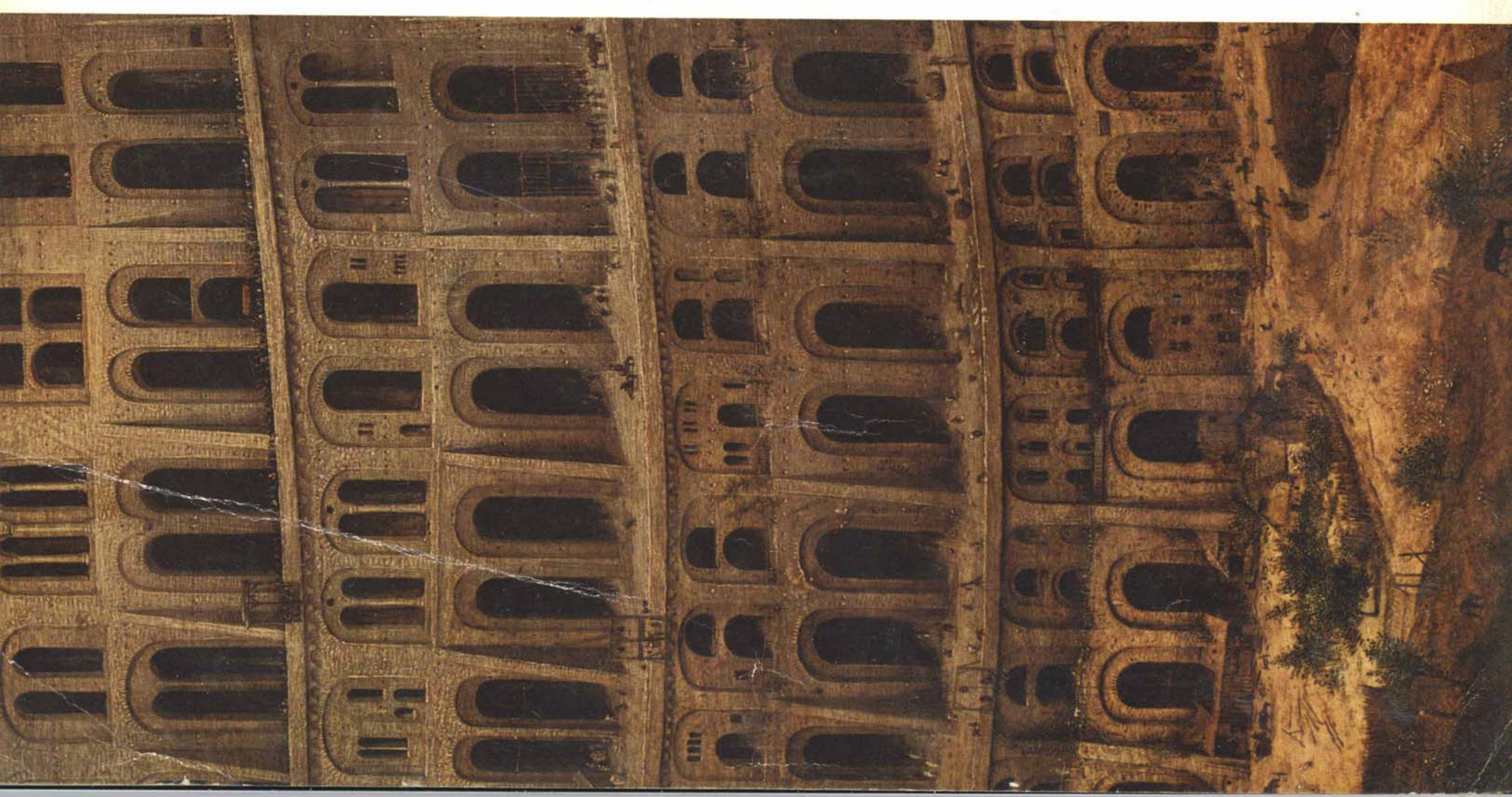
ARAMCO WORLD
January-February 1967

THE TOWER OF BABEL

ARAMCO WORLD
505 PARK AVENUE
NEW YORK, N.Y. 10022
RETURN REQUESTED

Mrs. Clarence E. May, Sr. CSF
45 Mechanic St.
Fitchburg, Mass. 01420

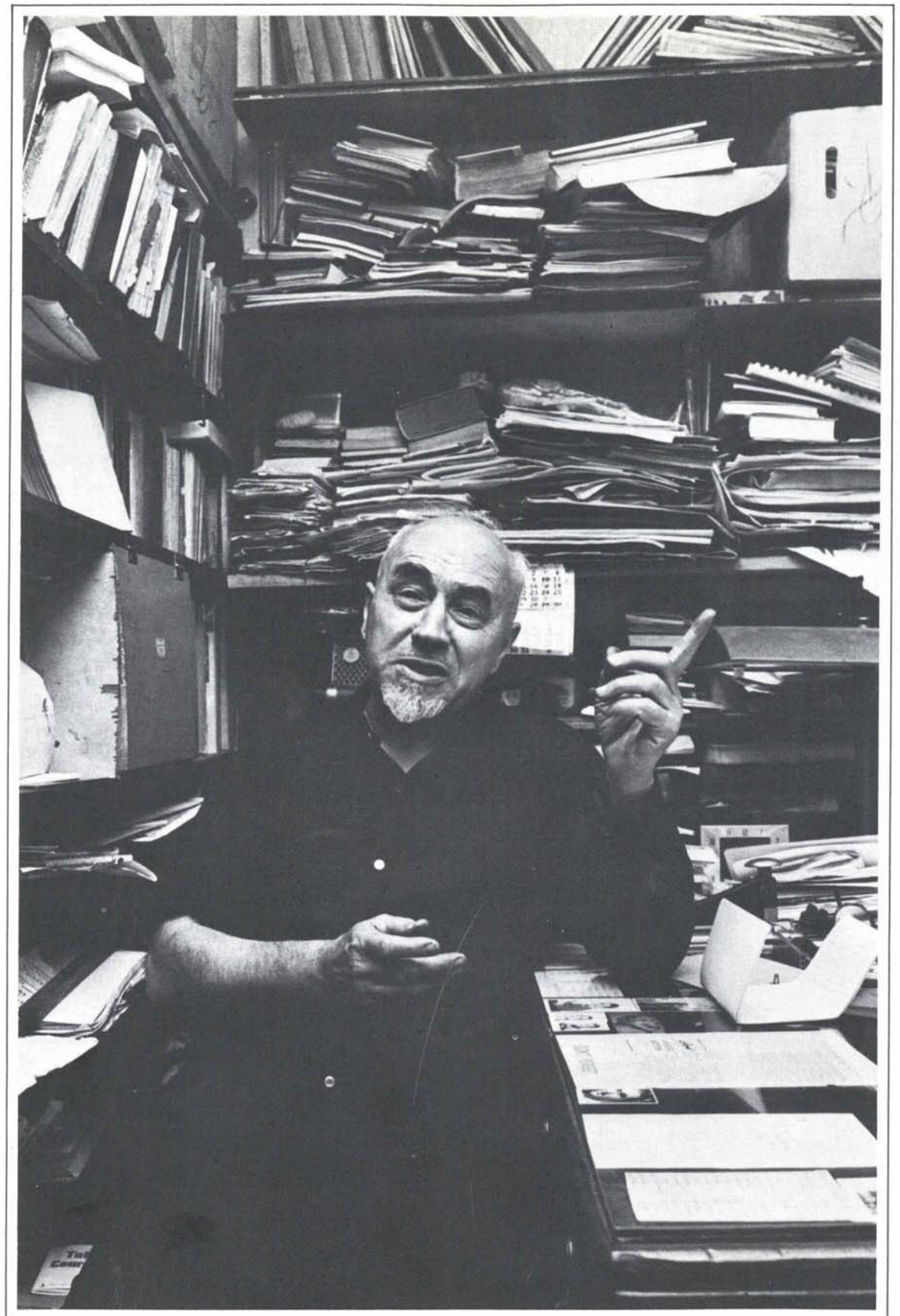


ARAMCO WORLD

VOL. 18 No. 1 PUBLISHED BIMONTHLY JANUARY-FEBRUARY 1967

Published by the Arabian American Oil Company, a Corporation, 505 Park Avenue, New York, New York, 10022; T. C. Barger, President; J.J. Johnston, Secretary; E. G. Voss, Treasurer. Paul F. Hoye, Editor. Designed and printed in Beirut, Lebanon, by the Middle East Export Press, Inc. In the United States, all correspondence concerning Aramco World should be addressed to T. O. Phillips, Manager, Public Relations, Arabian American Oil Company, 505 Park Avenue, New York, New York, 10022.

Cover: Of all the artists who have attempted to sketch or paint the famous Tower of Babel, none has achieved the magnificence of Pieter Brueghel the Elder, one of the most famous of the Flemish painters. Brueghel actually painted two versions of the tower, one of which hangs in Vienna and the other in Rotterdam. The cover is a detail of the Rotterdam masterpiece which was photographed for Aramco World by A. Frequin. Story on page 18.



"As long as only one person is dedicated...the Arab Press will survive"

THE REAR GUARD PRESS

PHOTOGRAPHY BY CHARLES MOORE, BLACK STAR

BY WILLIAM GEERHOLD

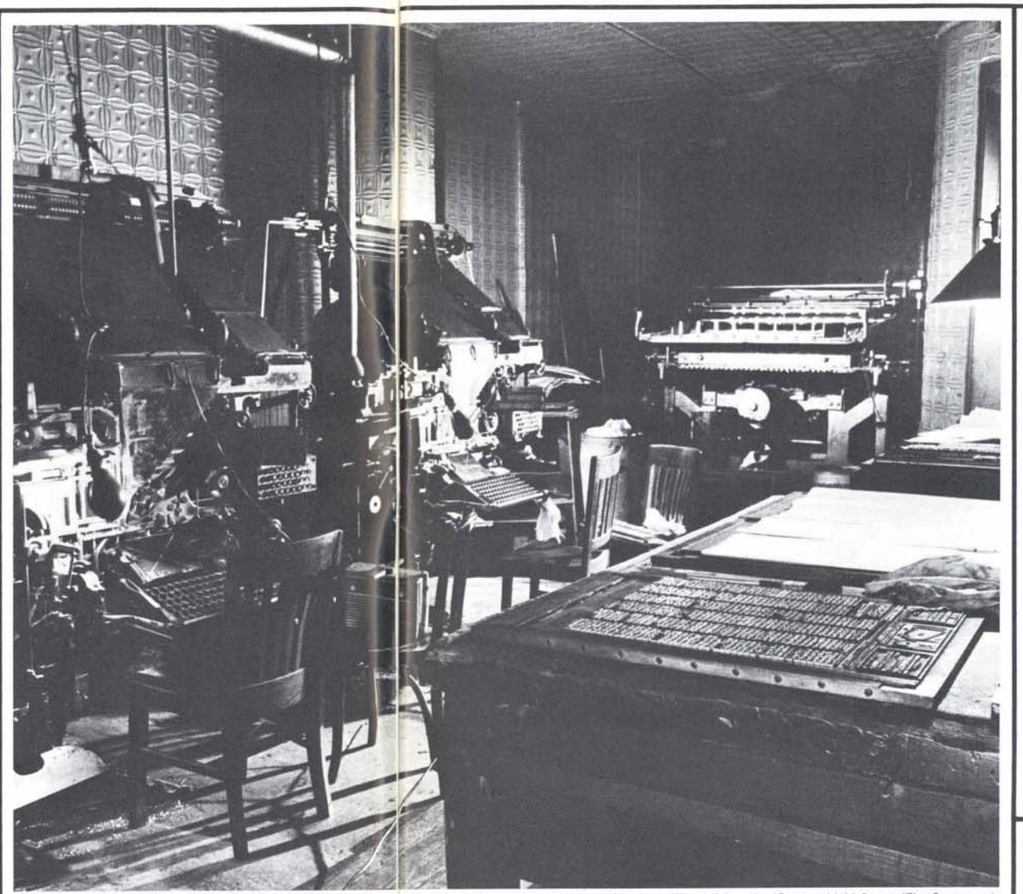
When typesetter Joe Sharbel told the editors of *Al-Hoda*, New York's oldest Arab-language newspaper, that they would have to enlarge the type because it was too small for him to read, the editors neither fired him nor laughed at him. For they knew, even if Joe did not, that despite 55 years of continuous service with *Al-Hoda* Joe Sharbel was more than just a typesetter. He was a spokesman for the thousands of Arab immigrants who still read the newspaper. If Joe Sharbel's eyes were dimming with age then the eyes of the readers probably were too. If Joe Sharbel was having trouble making out the delicate differences in the brass molds, then the readers were probably having trouble reading it. The type was enlarged, the columns were widened, and *Al-Hoda* went on publishing as it has for nearly 68 years.

Foreign-language newspapers used to be common in America. With each wave of newcomers—German, Polish, Italian, Russian, Puerto Rican—there immediately sprang up, wherever immigrants gathered in large numbers, at least one newspaper in the only language the immigrants could then read. Such publications served a vital function. They linked immigrants of one area with those of another. They offered information about jobs. They provided a familiar cultural bulwark in a strange country. Above all, they brought news of the countries that were and would be for years afterward, much closer to their hearts than the new land.

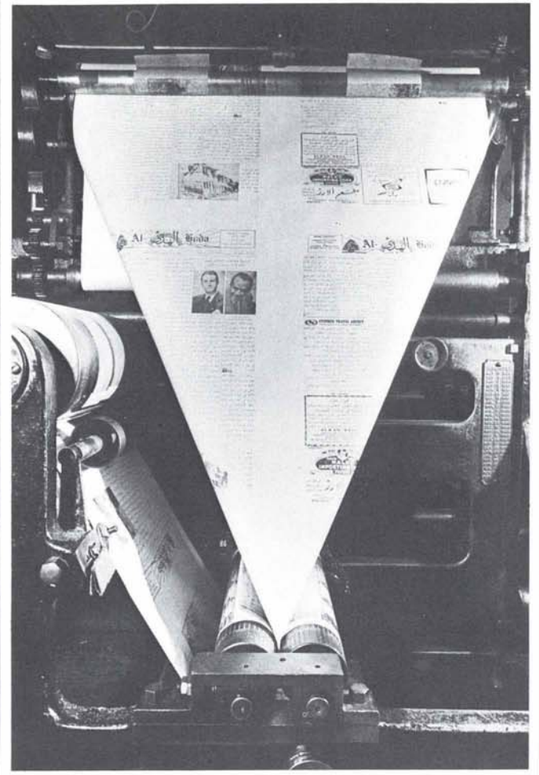
Arabs, of course, never figured greatly in the immigration to the United States. Even at the peak Arabs were counted in thousands, not millions. But for that very reason, because they were such a small minority among so many large minorities, the desire for close ties with their homelands—Lebanon, Syria, Iraq or Egypt—was possibly even stronger and newspapers in Arabic soon sprang up in both New York and Detroit, the two areas where Arab immigrants had settled in large numbers.

It was not easy to found an Arabic-language newspaper at the turn of the century. Type had to be imported, most of it from Lebanon. Whole newspapers had to be set in type by hand—by people like Joe Sharbel—because the lovely but unwieldy Arabic letters, symbols and vowel marks, more than 100 of them running right to left, defied all efforts to adapt them to the Linotype machine until 1910. Nevertheless, in 1892, the first Arabic newspaper made its appearance. It was called *Kowkab America* (The Star of America). It was published in Boston and it failed almost as soon as it appeared. So did its successor *Al-Hasr* (The Day), a short-lived publication launched in 1896. But then, in 1898, in a small office on East 28th Street, Naoum Mokarzel, a young Lebanese with an interest in journalism, founded an eight-page daily called *Al-Hoda* (The Guidance) that was soon reaching a readership of 5,000 people. Other publishers quickly followed suit and by the early 1900's the immigrants had numerous papers to choose from, most of which lasted for many years. As late as 1956, in fact, there were five Arabic-language newspapers in New York and five in Detroit, plus others that concentrated on Arab news but printed it in English—such as the Arab Information Center's *Arab World*, *Al-Hoda*'s sister paper *The Lebanese-American Journal*, and *The Heritage*.

The appearance of English-language newspapers for Arab immigrants was a



Here in this tiny two-room plant on Atlantic Avenue in the heart of Brooklyn's "Little Syria," Editor Raji Daher still publishes the 40-year-old Al-Bayan (The Statement).



New York's Al-Hoda (The Guidance) is the U.S.A.'s largest Arabic language newspaper.

Linotype operator sets Arabic type in Al-Hoda's composing room.

Arabic's lovely but unwieldy characters defied efforts to adapt them to Linotype machines until 1910.

Despite a decline in interest and readership many Arab papers survive and a few flourish.

Mary Mokarzel, publisher of Al-Hoda, carries on in the tradition of her uncle Naoum Mokarzel who founded it in 1898.

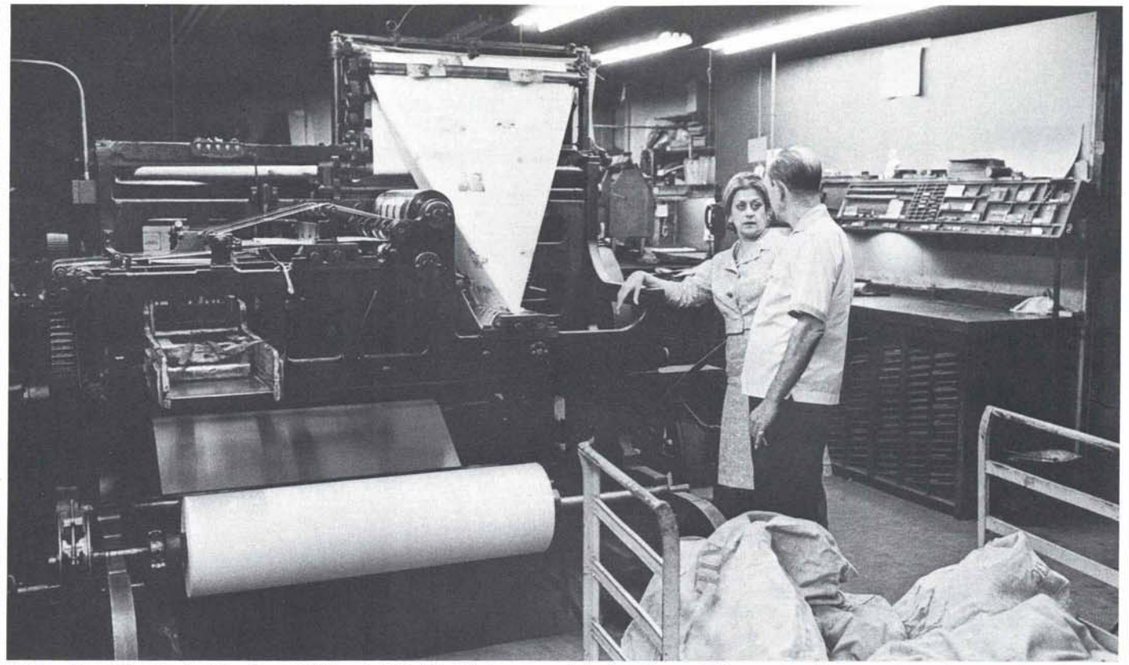
natural development since, to the second generation, English, not Arabic, would be the first language. But it was also an omen. It meant that second-generation Arabs, like most immigrants, were tending to shy away from the foreign language that set them apart from others at school, at play and at work. It meant that the need for publications in Arabic was waning. It meant that one day the Arab language press might disappear.

To an extent this has already begun to happen. Half the Arabic papers in existence in the New York area 10 years ago have quietly succumbed. Where there were six papers—*Al-Hoda*, *Al-Islah* (The Reform), *Al-Bayan* (The Statement), *As-Sayeh* (The Traveler), *Mera't Al-Gharb* (Mirror of the West) and *As-Samir* (The Entertainer)—there are now just three: *Al-Hoda*, a six-page semiweekly with a circulation of between 4,000 and 5,000 copies; *Al-Islah*, a four-page weekly, with a circulation of 1,000 copies; and *Al-Bayan*, which during the decade absorbed *Mera't Al-Gharb* and *As-Sayeh*. In Detroit, *Al-Mashriq* (The Orient) and *As-Sabah* (The Morning) have also disappeared, leaving only three still publishing: *Nahdat Al-Arab* (Arab Progress), *Lissan Al-Adl* (Mouthpiece of Justice) and *Al-Risaleh* (The Message).

Even the surviving papers have had to retrench. From daily publications they have shrunk to semiweeklies and weeklies, biweeklies and even, in some cases, to a "now and then" schedule. Some editors frankly say that the Arabic press can only survive as long as there is still a substantial number of people who read Arabic and that this number is dropping. Some, like Dr. Alphonse Chaurize, publisher of *Al-Islah*, are even more blunt. "When I die," he says, "this paper will die with me."

Dr. Chaurize is an unusual man. Born in Iraq, he is a professor of philosophy and law, a linguist, a priest (in the Chaldean Rite of the Roman Catholic Church) and a teacher who has taught in Iraq and lectured at Columbia and Yale. He is also a dedicated editor who is representative of all the men who in the last 60 years or so have founded or run Arabic newspapers.

At *Al-Islah* Dr. Chaurize, in his own words, is "it." In a small newsroom at 260 West Broadway, amid a familiar clutter of proofs, copy paper, stacks of



Al-Hoda, with a semiweekly circulation of nearly 5,000 copies is the "big" Arab newspaper in America. It has a publisher, an editor, Linotype operators, and even a modern rotary press.

books, old letters and a few items not usually seen in the editorial side—parts of a Linotype machine, headlines in elaborate swirling calligraphy—Dr. Chaurize functions not only as a publisher but also as editor, reporter, makeup man, business manager, typesetter and proof reader. He is even his own newsboy since being "it" at *Al-Islah* extends even to wheeling the papers to the post office every week in a hand cart.

Dr. Chaurize has been with the paper since 1947—when he went to work with Fawzi Braidy, the man who founded it in 1933—and has been the owner since 1950. Even that early, despite the assistance of his wife, his son and two daughters, it was still pretty much a one-man operation. Not only did he run the editorial and business sides of the paper but also, as he will tell you with pronounced, if justifiable pride, the mechanical side. Dr. Chaurize was his own Linotype operator and repairman and made up his own page forms and handled his own galleys. The only thing he didn't do, in fact, was actually print it. That was and is still done by an independent printer in the same building.

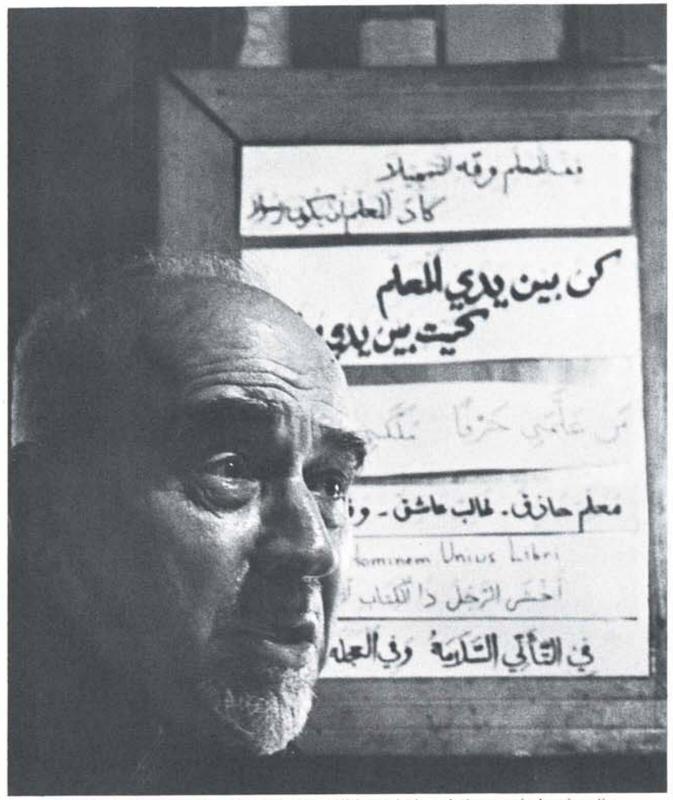
In the small world of the foreign-language press, however, Dr. Chaurize is more the rule than the exception. In Brooklyn, for example, where Raji Daher gamely absorbed two Arabic papers into his own, or in Detroit, where Chekri Kana'an at 73 is struggling to keep a once strong, now declining paper from going under, the story is the same: dedicated editors trying to do too many jobs, failing sometimes but not really minding very much.

Raji Daher bought the 40-year-old *Al-Bayan* in 1950 in Washington, D.C., where it had been moved in 1941 on the death of its founder, Arab nationalist Sulaiman Baddour. He moved it back to New York in 1953, combined it with *As-Sayeh*, a semiweekly put out by Abdul Massih Haddad, a well-known Arab writer, and with *Mera't Al-Gharb*, the second oldest Arabic paper in the country. Then he moved the whole operation, including two Linotype machines and a small press, into its present two-room plant at 139 Atlantic Avenue, the heart of Brooklyn's "Little Syria."

Mr. Daher, a bachelor, has devoted most of his life, and still devotes most of his time, to *Al-Bayan*. He gathers news, writes editorials, edits, sets type and even prints the paper on a small press in *Al-Bayan*'s office.

Yet, for all his efforts, the paper barely survives. *Al-Bayan*, he says, exists on about five per cent advertising and subscriptions of approximately $15 annually and will probably succumb "as soon as I do."

In a similar position is Chekri Kana'an, the 73-year-old publisher of *Lissan Al-Adl*. Chekri Kana'an first founded *Lissan Al-Adl* in 1912 in Lebanon, at the age of 22. Twelve years, later after he had emigrated to Detroit, failed in an attempt to publish a French-language magazine entitled *Liban*, and gone to work in a shipyard, he revived *Lissan Al-Adl* and nursed it into a flourishing 12-page daily that reached a large part of the nearly 40,000 Arabic-speaking peoples who had followed industry to Detroit. So successful was it that three years ago, on the occasion of the paper's 50th anniversary, the Mayor of Detroit presented a key of the city to Mr. Kana'an for his contributions to the Arabic-speaking peoples of the area. Yet today, the single Linotype machine standing in the *Lissan Al-Adl* plant at 10214 Charleroix, tells a sad story. It is the only one left of three that were once needed to get the paper out on time.

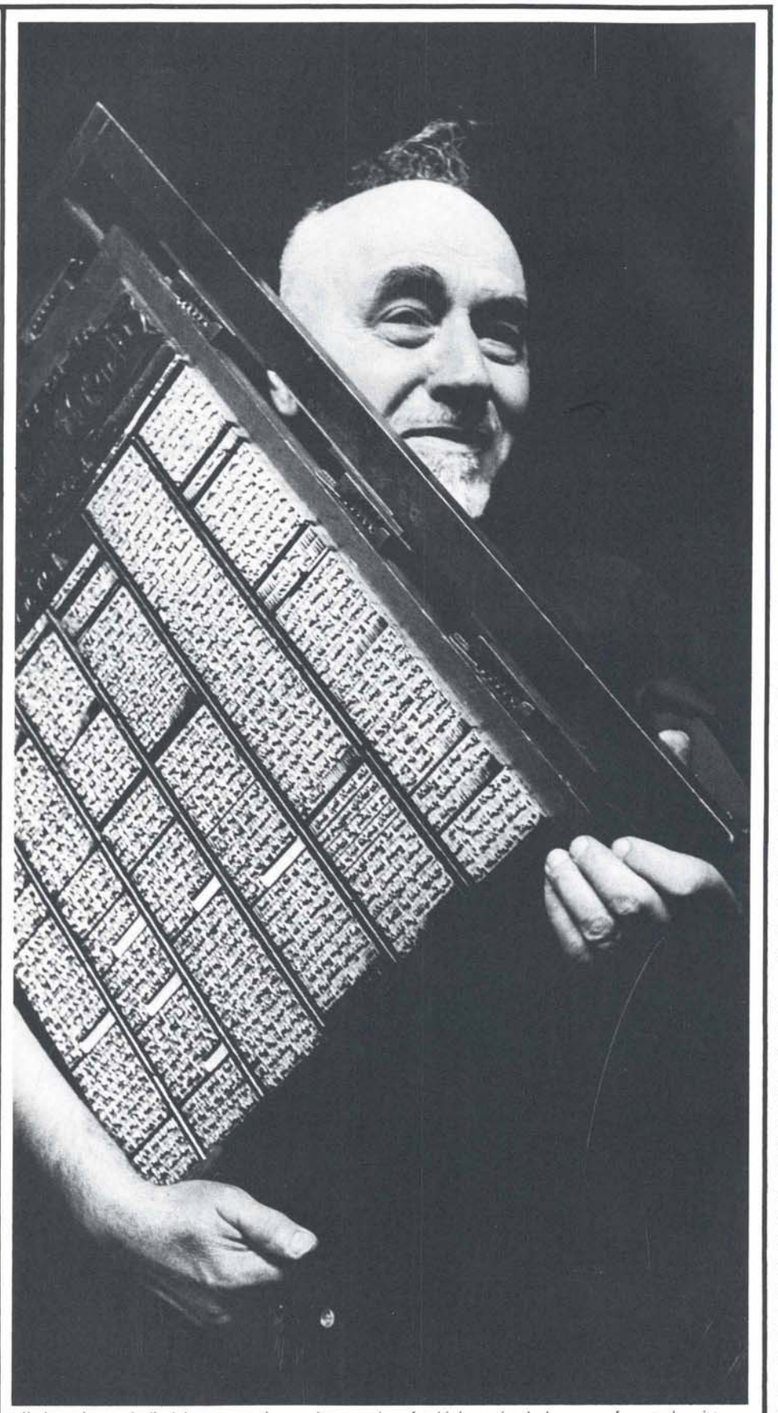


Dr. Alphonse Chaurize typifies the dedicated publishers who keep Arab papers in America alive.

In his cramped, cluttered office he writes and edits the whole paper.

He sets the copy in type himself on a Linotype machine.

As he approaches deadline Dr. Chaurize is often too busy to wolf more than a sandwich and gulp a cup of coffee.



Having written and edited the copy, set the copy in type and proofread it he carries the heavy page forms to the printers.

But if Mr. Daher and Mr. Kana'an are convinced that the Arabic press is on the way out, and if the decline in circulation seems to offer evidence that they are right, there are still some who see a bright future. One is editor Phillip Akel of Detroit, who acknowledges that the four-page, 20-year-old weekly *Nahdat Al-Arab* has suffered losses, but is still "pretty healthy." And Mary Mokarzel, publisher of *Al-Hoda*, insists that despite problems, the Arab-language press still has an important role to play.

Mary Mokarzel represents the second generation of American Arabs. Although the niece of the man who founded *Al-Hoda*, and although she has run the paper since 1952, Miss Mokarzel neither speaks nor reads Arabic, relying heavily on her editor Marwan Jabri to check all copy. But like her uncle who founded the paper, and her father who carried it on after, Mary has strong faith in the paper's capacity to survive. "It's true that we used to be a daily and that we're down to twice a week and it's true we're down from eight pages to six," she says, "But they were predicting the end of the Arab press 30 years ago and *Al-Hoda* is still very much alive."

Coming from *Al-Hoda*, that kind of optimism tends to stimulate all publishers. *Al-Hoda*, after all, is the "big" Arab paper. It's in New York. It has a publisher and an editor. It has Linotype operators. It even has more than one "department." If *Al-Hoda* can survive, the other publishers seem to say, maybe *we* can too.

And maybe they can. Mr. Daher, for example, is still putting out his paper regularly, his difficulties and his grim predictions notwithstanding, and shows no signs of giving up. Dr. Chaurize, ignoring his 76 years, says, "My father lived to be 102 and I plan to outlive him by two years." Although there is no doubt that they are now fighting a rearguard action, none of the publishers and editors is thinking of quitting. "And as long as only one person is dedicated to the service of the Arab world," one editor said, "the Arab press will survive."

William Geerhold, formerly a reporter with The Providence Journal, *is the editor of a weekly newspaper in New Hampshire and an occasional contributor to* Aramco World.

"As you need a corkscrew to get at the wine, so you need a drill to get at the oil."

BY KEITH CARMICHAEL

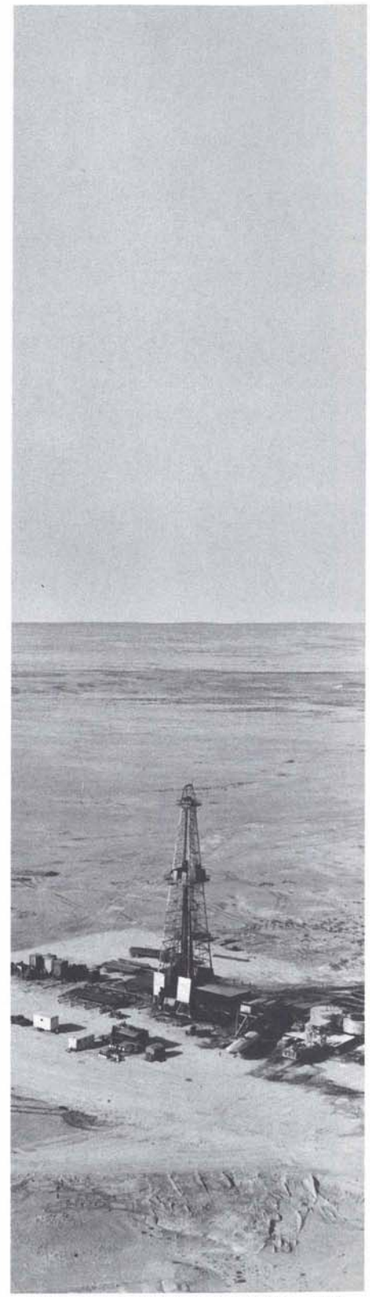
Some people think that drilling for oil is like opening a bottle of wine—drill the hole, pull the cork and out bubbles the oil. And in a certain sense they are right: as you need a corkscrew to get at the wine, so you need a drill to get at the oil.

But otherwise drilling is not nearly so simple. Drillers can't just twist their "corkscrew" into the ground and pull out a "cork." If they did they might blow themselves, their rig, their drills and several miles of steel pipe into limbo. Drillers, furthermore, don't just "drill" a well; they build it. Deep in the earth, in carefully planned stages, they construct a series of tapered, concentric shafts of steel and cement that usually go down about 7,000 feet but have gone down more than four miles—farther below the surface than Alaska's Mount McKinley is above it. In addition they must prepare the drilling site, build roads, bring in supplies, set up shops and move and erect drilling rigs. It is an operation requiring squads of experienced craftsmen, scores of machines and mountains of materials.

Some months ago in Saudi Arabia, on a stretch of desert 12 miles from the oil town of Abqaiq, just such an operation was getting underway. As it often is in that area, it was blazingly hot. Little flies dived and weaved in whining spirals of sound. A wind, moving at the speed of a cavalry troop, charged across the sands toward a cluster of sweating men who were leveling a site for a drilling rig and digging a cellar, a pit 10 feet square and four feet deep over which the workers later would set up a drilling derrick.

The scene looked more like the preparation of a missile launching pad than the site of an oil derrick. Bulldozers, their huge convex blades extended stiffly before them, leveled rolling mounds of sand to provide a track connecting with the nearest road. Crews of workmen laid and joined sections of long thin waterpipe. Earthmovers shuttled back and forth carrying what seemed to be megatons of sand. Others pulled in and out with loads of marl—a hard, chalky clay used to surface the track.

Elsewhere, other phases of the project were also getting underway. At Abqaiq, the headquarters for the drilling operations of the Arabian American Oil Company (Aramco), the transport section was assembling an armada of vehicles to transport enormous quantities of cement, water, chemicals, drill pipe, steel casing and tools. At another site, where a drilling crew had completed a well and the engineer in charge had just released the drilling rig, the foreman responsible for moving the rig was getting ready to start it on its way toward the new site.

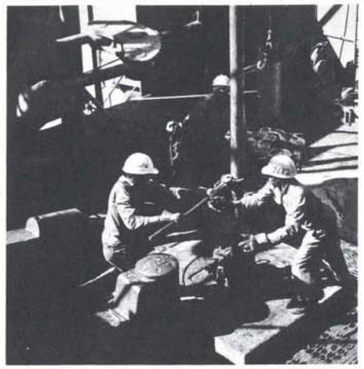

Drilling derrick in Saudi Arabia's South Ghawar field.

Moving a drilling rig was once a slow process. Twenty years ago Aramco workers spent many days breaking down a rig and its components into pieces small enough to be loaded on trucks, then moving and reassembling them. A drilling engineer then had a bright idea: why not fit wheels to the rig itself and move it in one piece? This posed problems, of course, since its weight and dimensions were huge. But the principle was sound. Today the rig is broken down into just three units—the derrick, the draw works and engines, and the pump—each of which is mounted on dollies so that the units can be pulled across the desert like trailers. Over the years Aramco has perfected this into such a well-organized routine that moving a rig now takes only one to four days depending on the distance.

"The key to this," explained the foreman, "is that there is very little dismantling. Everything is put onto its own wheels. Even the biggest and heaviest equipment—the derrick, the draw works and the engines, and the pumps—can be each put on wheels. Hydraulic jacks lift these units so that we can fit dollies underneath. The dollies are just steel frames fitted with clusters of low-pressure tires. In this way we make three trailer units of the drilling rig. Of course they're heavy—the derrick trailer weighs over 100 tons—but the 30 wheels of the dollies spread the weight out so it doesn't bog down in the sand."

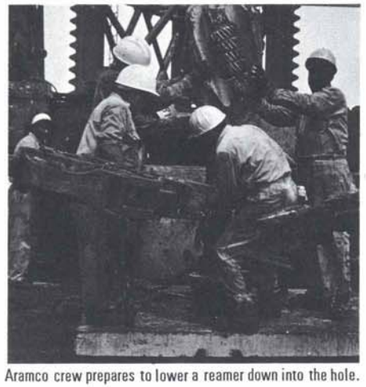
During that move, fortunately, no problems developed, partially because of good advance planning. "One of my crew," the foreman said, "scouted the terrain a couple of weeks back and picked a route that avoided steep slopes. Other-

PHOTOGRAPHY BY BURNETT H. MOODY, V. K. ANTONY, A. LATIF YOUSIF, T. F. WALTERS

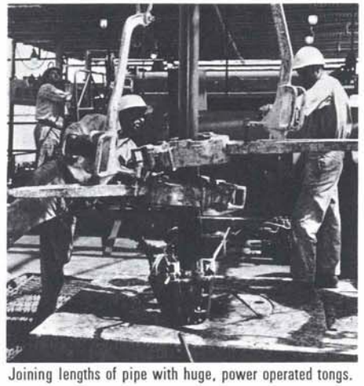


Aramco drilling team joins drill pipe at Abu Hadriyah.

Drilling mud spurts from well as crewmen pull out pipe.



Aramco crew prepares to lower a reamer down into the hole.



Joining lengths of pipe with huge, power operated tongs.

wise the derrick might topple over. It's 140 feet high, remember. On the steeper sand hills we had to slow down and we had to use all five Caterpillar tractors for towing, but still we managed a speed of four miles an hour. We started at sunrise and about 5 p.m. we lowered the rig over the cellar. Rigging down and up took just one day. That's a short move. And the rest of the equipment—the water tanks, the generators, the workshops, and the office—moves even faster because they are never taken off the wheels."

A few days later the new site was transformed. From far off, the drilling rig, 15 stories high, loomed against the sky like an obelisk. Nearer, it looked like a small replica of the Eiffel Tower. Around its base were clustered six large water tanks, row upon row of neatly stacked pipes, a mobile crane, dynamos, compressors, pumps, diesel engines, silver trailers, orange trucks and one sparkling white automobile. On the rig itself were gathered the men who would oversee the drilling: the foreman, called a "tool-pusher," who supervises all the mechanical operations; the petroleum engineer, who sees that the objectives of the well are achieved, and the drilling crew. Nearby, three diesel engines each as big as a locomotive, growled noisily. On the rig drillers, moving with the rhythm of a topflight acrobatic team, swiftly joined a new length of pipe to the upright shaft that turned the drilling bit into the strata of the earth, far below the ground.

On the first day, the day the rig was moved in, the drillers had immediately "spudded-in" the well, their way of saying they had drilled the first couple of feet. What they had also done was start an operation that would probably go on for the next 15 days, 24 hours a day, seven days a week. In that time three shifts of drillers, each eight men strong, would pour and pump up to 2,000 barrels of drilling fluid or "mud", about 5,000 bags of cement and nearly 2,500,000 gallons of water. They also would connect and disconnect, stack and unstack more than a mile of steel pipe and install more than 200 tons of steel casing. Most important of all, they would determine whether Aramco was going to bring in another producing oil well, or not.

Roughly speaking, oil wells in Saudi Arabia resemble a bottle thrust into the ground neck down. But instead of glass the "bottle" is made of cement.

At the beginning, the bit passes easily through the soft layers of sand. Then it hits firm rock and the petroleum engineer stops the drilling and orders the installation of the first length of steel casing. This entails hauling up the drill pipe, the long jointed shaft that turns the drilling bit, then lowering casing into the hole. Casing is simply a lining of steel pipe. The first section, called surface casing, is lowered into the hole until it is lodged solidly on the rock bed—solidly enough to support the successive lengths of additional casing that will be fitted inside it as the well gets deeper.

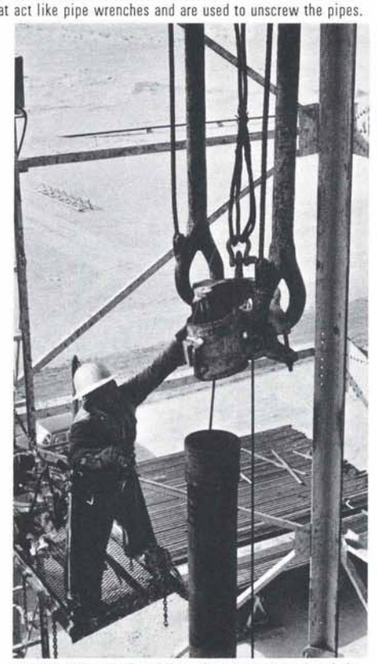
Engineers then fill the casing with cement and, quickly, before the cement sets, put a disc (actually a rubber plug with sealing cups) on top of the cement and begin to pump drilling mud on top of the disc. Drilling mud is a viscous fluid used among other things to lubricate the drilling bit and as it is pumped onto the disc, it forces the disc down into the casing. The disc in turn pushes the cement ahead of it. Squeezed out at the bottom of the casing and with nowhere to go but up, the cement flows back up toward the surface between the well hole and the outside of the casing. When the cement hardens, the drill pipe is lowered into the well through the casing, roughly like a fountain pen into its cap. Then drilling is resumed.

As the bit reaches successive depths drillers repeat the casing operation as often as necessary. In a well 7,000 feet deep, Aramco usually cements three concentric columns of steel casing. The shortest and largest is at the top. The longest and smallest extends the full 7,000 feet to the bottom. This arrangement of successively smaller diameter and longer tubes nested one within the other eventually comes to look something like a with giant telescope opened to its full length, the eyepiece buried in a stratum that, hopefully, bears oil.

Even at this stage there are still doubts about the well's potential. Although the petroleum engineer and Aramco's laboratories regularly check drill cuttings and cores, no one can be quite certain how much oil the well contains until specialists have opened channels from the oil sands into the well. One way of doing this is to lower a casing perforator down through the mud-filled production casing string and fire bullets through the casing and the cement lining at a point opposite the oil sands. Another way is to lower a packet of explosive charges and set them off. Either way they perforate the casing and the cement and open channels from the sands into the well.

Helmeted members of drilling crew attach drill pipe tongs that act like pipe wrenches and are used to unscrew the pipes.

A rig with, left, draw works, mud pumps and diesel engines.



Guiding "elevator" as joints of casing are run into hole.

The next step is to install still another string of tubing in the well. This tubing is relatively small—three to five inches—and extends from the surface down through the mud-filled casing to just below the perforations. The tubing has many functions, but mainly it can be used to fill the well with water or mud, if it should be necessary to "kill" the well to make repairs.

Now the final stage is at hand. The crewmen bolt into place on the surface the piping and central valves that make up what is known as the Christmas tree, open the valves and glue their eyes to the dials. With the pressure from above removed, whatever was fighting to come up, now comes up, pushing the head of water before it. At first there is just gas, rich with the familiar smell of rotten eggs. Then, usually, traces of petroleum appear in the water. Much later the proportion of oil to water increases. Then, at last, pure crude oil, as thick and shiny as butterscotch pudding, ready for processing and shipment to consumers around the world.

An oil well is like a space missile. Neither gets moving without lengthy research and calculation, careful planning, large expenditures on preparatory operations and logistical support. And all of it must be done, and most of the money must be spent, before the well produces a dime's worth of oil or the missile moves an inch off the launching pad. To put it another way, you can't launch part of a missile or get the oil out of half of an oil well. It's all or nothing.

But if the companies cannot avoid risks, they can lessen them. For one thing they try to improve the odds against finding a well by constantly improving the methods used in the initial phase: the search above the ground for geological

features that indicate potential oil traps. This is not a certain science by any means, but it is of great help. As one geologist put it, "Geology and geophysics indicate the structural and stratigraphic locations where oil might be found. What they can do is lead you to a point on the surface where odds favor oil."

What companies can also do—and have done—is increase the output. Companies also have improved their overall efficiency so that they drill more wells in less time, thus reducing the cost. When Aramco, for example, mounted its rigs on wheels and cut the moving time between drilling sites from 30 days to less than one day, it saved considerable sums of money. The same approach was invoked with regard to technology and management. Drilling bits, for example, are the spearheads of drilling. To supply bits for just one well costs $6,000. Improvement of the bits, obviously, would be reflected in the whole drilling operation. And that's just what happened. "More drilling progress was made in the past 10 years through jet bit hydraulics than through any other single technique in the rotary drilling process," an engineer said. "In 1948 we used to change the bit every 50 to 200 feet. Now, through a better understanding of hydraulics at the bit face—different densities and pressures of mud for various substructures—and improvements in design, we use a bit for a depth of over 500 feet and sometimes up to 2,000 feet. As a result we save much time and money in less frequent changes of the worn-out bit. Also we can turn the bit much faster."

Or take more fundamental aspects for the operation. In the early 1960's an analysis of the overall drilling operation produced evidence that if certain time-consuming habits and activities could be changed, Aramco could drill more wells each year with the same equipment and increase the footage per rig at less cost per foot. The recommended changes were made.

The cumulative effect of the improvements—the jet bit hydraulics, better organization of crews, and many others—has been impressive. Only six years ago Aramco took an average of 35 days to drill and complete a 7,200-foot well on land. If drilling were held up for any reason it could take 60 days and sometimes even longer. Now a similar well

—continued on page 15

"A RIG IS A RIG IS A..."

Modern rotary drilling rigs vary in shape, size, power and mobility, but their essential functions are the same: to turn a bit deep in the earth; to raise and lower the drill pipe, a long jointed shaft that turns the bit; to control the flow of drilling mud, a special compound that lubricates the bit and washes out drilling cuttings. Powerful, efficient and modern, they are the end products of experimentation and improvement that began some 17 centuries ago.

A Chinese scribe first mentioned drilling in the 3rd century A.D.—for salt water to provide salt. It isn't known what methods were used, but whatever they were they evolved, by A.D. 1100, into a surprisingly modern technique: the use of a bit hung from the end of a springboard and jerked up and down by relays of men bouncing on the springboard. Going up and down like a yo-yo, the bit pounded its way into the ground, sometimes to a depth of 3,500 feet. This system was the forerunner of the "cable-tool" method which was used by Colonel Drake in 1854 to drill America's first oil well and give birth to the petroleum industry.

In 1901, the cable-tool method gave way to a radically different drilling system called the "rotary method." The rotary method proved its worth for the first time at the fabulous Spindletop oil field in Texas. It also revolutionized drilling to such an extent that, there have been no significant changes since. Although the familiar wooden derrick with its primitive hoist and steam engine has given way to steel framing, pneumatic and hydraulic controls and diesel engines, the rotary drilling rig has remained virtually unchanged.

The spearhead of the modern rotary drilling rig is the bit, an arrangement of tough, sharp rotating teeth which gnaw their way through rock. The usual type of bit has three cones fitted with wedge-shaped teeth which, turning at between 75 and 250 revolutions per minute. The bit is turned by the drill pipe, a thin shaft of steel pipe made up of sections of pipe joined together at the surface one after the other as the hole grows deeper. The bit is forced downward by the weight of the drill collars, heavy-walled joints of pipe which are placed just above the bit in the drill string. The weight is considerable, as high as 50,000 pounds, and imposes on the bit a punishing load. But then all the stresses on a drilling rig are enormous.

The action of a drill—i.e. the turning and pushing—is similar to that of a corkscrew in the cork of a wine bottle but because of the extraordinary proportions of a drill pipe, the strain is almost overwhelming. If a scale model of a drill pipe 7,500 feet long and $4\frac{1}{2}$ inches in diameter, were made, and the diameter chosen for the model were about the same as that of a corkscrew—about 1/16 of an inch—the length of the "corkscrew" would be 130 feet. Furthermore, the pipe must be strong enough to bear its own weight yet relatively as flexible as a fishing rod since the upper end may have to make several revolutions before the bit itself catches up and starts to turn. Thus materials and workmanship have to meet exacting standards.

But despite the highest standards, bits do wear out and do need frequent changing. This means that the entire drill pipe must be pulled up and taken apart.

"When I decide the bit needs changing—and by the way, there is no formula; experience is what tells—we pull out the entire pipe, break it down into sections and rack the sections vertically in 90-foot stands inside the derrick," said a drilling foreman. "As soon as the new bit is fitted, the pipe is screwed together again and the whole lot lowered length by length down the hole. That's what we call 'making a trip' or 'yo-yoing the pipe'."

Despite modern equipment and powerful machinery, it is still no easy job to pick up a length of $4\frac{1}{2}$-inch steel pipe, standing 90 feet high and weighing more than 1,400 pounds, join it to the others and lower it into the upper part of the hole, all within 50 seconds. Even at that pace, "running" in 7,500 feet of pipe—a total weight of some 60 tons—takes at least $1\frac{1}{2}$ hours. A "round trip" takes nearly four hours. It also takes a combination of hoisting machinery, cables and pulleys which is strong enough to not only lift and lower tremendous loads at high speeds but also keep them under careful control.

In the lifting functions of an oil rig, the oil derrick and the draw works are particularly important. Derricks today have to be tall—usually about 136 feet, about a fourth the height of the Washington Monument—to accommodate the lengths of pipe which are stood inside the derrick's framework. They must also be strong because they support not only the pipe but the machinery, cables and pulleys used to lift and lower the pipe—like the "traveling block," a giant multiple pulley that is 12 feet high and weighs four to nine tons.

It is the draw works, however, the hoisting machinery, that provide the rig's muscle. Set on the derrick floor, the draw works not only lift pipes, but, through a system of pulleys and brakes, make sure they can't fall. This is not as easy as it sounds. Each time a drill pipe 7,500 feet long is run into the hole, the energy absorbed by the braking system equals about 2,500 horsepower. To insure that the great lengths of pipe don't get away, the cable that unwinds off a great spool and weaves through a complex of pulleys, has several speed settings and two sets of brakes: friction and hydraulic.

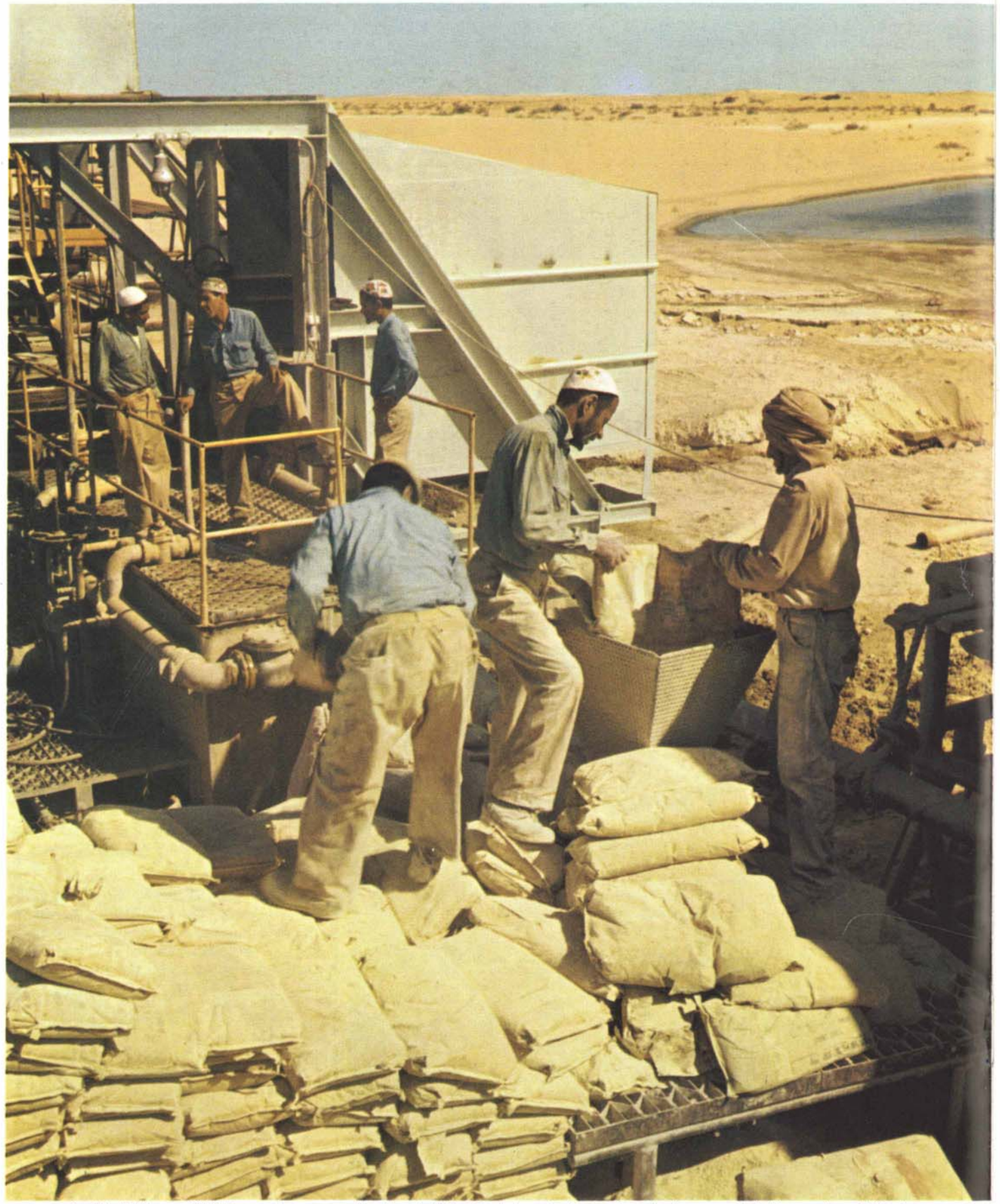
But lifting and lowering is only one of the rig's essential functions and the other two—turning the bit and circulating of mud—are equally demanding.

Turning a bit 7,500 feet underground from a platform on the surface requires an efficient series of links between the draw works and the bit. The first link, of course, is the pipe which extends from the bit up through a hole in the rig's platform. There the drillers join the kelly—a hollow square column of forged steel, about 40 feet long—to the top of the drill pipe section then emerging from the well. The kelly hangs from the swivel, which allows the kelly and drill pipe to turn freely. On the rig floor is a rotary table with a turntable, a rotatable disc running on roller bearings and driven by a chain drive from the draw works, which turns the kelly, the drill pipe and the bit, grinding far into the earth.

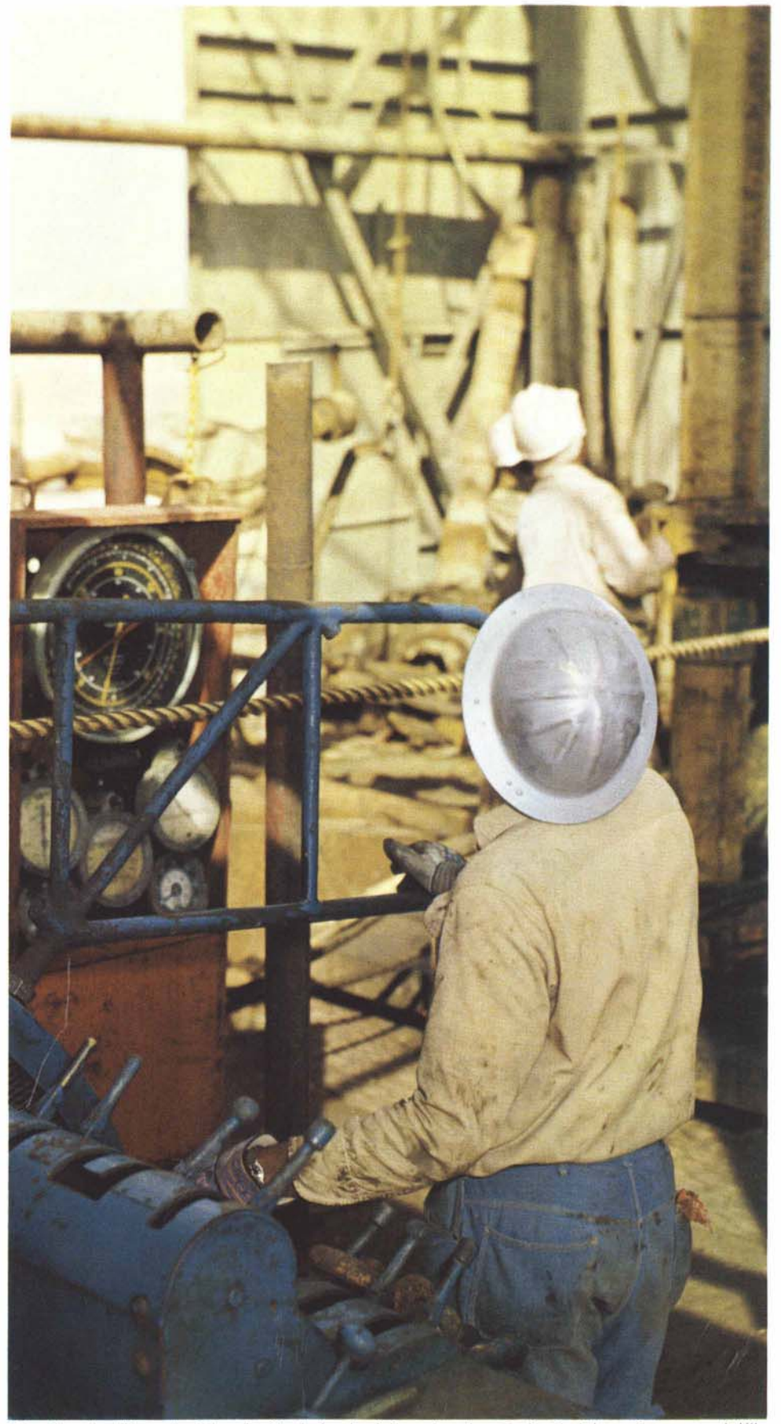
Then there's the circulation of drilling mud. Mud is a drilling fluid composed of barites and clay. It is pumped from large tanks through the kelly, down the hollow drill pipe to the bit where it spurts out of nozzles in the bit. Its function is fourfold: to help cool and lubricate the bit which can get as hot as 350-400 degrees Fahrenheit—a temperature that would lock the bit beyond the power of rig to move it, should the mud coagulate; to carry to the surface, as it flows back up the well, the bit cuttings; and, on the way up, to seal cracks, loose shale or sand. The fourth function of the mud, one vital to the safe completion of a well, is to provide a counterweight to the pressures of gas or oil or water which might seep into the hole from porous formations. So the weight of the column of the mud in the well must at all times be greater than the pressure of any gas or oil encountered. Sometimes, the mud is pumped at a formidable pressure: up to 3,000 pounds per square inch (only 15 pounds per square inch is enough to expel a passenger out of a broken window of a high-flying airplane.)

To drive these systems, an enormous amount of power is required. Less than 20 years ago it was provided by steam, but today the demands are met by three or four 500-horsepower diesel engines, coupled together by a compound transmission, a system of clutches and chain drives. This ensures great flexibility, since the combined power of all the engines can be used to drive either the draw works, for heavy hoisting, or the pumps, or both.

A drilling rig, in brief, is not a single machine; it is several tightly interlocking machines and systems able to muster the power, speed, and precision required to put a bit into the precious oil strata deep in the earth.



Saudi Arabia like most Middle East countries poses special problems in drilling. One is the need to haul supplies—like the cement unloaded here—to distant drilling sites.



To pull up the drilling string, join and unjoin the lengths of pipe and run the string into the hole, requires power and skill.

takes an average of only 15 days from spudding-in to completion. In 1965 the company recorded a 39 per cent increase in footage drilled compared with 1964, and notched a drilling record of just over nine days for a land well 6,584 feet deep. And although prices of vital materials have been spiraling upward like sand devils, over the last six years Aramco has succeeded in pulling down, by 40 per cent, the dollar cost per foot, the oil world's ultimate yardstick of efficiency.

Aramco, of course, like all Middle East companies, has special problems with costs. Compared, for example, with the United States, the average Middle East wells go down 2,500 feet more—a factor that boosts drilling costs appreciably. Others include the difficulty of getting water, which is fairly plentiful in the United States, but so scarce in many parts of the Middle East that it has to be brought in by tankers; the need to import basic tools and materials—bits, casing, mud and cement; the time and cost of transporting tools, materials, men, food, shops and living quarters sometimes hundreds of miles into the desert. The results? The Middle East cost per foot is at least four times as high as that of the United States.

Comparisons, however, are always tricky, and with regard to the United States and the Middle East they are as deceptive as mirages. The cost per foot comparison does not take into account the different production rates. For instance, 1965 was a record year for the Middle East; its production rate topped that of the United States. But only about 1,900 wells supplied all the oil, compared to about 625,000 in the United States. According to figures from the *Oil & Gas Journal*, the average well in the Middle East produced, in 1965, an average of 4,300 barrels per day of crude oil, compared with only 14 barrels per day in the United States.

It is obvious, then, that the Middle East has advantages as well as disadvantages. Not the least of them is the opportunity to develop fields in the most economical and efficient way. In the United States, a landowner's property rights cover the petroleum and minerals which lie beneath the surface of the earth. As a result, hundreds of wells may be drilled on land of different owners in the development of one field. For many reasons, this is uneconomic and inefficient.

In the Middle East, governments grant concessions which permit development of large areas as units. This gives oil companies the opportunities to achieve the ideal described by an engineer as the aim of proper field development: "To get the greatest economic benefit from the reservoir with the optimum number of wells."

At Berri, for example, a Saudi Arabian oil field 40 miles northwest of Aramco's marine terminal at Ras Tanura, the "wildcat" well—the first well—struck oil in June, 1964, and immediately became the "discovery" well. This shift of phraseology reflects an important change in the degree of risk. For although there was still risk involved, specialists, armed with solid facts provided by the discovery well, could move from speculation to calculation. The geologist, analyzing cuttings, cores and electric and radioactive logs, could begin to map the substructure with a much greater degree of accuracy. The reservoir engineer, concentrating on how much oil is down there and how it flows through the rock, could begin to plan how to maintain natural pressures as long as possible. The production engineer could begin to figure how to get the oil out of the ground and into the lines and tanks as economically as possible. And then, when they had made those calculations, they could decide where to drill the next wells—the wells for delineation of the field and the wells for production

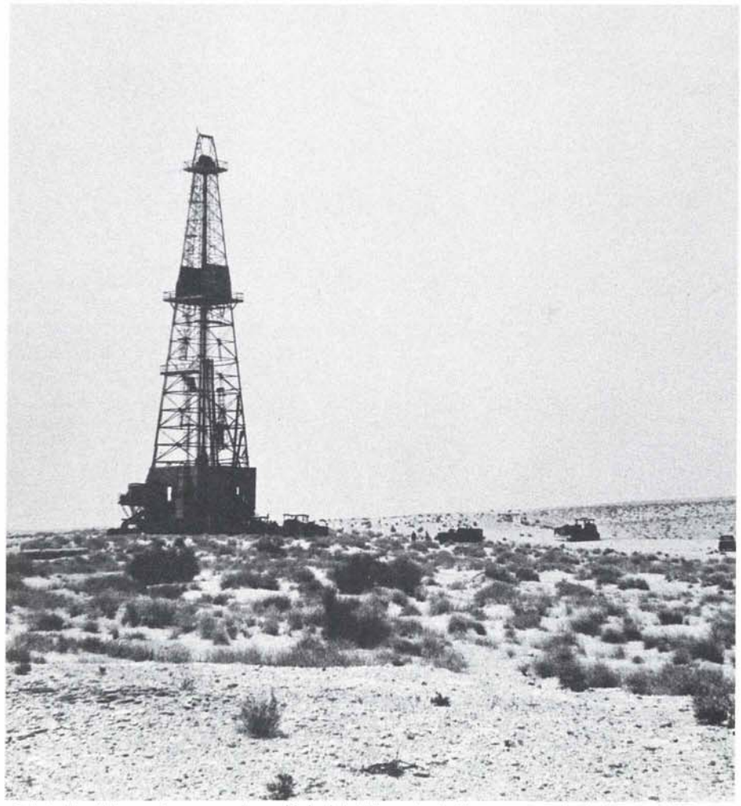
Delineation wells by which oilmen try to determine the shape and size of an oil field, are not as risky as wildcat wells, but the odds of the delineation well striking the boundary of the oil field are still slim. For it is virtually impossible for a geologist to be precise about the outline of a field on the basis of data from just one well. Thus, if the discovery well indicates a field that might be commercially attractive, then more information must be assembled, despite the risk of drilling even more dry holes.

At Berri, as it happened, Aramco drilled four delineation wells and all struck oil, thus providing enough information so that planners could get on with the refinement of initial cost estimates and tie them in with the many other factors which must be considered before decisions on production can be completed. The main one was the demand for the specific type of crude oil that was to be found in Berri. What would it be in the next three, five or even 10 years? Other factors considered were the long-range growth plans of Aramco; the number of years the field could produce oil efficiently without expenditures on pumps or on gas or water injection plants to keep the oil flowing; the number of production wells that would be required; the pipelines that would have to be laid; and the gas-oil separator plants, pumps and other installations that would be needed.

As the planners must consider a mathematically significant number of sets of all these variable factors, it was time for the computers to start humming—to see if and when, considering those and other factors, the per-barrel cost of placing a field on production was in balance with the cash realities of the market. This moment was the climax—the apex of a whole pyramid of decisions, for now Aramco management could make the final and major decision whether or not to "bring in the oil field." They had spent millions on geological and geophysical surveys, on wildcat and delineation wells. Now it was a question of balancing the demand for the Berri crude against the costs of such installations as pipelines, gas-oil separator plants and pumps, and of deciding if Berri prospects were as attractive as other potential fields in Saudi Arabia. Since the balance seemed favorable the decision was in the affirmative: "Bring it in."

It is a long road, obviously, from the exploration of a promising locality to putting an oil field "on stream." It is a road with many risks. It is a road without shortcuts. To find oil you have to have oil wells and to have wells you have to drill. There are no alternatives.

Keith Carmichael has published one novel, contributed articles to The Geographical Magazine, *the* Illustrated London News *and several newspapers and is now researching a book on ancient trade between the Middle East and the Far East.*

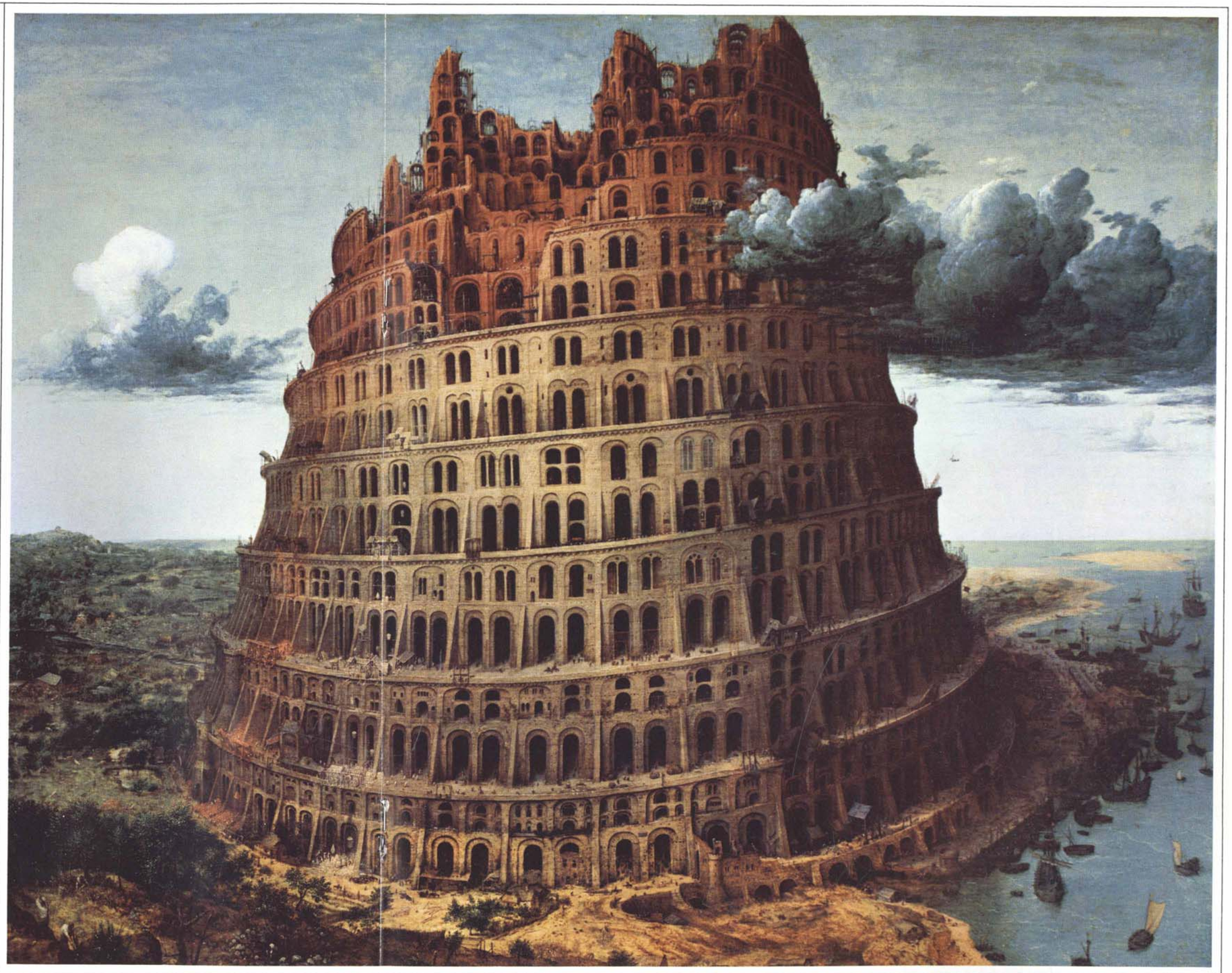


Tall derrick, all in one piece, mounted on multiwheeled dollies and pulled by tractors, crawls slowly across the desert.

THE TOWER OF BABEL

BY FRIEDRICH RAGETTE

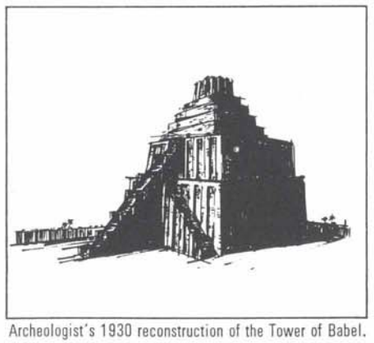
"And they had brick for stone, and slime had they for mortar. And they said... let us build us a tower whose top may reach into heaven..."



PAINTINGS BY BRUEGHEL THE ELDER, REPRODUCED BY COURTESY OF THE BOYMANS-VAN BEUNINGEN MUSEUM OF ROTTERDAM, THE NETHERLANDS, AND THE VIENNA KUNSTHISTORISCHES MUSEUM.

As told in the Old Testament (Genesis: 11) the story of the Tower of Babel is one of the most fascinating stories of all time. It tells, concisely, of man's efforts to build a great tower into the heavens, of God's wrath at such arrogance and of the curious punishment He imposes. It has color, excitement and a moral that is plain to see:

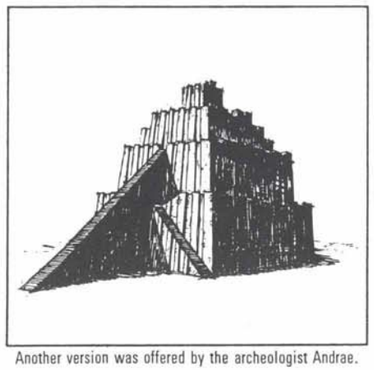
"*And the whole earth was of one language, and of one speech. And it came to pass, as they journeyed from the east, that they found a plain in the land of Shinar; and they dwelt there. And they said one to another, Go to, let us make brick and burn them thoroughly. And they had brick for stone, and slime had they for mortar. And they said, Go to, let us build us a city and a tower, whose top may reach unto heavens; and let us make us a name, lest we be scattered abroad upon the face of the whole earth. And the Lord came down to see the city and the tower, which the children of men builded. And the Lord said, Behold, the people is one, and they have all one language; and this they begin to do: and now nothing will be restrained from them, which they have imagined to do. Go to, let us go down, and there confound their language, that they may not understand one another's speech. So the Lord scattered them abroad from thence upon the face of all the earth: and they left off to build the city. Therefore is the name of it called Babel; because the Lord did there confound the language of all the earth: and from*



Archeologist's 1930 reconstruction of the Tower of Babel.

thence did the Lord scatter them abroad upon the face of the earth."

The moral of the story, of course, is that man should keep his place and not aspire to God-like creativity. But down through the centuries the theme of the story—man the builder challenging God the creator—has been interpreted and reinterpreted according to the age. In medieval times the moral element—pride goeth before a fall—was uppermost. During the dynamic, self-confident Renaissance the story was an occasion to celebrate the ingenuity and adventurousness of man. In the Space Age, the era of nuclear fission, it might well express renewed doubt about the ultimate results of man's endeavors.



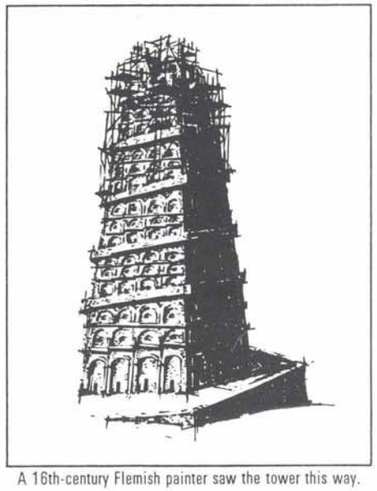
Another version was offered by the archeologist Andrae.

The story has had a particular appeal to artists. From faithful artisans carving simple versions on cathedral walls for the enlightment of unlettered peasants to imaginative giants like Brueghel, painting his splendid canvases for the pleasure of the world, it has been a fruitful subject for invention and enlargement. Perhaps it was the idea of man's recurring ambitions to create structures as high and as everlasting as possible. Perhaps it was the intriguing picture of thousands of workers suddenly breaking out into strange incomprehensible tongues. Whatever the reason, it touched the artistic imagination and brought forth almost as many versions of the tower as there were artists attempting to depict it. Some saw the tower as an early version of the leaning tower of Pisa. Some saw it as a massive pile of receding blocks of stone. Others likened it to a great wedding cake. Only a few turned to the surviving descriptions of what the tower actually looked like.

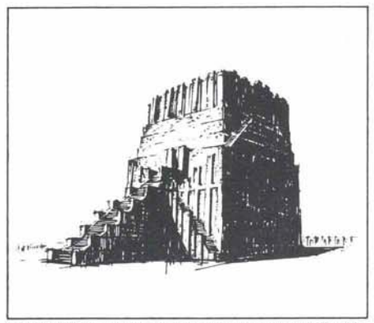
One of these descriptions came from the attempt Alexander the Great made to rebuild the tower after he found it in ruins. (Some 10,000 workers cleared away the rubble but with Alexander's death in 322 B.C. the project stopped.) Another, earlier description came from Herodotus, the Greek historian who visited Babylon about 460 B.C. and gave an eye-witness account:

"*In the midst of the temple a solid tower was constructed, one stadium* (about 200 yards) *in length and one stadium in width. Upon this tower stood another, and again upon this another, and so on, making eight towers in all, one upon another. All eight towers can be climbed by means of a spiral staircase, which runs around the outside. About halfway up there are seats where those who make the ascent can sit and rest. In the topmost tower there is a great temple, and in the temple is a great bed richly appointed, and beside it a golden table. No idol stands there. No one spends the night there save a woman of that country, designated by the god himself. The priests told me that the god descended some times to the temple and joined her ... but I cannot believe this.*"

With such a tangible description on record one would think there would be no doubts that the tower of Babel really existed. But since Babylon, for more than 20 centuries, was really little more than a name—a vague legend of grandeur and a few undifferentiated mounds of earth in Mesopotamia—serious historians still tended to dismiss the story as no more than an interesting legend. Then, in 1854, the British Foreign Office notified its consul in Basra, Mr. J. E. Taylor, that the British Museum wanted someone to search out ancient ruins in southern Mesopotamia. Mr. Taylor obliged and in excavating those undifferentiated mounds uncovered the top of a large man-made brick structure and some clay cylinders on which was written, in cuneiform, the history of the building. They were not startling discoveries but they did point the way for the expedition in the 1920's during which Sir Leonard Wooley, under the auspices of the British Museum and the University of Pennsylvania, found the famous "Ur of the Chaldees," the birthplace of Abraham, and unearthed evidence that the stories of ancient Babylon were not legend, but history.



A 16th-century Flemish painter saw the tower this way.



In 1918 Koldewey suggested that the tower looked like this.

It had been a splendid history while it lasted, rivaled only by that of ancient Egypt in brilliance and depth of civilization. It began sometime in the fourth millennium before Christ when a non-Semitic people called the Sumerians descended from the mountains of Persia and settled on the fertile plain between the Tigris and Euphrates rivers. They built cities, invented cuneiform writing, and perhaps the wheel, channeled the waters of the nearby Euphrates into a remarkable irrigation system, perfected the art of the goldsmith and built great towers of bricks made of clay. From them, eventually, evolved the Babylonian civilization, the center of which in the waning centuries of Mesopotamian importance, was Babylon, "the Glory of Kingdoms."

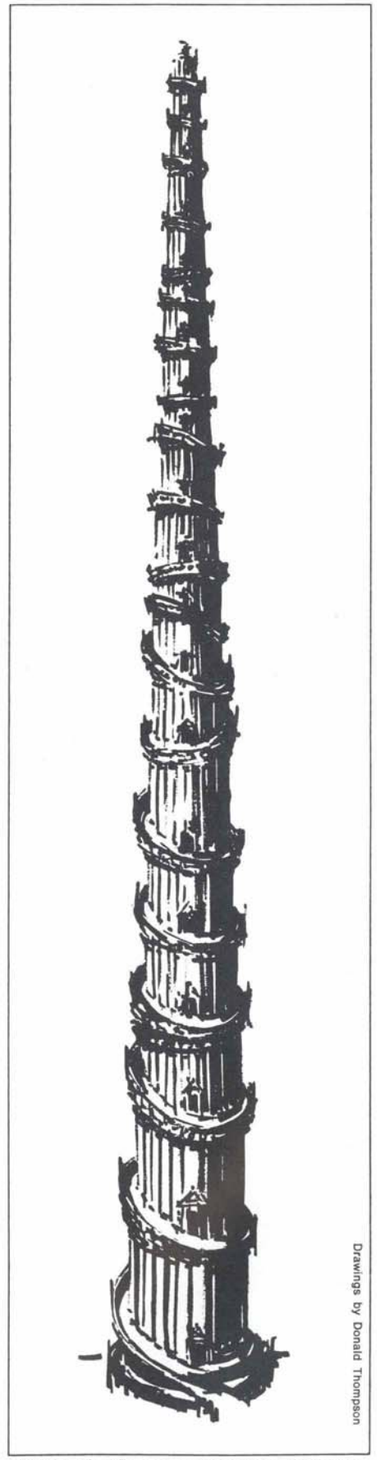
By any standards Babylon was a magnificent city. Sprawled along the banks of the palm-lined Euphrates, Babylon was a great metropolis of wide broad avenues, high buildings, numerous temples and great walls. Through the magnificent Ishtar Gate, a structure of yellow brick adorned with lions and bulls in glazed blue tile, streamed thousands of merchants, soldiers, priests and farmers. Armor glittered in the sun and chariots clattered down the avenues to the river. Beyond the city walls, lush fields of wheat, clusters of fruit trees and small gardens extended almost as far as the eye could see. And high above, looking down on this magnificence and out across the plains from a height of nearly 300 feet, stood the great tower that the ancient Jews, herded into Babylon for 70 years of captivity, were to describe to the world as the Tower of Babel.

In digging out the history of Babylon, archeologists found that in every important ancient town in the land between the rivers there existed the remains of tower-like structures called *ziggurats*. They also discovered representations of stepped towers on seals, amulets, cylinders and bas-reliefs, as well as cuneiform texts giving the names and dimensions of the towers. Eventually, near what is now the village of Hilleh in Iraq, they uncovered the ground plan of a particularly large tower. It was made of burnt bricks and was some 300 feet square. Texts found in the ruins called it "Etemenanki, the House of the Foundation of Heaven and Earth." The texts also told of its restoration during the reign of Nabopolassar in 625 B.C., mentioned baked bricks, streams of bitumen, the counsel of Babylonian gods, and, some 60 years later, the conscription of foreign labor by the famous Nebuchadnezzar to continue the restoration.

It all fitted. This was the Tower of Babel and the Tower of Babel, although perhaps larger and more important, was no more than another of the *ziggurats* that dotted the Mesopotamian plains. Thus they had at once confirmed the Biblical story and produced at least a possible explanation of the Bible's combination of two unrelated subjects: the building of a tower and the diversity of languages among men.

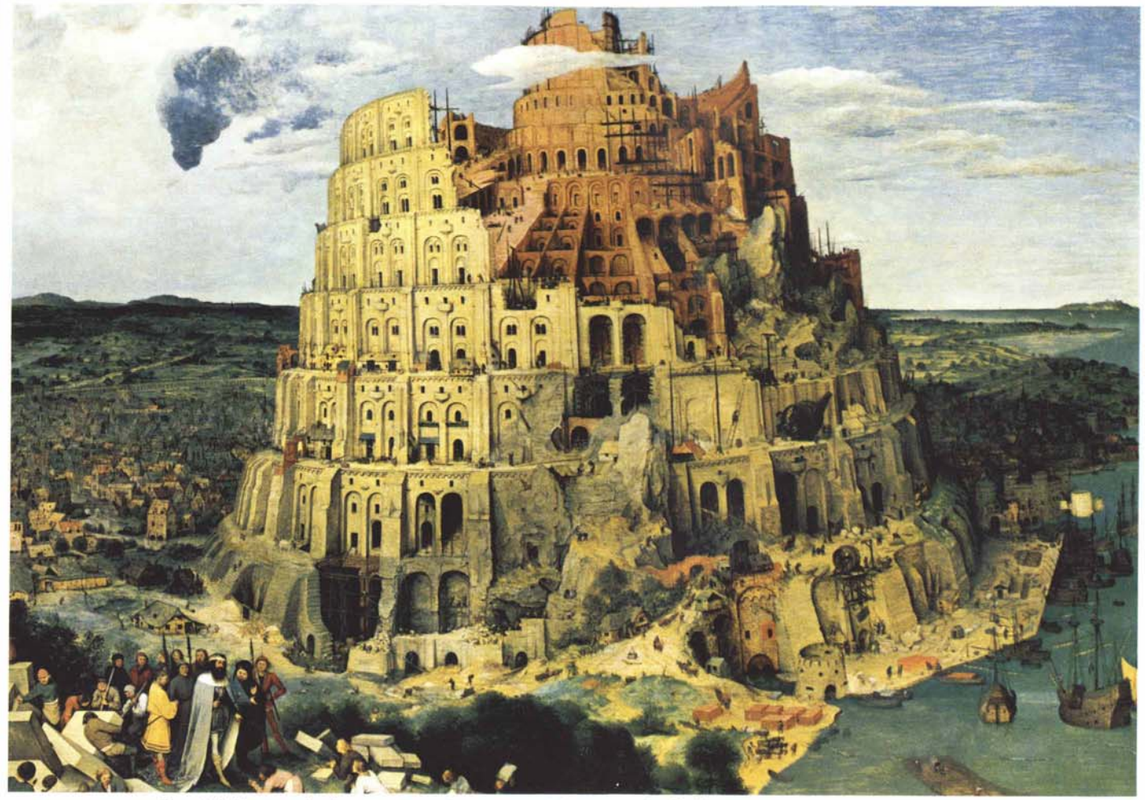
For thousands of years, apparently, *ziggurats* were an integral part of Mesopotamian cities, each differing from the other in detail like the cathedrals of Europe, but essentially the same: massive cube-like blocks, with stepped-back upper terraces, and monumental stairways leading to upper sections from which spiral stairs ascended to the topmost platform on which stood a temple or shrine.

Inevitably they reminded the explorers of those other marvels of ancient engineering, the pyramids of Egypt. But while the pyramids were tombs, built by individual rulers to provide safe resting places for



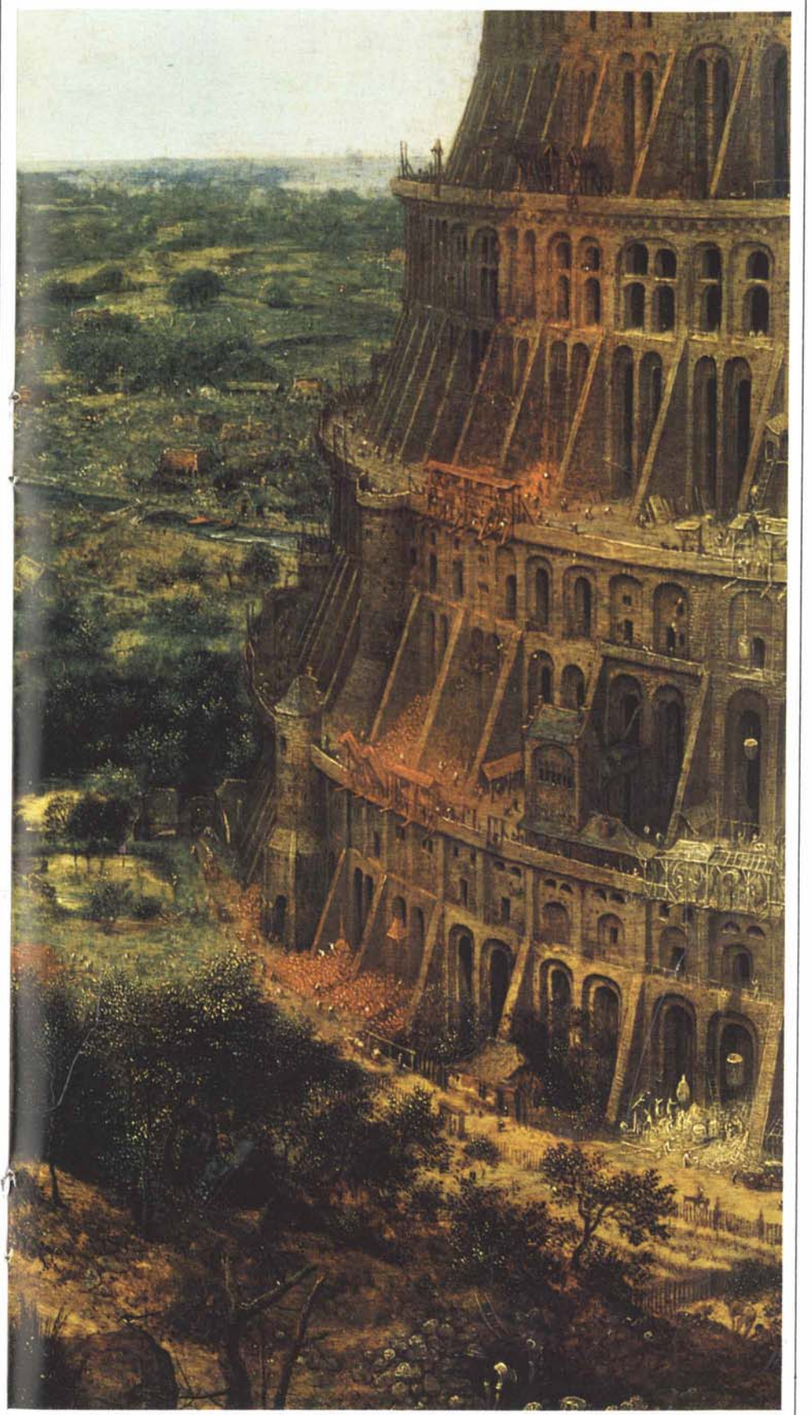
Drawings by Donald Thompson

An imaginative 17th-century concept engraved on copper.



The artist's Vienna version shows masons greeting an emperor during construction. Clothing and equipment, however, are 16th century.

Brueghel imagined the structure as an intricate system of Roman arches and vaults. Actually the tower was a solid mass of masonry.



Naturalistic details include transportation of brick and lime with their powdery red and white traces on the tower.

their bodies and to ensure their comfort in afterlife, the *ziggurats* were clearly places of worship, built, enlarged, restored, and embellished by generation after generation. Why, archeologists wondered, was such tremendous labor expended to give them this form?

From available evidence, the answer seems to be this. The Sumerians originated in mountainous country. They frequently depicted their gods standing on mountain tops, and many of the animals in their art are of a mountain type. When they migrated to the plain, they did not change their religion but, where nature had failed to provide mountains, they fashioned their own out of the only material available to them: clay bricks. Thus, far from challenging God as the Hebrews thought, the Sumerians and their successors worshipped from the *ziggurats*, and offered their gods a stepping stone between heaven and earth in the hope that they would descend and follow them to their new habitat.

As to the second part of the story, God's decision to "confound their language," one theory is that the captives might have mistaken the sacred name of Babylon, *Bab-ili*, meaning the gate of God, for the Hebrew *balal*, meaning confusion—an ironic twist in a story about a confusion of tongues. Another theory is that because many nations had traversed the plains of Mesopotamia, Babylon probably housed people of many races—remnants of older inhabitants, slaves and conscripted labor, perhaps business or diplomatic representatives of neighboring tribes—all speaking different languages or dialects. To the simple nomadic Jews, marched off from their pastoral lands 800 miles away and set down in this teeming city, the diversity of language was unsettling and mysterious and called for an explanation. In the habit of seeking theological explanations for all human phenomena, they may have concluded that the confusion of tongues was God's curse on the Babylonians for setting up strange religions and for constructing these arrogant towers into the heavens. That, in any case, is how they told it and why, ever since, Babel has been a warning to man to limit his pride and put a rein on ambition.

Friedrich Ragette is Assistant Professor of architecture at the American University of Beirut.

ON THE STREETS OF BEIRUT

BY LORENZO VACCHIOTTI

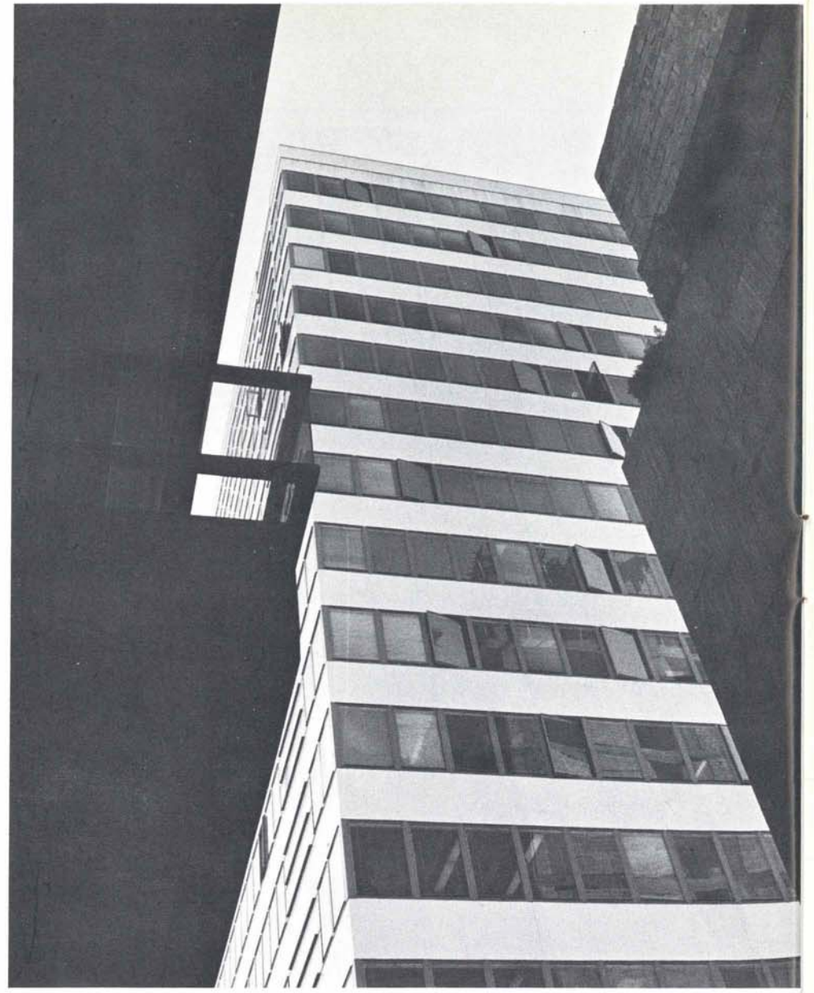
Beirut is a new city growing out of the rubble of the old.

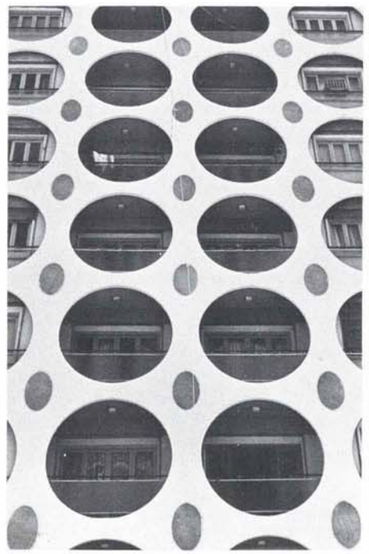
Each day the long shapes of steel and stone and glass thrust their way skyward leaving the old and often charming Beirut, the Beirut that was once as much east as west, to survive, if at all, in the shadows.

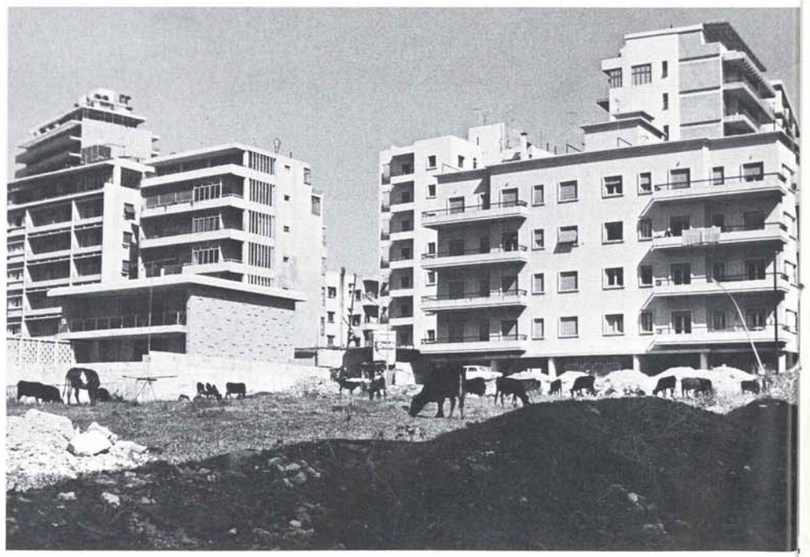
But survive it does.

On a little street here, a tiny shop there, or on a quiet terrace by the sea, the old Beirut survives. Side by side with the Beirut of the tourist, the Beirut of the banker, the Beirut of fast cars and thundering jets, the old Beirut quietly holds on, its individuality undiluted, its spirit alive, its charm intact. You may not see it right away, for the big new buildings and the rushing traffic will distract you. But it is there.

All you have to do is look...



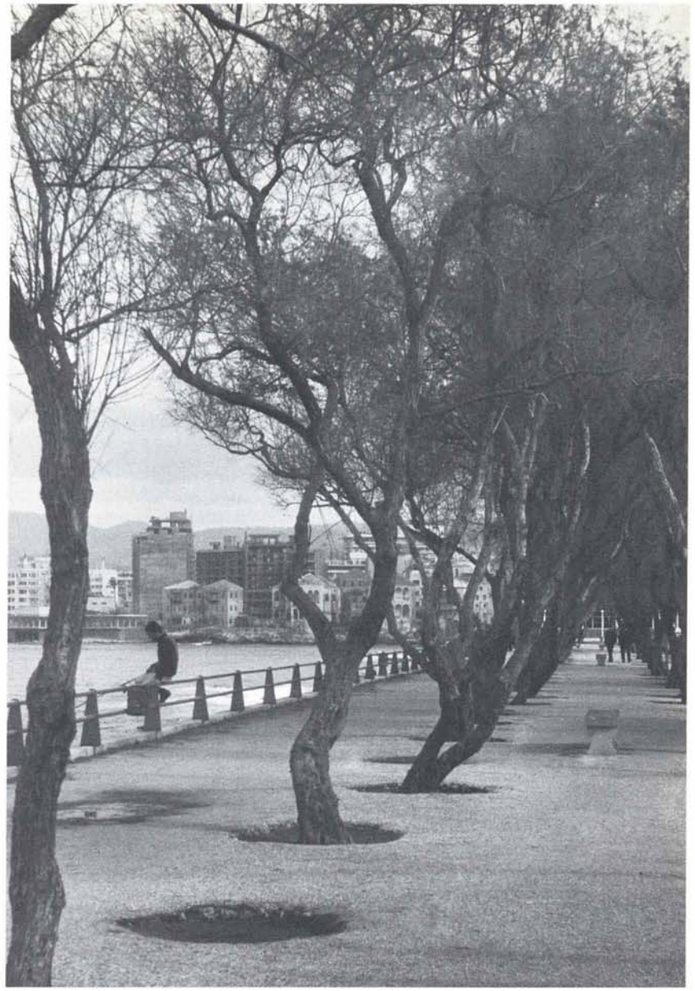


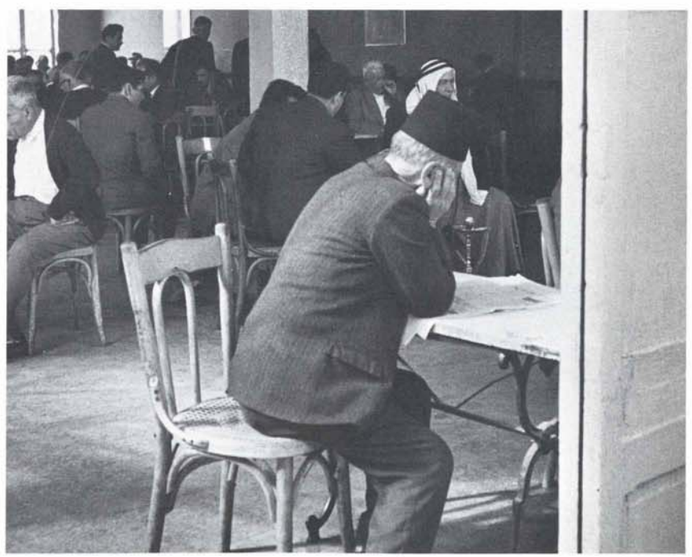


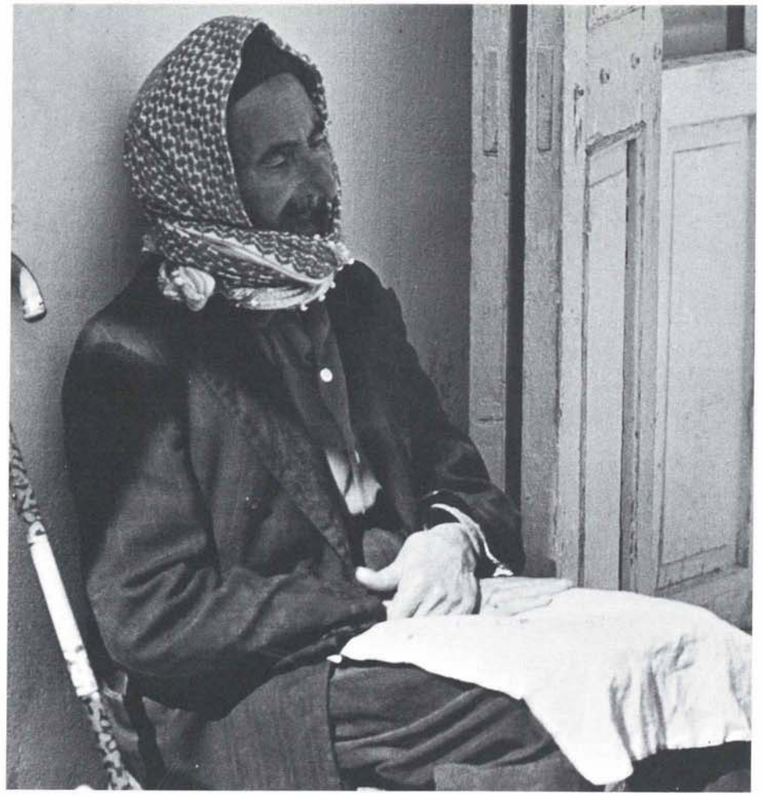
Wherever you go after Beirut you will never forget the smell or the taste of shawarmas, a large cone of lamb piled up in paper-thin slices that are soaked overnight in juices and spices, then roasted on a revolving spit, sliced verticaly into slivers and served in an envelope of fresh Arab bread stuffed with mint, pickles and fresh tomatoes...

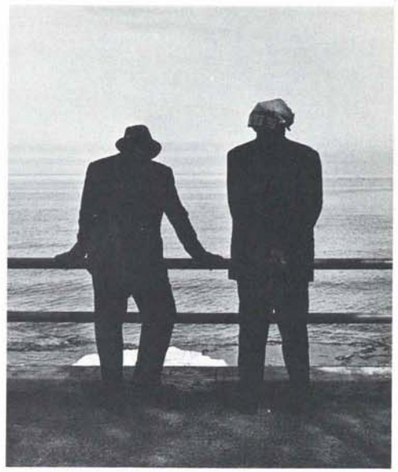
Beirut is a bustling city. Its taxis race in fits and starts from point to point. Its tourists hurry off to see its sights. Its businessmen scurry to their offices. But amid the bustle, the easy pace of another time still remains, a pace that is suited somehow to a quiet boulevard by the sea, to a breeze in the gnarled branches of a tree, to a young man fishing in the sea in the stillness of the afternoon...

In Beirut, as in Paris, the old cafés are friendly places where a man can sip his coffee, and quietly read his paper in the middle of the morning...

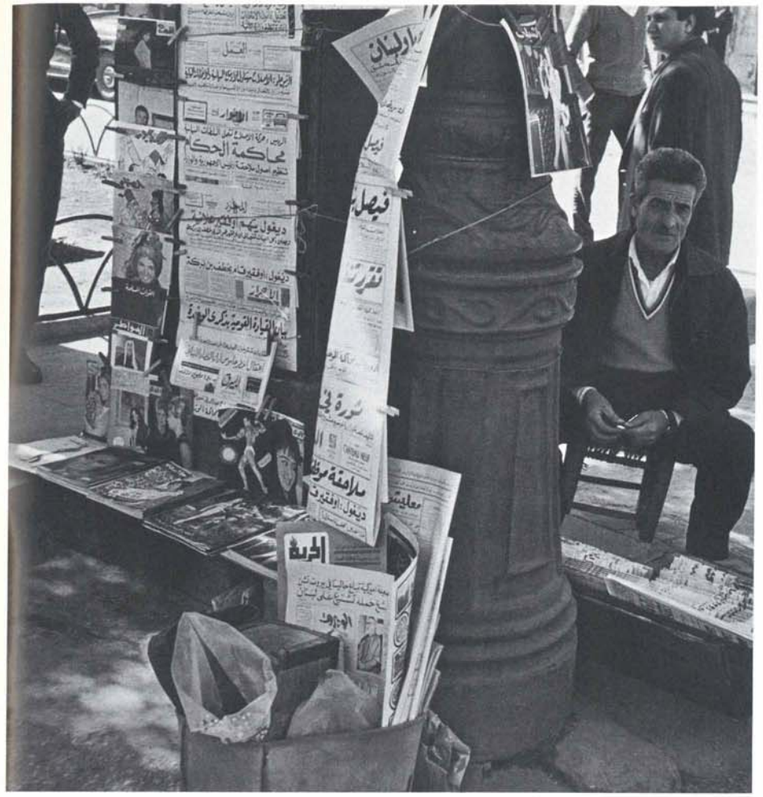


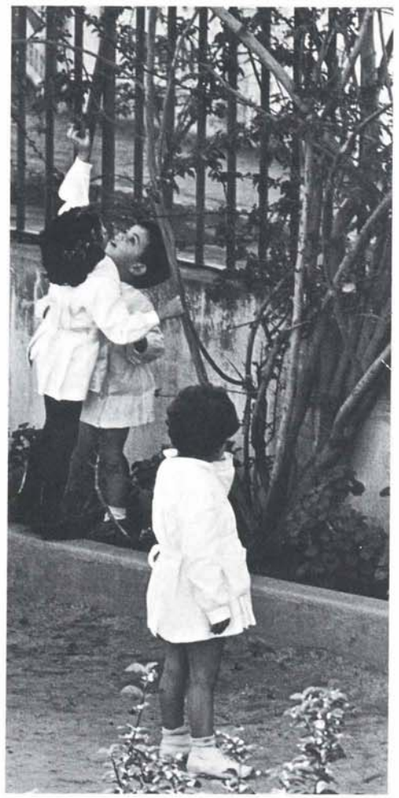


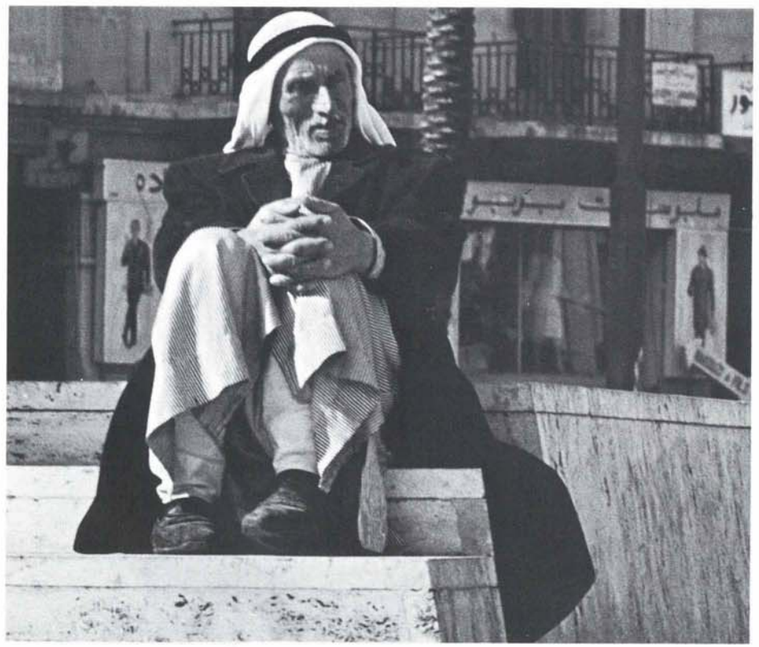


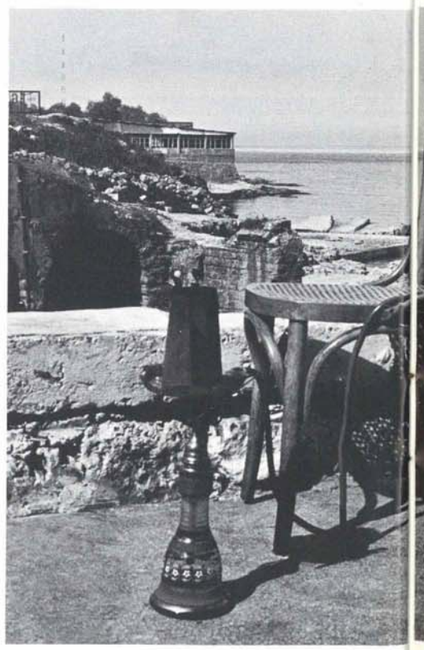


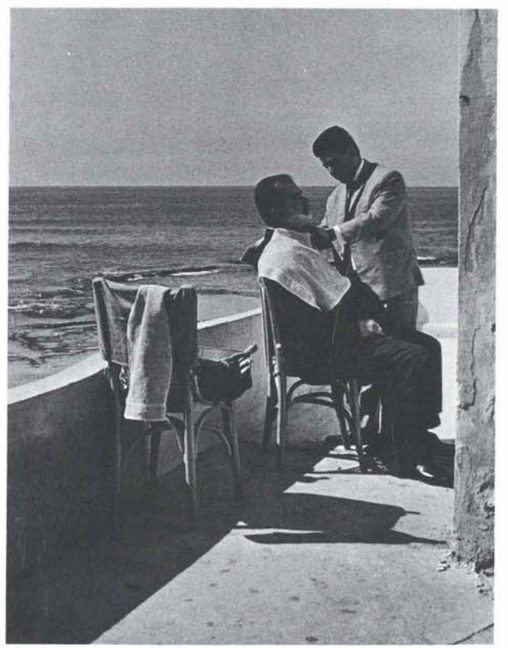
In Old Beirut there live the aging men of another time who proudly wear the head-cloths of other days and other places, who pass their time in the pleasant sunshine outside a favored café or on the stone steps that lead down to the sea...









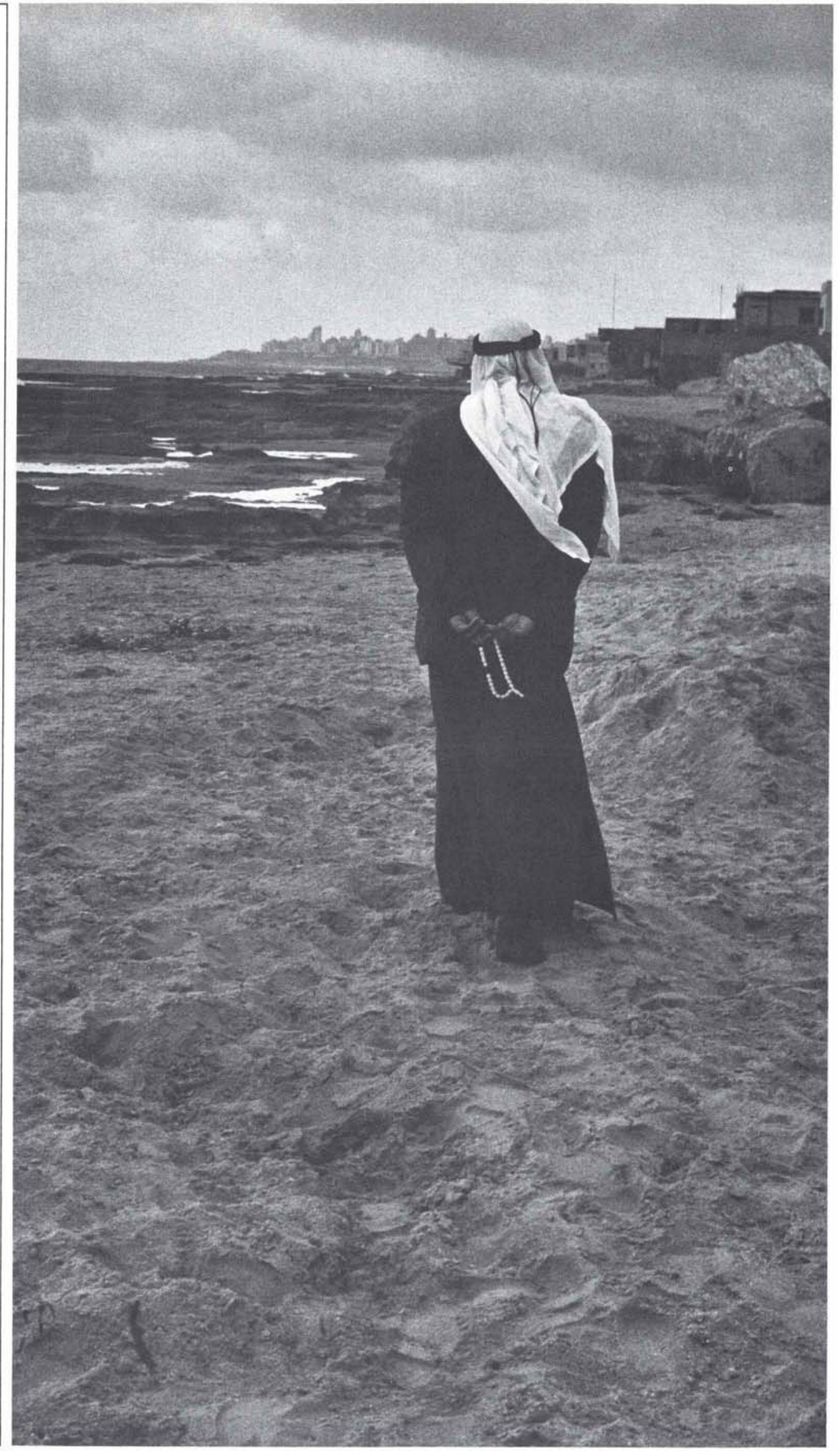


"Reading all about it" in Beirut is not hard. In Arabic, in French, in Armenian, in English, the newspapers of Beirut come off the presses like leaves from a tree. There are 35 daily newspapers, and more than 30 weekly and monthly magazines...

There are children of course. There are always children. But in Beirut they tell of another time when France ruled the land and the ways of France put their mark upon the people and upon their children...

Old Beirut lives outdoors most of the time. Under blue skies and a constant sun the people of the old city play and eat and shave or just sit in an old chair on a terrace above the sea and inhale the cooling smoke of a narghila...

Swiftly, inexorably, new Beirut, now just towers in the distance, is moving south. Where today a man can stroll in peace on a sandy shore, tomorrow he may have to pick his way among the swimmers crowded on a concrete patio by a tiled pool. But that is tomorrow. For now, today at least the old world lingers on...



KHANJAR! When you wear the Khanjar you're dressed ...but not to kill.

STORY AND PHOTOGRAPHY
BY KENNETH R. BLEVINS

Since ancient man threw away his last club and picked up his first knife, cold steel has almost always been his favorite weapon. From broadsword to bowie knife, from saber to switchblade, man has instinctively reached for a trusty blade to fight his wars, settle his quarrels, defend his honor and avenge his wrongs. Even today when most men rarely need a keen blade for anything more challenging than a day's crop of whiskers, the habit survives—nowhere with more fervor than in the Middle East where the sight of a Damascus blade once sent chills

down a warrior's spine and where the Sword of Allah was once the key to Paradise.

The Arab world has always been famous for its weapons—as Frankish knights, galloping ponderously toward the Holy Land, learned to their dismay. With their great, two-handed broadswords, the knights were confident that they could easily crush the thin-bladed, elegant, curved scimitars of the Arabs. What they didn't know was that the shape of the blade was not decoration; in curving the blade Arab swordsmiths did decrease the contact area of the blade, but also increased the depth of the blade's cut. Furthermore, by adding a half round ridge to the center of the blade, they gave the blade great strength without adding

much weight. The result was a weapon that was very light, very strong and cut deeply—deeply enough, at least, to inflict galling defeats on the overconfident knights.

Swords and daggers, of course, are no longer in use as military weapons, but in the Arab world they are still popular as ceremonial ornaments—especially the *khanjar*, the famous curved Arab dagger. The deadly *khanjar*, in fact, with its layers of silver and gold and its gem-studded scabbard, is often the most striking part of a man's attire at formal dinners, weddings or important civic or military events, much like the dress swords or sabers worn during certain ceremonies in the United States, Europe and elsewhere.

It takes a great deal of skill to make a *khanjar* and its magnificent scabbard, a skill which has been passed on through the ages, through the time-honored show-and-do-method which, without any regulated craft system of education, or even a formal apprentice program, has enabled Arab craftsmen to continue to practice a craft older than written history.

One of these craftsmen is Yasin ibn Ali an-Nasir, a silversmith near the *suq* of Dammam, capital of Saudi Arabia's Eastern Province. Yasin imports his blades from Yemen and the Hadhramaut, where for thousands of years Arab craftsmen have been learning to forge and shape, harden and temper what the ancients called the "white metal" and we call malleable steel, and then begins the slow, careful process of adding and decorating a handle and a matching scabbard.

The first step is to fit the blade with a handle of wood or horn. The second is to cover the cutting edges of the blade with slabs of wood cut to fit the curvature of the blade, but continuing to curve past the point. This is done for artistic purposes and gives the curious impression that the blade, once it's inside the scabbard, won't be able to come out again.

Finishing the basic scabbard, Yasin glues colored leather or felt to it, and then adds the final layer—the layer that gives the scabbard its personality and beauty. First he pulls rods of gold and silver through holes in a hard steel file to produce drawn wire. The holes—and thus the wire—gradually get smaller and smaller until the wire is finally reduced to the diameter of sewing thread. These "threads" are twisted into ropes, and shaped into circles, squares, diamonds, or any other pattern that the metalsmith can create. They are then soldered onto plates of gold or silver that have been shaped to fit over the leather-covered scabbard. Like the *khanjar's* handle, the scabbard may

also be adorned with one or more precious stones of various colors. Often silver or gold rings, made either from wire or from cast metal, are also soldered to the scabbard. They serve not only as decorations but also as loops to support the finished weapon on a belt.

Craftsmanship of this kind, of course, takes time. Metalsmiths usually spend weeks, and have spent as long as three or four months on just one dagger. It also takes money. But in the Arab world time and money are trivialities when spent on such treasured symbols of a reckless and glorious past.

Kenneth R. Blevins holds a Master's Degree in Industrial Education, has taught in California and is now an instructor for Aramco.

THE FOURTH HOLY CITY

The base for the Muslim conquest of the West... The capital of Africa for five centuries of Arab rule...

BY JOHN ANTHONY

Reprinted from "About Tunisia" by John Anthony, by permission of Geoffrey Bles Ltd., London.

The city of Kairouan has no neighbors. It stands alone, surrounded by the *bled* —the undefined hinterland in central Tunisia. Midway between sea and mountains, it is beyond the influence of both. The massive ochre walls rise straight from the featureless plain; above them swell the domes of a hundred mosques, and the sky is stabbed with the virile shape of minarets. A suburb of turban-shaped tombstones crowds beneath the walls, and herds of hobbled camels lurch across the prairie looking for grass. In isolation, Kairouan preserves its purity. As the shadow of night sweeps over the *bled* and the mountains of the Maghreb darken in the distance, a *muezzin* climbs the minaret of the Great Mosque and calls out over city and plain the pure, cold formula: *There is no god but God.* A caravan of pilgrims, perhaps carrying a corpse to be buried in holy ground, hurries to reach the city before dark. As the voice of the *muezzin* dies, the gates in the ramparts close.

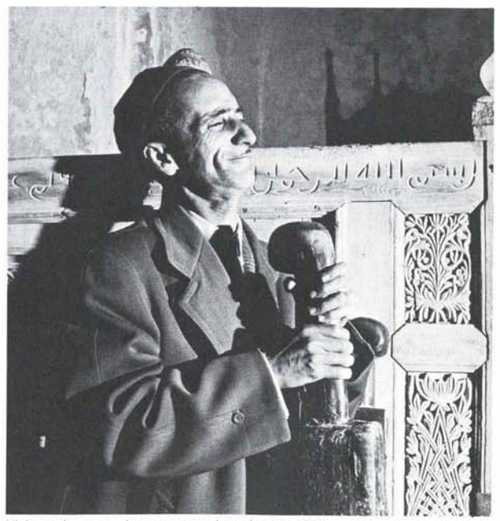
When Sidi Oqba ibn Nafi arrived here only forty years after the Prophet's death, there was nothing but desert. Where he stopped, it is said, a spring of water broke miraculously from the ground at his feet. Stooping to drink, he picked out of the water a gold cup he had lost years ago in the holy fountain of Zemzem in Mecca. On this sign, he pitched his camp and founded the city. Kairouan—the name means caravanserai—remains the most Arab town in Tunisia. There was no Punic, Roman or Berber settlement here before, and nothing of importance was added by the Turks or the French. It was the base for the Muslim conquest of the West, and the capital of Africa for most of the five centuries of Arab rule. The inhabitants claim to be of pure Arab lineage. And it is one of the holiest cities of Islam. To the perhaps parochial Muslims of North Africa in fact the sanctity of Kairouan is second only to Mecca among all cities of the world. And they make frequent pilgrimages to the city. The pilgrims arrive on foot, by camel and horseback, in ramshackle buses or crowded taxis, a few in limousines driven by liveried chauffeurs. They pitch their tents outside the walls, or stay at a *funduk*—a hollow square of unfurnished cells for the people, round a big courtyard for their animals—or in a hospice attached to one of the mosques, or in one of many hotels. They visit each shrine and mosque and honor the saint or hero buried there. They drink water from the Well of Barouta that flows from Mecca. They squeeze between two pillars that winnow out the fat and self-indulgent from the portals of paradise. They gaze on the tomb of the Barber, which contains three hairs from Muhammad's beard.

For tourists who come to Kairouan, the procedure is equally cut and dried. You buy a ticket from the tourist office and are obliged to take a licensed guide. The mosques may be visited only at certain hours (between prayers) and the itinerary is always the same. One of the guides was old and angular and had a concave chest that made him rasp and wheeze. He was a true Kairouanese—"*pur sang arabe*" he said as if he were at stud—and threw the names and dates of conquests and dynasties, shrines and schisms at us, contemptuous of our ignorance of the capital of the world. I got fond of him, contempt, villainy and all, however, and asked for him every time until he died of whatever was gnawing inside his chest.

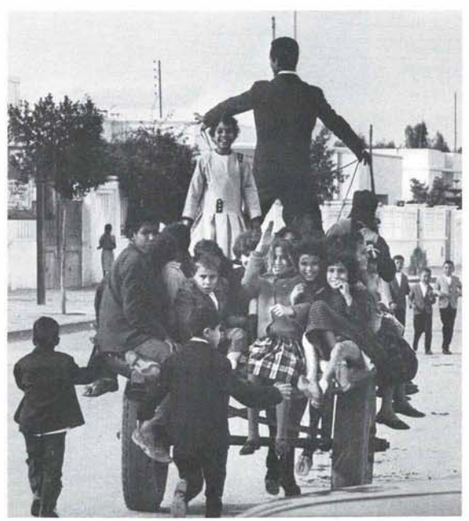
First, the Mosque of the Sabres, less than a century old but already a favorite with the simpler pilgrims and the simple-minded tourists. Sidi Amor, the *marabout* —a very holy man whose name is usually revered—who built it, was a blacksmith and something of a clown. He filled the mosque with gigantic furniture, fashioned by himself: a huge pipe wreathed with meaningless inscriptions (was he illiterate?), a sword stuck fast in its scabbard which each tourist is asked to try to pull. In the courtyard lie some heavy anchors brought by Sidi Amor from Porta Farina against the day Kairouan becomes a seaport. There are five tombs, in three of which lie the bones of Sidi Amor, his daughter, and a servant. The others are reserved for the final *imam* and a companion. This *imam* will draw the sword from the scabbard, complete the seventh dome of the mosque which is now open to the sky, and save Islam. Blue-gray pigeons wheel through the hole of the seventh dome and perch on the waiting tombs, and the beat of their wings resounds through the mosque like the sound of subdued laughter.

The next stop is the Mosque of the Three Doors: no legends, but a handsome 9th-century facade inscribed with arabesques, which was taken apart for the inclusion of a minaret in 1440 and put back stone by stone. Next, the Mosque of the Barber, which is what—the guide scolds us crossly—the ignorant insist on calling the tomb of Sidi Sahib, a companion of the Prophet who was buried with his most prized possession, three hairs from Muhammad's beard. The mosque stands outside the walls and looks like a miniature town itself, for a school,

Among the attractions of Kairouan's Mosque of the Sabres is a giant pipe (center) and huge swords.



Visitors always try, but never can draw the great 55-pound sword from scabbard.



In Kairouan, as in any Arab community, the men gather at the cafés to chat over coffee, the children laugh and play and women shop.

a hospice, retreat house, and various other connected buildings have grown up around it. Although the Prophet's Companion must have died in the 7th century, his shrine was refurbished in the 17th and has a rose-colored minaret, doors of Italian marble, and a vestibule in cool blue-green tiles and white stucco.

Why, I used to wonder, were the mosques in Kairouan the only mosques in Tunisia open to the infidel? Every Tunisian I asked had a different answer. That the mosques of Kairouan were profaned by the invading French army in 1881 and therefore no longer holy. That sacrileges had been committed elsewhere, but not here, so the mosques in other places were henceforth closed to non-Muslims. That the Kairouanese care only for money and gladly prostitute their shrines to attract tourists. Listening to the scornful old guide, I wondered if this were not the ultimate arrogance of Kairouan. Elsewhere we were physically excluded from the mystery. Here the barriers are down; we are permitted to share the holiness, enter it, stare at it, even touch it. And we expect a revelation. Is this it—the miraculous well, the huge sword and pipe, the winnowing pillars, the whiskers of the Prophet? The single eye of the guide glittered with mockery. You thought you were admitted to the mystery? Fools! You will not find it here.

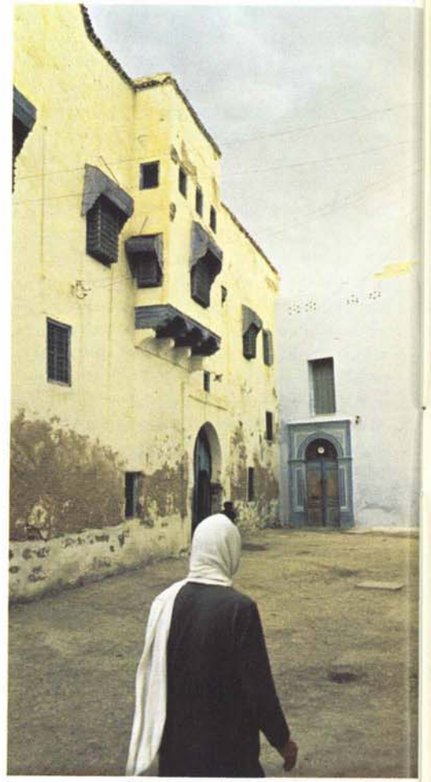
Where then is the mystery to be found? Islam is perhaps the most historical of the world's great religions, linked as it is with the history of a certain people in a certain country at a certain time. Mecca is inaccessible. Perhaps the history of Kairouan, itself an important chapter in the history of Islam, will provide a clue.

Apart from the resemblance to Arabia, symbolized by the gold cup, the site of Kairouan had several practical advantages when Sidi Oqba arrived there from the sands of Libya in A.D. 670. The Arabs faced two enemies, the Byzantines and the Berbers. The unprepossessing site was out of reach of the Byzantine fleet on the coast, and it commanded the mountains where the Berber forces lodged. It was also near the intersection of the main caravan routes, both to the north and to the west. The Berbers at first welcomed the new invaders against the Byzantines, and many joined the ranks of Islam. But Sidi Oqba treated them as a subject people, even when they were converted, and severely punished any who apostatized. The Berbers thereupon repudiated the alliance and began fighting the invaders, alone or in conjunction with the Byzantines. The Arab governor of Egypt, displeased with the results of Oqba's policy, sent his freedman Dinar to relieve him. Dinar took Oqba prisoner and abandoned Kairouan. He made peace with the great Berber chief Kusaila and was therefore able to occupy the country as far westward as Tlemsin.

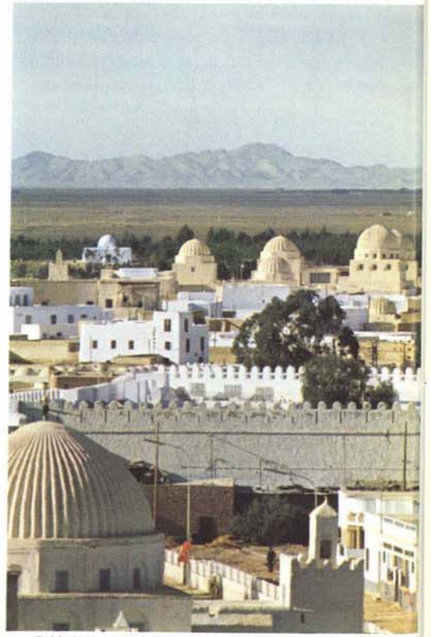
Ten years later Sidi Oqba was reinstated by the Caliph himself. He threw Dinar in chains and re-established his old base at Kairouan. Kusaila quickly deserted the Arabs and withdrew into the mountains. Leading Dinar in chains, Oqba pushed westward across Africa till he reached the Atlantic. There, according to Muslim tradition, he rode his horse into the waves, declaring he would conquer the sea itself and the lands beyond for the One God. Turning back through what he thought was conquered territory, Sidi Oqba was attacked by Berbers near Biskra. He released Dinar from his chains and gave him a sword. Throwing their scabbards away, the two rivals fought side by side till they were cut down. The death of Oqba signaled a general uprising in which Berbers and Byzantines combined to throw the Arabs back into Libya. Kairouan was lost and Kusaila became master of the interior.

All of Sidi Oqba's conquests had to be won again by others. In 688 Kairouan was recaptured and Kusaila defeated and killed. Nine years later Byzantine power in Africa was broken when the Arabs took Carthage and defeated the Greek fleet. The Berbers continued resistance for a time; but by skillful diplomacy some of the tribes were regained for Islam, the rest defeated, and the pacification of Africa began.

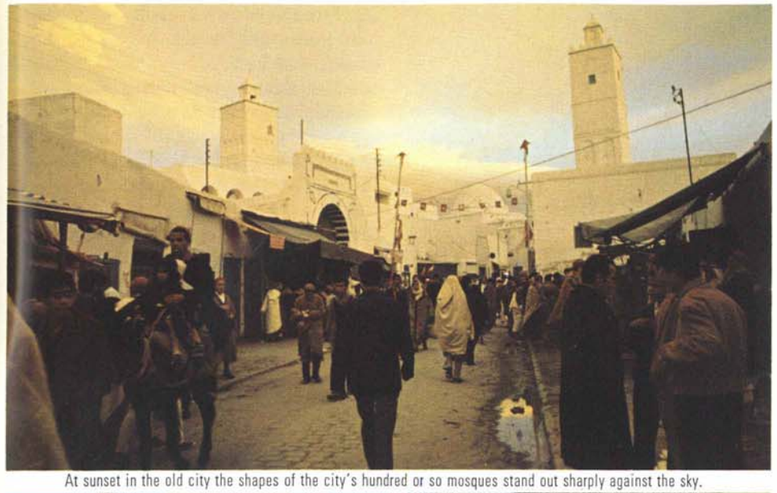
Despite setbacks and dissension, the Arabs conquered Africa with the speed and ease of a sharp blade cutting through soft, ripe cheese. Perhaps the ripeness was all. Two centuries of invasion, the Vandal incursion and the Byzantine restoration, the dissatisfaction of the tribes, religious dissension and economic grief—all contributed to the softening. The Berbers, after their short-lived resistance, flocked to the standard of the invaders. The Arabs' roving, martial life and tribal organization were similar to theirs, and no doubt the



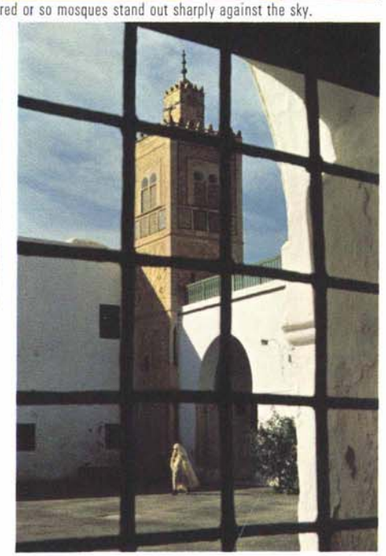
In a remote corner of the city a workman makes his way to his home.

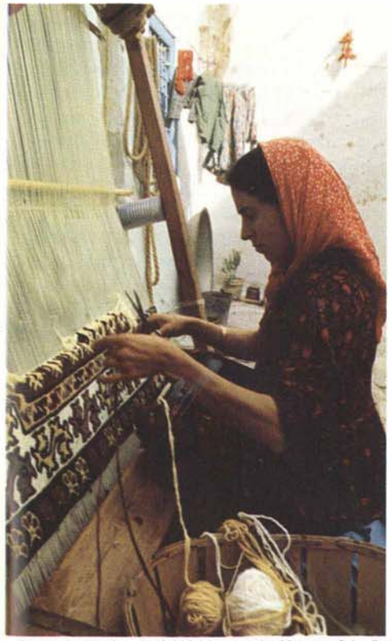


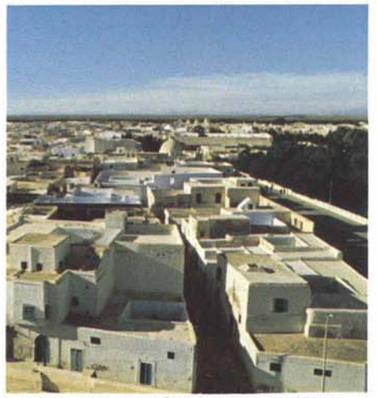
Behind massive walls Kairouan rises from featureless plain.



At sunset in the old city the shapes of the city's hundred or so mosques stand out sharply against the sky.





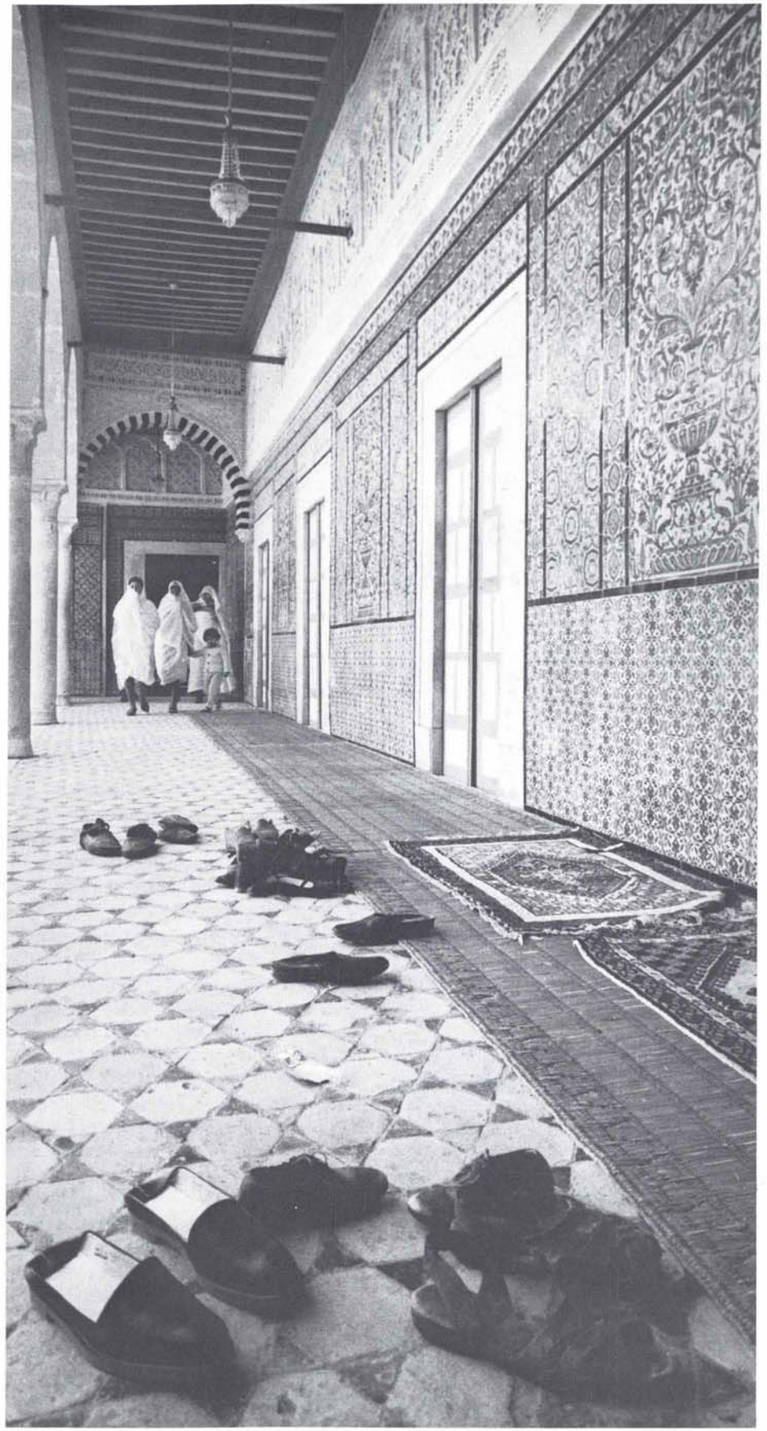


Scenes in the city: the faithful leaving the Mosque of the Barber, a girl weaving a carpet, a view from the Grand Mosque.

prospect of further conquest to the west appealed to them. But Islam itself must have been an attraction: it was simple and manly, and it sanctified many of their own basic instincts. The spread of Islam is sometimes ascribed to an Arab policy of conversion or death, circumcision by the sword as it were. If this were so we would expect to hear the name of at least a handful of Christian martyrs in 7th-century Africa, for it is not human nature to submit to such an ultimatum. But the Arab invasion produced no Perpetua and Felicity, no Cyprian, not even a defiant Tertullian. The Arabs did not seek wholesale conversions. They considered themselves an hereditary elite, distinguished by blood and religion from their subjects. Although the religion of Jews and Christian was respected, a special tax was levied on non-Muslims, and mass conversion deprived the Arabs of revenue. Yet within a century Christianity vanished from North Africa, partly through flight but largely through voluntary submission to Islam.

The founding of Kairouan was one of those momentous acts that alter the direction of history. The establishment of a permanent base in Africa meant that the Arabs would no longer merely raid the Maghreb—roughly Algeria, Morocco and Tunisia—and then withdraw, that they were committed to remain in the West and—these things having a momentum of their own—to continue westward to Algeria, Morocco, and Spain, until the momentum died in southern Gaul. And by breaking new ground and ignoring the older centers, Sidi Oqba cut the history of Africa in two as if with the edge of his blade. Carthage was the past: Kairouan the future. There was to be no dilution of the new with the old. The contending voices of the past were silenced by the cry of the *muezzin: There is no god but God. Muhammad is the messenger of God.*

The 9th century was the golden age of Kairouan. In 800, Ibrahim bin Aghlab, an Arab from Algeria, seized the city and thereby half of North Africa. The Aghlabite dynasty constructed an extensive irrigation system that brought water from the mountains to encircle the city in a green belt of parks and gardens. Aghlabite princes built the Great Mosque in its present form and, along the coast, erected and endowed the *ribats*—fortresses



The Mosque of the Barber is the tomb of Sidi Sahib, who was buried with three hairs from the Prophet's beard.

that were also a kind of monastery and were garrisoned by men as dedicated to prayer as to battle. Under them, African religious thought and jurisprudence developed distinctive forms. The princes lived outside the walls of Kairouan, in a fortified palace set in gardens and guarded by an army of Negro slaves. Despite their patronage of religion, the Aghlabites themselves were said to live dissolute lives and indulge in the drinking of wine. Ambassadors from Charlemagne and renegade Byzantines were received at court. Kairouan's only rival for brilliance in the West was Cordova in Muslim Spain.

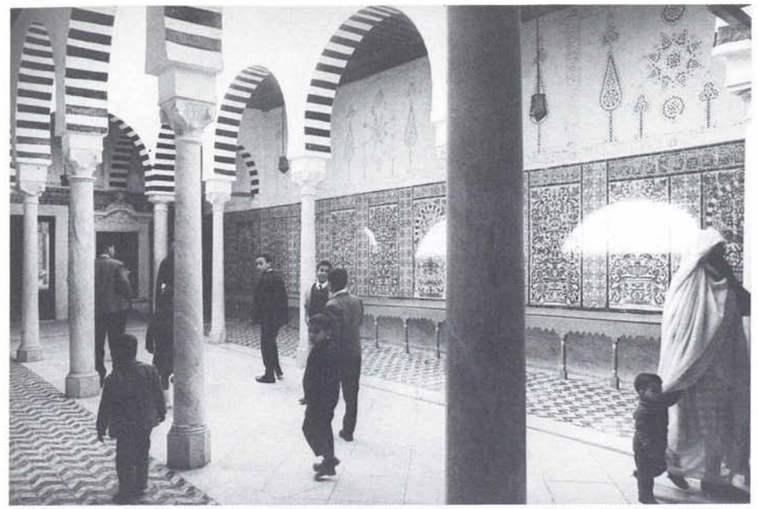
It was under the Aghlabites that the Arabs began the conquest of Malta, Sicily, and southern Italy. A Byzantine official, on the outs with the authorities of Syracuse, came to Kairouan seeking support. The 70-year-old Qadhi of Kairouan was so enthusiastic for a crusade against the Christians that he led the first expedition himself. An army of 11,000 Arabs and Berbers sailed for Sicily. They laid siege to Syracuse, but an epidemic killed many of them, including the aged Qadhi. Joining forces with a body of Spanish Muslims arrived on a raid of their own, the survivors proceeded to reduce the island, city by city. Even before they controlled all of Sicily, they invaded the mainland—again invited by a Christian, the Duke of Naples who, in return for their help against the Duke of Benevento, helped the Muslims capture Messina. The victorious Africans pushed up the Adriatic, reduced Bari, and raided the territories of Venice.

In 846, an Aghlabite fleet appeared off Ostia. The Muslims sacked Rome outside the walls and seized the treasures of St. Peter and St. Paul, though the departing ships were destroyed by a storm. A few years later, the Arabs directed another raid toward Rome but again a storm intervened and destroyed the fleet before it got there—as can be seen in Raphael's frescos in the Stanze of the Vatican. The Franks and Byzantines finally drove them from central Italy, but Bari remained Muslim for thirty years, ruled at the end by an independent Sultan. And Sicily settled down to its most brilliant century as a province of Islam.

When the successors to the Aghlabites, the Fatimite princes, moved to Cairo in 972 they left an Arab dynasty to represent them in Sicily and a Berber clan, the Zirides, to rule in Kairouan. The city reflected an afterglow of the preceding centuries, and the countryside was prosperous. The Zirides collected taxes in the name of the Fatimites and forwarded part of the revenue to Cairo; and dutifully mentioned the Shi'ite Caliph in the public prayers. But most of the populace was not Shi'ite, and it may have occurred to the Zirides to wonder why the wealth of Africa should be shared with Cairo. In 1049 the Ziride princes stopped payments to Egypt and substituted the name of the orthodox Caliph of Baghdad in the prayers. The Fatimites were quick to punish their disloyal vassals and in a diabolical way. They unleashed the lawless and rapacious nomads of upper Egypt. These tribes, which had been held in check since Roman times, swarmed westward like locusts. In successive waves they plundered farms and villages, burned orchards and cut down the olive trees for fire wood. Their herds stripped the vines, trampled gardens, and devoured the fields of grain.

In six years the plain of Kairouan was reduced to the desert that Sidi Oqba had found there and which exists today. The city became untenable. Simultaneously, Pisan and Genoese fleets attacked the coast. For the next two hundred years Ifriqyah (Africa) was fought for and dismembered by foreign and native adventurers. Tunis and Sfax became independent amirates. The Normans of Sicily occupied the cities of the *Sahel*. An Armenian *condottieri* named Karakoush tried to carve out a kingdom in the south. Berbers from Morocco and Spain fought each other for control of the country. At last a Moroccan named Abu Hafez quelled the chaos in the 13th century and established a dynasty that ruled for 350 years. But the Hafsite capital was Tunis. Kairouan had entered its dark age.

The holiness remains. There is one more monument to visit, and the guide always leaves it till last. It is the Great Mosque of Kairouan, the shrine of Sidi Oqba himself. It stands in one of the atrophied quarters of town, among empty streets and abandoned houses. The outside is like a fortress, with sloping walls and heavy buttresses blunted with layers of chalky lime. A squat tower of ochre brick stands at one end, and some dwarfish domes peer over the parapet. The impression is one of strength—severe, uncouth, almost brutal. Stepping through



The numerous mosques in Islam's Fourth Holy City offer rich examples of the decorative skill characteristic of Islamic art.

the gate you enter a wide flat courtyard with colonnades on three sides, a porch on the other. Behind the porch is a prayer-room, a vast hall supported by rows of columns. On the opposite side of the court stands the square tower, with two white-washed balconies and cupola, to serve as a minaret. It is as simple and plain as that.

The Mosque of Sidi Oqba is the oldest Muslim edifice in the West, parts of it perhaps the oldest in the world. Where Sidi Oqba himself worshipped—if he prayed indoors at all—is of course lost. This is the fifth or sixth mosque on the site, erected by the Aghlabites and restored and embellished many times since. But the form is as old as Islam: it follows the design of the one built in Medina for Muhammad himself, though greatly enlarged and translated from clay and palm trunks into marble and stone. The building breathes the spirit of primitive Islam. Sidi Oqba and his band were hard-headed men of action, unlettered warriors recently emerged from the Arabian desert, who had surrendered to the Will of God, but to no other. Their city was a camp, their place of worship a fortress. Later Islam might refine itself to the delicacy of the Blue Mosque or the frivolity of the shrine of Sidi Sahib, and Persian mysticism would some day inspire those eastern minarets that seem to be suspended from the sky rather than to rise from the earth. The minaret of Sidi Oqba is as earthbound as a mountain, its bricks dug from the earth, its single door as low as the mouth of a cave. Its purpose was simply that of a platform—to enable the *muezzin* to be heard over the city, not to bring him closer to heaven. The early Muslims submitted to God, they did not aspire to be like Him.

Yet, as you look more closely at the Mosque of Sidi Oqba, you see that the fabric itself is not all that simple. The walls are a patchwork of brick and stone, augmented with blocks of marble, even Latin inscriptions set sideways or upside-down. The door of the minaret is framed with three antique lintels carved with stylized foliage; the steps of the tower are made of ancient grave stones. And the columns—both those that ring the courtyard and those that throng the prayer-room—are a heterogeneous collection of ancient and medieval styles, of marble, porphyry, and onyx, compiled from pagan temples, Roman theaters, Vandal palaces, Byzantine basilicas, brought from the ruins of Hadrumetum, Thysdrus, Ruspina, and Carthage, mutilated, mismated, and indiscriminately combined. Yet the effect is neither classical, Christian, nor heteroclite. The Mosque is harmonious and unmistakably Arab, demonstrating that space, not wood or brick or stone, is the material of architecture.

The Mosque of Sidi Oqba was thrown up, of whatever materials lay at hand, in the rush of an urgent idea. That Idea is the central conviction of Islam. Here is no pantheon of minor gods, no hierarchy of prophets nor communion of saints.

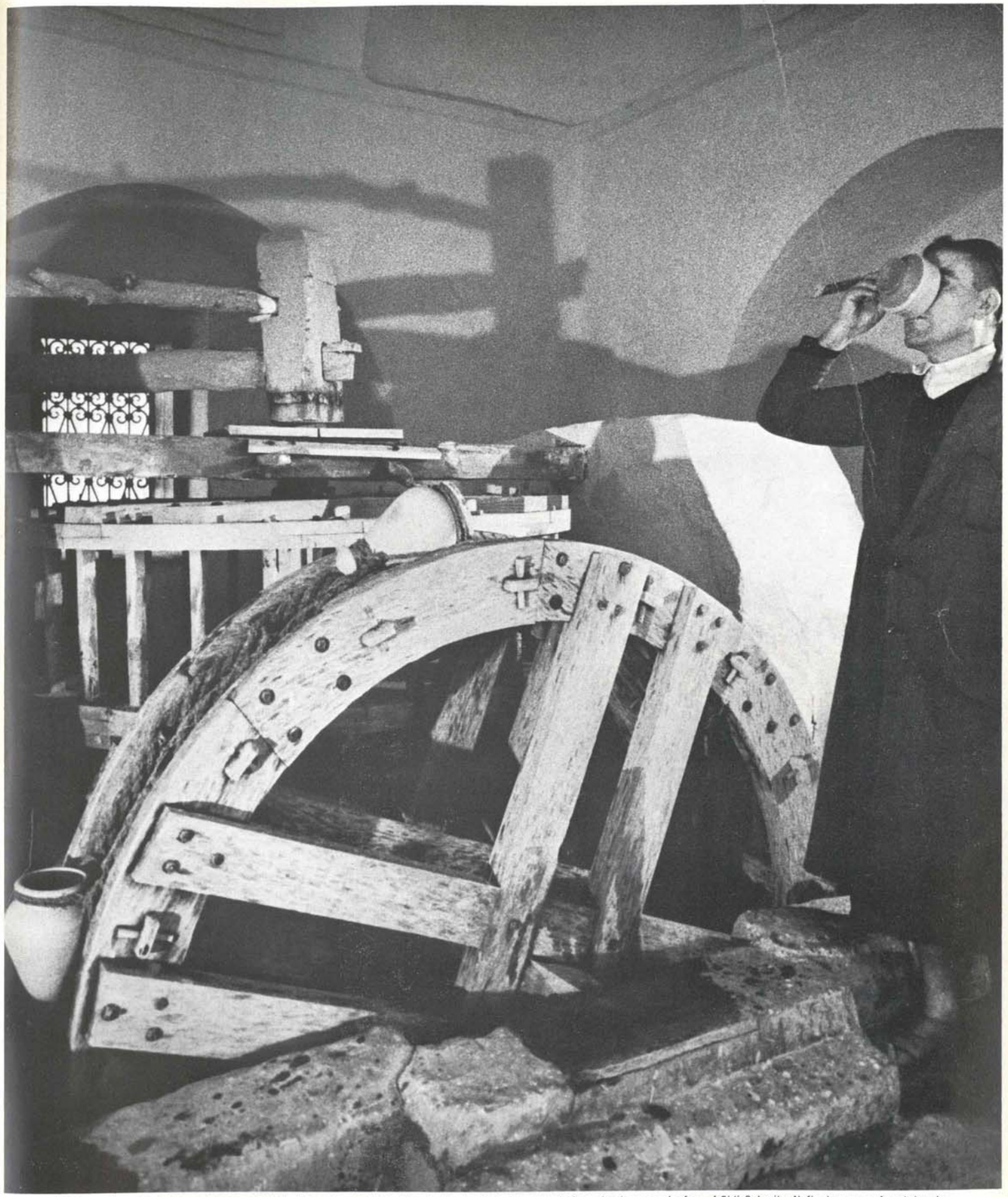
Outside the gate of the city crowds gather at the end of Ramadan, the Islamic fast, for traditional folk dancing.

The Koran itself contains elements from many different religious sources and its vocabulary reveals Greek, Aramaic, even Abyssinian influences. But the message is plain: *He is God, the One and Only. God, the Eternal, Absolute. He begetteth not, nor is He begotten. And there is none like unto Him.* That is the burning conviction of Islam, for which Jewish ideas, Greek words, Latin inscriptions, and Byzantine columns are only the fuel. The form of the Great Mosque is the cry of the *muezzin* in stone.

The Mosque of Sidi Oqba is a world. At the gate there is always a blind beggar, a little knot of solemn children. Pale, undernourished students in groups of two and three talk quietly between Koranic classes. In the calm clearing of the courtyard men meet, kiss their forefinger in greeting, and stroll under the colonnades in earnest conversation. Officials of the Mosque, in neatly pleated turbans and short clipped beards, walk unhurriedly across the pavement and disappear through private doors. An old man dozes on a warm stone in the sun. There are no women, or very few—they prefer the Mosque of Sidi Sahib or a neighborhood shrine. This is a man's world. In the center of the courtyard a sundial tells the time of prayers and fasting. Beneath the pavement cisterns collect the rain water, and sockets of ancient columns, hollowed out, serve as well mouths, their lips deeply grooved by the ropes. A man lowers a bucket and prepares to wash himself before prayers. *When you rise up for prayer, wash your faces, and your hands up to the elbows, and lightly rub your heads and your feet up to the ankles.* Every aspect of life, from the most spiritual to the most carnal, is regulated. *Establish worship, pay the poor-due, and bow your heads with those that bow .... Forbidden unto you are carrion and blood and swine-flesh ... and the strangled, and the dead through beating ... Tell the believing women to lower their gaze and be modest, and to display of their adornment only that which is apparent, and to draw their veils over their bosoms ... For divorced women make provision in kindness: a duty for those who ward off evil.* What the Koran does not enjoin, *hadith* or tradition takes care of. You will use your right hand for eating, your left for unclean things. You will not spit or relieve yourself in the direction of Mecca. You will not carry the Koran lower than your waist nor place another book upon it. Islam is ringed with strictures, areas of life where no question is permitted lest society perish. The Athenians tried to do without them and lost their cohesion. The French since Descartes and the Marquis de Sade have embarked on the stimulating but dangerous experiment. Many of the taboos of Islam seem trivial, parochial, outdated, and harsh. But Islam survives.

In the dim cavern of the prayer-room, a group of students sits on amber mats in a broken circle about their teacher. They are committing verses of the Koran to memory. Everything they need to know is there, for it is a transcription of a book inscribed on tablets in heaven. They buzz over the pages like bees extracting nectar from a garden to store in the hive. In front of the *mihrab*, a man prostrates himself in prayer. *God is as close as the vein in a man's neck.* From the top of the minaret, the voiće of the *muezzin* rings out over the courtyard, over the rooftops and across the *bled. God is most great. I testify that there is no god but God. I testify that Muhammad is the Messenger of God. Come to prayer. Come to salvation. God is great. There is no god but God.*

John Anthony lived and worked in Tunisia for many years before writing the book About Tunisia, *from which this chapter on Kairouan is taken.*



Pilgrims today still drink from the sacred Well of Barouta which, tradition holds, bubbled miraculously from the desert at the feet of Sidi Oqba ibn Nafi who was to found the city.