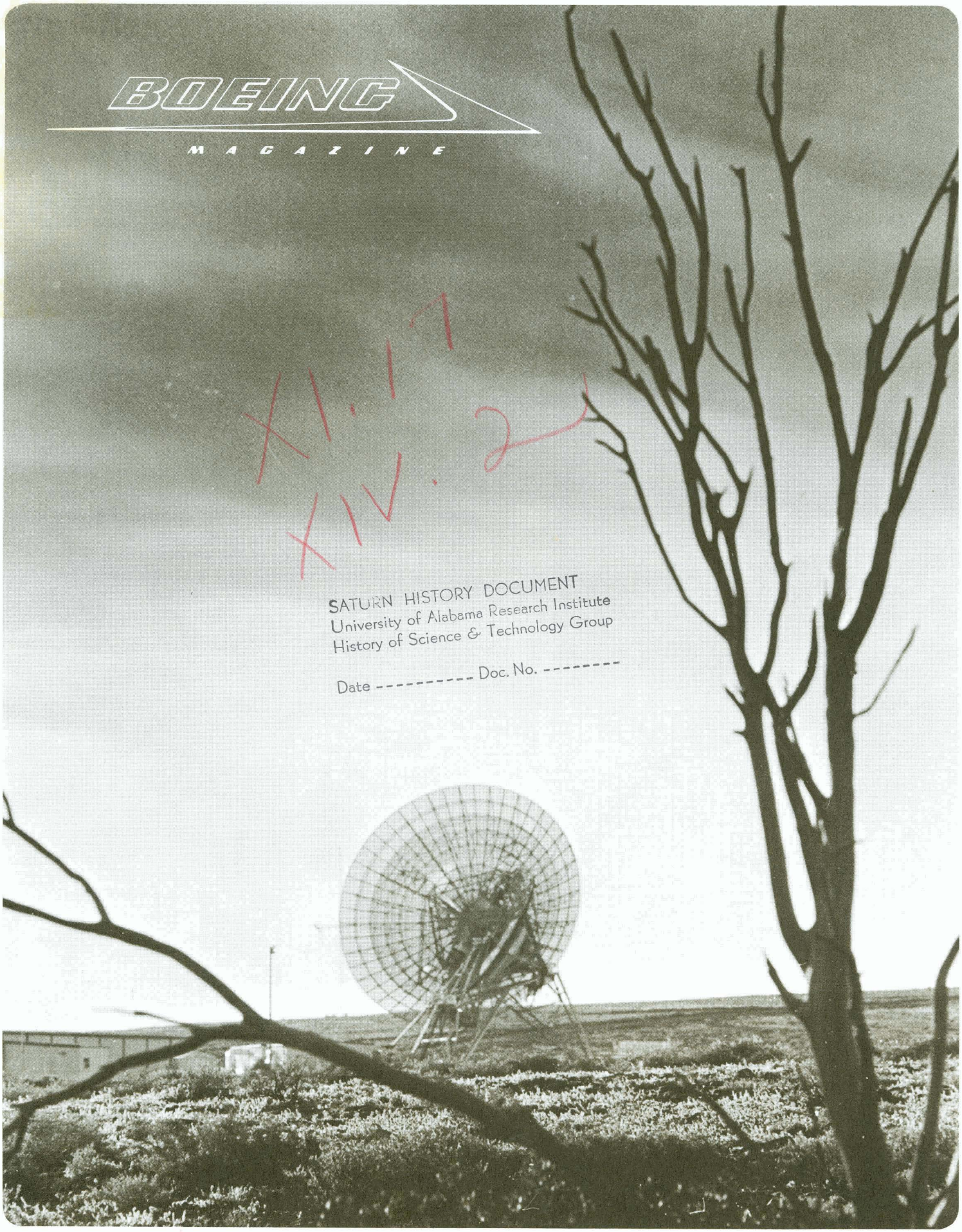
BOEING

MAGAZINE



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ON OUR COVER—The desert region around Woomera is what Australians call the "outback." When the Boeing-built Lunar Orbiter spacecraft is spinning around the moon, it sends its messages to the National Aeronautics and Space Administration antenna.

THE BOEING COMPANY
HEADQUARTERS OFFICES
7755 East Marginal Way, Seattle, Washington 98124

BRIEFING

The Professional

Chester Chatfield, whose name has appeared on the masthead of this magazine since November, 1954, and as editor since February, 1959, is on leave of absence. He is recovering from a heart attack. His name still appears in the staff listing at left but with a new title: consulting editor. This lets us use Chet's ideas and experience while enabling him to follow doctor's orders to stay home and take it easy. Chet has been with the Boeing public relations organization since 1950. Before that he was a supervisor of Seattle City Light publications. You have seen his name in *Field and Stream* or *Sports Afield* or *Ford Times*. He is one of the country's best-known outdoor and travel writers. And we think he was one of the country's best company magazine editors, too. The walls of his office are filled with plaques and certificates attesting to that.

Blowing in the Wind

Flying a new airplane is, of course, the ultimate test. But many people don't realize how many hours are spent flying a scale model of that airplane in a wind tunnel, most of those hours before the plane ever takes off under its own power. The B-29 *Superfortress*, for example, had 2,199 hours in a subsonic wind tunnel. The B-47 *Stratojet* bomber logged 7,265 hours in both subsonic and transonic tunnels; the B-52 *Stratofort* bomber, 11,498 hours total in both tunnels; the Model 707 jetliner, 10,028 total hours in both tunnels plus another 1,435 for the KC-135 jet tanker version; the Model 727 trijet, 5,345 hours in both tunnels. As of last November, the little twinjet Model 737 had 6,117 total wind tunnel hours; the Model 747 superjet, which will fly by late 1968, had 6,494 hours. The supersonic transport had 5,373 hours in the subsonic tunnel, 4,528 hours in the transonic tunnel and 9,015 in the supersonic tunnel for a total, as of November, of 18,916 hours. That's 788 days or more than two solid years of blowing in the wind.

By JAMES GRAFTON

EACH TIME a Lunar Orbiter spacecraft is lofted moonward, it trails an invisible link with Earth. The camera-carrying moon satellite receives instructions and sends photographs and other data back through thousands of miles of space over this radio link.

Eight to ten Boeing engineers and electricians are on duty at National Aeronautics and Space Administration Deep Space Network stations in Spain and in Australia on each flight. A larger Boeing crew helps man a third station at Goldstone, California. These three locations around the world give Earthmen an uninterrupted view of the moon throughout each day and line-of-sight contact with the Orbiter except when the spacecraft is behind the moon.

Orbiter missions may stretch into 40 days or more and the command consoles at each station must be manned on a 24-hour schedule during a mission. The exacting duties require intense concentration. It is hard work. But the overseas space network jobs have a fringe benefit which makes them among the most desired assignments in the Lunar Orbiter program:

Off-duty hours can be spent enjoying two of the most interesting and contrasting parts of the world.

Spain is a blend of the ancient and the modern. Spanish masons who built the stone walls of NASA's Madrid Deep Space Network station were insulted by construction specifications calling for mortar. They refused to comply. Instead, they cut the stones and fitted them so precisely that no mortar was needed. These are the same skills which built Spanish castles and the aqueduct which now carries water to Segovia about 50 miles north of Madrid. That aqueduct was erected more than 1,800 years ago.

The visiting American technicians found it easy to pick up enough Spanish to get along comfortably, but efforts to "naturalize"

Overseas moon watchers spend free time in

CUT-STONE CASTLES AND OPAL FIELDS

Woomera sand sustains plant life with nine inches of rainfall a year.

the accents gave their Spanish co-workers hours of amusement. One English-speaking secretary gave informal Spanish lessons on the hour-long drive between Madrid and the tracking station. She found the Spanish word pronunciations of the Southern-bred Americans almost more than she could bear.

Pat Feist, an engineering aide, took his wife and three children to Spain for his six-month stay. Managing a household in Madrid proved quite a change-of-pace from Seattle. For the first week or so the Feist's ate a lot of peanut butter sandwiches until Marilyn Feist learned to appreciate native foods. Spanish food is cheap. Household help is good, available and inexpensive. David, Danny and Barbara Feist attended a nursery school where tuition was one dollar a day for all three. The experience was invaluable. Six-year-old Danny is now the best linguist in the family.

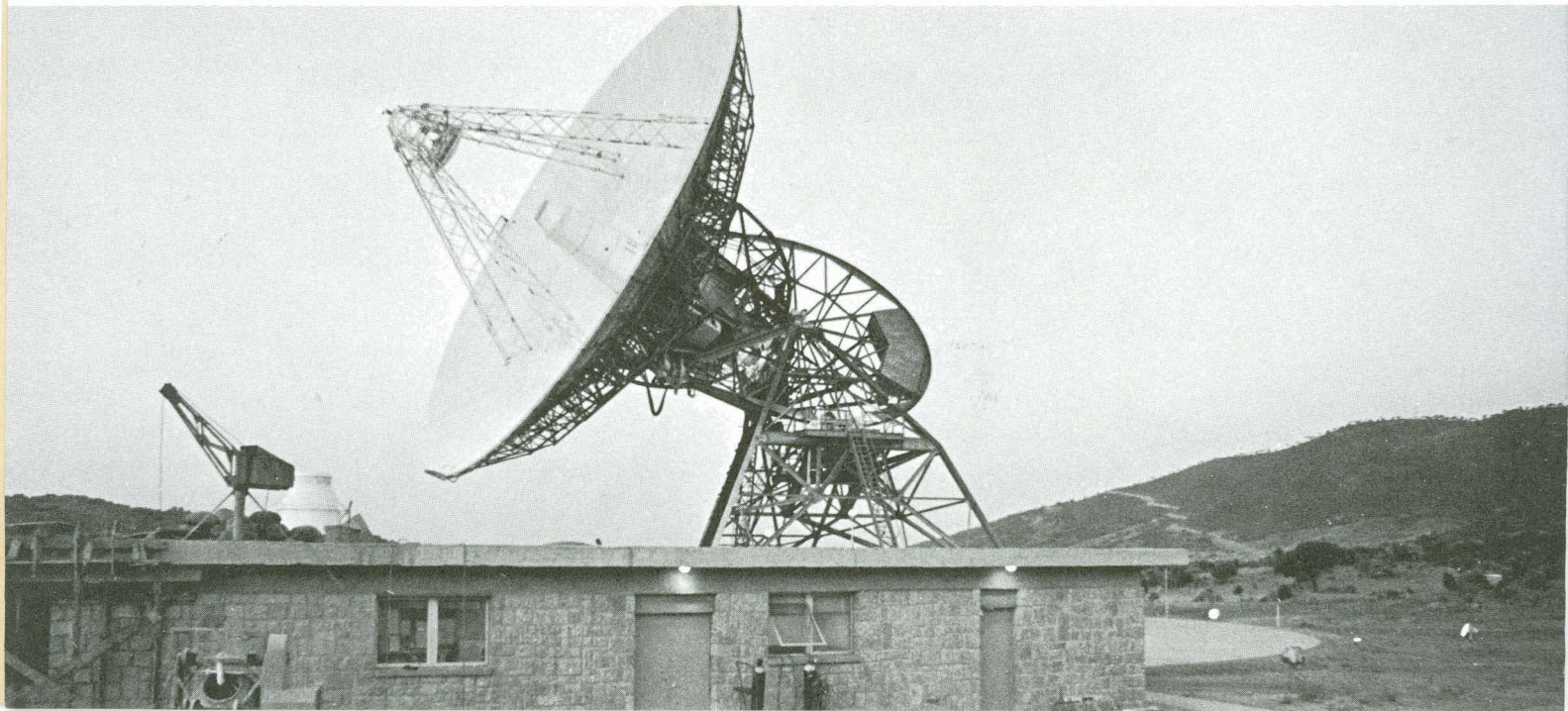
In the American view the Spanish seem relaxed, easy going and late for everything but mass and bullfights. The Spanish manner is infectious, and the visitors found themselves adopting outgoing and more relaxed ways.

For the tourista the Spanish countryside offers El San Lorenzo Del El Escorial near Madrid, the final resting place of Spanish kings; and the Alcazar in Seville, where Columbus presented his plea for ships and men to Ferdinand and Isabella. That venture has been likened to man's coming conquest of the moon — a conquest for which Lunar Orbiter is an advance scout.

Deep space station personnel got special treatment when introduced as members of the Lunar Orbiter crew. Spain, Madrid in particular, is fiercely proud of the part the nearby NASA station is playing in receiving photos and sending commands to the moon-orbiting spacecraft. The Boeing-built Lunar Orbiter is "their spacecraft," and anyone connected with it becomes a part of the family.

Australia presents a striking contrast. The down under and outback is new country with the excitement and the brashness that pioneering engenders. NASA's Deep Space Network station is 16 miles from Woomera, a newly-built city

The aqueduct to Segovia has stood firm for 1,800 years with no mortar between its stones. The similarly built space network station should be as sturdy.



conceived to serve the space age. With a population of 5,000, Woomera is the 17th largest city in Australia. It is in a desert some 300 miles from Adelaide.

Boeing crews first arrived in early 1966 to install special equipment and to train on simulated Orbiter flights. Despite heat and flies, back country Australia is attractive. Activities include cricket, swimming and pool — the green-felt table kind. The Woomera golf course offers sand tees, sand fairways and black, oiled-sand greens. Tennis, lawn bowling, Australian football, rabbit hunting with small-bore rifles, and kangaroo hunting with cameras fill an outdoor-dominated schedule.

Another Woomera pastime is the hunt for spear heads and boomerangs. These have become increasingly scarce. The Australian native still turns out quantities of the artifacts but the ways of the white man have shown the simple aborigine a better way to market his product. The spears and boomerangs he makes these days are placed on sale at government trading posts and the income used to buy rifles and ammunition.

Bob Hahn breaks rock in opal field.

But if the desert won't yield spear heads, it will yield opals. Boeing space trackers Bill Ramsey and Bob Hahn staked out a claim at Andamooka, the world's largest opal field, some 70 miles northeast of Woomera. Although they worked their Orbiter shift sitting at an electronic console, they worked

A miner's shack at Andamooka opal field offers shelter from December sun and June frost.

(Above left). A family's wash hangs out to dry on a back street in Madrid, city of contrasts.

From the 35-story Torre de Madrid Hotel, Lunar Orbiter crews got this view of the city.

their mine on the business end of a pick and shovel. They took out "souvenir" grade opals from the pit by hand after a bulldozer stripped some six feet of over-bearing from a 20-foot-long trench. Unconfirmed reports filtering back "stateside" indicate that claim jumpers worked the Ramsay-Hahn diggings last spring and took several thousand dollars worth of opal from a spot just six inches from where the Americans had plowed their trench.

Claim-jumpers aside, Woomeranians are the top-rated hosts on a continent full of friendly people. The only barrier to complete understanding between the Aussies and Yanks was the handicap of a common language. Familiar American words have unfamiliar meanings down under. A "broad" is an eminently acceptable slang term for a pretty girl, but don't call her "a Sheila." Due to one misunderstanding, a Boeing engineer ate an early evening meal before proceeding to a Woomera home for a 7 o'clock "tea." To his gastric discomfort he found, at 7 p.m., "tea" means "dinner."

From castles in Spain to opals in Australia, the off-duty hours of Boeing's Lunar Orbiter overseas flight personnel have seldom been boring. The crew members have spectacular slides and photos of the Spanish and Australian countrysides. But the pictures they have framed for the wall at home are the ones they helped take of the moon.

Australian and United States flags fly over the Woomera station.

By DARRELL BARTEE

A BIG RESEARCH job is being done in a small way by engineers at Boeing's Wichita Division.

It's big because it promises design benefits to large jets of the future. It's small because it centers around a jet model plane 1/30th the size of a present-day plane.

This complex scale model will be flown in wind tunnel tests at the National Aeronautics and Space Administration's transonics dynamics tunnel at Langley Research Center, Hampton, Virginia. The tests are part of a new $800,000 research program being conducted over 18 months by Boeing-Wichita researchers.

The "aeroelastic" miniature jet will twist and bend in flight like a full-scale aircraft. It is expected to contribute to big-jet efficiency by advancing the art of flight control design. The work is sponsored by the Air Force Flight Dynamics Laboratory.

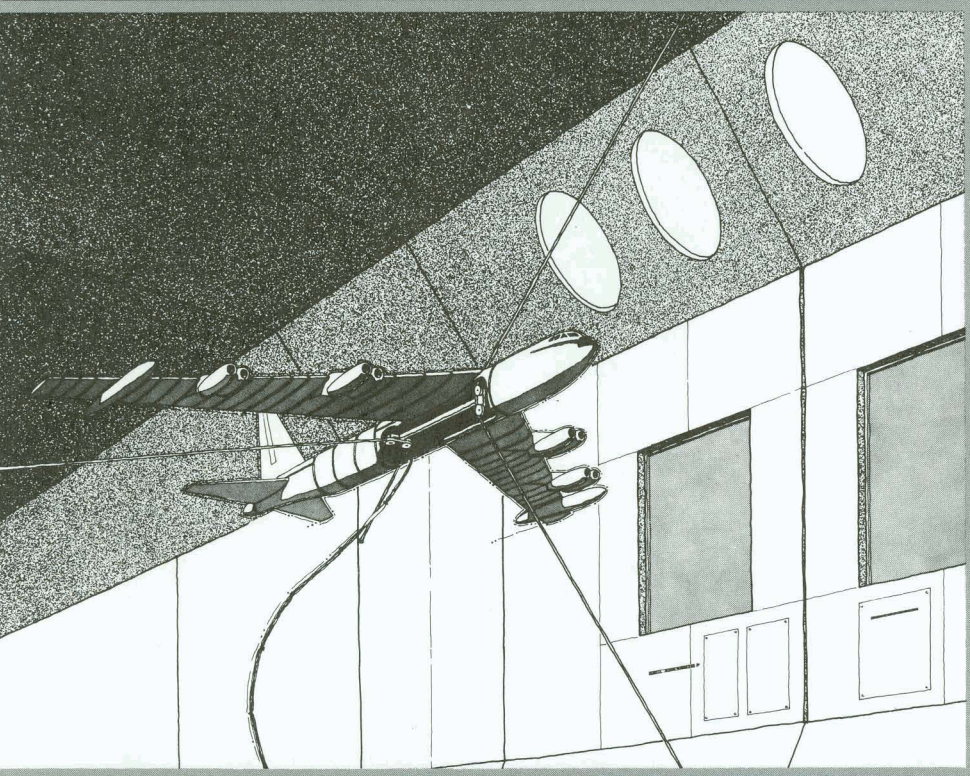
This is a different kind of wind tunnel model. It represents a specific plane. Structures of the 63.2-pound jet will flex in the same way as those of the Boeing B-52E bomber it simulates. In addition, the model will have powered flight control surfaces functioning as if they were the surfaces of the actual *Stratofortress*.

A model of the B-52E (No. 56-532) was chosen by the Air Force for these tests because of the large amount of flight test data Boeing has collected on this particular airplane. The model must simulate dimensions, mass distributions, structural elasticity, and aerodynamics of the 419,000-pound B-52E. It must be instrumented at many points to measure response to stormy air gusts.

In the NASA wind tunnel, the

In wind-tunnel tests this B-52 model will fly

FAST AND LOOSE



$$+ \left[U_2\right] \left\{ \frac{d}{ds} q(0^-) K(s) + \int_0^s K(s-\tau) \frac{d^2}{d\tau^2} q(\tau)\, d\tau \right\}$$

$$+ \left[U_3\right] \left\{ q(0^-) K(s) + \int_0^s K(s-\tau) \frac{d}{d\tau} q(\tau)\, d\tau \right\}$$

$$+ \left[U_4\right] \left\{ \frac{d^2}{ds^2} q \right\} + \left[U_5\right] \left\{ \frac{d}{ds} q \right\} + \left[U_6\right] \left\{ q \right\} \Big)$$

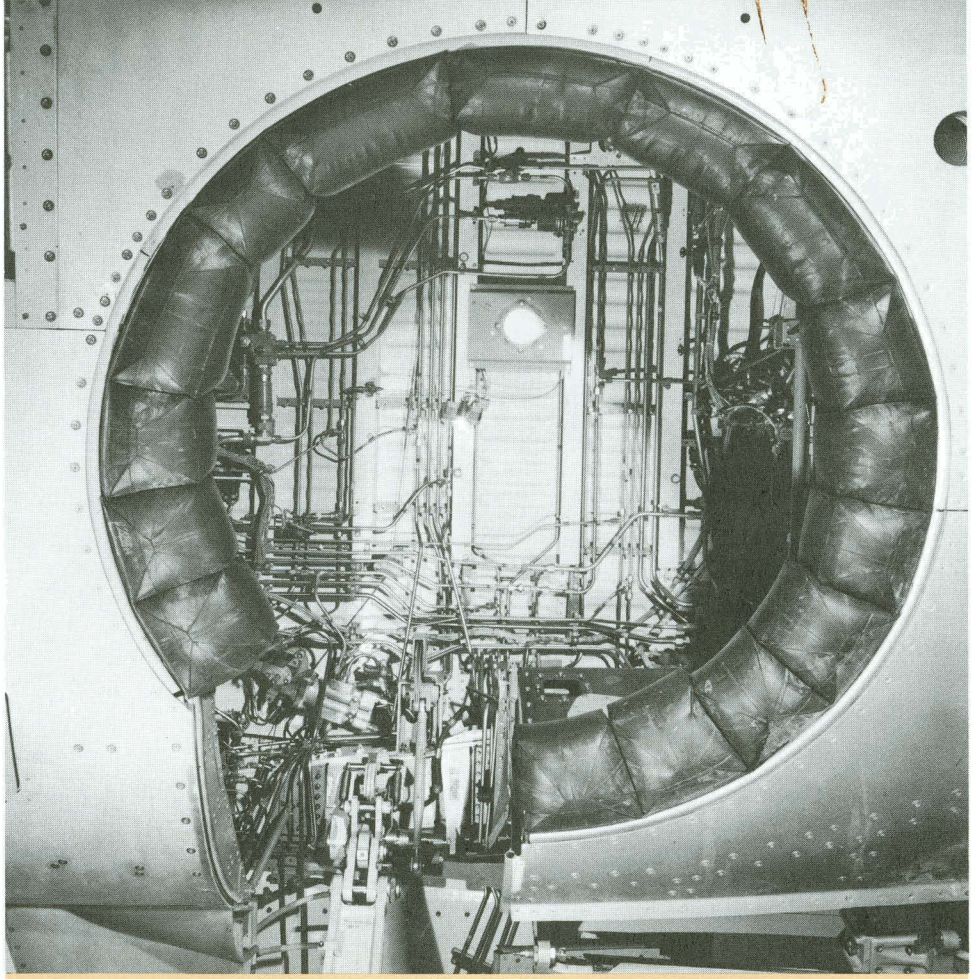
model will be suspended to approximate free flight. Oscillating airfoils located upstream will provide the simulated air turbulence. Data on the model reaction to the rough air will be fed to computers outside the tunnel.

Primary objective is to evaluate response, stability, and control characteristics of the model against theory and flight test information. Another goal is to design and operate a flight control system which "softens" the effects of air gusts on the model structure. A third purpose is to help determine the utility and economy of using models to resolve aeroelastic control system problems. If tunnel tests are successful, similar techniques can be used to design and perfect flight control systems for large, flexible aircraft yet to be built.

One of the most difficult tasks is the design and development of tiny mechanisms to move the ailerons and elevators on the model. The job will be handled by miniature electric motors controlled by signals generated within the model and processed through an analog computer located outside the tunnel. Wichita design specifications for the model will be supplied to a subcontractor experienced in building aeroelastic models.

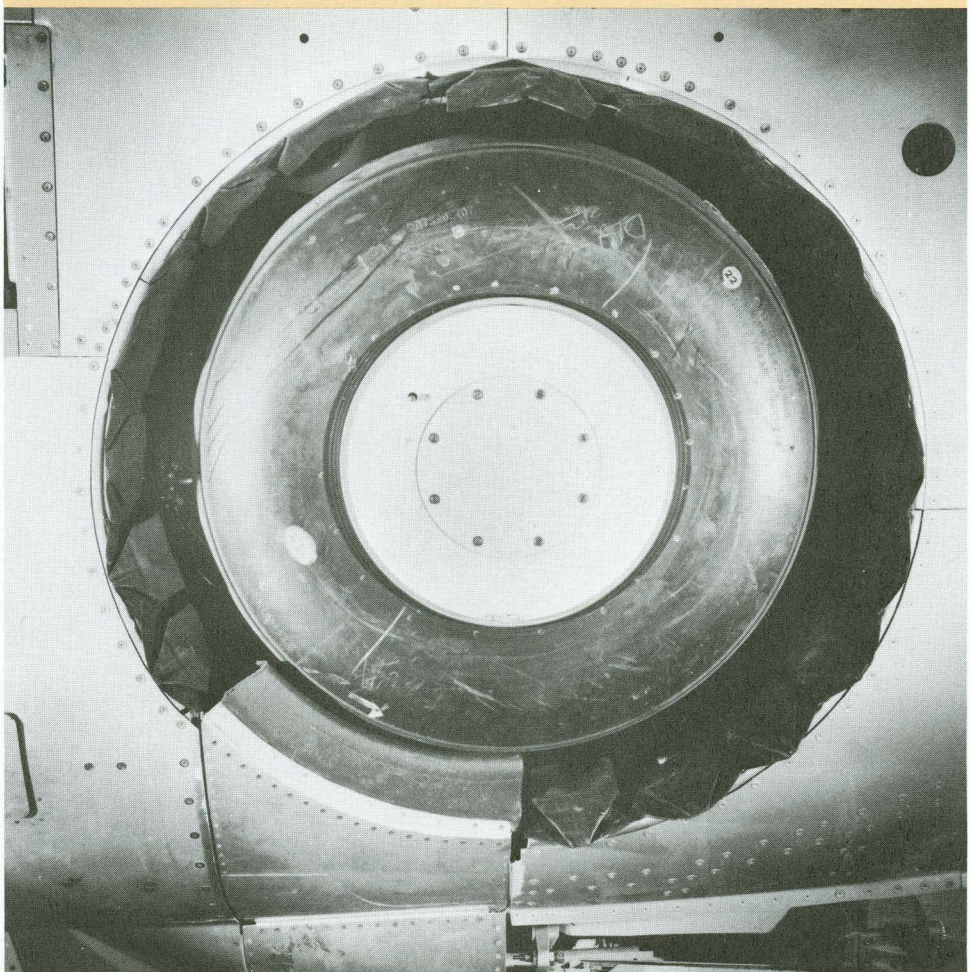
NASA personnel at Langley will begin five weeks of testing in January. Boeing will supply technical and engineering support. The raw data will be reduced by NASA and supplied to Boeing for the final program report.

Twelve years of experience with the 200-ton B-52 have provided Wichita engineers extensive experience and knowledge in the flight control of big, flexible jets. These tests promise to add to that experience and knowledge.



Extended landing gear leave this hole in underside of plane.

Retracted wheel closes the hole; makes smooth flying surface.



Wheels tucked up, barefeet showing, Model 737 wings away.

Weight-saving landing-gear idea makes Model 737

THE BAREFOOT FLYER

By ROGER KOCH

AIRPLANE buffs who rubberneck at the sound of an aircraft passing over head will see something different on the underside of the new Boeing Model 737 jetliner. The wheels of the main landing gear are visible even when retracted. There are no landing-gear doors. Instead, inflated rubber bags seal the gap around the tires when the twinjet is in flight. This particular wheel "tuck-away" system is a first for an American aircraft.

The exposed-wheel design weighs about 150 pounds less than would wheel-well doors with their hydraulic activating mechanisms. That represents 150 pounds more payload.

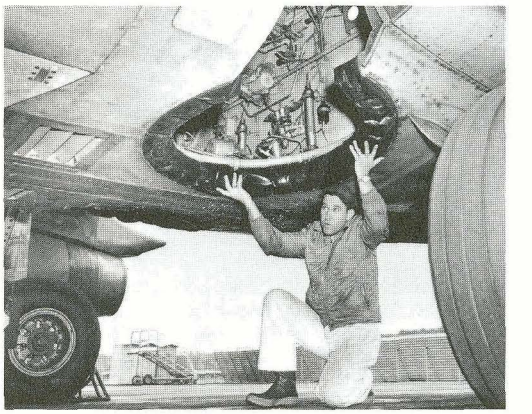
The simplicity of the wheel "tuck-away" is especially effective in multi-landings duty. The 737 is designed for just such duty. In a day's work, the little jetliner will be making many more takeoffs and landings than the longer-ranged jets. The seal is designed to maintain the plane's aerodynamically smooth exterior without the weight and complications of doors.

Each rubber bag seal is about the size and shape of a large tin of corned beef—broad at the base, narrower at the top. Sixteen of these bags ring the wheel well, their smaller ends facing the tread of the tire when the wheels are up. As the bags inflate, they jam against the tire's outer edge. One hard-rubber seal, looking like a two-foot section of a small auto tire, is mounted on the landing gear leg. It completes the circle of rubber when the landing gear swings closed into the fuselage. A flat, disc hub cap on each outer wheel blends with the tire and rubber seals to form a smooth surface.

A manifold chamber in the 737 feeds regulated low-pressure air from the jet engine compressor into each seal unit. When the plane takes off, the air is drawn out of the seals to flatten them against the side of the wheel well. Once the jetliner is airborne and the landing gear has been retracted, the seals are inflated against the edges of the two outer tires.

As the 737 makes an approach for a landing, the seals are deflated, freeing the wheels for let down. The units are engineered so that the main wheels can come down quickly into landing position even if a malfunction prevents deflation of the seals.

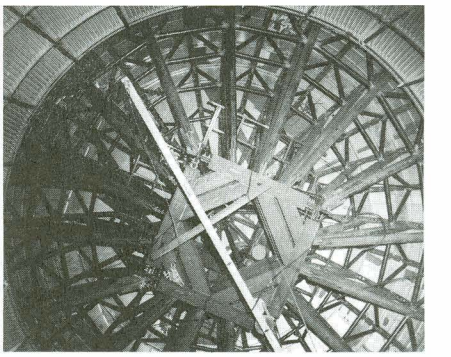
The 737 tucks its legs up somewhat the same way as any other bird in flight. A difference is that it doesn't cover its feet with feathers.



Boeing mechanic Jim Richard gives wheel-well inflatable seals check before flight.

Testing a Saturn tank is like putting a

BOAT IN A BOTTLE



Inside the oxygen tank the umbrella-like rig can't touch inside surfaces.

Oxygen tank was lowered over beams, which entered fuel-line holes.

By RAY THOMAS

THOSE WHO admire the techniques of getting a model ship inside of a bottle would have appreciated the problem faced by Boeing men at Marshall Space Flight Center in Huntsville, Alabama.

They built a test fixture inside a liquid oxygen tank by passing tons of structural steel through an opening about the size of a bushel basket. The domed tank was inside the shell of a S-1C booster for the Apollo/Saturn 5 moon rocket, an arrangement comparable to that of the glass liner in a Thermos bottle. The tank is 33 feet in diameter.

About 129,000 pounds of steel beams and pipes were used to build a pressure-test fixture inside the oxygen tank. When assembled, this fixture resembled a beefed-up, inverted umbrella, short just four inches of being 33 feet broad. It was the bearing surface against which inflated bags could brace while exerting pressure on the lower inside areas of the oxygen tank. That was the purpose of the fixture: to help in the simulation of internal forces experienced during flight.

"One of the interesting aspects was that no part of this upside-down 'umbrella' could touch any part of the tank," commented Harry Jorgensen, Boeing project engineering supervisor. "If it did, the test results would be affected. So we had to weld the test structure to four huge beams which entered the tank through openings in the bottom."

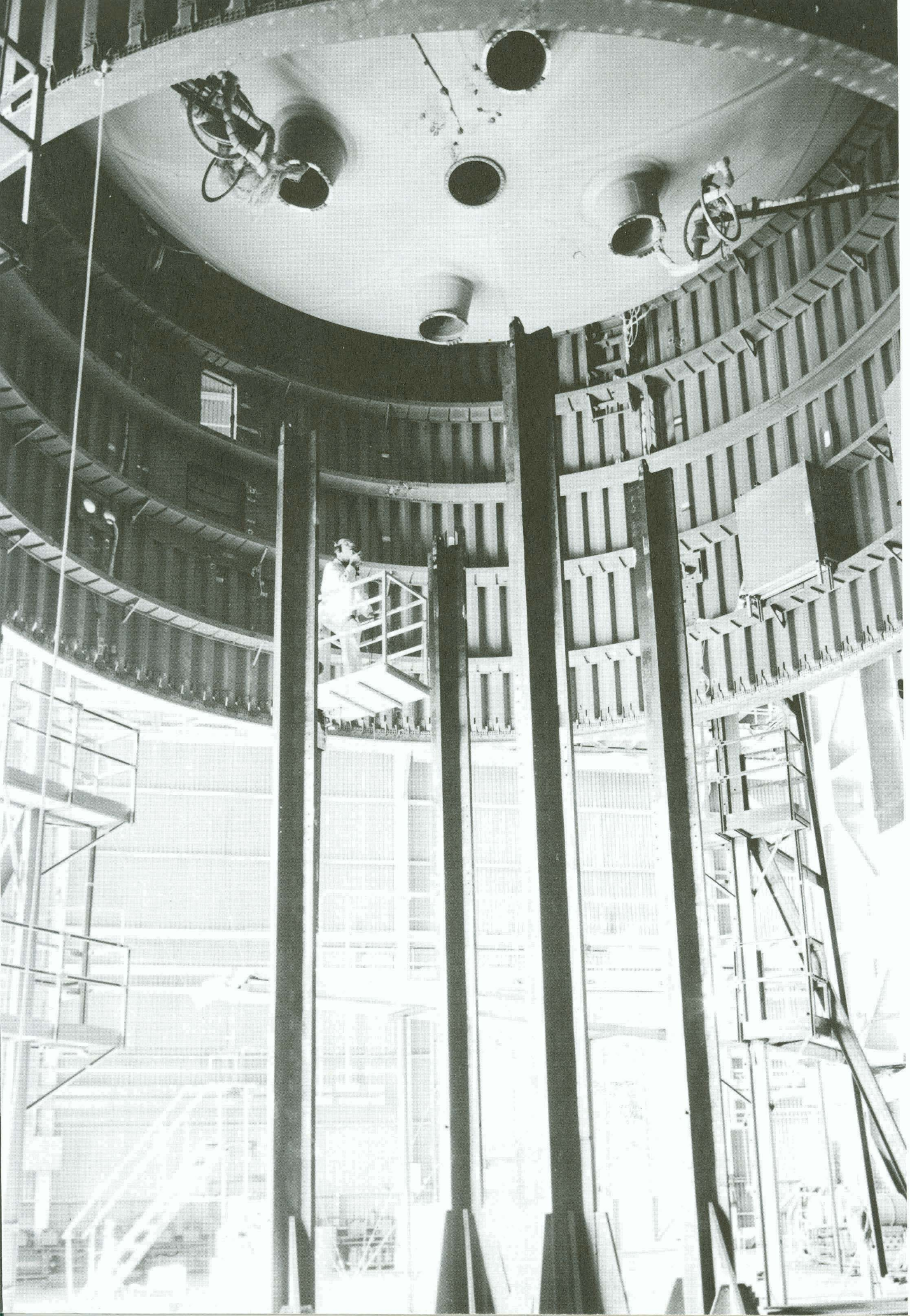
The beams were anchored upright to the floor beneath the S-1C and the booster lowered slowly over them. The four beams entered the tank through fuel line holes in its base. Individual parts of the assembly then were passed through an access hatch and lifted through an interior opening measuring 26 inches in diameter. More than 7,600 separate parts, some weighing up to 900 pounds, went into, and later came out of, the tank in this fashion.

More than 2,000 welds later the structure was complete—the boat was in the bottle.

Before any of this could begin, however, 92 rubber air bags were installed over the lower inside wall of the oxygen tank. Each was equipped with pressure controls. Workers placed aluminum plates over the air cells and over this built the massive "umbrella."

Pumping air into the rubber cells exerted a downward force of more than four million pounds against the inside of the tank. The pressure was controlled and varied to simulate flight conditions. Some 700 instrumented points fed test data into computers for analysis.

Object of the test — one of many to qualify the S-1C booster for flight — was to verify design-engineer predictions of tank strength and stress. This test of the oxygen tank's lower area met all requirements, moving the Apollo/Saturn 5 program one notch closer to the day of launch at Cape Kennedy.



MAN IN ACTION

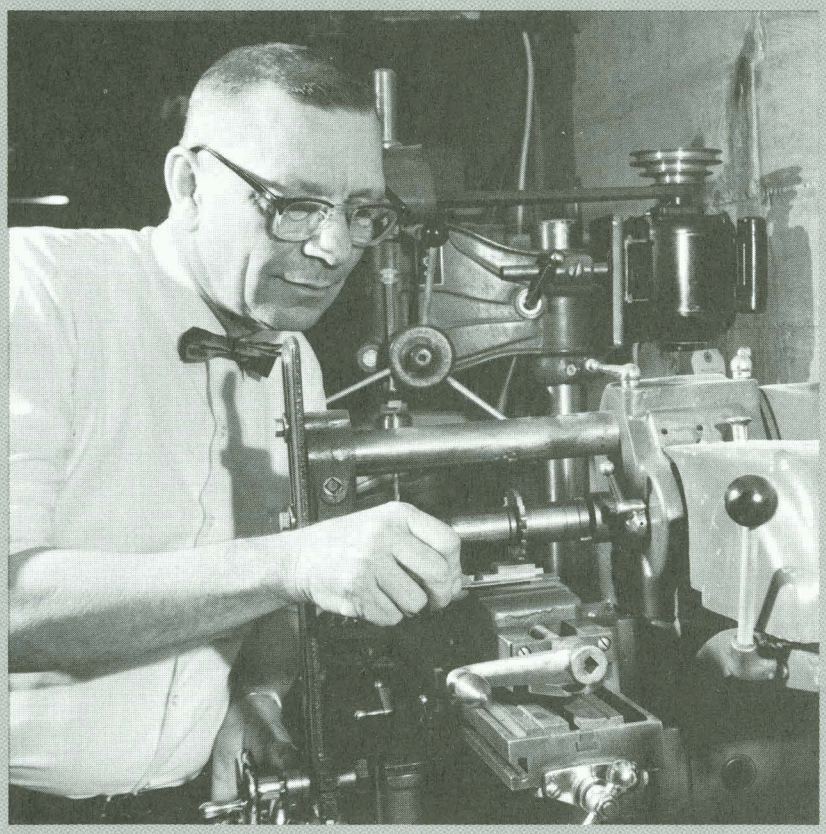
MAKING THE RIGHT THING HAPPEN

THERE are times when Allen Ward Loether comes close to being ordered off Boeing property. He knows he should take the standard number of vacations but he has trouble working them in, until his boss insists.

Admittedly a man with a lopsided interest in his work, Loether believes that when a job is complex and absorbing, it can logically take the place of fun and games. As the factory operations manager at Boeing's Wichita Division, he supervises some 7,000 people in the manufacturing department. His job involves more people than live in the Kansas town of Fredonia, where Loether was born.

Al likes to circulate among factory people. He scooters around to widely scattered shops, like a TV director with a dozen shows in production at once. He foregoes the megaphone and dramatic outbursts, however. If he finds something wrong, he talks with the man in charge. Often he gets the conversation down to work attitudes. Loether wants people to *want* to do successful work. When this attitude prevails, he feels, both the manager and the man on the production line really zero in on the same target and the right things happen.

Contrary to what you might expect from one so involved with his work, Al knows when to stop talking shop. He shows up at lunch time with his share of the light-hearted stories and, according to a table partner, "There's certainly nothing shop-bound about his narrative style." Another associate reports that in his business meetings, "Al dominates the outfit but like as not will wind up by inquiring about so-and-so in the hospital."



Hand-crafted gun stocks and automatic record-changers, built from scratch, are among the items that have emerged from Loether's hobby-jammed basement at home. His friends built them. Al could not find the time. "While the wife was not looking" he has managed to fill the basement with electronic gear, a miniature machine shop and a string of woodworking tools. He still intends to do more tinkering there, when things settle down.

So far there are few signs of any settling down. His current excitement is the new "program mix" at the Kansas complex, which includes B-52 and commercial modification work, plus assistance jobs on Boeing jets, helicopters and the Saturn 5 moon rocket.

Loether set the pace for his Boeing career back in 1942, when he started as a machinist. Within five months he was a foreman. He had completed three semesters at Wichita State University when he ran out of two things: money and patience. In the 1945-48 period there was time out for his own business venture (electrical) but he has 23 years with Boeing.

When Loether took over factory operations in May of last year, he personally evaluated nearly everything and everybody in the organization. He spent long hours matching management talents and shop skills with new tasks at hand.

If a vacation is supposed to be a contrast to the pace of the work-a-day world, Loether has the answer. He intends to find an easy chair on the terrace of a mountain lodge. With his usual concentration on the business at hand, he will stock up on books and magazines and will not budge for days.

Using jet-assisted KC-97s

THE GUARD GOES GLOBAL

By MAJOR PHILIP E. GUNBY
126th Air Refueling Wing

CITIZENS OF the Federal Republic of Germany are showing considerable interest these days in the "new" airplane which is flying from the busy Rhein-Main Air Base near Frankfurt. The airplane involved is hardly new, but its latest assignment is.

For this is the veteran Boeing KC-97—the "L" version augmented with two J-47 jet engines. It has been in the aerial refueling business with the Air National Guard for nearly six years.

Air Guardmen like Maj. Gen. Donald J. Smith, chief of staff for the ANG in Illinois, and Brig. Gen. Howard T. Markey, commander of the 126th Air Refueling Wing, have played a key role in giving a new lease on life to this 11th and final model of the KC-97 series.

Five of the KC-97Ls are in place in West Germany at Rhein-Main to provide in-flight refueling to jet fighters of the United States Air Forces in Europe. It is the first time the Air Guard has been stationed abroad without being called to active duty.

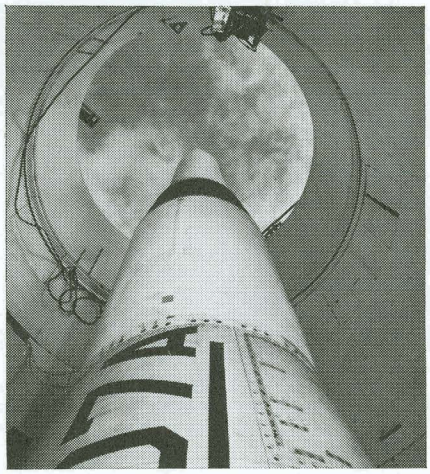
And, while the KC-97L has been overseas several times since she got her rejuvenating jets, this is the first time she has gone there to stay.

For the citizen-airmen of the Air Guard, the fulltime job is being done on a part-time basis. That is, they are serving in Germany on their annual active duty, then returning and being replaced by other Air Guardmen serving their annual 15 days or more of active duty.

Texans from the refueling group at Dallas began the program in May. They were succeeded in June and July by Air Guardmen from the three groups of the 126th Air Refueling Wing. These Air Guardmen are from O'Hare International Airport, Chicago, from Gen. Billy Mitchell Field, Milwaukee, and from Clinton County Air Force Base near Wilmington, Ohio. In August, they were to be succeeded by Air Guard refuelers from Tennessee.

Then, in September and October, the Illinois-Ohio-Wisconsin wing Air Guardmen are scheduled to take up the job again.

In May, the 136th ARW refuelers off-loaded about 1.5 million pounds to fighters of 17th Air Force. In June and July, the 126th Air Refueling Wing refuelers were making hookups with fighters from Third Air Force as well as 17th Air Force. Third has headquarters in Britain; 17th in Germany.



Minuteman, the nation's major strategic missile system.

Scattered beneath farm fields in seven states, Minuteman ICBMs stand in underground silos, the nation's primary strategic deterrent force.

These Minuteman intercontinental ballistic missiles are a family of successive missiles, each representing an advance in capability.

Minuteman is a dynamic, technically advancing system. In a force modernization program, Boeing is delivering improved Minuteman II missiles to the Air Force and retro-fitting them into existing Minuteman I silos. The result will be greatly stepped-up missile capability at a fraction of the cost of deploying a new system.

From the first, Minuteman set records. It went from drawing board to operational status in under four years — a record for the design-development-production-delivery cycle of a major weapon system.

As weapon system integrator on Minuteman, Boeing assembled the missiles, installed and checked out each one in underground silos, provided ground support and launch control equipment, supervised construction of all bases, and supported the Air Force in more than 160 test and operational missile firings. For over three years, Boeing has delivered Minuteman missiles at a rate of more than one per working day.

Through advanced systems-management techniques—many representing innovative breakthroughs in the management of massive weapons systems—Boeing delivered every base installation on or ahead of schedule.

An entire wing of 150 missiles was installed and made combat ready in less than four months, a feat described as "outstanding in ICBM history."

Continuing improvement programs have enabled the Minuteman ICBM system to keep abreast of defense requirements far beyond the life expectancy normal in an era of rapid technological change.

Meantime, evolutionary advances will keep Minuteman at the forefront of ballistic system weaponry for years to come. Boeing's Missile and Information Systems Division is now at work—with the U.S. Air Force—on the design and development of Minuteman III.

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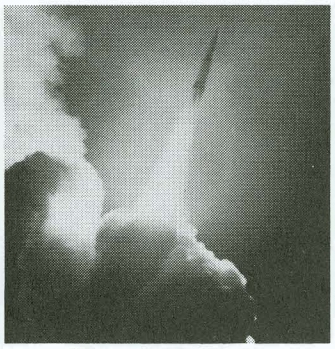
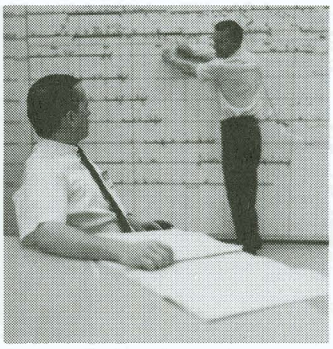
Boeing's Minuteman responsibilities include...



Weapon system testing

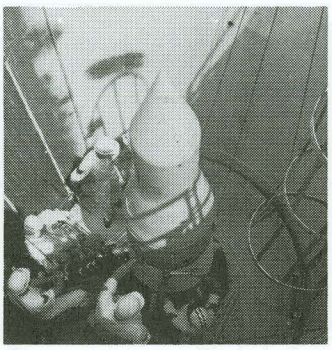


Systems integration

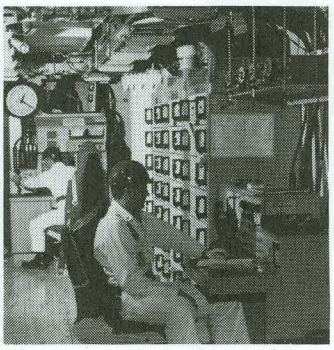
Missile assembly

Command & control equipment

Transportation & handling equipment



Weapon system assembly & checkout



Assistance with Air Force training