF

Old fortress at Hofuf in Eastern Province of Saudi Arabia.

THE VANISHING FORTRESS

stood at his side: "We'll put our cannon over there."

For two days artillerymen struggled through marshes setting their batteries in place. On April 10 General Gillmore shouted: "Fire!" The cannons, rebored with spiral grooves to spin the shells as they left the barrel, ripped gaping holes in Fort Pulaski's masonry walls. Within a day the fort was surrendered. The penetrating power of the new artillery had outmoded the open fortress.

In an earlier age, fortresses had proved no more successful. "All armies prefer high ground to low," said Sun Tzu Wu in *The Art of War* in 500 B.C., and so history has demonstrated. But height has not always proved a friend. Troy's geographical position atop the hill of Hissarlik in modern Turkey may indeed have been a desirable location, but the rubble layers of Hissarlik reflect the city's vulnerability. They tell the tale of at least nine resurrections of the "impregnable" fortress of Troy. These archaeological strata show that even the most advantageous site cannot withstand an enemy's determination to seize another's treasure.

Forts fell for a number of reasons: they could not be adequately staffed, they could not be stocked with sufficient provisions or water, the enemy possessed weapons that proved stronger than the walls, and so forth. But many forts fell as a result of subterfuge, such as Troy and its wooden horse. One of the most bizarre examples was a New World fort, Michilmackinac, on what is now Mackinac Island in Michigan.

Originally French, the wealthy fort and trading post had been taken over by the English in 1761. Although its commander, Major George Etherington, had been warned that the local Chippewa were planning to seize the fort, he scoffed at the absurd notion that they could take a garrison as strong as his.

One day in 1763 he was approached by a peace party of Indians. Lacrosse enthusiasts, the Indians wished to stage their version of the Olympic games in honor of King George's birthday on June 4. Major Etherington saw the possibilities of sport to improve international relations.

On the day of the celebration, two Indian teams lined up outside the fort's gates. The Chippewa were matched against visiting Sauks from Green Bay. During early play, the ball was accidentally thrown over Fort Michilmackinac's walls. Major Etherington sent an enlisted man to retrieve it. A second time the ball flew out of bounds; again it was fetched. Not wanting to delay the game, Major Etherington turned to a sergeant: "Throw the fort's gates open. The Indians can then retrieve their own ball."

Once more the ball cleared the wall and team members streamed into the fort to search for it. They were followed by squaws with tomahawks concealed under their robes. The ball did not have to be thrown a fourth time.

Some forts were never designed as such. Often buildings were transformed into makeshift barricades when the fortunes of war brought battle to their doorsteps. In 1933 a hotel in Cuba and a year later a block of apartment dwellings in Vienna withstood long sieges. During the Spanish Civil War soldiers held the Alcazar mosque in Toledo for 72 days against artillery and airplanes. A belt of fortified factories on Stalingrad's outskirts barred further Nazi advance in World War II. And one of America's most famous battles took place at a Franciscan mission – the Alamo.

Following the War between the States and the introduction of the rifled cannon, permanent above-ground fortifications lost their value among military strategists. World War I was fought in trenches, World War II from foxholes. The last great fortress, the Maginot Line, which was a long continuous chain of pillboxes, trenches and tank traps, was a throwback to the Great Wall of China. Never conquered by the Germans but outflanked, this French line of defense, like its Teutonic counterpart, the Siegfried Line, fell prey to the blitzkrieg mobility of modern warfare.

The fort is now a relic of the past, the province of tourists instead of troops. ■

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PIPELINE PATTERN
AT RAS TANURA

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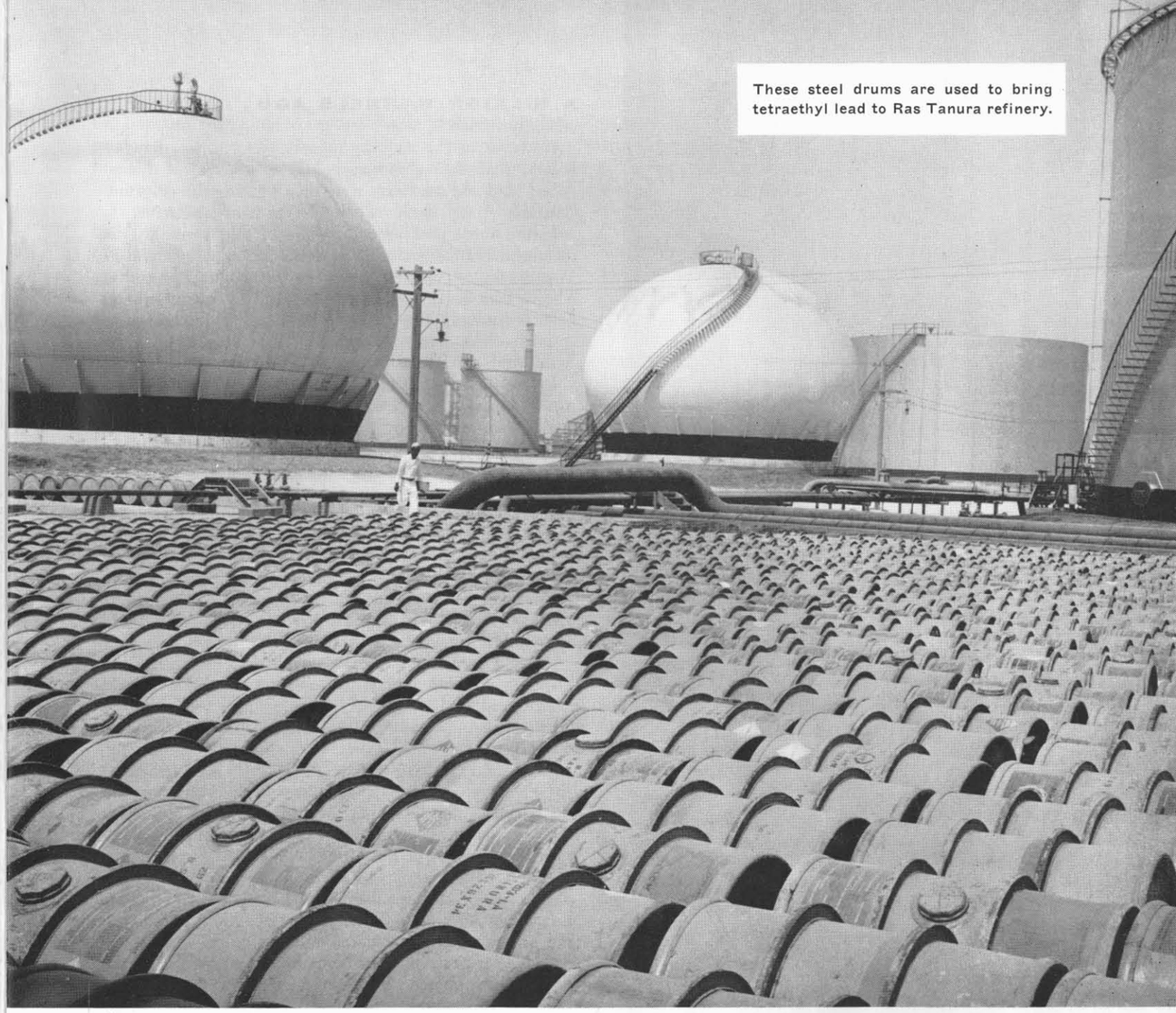


These steel drums are used to bring tetraethyl lead to Ras Tanura refinery.

A BILLION BARRELS AGO...

Close to the source of oil, Aramco's Ras Tanura refinery has been meeting a new type of world oil demand

TUCKED AWAY in the 35 sandy acres of the Arabian American Oil Company refinery at Ras Tanura, Saudi Arabia is a strange clearing that might remind some visitors with long memories of the abandoned sidewalks of real estate booms that collapsed in the 1920's.

The site was laid out for a catalytic cracking facilities system. One can still see concrete footings meant to support part of the giant aviation gasoline facility. But the "cat cracker" was never built. Only the ghostly outlines of the site remain.

To Aramco old-timers the survey lines of the clearing bring memories quite different from those long ago inspired by the eerie geometry of houseless suburbs. For traced in the loose driftsand at Ras Tanura is a reminder of the grim purpose that lay behind the beginnings of the refinery.

The Aramco plant is now 17 years old. Since the termination of World War II, it has been turning out the fuels that are basic to the economic growth of both Saudi Arabia and the other free world markets the company serves. It has grown more than fourfold, from 50,000 to 210,000-barrels-a-day capacity, a good index to the whopping increase in world

Alkylation plant at Ras Tanura refinery turns out high octane alkylate, which is used to produce aviation fuel.

A BILLION BARRELS AGO . . .

oil consumption in recent times.

However, at the time the refinery went on the drawing boards, peacetime economic growth was a distant dream. Allied land and sea forces were then fighting the desperate "island-hopping" battles of World War II in the Pacific.

In the autumn of 1943 the drain of global military demands on United States oil fields caused growing alarm in Washington. A team of American oil experts flew to the Middle East on an urgent survey of the Persian Gulf oil fields. Fortunately, an American company – now known as Aramco – had developed commercial production of oil in Saudi Arabia five years earlier.

When the experts flew back to Washington, the government decided to release war-priority materials for a refinery at Ras Tanura in Saudi Arabia.

Announcement of the war emergency plant brought on an outbreak of newspaper headlines and editorial comment. Harold L. Ickes, Secretary of the Interior and head of the Petroleum Administration for War, wanted the government to acquire an interest in Aramco and to finance, build and control the proposed refinery.

Oil men, newspapers and Congressmen objected – strenuously. The Ickes plan was quickly abandoned by the government. Instead, Aramco was given the go-ahead to build the refinery.

Against great wartime odds, work on the Ras Tanura plant was speeded. By late 1944 the construction camp was nearly finished. However, before the refinery itself was very far advanced, the war in Europe was over, and American oil supplies were diverted to the massive Pacific air offenses. The tide had turned.

Happily, the millions of gallons of Pacific bombing-mission gasoline that had been designed into the Ras Tanura refinery were not needed. So the big cat cracker being fabricated for Aramco in the United States was rerouted to a refinery near Chicago.

The site clearing for the catalytic cracker at Ras Tanura thus remained empty. The new Aramco plant, the first of the postwar international refineries to go on stream, was destined for peaceful uses. Nonetheless, a product of swift and dramatic changes itself, the plant was to witness a further parade of changes that would reshape the world of oil.

Oil men are an adaptable lot. They long ago learned that if there is one thing that is constant in their business it is *change*. The lament of an American refinery superintendent's wife eloquently underlines this on-the-move atmosphere: "Never hang the last curtain. Soon as you do, something changes."

Early in 1962 the billionth barrel of crude oil flowed into the refinery at Ras Tanura. It took only nine-tenths of a second to slip silently past a flow meter. On the way through the array of refining units it yielded its hydrocarbons in a dazzling variety of chemical reactions, some of which are speeded up by catalysts. Part of it was boiled off and the vapors collected in a simple distillation. In some processes its hydrocarbon molecules were reformed into new molecules of a different structure.

Like the river of crude oil of which it was a mere drop, the billionth barrel ended up as saleable products. Underground it had only potential value. Once it was refined into products and headed toward the market, its real economic life was ready to begin.

It came out of the processing streams at Ras Tanura as bunker fuel for ships, fuel oil for industrial use, diesel oil for truck and railroad engines, kerosene, motor gasoline and aviation gasoline. Part of it was also changed into liquefied petroleum gas, which upon release from pressure or refrigeration into normal temperature and atmospheric pressure once more becomes a gas and is ready for use as fuel.

From product storage it entered into the economic lifestream of Saudi Arabia or one of the other free world markets. Within the Kingdom it would be used by the company in its own operations, by the Government or by private Saudi Arab consumers. The Saudi Government Railroad is a major consumer of diesel fuel; Saudi industrial plants use other fuels. But in all, Saudi Arabia can currently consume only less than five per cent of the petroleum products processed at Ras Tanura, the country's sole refinery. The remaining output must be exported.

A billion barrels ago, when the refinery went on stream in October of 1945, a puzzling phenomenon was in the making. The slide rules of oil economists everywhere had delivered a pessimistic verdict. They predicted that as the world turned away from war and took up its civilian pursuits, oil consumption would fall off severely.

Just the opposite happened. Countries the world over were determined to go all out for industrial development and economic progress. Postwar oil consumption zoomed.

As a part of this spiraling use of oil, a shift took place in the historic location of international refining. The best way to visualize the shift is to imagine three toy blocks set in a line. From right to left they read: Production, Refining, Marketing. At the end of World War II, the block marked Refining lay very close to the one marked Production and a

long way from the block marked Marketing.

In other words, historically the petroleum refinery was built close to the oil fields, the crude oil source. There were many reasons for this. For instance, there are always some vapor losses in refining. Today this loss is small, but once such loss was great enough for oil men to ask: "Why pay to ship your losses a great distance to a refinery located near a big marketing area?"

Further, a refinery makes use of some of its by-product gases to fire its many furnaces. Oil is always heated and reheated on its journey through the processing units. "Why," oil men asked, "pay to ship your own by-product fuel?"

The ideal refinery was thus located near an oil field, close to home.

By the end of World War II this tradition still held, but a change was in the making. It must be kept in mind that outside of the United States and a few nations of western Europe, there were very few countries that used enough oil in the mid-1940's to support an oil refinery large enough to operate efficiently.

But within five years industrial progress the world over slipped into high gear. Consequently, the historic location of the petroleum refinery began to change. The growing marketing areas – the consumer countries – wanted their own refineries for a number of reasons.

The image of the toy blocks provides a simple visualization of the change. The block marked Refining began slowly and inexorably to move away from that marked Production

toward that called Marketing. A trend was in the making. More new refining capacity was being built in the marketing countries rather than in the producing-exporting nations.

In 1950 about two-thirds of the world refining capacity was located in the oil producing-exporting countries. When the new refining capacity now being built (1962) is completed, the ratio will have been reversed: almost two-thirds of the world capacity will lie outside the countries with the big oil fields.

Recently the Petroleum Press Service of London listed 105 refinery construction projects around the world. "The new capacity will be spread over 51 countries in all continents and will include plants in 18 countries where there is as yet no refinery in existence," the survey reported.

The basic cause of this change lies in the simple economic fact that many, in fact *most*, market countries can now consume the output of one or more refineries. But there are other factors influencing the change. For one thing, marine tech-

Gaugers from Aramco and Saudi Arab Government measure the volume of the crude oil to be refined at Ras Tanura.

A BILLION BARRELS AGO...

nology has had a hand in it. Huge supertankers have greatly reduced the cost of shipping crude oil from export to import countries. The per-barrel transport cost has dropped steeply from the old days. Worry about the cost of "shipping your refining losses" has been wiped out as an economic factor.

Once, a refinery near an oil field had the advantage of a sure source of crude oil for round-the-clock operations. Today a refinery in a big marketing area, say in the Far East, can draw from many oil fields for its crude oil supplies and have assurance of a steady flow of tanker shipments.

A critical financial factor also bears upon the trend toward "market-oriented" refineries, as economists designate them. The marketing countries need to maintain a favorable balance of trade in foreign exchange in all segments of their domestic economy to promote industrial growth. They have, therefore, instituted protective tariffs and have built government-owned, or subsidized, refineries in an aggressive program to develop refining capacity.

The oil consumer countries are also guided in their refinery construction programs by the fact that it is cheaper to import crude oil than it is to import refined products. Crude oil costs less. When it is upgraded by refining, several changes in value take place. The change in value of the oil itself as it is turned into saleable products is obvious. But there are also hidden economic values that accrue to the country with its own refining industry: added employment, added tax revenues, a broader industrial base for the country and the financial vitality that comes from the use of domestic capital to create more capital to be used in further expansion.

These are some of the factors behind the big change in international refining.

The world of oil is complex and filled with economic subtleties. One might assume that the usefulness of the refinery located close to the oil field in the producer-exporter countries has been diminished as a result of the boom in "local" refineries. The fourfold growth of the Aramco refinery at Ras Tanura shows that, on the contrary, the resource-oriented processing facility has simply adopted a new role.

In the language of international oil economics, Ras Tanura has become a "swing" refinery. It might today be described as a basic refinery that incorporates many processes to assure efficiency in meeting changing requirements.

For example, many of the new market-oriented refineries are designed to meet average local conditions. When they head into the heavy summer motoring season, they are unable to meet the peak demand for automobile gasolines. A severe winter may create heating oil shortages. Or perhaps industrial expansion may suddenly increase the need for fuel oils. If local refineries cannot meet these changing consumer conditions, the refineries of the producer-exporter nations, such as that at Ras Tanura, make up the shortages. And they continue to supply countries that do not yet have sufficient demand to support a refinery of economic size.

The Aramco refinery also joins with other resource refineries to serve unpredictable peaks in world demand such as those created by the Korean emergency in the 1950's.

In addition to these distant demand "swings," the Ras Tanura plant supplies large volumes of the bunker oil that runs the tankers that ply the world's sea lanes and "lift" crude oil and products at Aramco piers in Saudi Arabia.

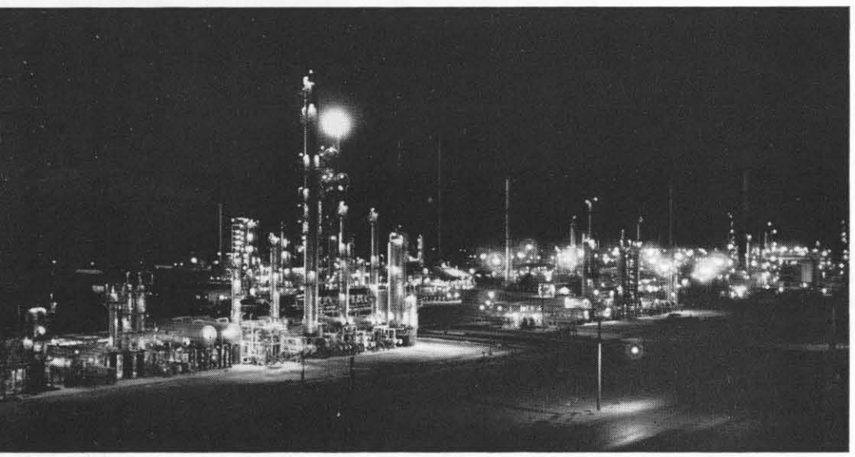
And, of course, it continues to meet the steadily increasing Saudi Arabian demand.

Several months ago the Ras Tanura refinery quietly and proudly observed another of the significant changes which have marked its career. One night at 11 P.M. the first crew made up entirely of Saudi Arab employees took over an eight-hour shift on the fluid hydroformer. This unit turns out high octane gasoline; there are fewer than ten of its size and type in the world. The all-Saudi Arab crew now regularly mans its daily shift.

The crew supervisor, Ahmed R. al-Magbil, started to learn his art just about five weeks after the formal surrender of Japan ended World War II. He knows well the meaning of *change*, and he stands as a personal symbol of that permanent condition of the world's oil industry.

He has seen the Ras Tanura refinery grow from a "war baby" to a peacetime refinery, grow fourfold in its output, and efficiently assume the role of a "swing" refinery in the changing economic pattern of international oil processing.

Ahmed R. al-Magbil, along with other Ras Tanura refinery veterans, sometimes passes the clearing that was surveyed for a catalytic cracking unit late in World War II. None of them regrets that it never had to be delivered. ■



Crews work around the clock at Aramco's Ras Tanura refinery.

Puzzle of the

PRAIRIE

ONE HOT AUGUST DAY in South Dakota, a boy shouted to his father: "Fire!" As the farmer came running the youngster whirled him around and pointed:

"Over there. It's coming fast!"

On the far horizon hovered a column of angry yellow smoke, coiling and uncoiling like a snake about to attack. The smoke was being pushed toward the farm by the wind, and the family saw the glare of flames.

"Hurry!" shouted the farmer. "Get the truck."

Moments later the whole family was aboard a flat, sideless truck, rushing toward the smoke. From all directions families boarded trucks and rushed across the low prairie hills.

Fighting the flames by digging trenches, the farmer recalled a faded yellow letter written by his grandfather years ago: "Life on the American prairie will always have its perils – blizzards, tornadoes, droughts – and fire. A prairie fire is an awful thing – almost uncontrollable.

"This is lonely country, which makes the perils seem greater. We miss the trees, which would make it seem friendly. We can never understand why so rich a land produces only grass – no trees."

Riding home that night, the tired family watched the sun set behind their farm. The crop had been saved and the ripe, golden wheat looked splendid as it spread across the prairie.

The great American prairie, an unexplained phenomenon, is less lonesome these days as prosperous farms, cities and towns spread. But the lack of trees, except where man has planted and protected them, still puzzles science.

A westward traveler comes upon the prairie as he might come upon the desert. Suddenly he leaves the eastern forests and wooded farms – and there it lies ahead of him, empty and treeless as far as the eye can see. Like the desert, the land rolls in gentle hills. Unlike the desert, it is covered with grass. It is not the short grass of the Russian steppes or the high plains of Wyoming and Colorado. Nor is it the long, dry grass of the thin-soiled African or Brazilian savannas. It is tall, lavish, shoulder-high grass of richest green, growing from deep, fertile soil, and there are some 140 different species in all. When wheat, corn, cotton and other crops have been planted in place of the grass, farms have prospered and given the prairie the name of "the world's greatest breadbasket."

The prairie begins in central Ohio and extends west 800 miles to central Kansas. North to south it reaches from deep in Canada to a narrow belt across Texas right down to Mexico. It takes in all or part of 14 states: Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, the Dakotas, Iowa, Nebraska, Kansas, Oklahoma, Missouri and Texas. In all the world the only other prairie as large is the pampas of Argentina, Uruguay and Paraguay in South America.

There are flowers on the prairie, notably the shining sunflower, aster, daisy and, in the fall, the nodding goldenrod. But except where men have cultivated them, or along a few riverbeds, there still are no trees!

Scientists suggest that droughts may have killed the trees. But the prairie is not arid country; the climate is semihumid. And if drought is to blame, why don't trees grow, as they do elsewhere in the world, in the many prairie swamps, which never dry out?

Science offers another explanation: the wonderful vigor of those 140 prairie grasses – buffalo grass, wild ryes, fescue, wild June grass and others. Can it be that fast-growing grass simply chokes out small trees?

This may very well be. And yet there is a third possible explanation – prairie fires.

A few days after the South Dakota fire the farm family went back to examine the "burn." The grass had been razed down to the blackened soil. No young tree sapling or seedling could possibly have survived. The earth was burned clean.

Yet a week later, after a rain, the burned prairie was losing its blackness. Spreading over the destroyed area was the faintest tinge of green. The prairie grasses were already fighting to grow again.

Since earliest times the prairie has been swept periodically by countless fires. Long before civilization brought careless trappers or spark-belching locomotives, or even before there were Indians to start fires, there were prairie fires. If there were no men to start them, how did they start? The villain was lightning.

But – if lightning burned off the prairies and destroyed tree life long before man came, why didn't it also destroy the eastern forests? The answer may lie in a curious phenomenon that plainsmen know well. In the East, lightning usually comes with a drenching rainstorm that thoroughly soaks the woods. But across the western prairies the sky is often dark with strange veils laced with lightning. The veils, known as "verga," are rain that never reaches ground. In the dry western air even a cloudburst may actually dry up in mid-air long before it can wet the earth. Thus when lightning starts grass burning, there may be no water at all to put out the fire.

Here, it seems, may be a key to the mystery of the American prairie – the "sea of grass." ■

GOLDEN AGE OF MUSLIM MEDICINE

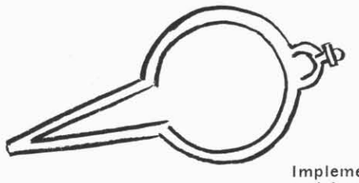
A wave of enlightenment swept through the healing arts of medieval Islam

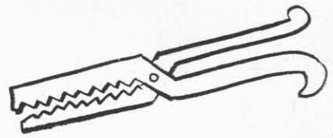
At a time when Europe still believed sick people were possessed by devils, the practice of healing became an art in Arabia. Custodians of Greek and Roman science, the Arabs blended the best of Syrian, Persian and Indian medicine during the ninth to eleventh centuries. So esteemed was medicine that physicians enjoyed such rare privileges as dining with the caliph, remaining seated in his presence and treating members of the royal family. Some even became court officials. Early in the period, no man was more respected than Johannitius, the "shaikh of translators," credited with translating some 200 works of Aristotle, Galen and Hippocrates. The most original clinician was Rhazes. Popular because of his pleasing bedside manner, Rhazes was a busy practitioner, hospital head and consultant. Yet he found time to pen over 235 tracts. More than 300 years after his death, his famous "al-Hawi" was one of nine books in the Paris medical school library. Rhazes was followed by the brightest star of all — Avicenna. The unorthodox, argumentative physician wrote a comprehensive "Canon of Medicine" that was the medical Bible for six centuries. Despite the brilliance of Rhazes and Avicenna, surgery remained suspect until Albucasis, "Islam's greatest surgeon," raised its stature. Many of his procedures and instruments have been refined only slightly to this day. Avenzoar, working in Spain, was first to detect throat cancer; and in Cairo, Alhazen diagramed the intricacies of the eye. These men and others created a body of medicine matchless in its scope and lasting impact.

At 17 Avicenna became court physician to the Sultan of Bukhara. His long and brilliant career inspired historians to rank him with medical greats Galen and Hippocrates.

Persian-born physician Rhazes did not take up medicine until he was 40 years old. Yet, as head of Baghdad Hospital, he became the most celebrated clinician of his time and the first to diagnose measles and smallpox from on-the-spot observations.

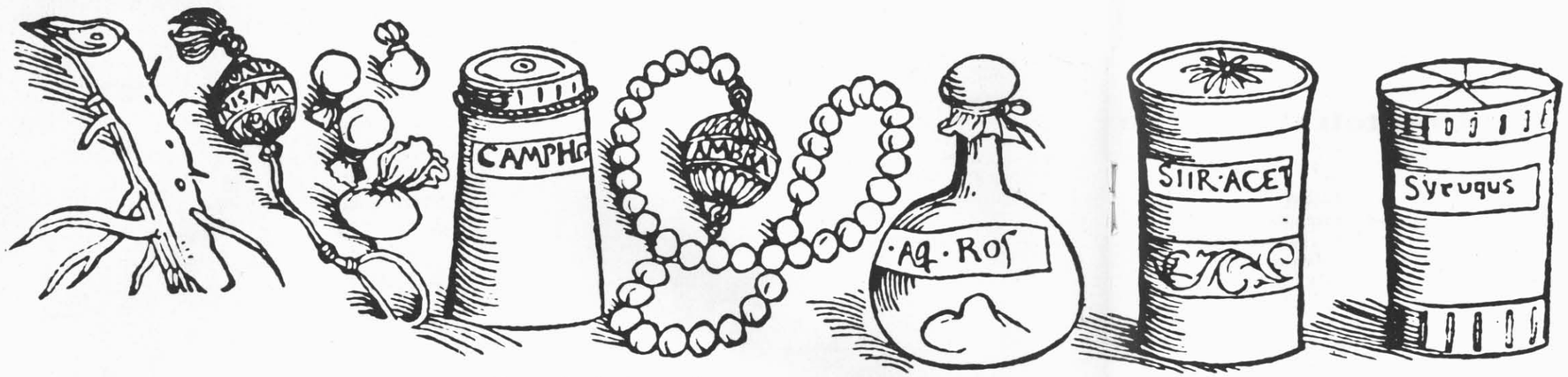
To make patients more comfortable, Arab doctors often administered sedatives and sweetened sickroom air by burning balsam and other herbs.





Implements such as nose dropper (left), dental scraper (center) and dental forceps were diagramed in Albucasis' tenth-century treatise, which was the authoritative textbook on surgical techniques for hundreds of years.

Moorish doctor Avenzoar, diagnostician and medical writer of the Western Caliphate, originated advanced procedures for feeding the critically ill.

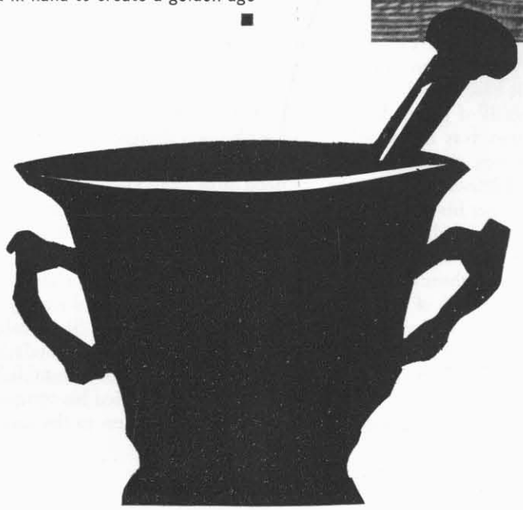


Arab apothecaries relied heavily on nature to provide remedies for human ailments. Among the medicines they developed were balsam for healing wounds, camphor as an antispasmodic, amber for whooping cough, rosewater for headaches, syrup for coughs.

GOLDEN AGE OF MUSLIM MEDICINE

Perhaps because Arabia Felix supplied the world with exotic herbs and spices, pharmacy reached new heights under the Arabs. Even today the term "Arabian medicine" means cure by natural methods, and as far back as Rhazes the Arabs believed that no other remedy should be prescribed when a physician could heal through diet. Not content to use only native "materia medica," they scoured the globe for other medicinals. From the Hindus they borrowed aconite and mercury, and expeditions returned with senna, camphor, sandalwood and tamarind. These substances—as well as ambergris for cramps, colchicum for arthritis, borax as a dentifrice—were in common use. Avicenna listed some 760 drugs that came from Arab laboratories, where raw drugs were evaporated, filtrated, crystallized and distilled. Some drugs were rendered more palatable by mixing them with syrups, gums and fruit rinds. Early Arab physicians compounded their own medicines, but when drugs became highly diversified, pharmacology came into being. The Arabian pharmacist, like the doctor, was universally renowned for his knowledge and integrity. Rigidly supervised by "muhtasibs," inspectors appointed by the caliphs to keep watch over occupations relating to public health, pharmacy developed into a revered profession second only to medicine. The two went hand in hand to create a golden age in Muslim medicine. ■

Modern synthetic chemistry owes a debt to Arab druggists, whose search for more effective medicines led to improved laboratory processes.



Medical knowledge of distant nations was transmitted by far-ranging caravans, which returned to Arabia with new drugs and herbs that were prepared by market-place pharmacists.

Queen Zenobia

Few men could match the brave deeds of the woman who ruled an ancient empire

THE BRIGHT STARS of the Syrian desert shone on Palmyra, capital of the caravan empire. White limestone colonnades, temples and palaces gleamed in the moonlight, and a hot dry wind stirred in the palm trees that gave the city its name.

The soldier Yarkai, captain of the guard, wrinkled his nostrils as the breeze assailed them with the reek of the sulphur springs that had been supplying water to passing caravans for 20 centuries. Not all the primrose and oleander near Queen Zenobia's palace, where he was standing guard duty, could dispel the acrid fumes, but Yarkai was used to them. Any good Palmyrene had to be. Turning his head from the familiar pattern of streets he nightly covered on his rounds, he gazed uneasily toward a high, arched window in the castle's red walls. He knew that beyond the window was the beautiful, dark-haired woman who held the destiny of all Palmyrenes in her dainty hands. Yarkai admired his ruler, but it made him apprehensive to think that all the opulence and security of his native city, all the aspirations of a swiftly risen empire stretching from the Nile to the Euphrates, depended upon one daring, spirited and sometimes unpredictable queen.

It was nearly midnight. Most of the palace windows were dark. No torches burned in the theater as they did when public discussions were under way or the Council of the People had met. The voices of the Greek, Phoenician, Persian, Parthian, Babylonian, Roman and Egyptian merchants had fallen silent in the *agora,* the central market place. He could hear muffled shouts in the caravanserai, where late-arriving camel trains were being unloaded and bedded down. The clatter of footsteps echoed in the streets as a group of men gowned in richly embroidered tunics, led by a white-robed priest with conical cap and mitre, hastened by on their way to late rites at the Temple of Bel.

Palace, temple and most of the public buildings stood to the south of the broad-columned avenue that crossed the city from northwest to northeast. Once it had been nothing more than a caravan road, but now it was one of the most splendid boulevards in the world. Yarkai compared it in his mind to other great avenues, for as one of the famed Palmyrene archers he had been stationed in many cities, even in Rome. The street was more than 1,200 yards long, lined with tall Corinthian columns topped with capitals of gilded bronze, nearly 400 on each side. Each column was bracketed to hold statues of famous men – merchants, caravan leaders and chiefs of market – for the city did honor to commerce.

Palmyra, he had learned long ago under his father's roof, had once been nothing but a mud-hut oasis called Tadmor, a tiny village at the junction of two great trading routes. Then King Solomon had erected a temple there – with the help of a jinni, some said – to direct the wealth of the far-off east toward his kingdom. But Tadmor remained an obscure desert outpost until some three centuries before Yarkai's time, just prior to the birth of Jesus. Then, suddenly, with a shift in world powers, Palmyra began to grow.

Almost midway in the desert, 150 miles from Damascus and 190 miles – four days' journey by swift camel – from the Euphrates, it lay on the shortest route between the Phoenician coastal towns that gathered the rich merchandise of the western world and the Mesopotamian cities that commanded the fabulous eastern trade. To the west stood the mighty empire of Rome; to the east, the savage Parthians. Neither felt confident enough to wage war against the other. Swiftly, almost like a boom town privileged by both sides, Palmyra waxed rich and important as a trading center, a balance wheel and bulwark between two hesitant enemies.

In 41 B.C. Mark Antony tried to capture Palmyra, but the citizens retreated beyond the Euphrates, bearing their valuables with them. Trajan granted the city honor, and years later Hadrian attempted to give it his name. Operating within the Roman Empire, it remained independent, free to make its laws and collect its levies. The city's camel corps rode out to escort and protect the caravans. Its merchants established their own trading centers from Babylon to the Danube, Rome and Gaul. Borrowing from cultures with which it came in contact, Palmyra made up its own: Iranian dress, weapons and furniture; Persian manners; Babylonian temples, houses and gods, and other gods, too, including the caravan deities, Arsu and Azizu. And everything tempered and refined by the tastes of the Latins and Greeks.

But Palmyra had been content to remain a bulwark town, contributing to the greatness of others, until King Odenathus and his queen, Zenobia, came to the throne.

Footsteps sounded on the tiles of the courtyard and Yarkai came alert. He recognized Worod, swift-footed messenger of Zabda, Zenobia's general. It was Zabda who had ridden at her side when she led her 80,000 troops into Egypt and garrisoned Alexandria with Palmyrenes, spread her empire over Syria and part of Asia Minor and northern Arabia, captured Hims and Antioch. His messenger spoke now in Arabic, the language of Palmyra's streets.

"My message is for the queen. The Roman legions are marching southward!"

Silently Yarkai pointed to the arched window.

In her bedroom, a high-ceilinged chamber hung with tapestries, Zenobia ran her strong hands over a bolt of silk taffeta woven on a loom known only in China. Did she prefer it, she wondered, to the gossamer-thin wool with the Greek floral design? To one side lay the suit of iron armor and the helmet that transformed her into a soldier when the need arose. She knew that she must shortly don that armor. Emperor Aurelian was threatening her from the north. She must soon ride at the head of her troops to meet him. But for a while longer she would be a woman as well as a queen.

Her mirror reflected a vivacious, dark-skinned face with large, black eyes. Her lithe body was garbed in robes of heavy purple silk and jewels. She recalled how she had come to the palace as a young second wife when her husband, Odenathus, had first started to establish Palmyra as a power in its own right and carried his conquests to the shores of the Red Sea. She had ridden to the hunt and the battlefield beside him and shared his ambition to make Palmyra the military as well as the commercial capital of the caravan world.

Brave as Diana and beautiful as Venus men called her; known for her wisdom, too, for had not Longinus, the philosopher, the "walking university," come out of Athens to instruct her and make her worthy of any throne? Did she not know Greek, Egyptian, Aramaic and a little Latin? She had compiled a history as well, and was versed in Plato and Homer. But when Odenathus and his heir were treacherously murdered, she was forced to put aside her literary and artistic interests. She had rallied the sons of the desert, and they had ridden forth to bear arms for their heroic queen. She had led them into battle and conquered many lands and cities, establishing the title of "King of Kings" for her own young son, Waballath.

The coins from Zenobia's mint bore Waballath's likeness on one side and, as a conciliatory gesture, Aurelian's on the reverse. But Aurelian struck his own coins, bearing the threatening words *Restitutor Orientis* (Restorer of the Orient). Proud Zenobia answered the challenge with an issue of new coins from which Aurelian's face had been removed and her own substituted. The act caused the Roman emperor to consider Zenobia a dangerous, insubordinate woman who must be put down. He and his legions were on the march. At any moment Zabda would send for Zenobia, and she must don her armor and lead out the cavalry.

Unhappiness and foreboding oppressed her mind, and she thought, as she seldom did, of death and its prominence in Palmyra's religion. Tall rectangular tower tombs on the sands, vaulted underground chamber tombs, temple tombs in the city – all these were made splendid for the dead of leading families and banquets were held in them to honor the departed.

Zenobia's mirror did not reveal the events soon to come. Worod's message proved true and Yarkai the soldier once again fought for his queen. But the gods of war turned away from Zenobia. Within the year Aurelian's newly developed light cavalry had outmaneuvered and defeated Zenobia's archers and heavy cavalry. The caravan empress herself was captured by a Roman patrol as she set out to appeal for troops from an ally.

Her fate was never recorded. One legend has it that Zenobia, determined to prevent the humiliation of being paraded through the streets of Rome, starved herself and died en route. Another story relates that she was driven through the streets of the Eternal City bound in chains of gold, then was pardoned to live happily ever after in a villa at Tivoli.

The fate of her city is, however, certain. Palmyra was sacked and despoiled by Aurelian, and it slowly went back to the desert again, to the cluster of huts it had been in Solomon's time. But even today there is a difference about it. Many of its splendid columns remain, and its ruined temples, and the memory of Queen Zenobia, certainly one of the world's most fascinating women. ■

Bahrain Petroleum Company refinery forms backdrop for date palms.

Isle in the Gulf

It was from the shores of Bahrain that oil explorers looked searchingly across the Persian Gulf to the Saudi Arabian mainland 16 miles away

THERE ARE LEGENDS within legends . . .

Four thousand years ago in the fabled Sumerian city of Ur, children listened wide-eyed to tales of the land of Dilmun – tales so wondrously ancient, so close to the beginning, that they have been part of the lore of all men ever since.

There was the story of the "First Place," the misty Garden of Eden made ready by the gods for the first man and woman. There was the "Great Deluge," the terrible tale of Ziusudra – elsewhere called Noah or Utnapishtim or Xisuthros – who dwelt at Dilmun after he had been spared and made immortal. There was the saga of Gilgamesh, the wandering hero-king, who came to Dilmun in his search to evade death and found and lost the "Flower of Eternal Life" beneath its waters.

At Dilmun, they were told, the gods first gave man understanding, taught him to read and write his language, to grow crops, tend herds, work metal, first endowed him with a sense of the spiritual and instructed him in the arts and sciences.

The island they called Dilmun, we know as Bahrain. Today we can still visit it, explore it, attempt to understand it. In a way it is like going home.

Bahrain, the largest of six islands in an archipelago 15 miles off the eastern coast of Saudi Arabia in the Persian Gulf, is about 30 miles long and nine miles wide. A three-mile-wide fertile strip of land arches across the northern part of the island. With the exception of scattered oases, the central and southern areas consist of flat desert and barren, rocky slopes.

It was not always so.

A thousand centuries ago, when Neanderthal Man was shivering in his glacier-threatened caves in northern France, Bahrain had a lush and temperate climate. It may have been grassland or forest; it may not have been an island at all. But whatever its appearance, anthropologists believe that it was one of the regions where man developed.

On the flat lands and prehistoric beaches of the island, early man has left us thousands of mementos of his presence: tiny flint chips – the debris of his tool and weapon making – which are found wherever the original surface has not been buried under layers and layers of fine grains of sand.

During the Copper Age, 5,000 years ago, the inhabitants of Bahrain constructed time's most unusual memorial – a graveyard of 100,000 tombs, each one a gigantic mound of gravel containing one or more stone-built chambers which served as the grave of a single person. Nowhere in the world, then or since, has there been a society so prosperous as to permit of such elaborate burial for so many of its citizens.

What was the source of its wealth?

Dilmun was the first of the three great seafaring civilizations of the ancient world. Before Crete and Phoenicia expanded the boundaries of geography to include the Mediterranean, the coastal Atlantic and the British Isles, Dilmun was the nucleus for ships plying waters off Arabia, West Africa, Persia, India and all the great lands of the East.

From then to recent times its pearls – "fish eyes" – were the finest and most plentiful found anywhere. Islanders brought pearl diving to a perfection still apparent today in the Persian Gulf. Before the tides turned and the winds changed and the *shamals* (sandstorms) brought their suffo-

For centuries Bahrainis have been pearl divers, shipwrights and fishermen, such as this islander who casts his circular net to land flat.

Bahrain dhows ply coastal waters, carrying cargo and passengers or serving as bases for pearl divers.

ISLE IN THE GULF

cating dust, Bahrain's agriculture – particularly the tasty dates still grown on the island – fed the neighboring regions.

One of the reasons for this agricultural abundance was the great fresh water sea that lies beneath the island and the salty waters of the Gulf itself. Where the sweet water flowed, from beneath the ground and through the saline seas, there was no thirst.

More important was the island's strategic location midway down the length of the Gulf. Merchants who entrusted their cargoes to primitive wooden ships that sailed in pirate-infested waters were more than anxious to sell or exchange their wares at the halfway point. While to the north and west splendid civilizations rose and fell amidst war and turmoil – the Sumerians yielding to the Babylonians, who in turn were overwhelmed by the Amorites of the Syrian deserts and later by the Kassites from the Iranian highlands – Dilmun remained insulated from and vital to her warring neighbors.

Great cities rose on the island. Gold, ivory, copper, dolomite, jewels, jade – all the riches that moved from land to land passed through her harbors. Inzak, the god of Dilmun, watched over his people.

The first great decline came about 1800 to 1600 B.C. when an Indo-European group called Aryans swept south through the Hindu Kush into present-day Pakistan and destroyed the great and still mysterious Indus Valley civilization. With the cities of Harrapa and Mohenjo-Daro severed suddenly from the trade patterns that were the main source of Dilmun's economic life, the island's prosperity dwindled, almost died.

Pearls and dates, always in local demand, were probably the principal sources of income for Dilmun for the next seven or eight hundred years. The island survived – but only that. Growth and construction came to a standstill. The great temples at Bar Bar fell into ruin, the wells and subterranean baths were clogged with rubble, the city at Qala'at al-Bahrain was buried beneath the ruins of succeeding villages. Today it is a broad hillock, topped by the crumbling remains of a fort built by the Portuguese four short centuries ago.

Relative prosperity returned about 850 B.C., but no longer was the island totally its own master. The Assyrian Empire had arisen in Mesopotamia, and at least token subjectivity was paid its rulers. One legend tells of the destruction of Babylon by the Assyrian king, Sennacherib, who sent samples of the charred debris to Dilmun as a warning to those who might be tempted to oppose his might.

The island entered new cycles of progress. But perhaps as an omen of eventual decay, each period of rise and fall was shorter than the one before. As the boundaries of civilizations, then nations, then cities, then tribes flowed across Bahrain, it seemed almost as if the races of men who had found their beginnings there were futilely trying to regain their lost heritage.

The struggles of antiquity passed into darkness, the island into decay. Not until the rise of Islam and the birth of a new calendar to record events did Bahrain reawaken. The expansive mood of the Islamic movement, felt so keenly and profoundly in the West, had its effect on Bahrain as well. The marks of those tremulous times are reflected in the lineage of modern-day Bahrain – in the Baharna, oldest known inhabitants of the island, who trace their genealogy to the desert races taken into Iraq by the Babylonian king, Nebuchadnezzar, and in the Shi'ite and Sunni Arabs, who trace their differences to the early development of Islam.

The present ruler of Bahrain, Shaikh Isa bin Sulman al-Khalifah, is a direct descendant of Shaikh Ahmed bin Khalifah, who conquered the island in 1782. The present government succeeds a series of modern dominations, principally by the Portuguese, who controlled the island from 1521 to 1602, and the Persians, whose sovereignty lasted throughout most of the seventeenth century.

In 1820 a treaty was signed between the ruling shaikh of Bahrain and the British East India Company. This agreement has guided the destiny of the island. The discovery in 1932 of oil on Bahrain, immediately south of the city of 'Awali, signaled a rebirth that was eventually to lead to a new way of life for all the peoples of the Arab world. It was on the shores of Bahrain, looking westward, that geologists decided that Saudi Arabia might also hide black wealth beneath its shifting dunes.

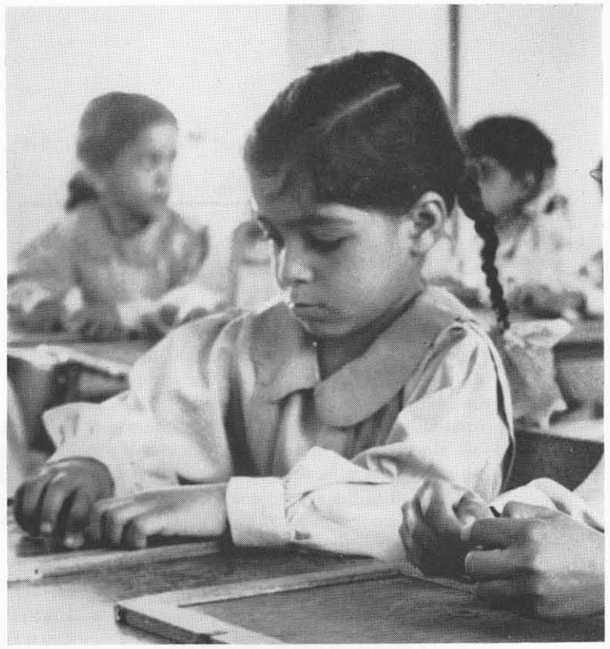
Today Bahrain, the great grandchild of Dilmun, experiences a new life, one that calmly, yet impatiently, links its 150,000 inhabitants to the glories of its past and the promise of its future. Once again its harbors are crowded with ships from distant ports, its fishermen cast their nets in ripe waters, its gardens and oases press back against the desert wastes. No longer faced with the heartaches of bare survival, they are free to reflect on the legendary wonders of their past and test those reflections with the tools of modern science and space age technology.

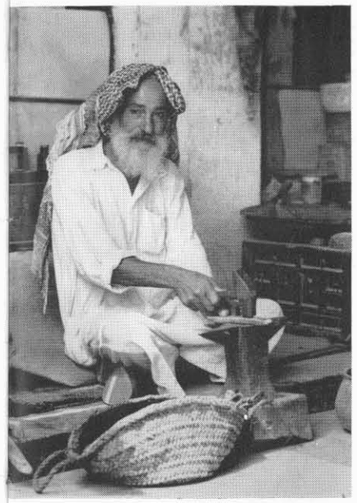
Today the mongoose scurries in gardens that fringe hospitals and schools. The hunting falcons soar above bustling seaports and wells pumping oil.

Now legend has the leisure needed to come true. ■

Diver checks submarine pipeline that carries crude oil from Saudi Arabia to Bahrain refinery. Aramco laid the first line in 1945 and another in 1952.

Some 17,000 Bahrain youngsters attend over 45 government schools, where classroom studies are complemented by active sports programs.





Among older generation are artisans skilled in traditional crafts like silverwork (above), pottery and weaving.

Avenue in Manama, 500-year-old capital of Bahrain, reflects island's 20th-century tempo.

THE VANISHING FORTRESS

Not until recently did military men stop putting their faith in high, strong walls

THE GUNNERS on the ramparts have been replaced by guides, the cannons serve as curiosities, and tourists with a yen to be part of history scribble their footnotes on crumbling walls that once echoed the sounds of battle. Yet these ruined fortifications that dot the countryside of almost every nation still grip the attention and tease the imagination.

Since earliest times it has been man's conviction that the higher the walls, the safer the shelter behind them. This belief led to the surrounding of homes with wooden stockades, stone garrisons, brick castles. The ancients even attempted to girdle entire countries with high, twisting walls.

As towns spread and enemies became stronger, walls grew higher and enclosures larger. A military man on the march could not bypass a fortress without endangering his lines of supply. He could not take the fort without an overwhelming force of men and arms. Forts were constructed to house garrisons powerful enough to destroy or delay the enemy, or they were built to house a city's whole population, as was the case with old Nineveh or Babylon.

Two of man's more celebrated fortification projects were actually walls. One rose in the East, the other in the West.

By 221 B.C. Emperor Shih Huang-ti had united all of China and wished to immortalize his achievements. Abetted by his people's age-old fear of barbaric nomads from the north, he constructed a giant bastion along his nation's borders. The Chinese called it *Chang Cheng,* the Wall of 10,000 Li; we know it today as the Great Wall of China.

A third of the male population was conscripted to labor on the wall. Its very size contributed to the nation's downfall, for the people relaxed their vigilance in false security and exhausted their treasury on the constant repairs that were necessary to maintain a structure of such vast dimensions. It was only in times of weakness that the Chinese hid behind it. Like all warriors, when they were strong they preferred to wage open battle rather than seek asylum behind walls.

Until recently historians believed the current Great Wall was the same antique bulwark. But it is now understood that there were two different walls and that Shih Huang-ti's wall probably disappeared by the end of the thirteenth century. The modern wall, begun about 1400 and completed 200 years later, is roughly 1,400 miles long and contains enough material to build 120 Great Pyramids. In many places the wall is 50 feet high and 25 feet thick. It seemed invincible, but only a quarter of a century after it was completed, it crumbled before the onslaught of the Manchu, a Mongol tribe that captured the entire peninsula. The Chinese had not learned a lesson from an earlier Roman undertaking.

During the first century Rome reached the height of her power, yet endured constant uprisings in Palestine, Syria, Gaul and along the Rhine. Emperor Domitian conceived the idea of a Roman Wall – a barrier around the civilized world. Three rulers – Domitian, Trajan and Hadrian – built and extended this wall until it bounded the Empire along all its frontiers in Europe, Africa and Asia.

The future of the Empire, however, depended upon the German frontier, which ran 350 miles through central Europe. Thus the Romans built a wall which started from the Rhine and ran across the Taunus mountains as far as Wurttemberg in West Germany.

The engineers of Hadrian, who became emperor in 117, executed a technical triumph when they actually straightened out the winding wall, disregarding obstacles like mountains, rivers and forests. Little is known of its dimensions, but later generations thought the partition so huge they called it the Wall of Satan. But it required so many skilled soldiers to man it that auxiliary troops were drawn from the local population – the same people the wall was supposed to keep in check. This practice eventually led to the wall's downfall in 233 when Alemanni tribes breached the bulwark and recaptured their country. As the Roman Empire declined so, too, did the art of wall fortification in the West.

Walls went out of style, but individual forts grew in importance as the order of the Roman Empire broke down and Europe divided itself into tiny, suspicious sovereignties. Local rulers compelled labor by force of arms and erected castles to defend themselves against the ambitions of other local rulers. The European landscape soon became laced with palaces, some modest, others goliaths of grim stonework.

Castle design depended largely on the whim of the ruler; only one requirement remained constant: that the walls be high and thick. Ten feet of solid masonry was not an uncommon width, and within the walls were stocked all the necessities to withstand long sieges – an armory of weapons, supplies of food, water wells. Spaced along the wall were towers from which arrows, boiling water or molten lead could be poured on the enemy in case of attack.

Sometimes there were two walls, the outer one reached only after attackers had first forced their way across 40 or 50 feet of water-filled moat. With its drawbridge up, its portcullis down and its walls manned with archers, the castle smugly challenged all comers.

For centuries men depended on such defenses for survival. Then, in the thirteenth century, the castle suddenly became vulnerable. The reason: black powder and cannon.

For a time stubborn builders resisted the fateful truth by constructing ever thicker walls. But finally in April 1862 the death knell of walled fortresses was tolled at the mouth of the Savannah River in Georgia.

There Fort Pulaski sat defiantly astride Cockspur Island in the river's mouth, its smoothbore cannons trained out to sea. Union captains could not effectively blockade Savannah without approaching the fort, yet to do so meant destruction by Confederate guns.

One morning Union General Q. A. Gillmore stood on a hill overlooking the river. Surveying the fort's defenses, he gestured at two nearby islands and told the lieutenant who

Surrounded by 39-foot-high walls, city of Avila in central Spain is a medieval tribute to the art of fortification. The walls, completed in 1099, are a mile and a half around and studded with 88 towers, nine gates and 2500 individual battlements.